DOI: 10.20472/ES.2018.7.2.007

SKILLS HETEROGENEITY AND IMMIGRANT-NATIVE WAGE GAP IN THE EUROPEAN COUNTRIES

MARYNA TVERDOSTUP, TIIU PAAS

Abstract:

The paper analyses individual human capital, measured by the education, literacy and numeracy skills, and explores to what extent immigrants employ their cognitive skills at work. Based on the Program of International Assessment of Adult Competencies (PIAAC) data for 15 European countries, we document that, on average, foreign-born respondents achieve substantially worse scores in literacy and numeracy test domains in majority of analysed countries. Only immigrants in the Nordic countries reveal skill improvement over immigration tenure. Once we account for both skill levels and use of skills at work in wage regressions, no statistically significant gap in earnings across immigrants and natives remains. Although, once immigrants attain comparable to natives' skill use frequency, their pay disadvantage turns statistically insignificant in all countries, except Estonia and Ireland. The results are leading us to the conclusion that potential for development and utilization of immigrants' skills in the European labour markets is still underused. Immigrants are not yet sufficiently well integrated in labour markets in most of the European countries.

Keywords:

migration, wage, human capital, cognitive skills, PIAAC

JEL Classification: J21, J24, O15

Authors:

MARYNA TVERDOSTUP, University of Tartu; University of Innsbruck, Estonia, Email: maryna.tverdostup@ut.ee
TIIU PAAS, University of Tartu, Estonia, Email: tiiu.paas@ut.ee

Citation:

MARYNA TVERDOSTUP, TIIU PAAS (2018). Skills heterogeneity and immigrant-native wage gap in the European countries. International Journal of Economic Sciences, Vol. VII(2), pp. 119-142., 10.20472/ES.2018.7.2.007

1. Introduction

There is an ample research analysing disadvantages faced by immigrants on the host market. Majority of studies documents that immigrants tend to earn on average less than natives (Borjas 2015, Dustmann et al. 2013, Borjas 2000). Previous findings also suggest that wage disadvantage is the highest for newly-arrived immigrant but decreases slowly over years spent in a host country (Sarvimäki 2011). However, some part of initial immigrant-native pay gap persists even after long years in a receiving country (Sarvimäki 2011), suggesting that immigrants' wage penalty do not ultimately disappear.

Existing literature addresses various reasons behind an observed wage disadvantage of immigrants. According to a classical human capital theory (Becker 1975), differences in skills transmit into earnings. However, immigrants may lack qualifications and abilities demanded by host country, so called host country-specific human capital, yielding their wage penalty (Zibrowius 2012). Due to a lack of appropriate data, previous studies mostly approximated human capital with formal education to measure wage gap and occupation-qualification match. In a context of immigrant-native comparison, this approximation yields a number of serious limitations. The major one is potential non-comparability of formal degrees held by natives and immigrants (Green and Worswick 2012, Bonikowska et al. 2008). It results in objective differences in capabilities, as well as simple non-recognition of foreign degree by host-country employers. Hence, using a formal education as a proxy of qualification does not allow to get a pure effect of immigrants' human capital gap on labour market outcomes. The gap in formal education only roughly reflects human capital gap, as formally same degree acquired in host country by natives and in country of origin by immigrants may yield different competencies and skills. Thus, a part of labour market outcome gap attributed to a difference in formal education tells little about actual difference in skills and abilities.

The paper contributes to this debate by incorporating actual literacy and numeracy skills, rather than only formal education, to evaluate actual immigrant-native human capital gap. Namely, we use actual test scores in literacy and numeracy cognitive skill domains, provided by Program of International Assessment of Adult Competencies (PIAAC), conducted within a Survey of Adult Skills. Relying on PIAAC-based measures of individual cognitive skills, we evaluate systematic skill differences across immigrants and natives in 15 European countries. Therefore, the first contribution of the paper concerns the development of immigrants' human capital, approximated with literacy and numeracy skills, over immigration tenure in the analysed countries. The paper tests whether immigrants are indeed prone to improve their skill profile, as they acquire skills valued and demanded in a host country.

The second contribution relates to incorporation of skill use measures in immigrant-native pay gap analysis. Intensity of skill use at work has non-trivial association with immigrants' wage improvement. Why should one account for an extent to which

immigrant utilizes his skills when analysing wage disadvantage of immigrants? We argue that some labour market disadvantages may persist despite immigrants' true skills and abilities. Even when having a relatively strong qualification profile, immigrants still frequently face disadvantages on labour market.

Previous studies widely documented that immigrants tend to be overqualified (Dustmann et al. 2013, Chiswick and Miller 2010), suggesting that even when immigrant has sufficiently good abilities, he does not attain position comparable to otherwise similar native. Among other factors, over education can be induced by difficulties of labour market entry, non-familiarity with local labour market, lower level of credibility from employers' perspective (. Quilllian 2006), etc. These facts infer that immigrants have lower access to challenging and highly-rewarding jobs. These restrictions may enforce their selection into smaller and less profitable firms, which yields their lower wage returns (Sun and Kim 2014). Hence, even when having relatively profound competencies, the aforementioned disadvantages may deter immigrants' career progression, leading to persistent wage penalty, which may to a large extent offset positive wage returns to human capital improvement. Therefore, investments in human capital and own skills development may not immediately translate into positive wage returns, resulting in persistent wage penalty even after long years spent in a host country.

Relying on these rationales, we ask two research questions. Do immigrants, in the analysed European countries, improve their cognitive skills over time in a host country? Do cognitive skills fully explain the immigrant-native wage gap, or does their on-job use matter? Both questions will be analysed in country-specific context and respective conclusions will be drawn for each analysed country.

The validity of the settled hypotheses is empirically tested separately in the case of all 15 European countries under observation. In our approach, we relate intensity of skill use at work with wage returns through two channels. The first one is an indirect effect of skill use at work on wages through skill accumulation, as there is a strong association between skill application at work and cognitive skill level. Second channel implies that skill use at work is an approximation of (i) complexity, challenge and reward level associated with job; (ii) individual effort exerted by respondent when dealing with job tasks. The first channel relies on an obvious assumption that skill associates with skill use with no clear direction of causality[1], while in the second channel we introduce a number of important assumptions. Namely, (a) more complex and challenging work requires more frequent use of certain skills, relative to less complex; (b) extent of skill use at work largely represent individual effort exerted at work; (c) individual skills are generating positive wage returns only when utilized at

[1] Allen et al. (2013) reports that there is a positive correlation between skill level and intensity of skill use in PIAAC dataset. The direction of causality is not clear with observational data in hand. However, in our research causality direction of skill and skill use is not of a prime interest and does not directly affect our results.

work. We find empirical evidence for all assumptions[2], allowing us to safely argue that skill use at work is an important factor in immigrant-native wage gap debate.

Our results suggest that immigrants' literacy and numeracy skills tend to improve over years since migration, but only in the Nordic countries. However, controlling for cognitive skills does not eliminate statistically significant immigrant-native pay gap in majority of the European counties. Incorporating skill use at work reveal that indeed intensity of skill application at work accounts for a large share of immigrant-native pay gap. As expected, we found that the skill use at work yields positive wage returns. The empirical results of the paper proved that, not only a mere stock of skills matter in narrowing down immigrant-native pay gap but also access to complex, challenging and highly-rewarding positions, as well as individual effort exerted in solving job tasks account for a large share of immigrant-native pay disparity. If immigrants are not well assimilated into labour markets, their skills are underused, possibilities for development of human capital are restricted and consequently immigrants-native wage gap remains.

The rest of the paper is organized as follows. The next section presents an overview of related literature followed by explanation of data and research methodology and discussions of main empirical results. The final part presents conclusions and some policy implications.

2. Theoretical Background

Education-qualification mismatch and immigrant-native pay gap are the most comprehensively studied disadvantages faced by immigrants on the host labour market. The pioneer study by Chiswick (1978), showed that in the U.S. immigrants are earning significantly less that than native-born. Similarly, significant immigrant-native pay disproportionalities were documented in the influential papers by Borjas (2000 and 1985). In the study of immigrants in Ireland Barrett et al. (2006) documented a significant occupational gap between immigrants and natives, controlling for a range of background characteristics. Chiswick and Miller (2009) reported that foreign-born in the U.S. are more prone to be overeducated, with the highest likelihood for newly-arrived immigrants. Dustmann et al. (2013) documented a similar pattern in the context of UK, where immigrants tend to be employed in lower level jobs, compared to natives having comparable education level. Reitz et al. (2014) addresses an issue of immigrants' "brain waste", as a result of immigrants' skill underutilization in Canada. Ultimately, limited occupational prospects and inability to fully realize own competencies result in wage penalty for immigrants.

These labour market disadvantages of immigrants have been attributed to various factors. Several studies stressed that non-recognition of immigrants' credentials and formal education degree accelerates labour market disparities (Green and Worswick

[2] The results of the robustness checks are available upon request.

2012). Employers may simply treat host- and foreign-acquired degrees differently. They may statistically discriminate foreign country qualification, due to a lack of knowledge about actual content and quality of received education. It yields lower credibility of foreigners' educational attainments, compared to natives'. Noteworthy, some findings suggest that employment success of immigrants depends heavily on a field of degree. Galarneau and Morissette (2004) found that Canadian immigrants holding a degree in engineering, computer and health sciences benefit more relative to their peers with qualification in other fields. Similarly, Lehmer and Ludsteck (2011) reported that a size of wage penalty varies across wage distribution, with a largest magnitude in the lower quantiles.

However, labour market gaps may stem not from non-recognition solely, immigrant and native population may differ in actual qualifications and competencies due to differences in content and quality of educational programs in sending and receiving countries. Differences in educational standards, study curriculum and formal requirements yield objective disparities in acquired competencies. Hence, an extent of human capital acquired while studying may differ drastically across natives with host-country diploma and immigrants with formally similar foreign-acquired education. To address this issue, Chiswick (1978) developed a concept of skill transferability, as a generalized approach to assess a degree to which immigrants' skills can be successfully utilized in a host country. Immigrants' knowledge and skills may be not entirely equivalent to host country degree (Reitz et al. 2014, Sweetman 2004). Furthermore, individual skill profile of immigrants may not entirely match a host country needs (Bonikowska et al. 2008). All in all, this induces low transferability of immigrants' skills and lowers employers' trust towards true competence of foreign-born employee, potentially resulting in statistical discrimination towards immigrants.

Employment related disadvantages faced by immigrants on a host labour market may lead to two types of consequences for individual human capital. One strand of literature suggests that due to reduced employment possibilities immigrants tend to experience further skill downgrading (Akresh 2008), while Duleep (2007) argues that low-skill-transferability immigration is characterized by higher potential to invest in own human capital to improve occupational outcomes. Thus, immigrants with low-transferable skills and initially high human capital gap relative to natives, are motivated to improve individual human capital profile and, thus, to catch up with native-born over time. The argument by Duleep (200f) goes in line with a large body of empirical findings suggesting that immigrants' wages tend to improve over years since immigration. These studies commonly report that immigrant-native pay gap tends to narrow down the longer is the time spent in receiving country (Sarvimäki 2011, Chiswick 1978). Observed positive dynamics may be a result of human capital investments, better acquaintance with host labour market and, consequently, getting position, which fits actual qualification better (Beyer 2016). Several studies also underlined the role of state programs in immigrants' economic and social integration. Sarvimäki and Hämäläinen (2016) showed that in Finland Active Labour Market

Policy, aiming to design an individual training program for unemployed immigrants, significantly increases compliers' earnings over subsequent years.

Host-country language proficiency, as an important factor of wage improvement and career development, is also widely discussed in the literature. In a recent study Geurts and Lubbers (2017) documented that immigrants changing their intension to stay in Netherlands from temporary to permanent have a larger increase in Dutch language proficiency. Earlier studies reported a positive association between host-county language command and employment outcomes (Van Tubergen and Kalmijn 2009). Chiswick and Repetto (2001) report a higher wage returns to Israeli immigrants advanced in written Hebrew, relative to those reporting a language level sufficient for speaking and understanding. Beyer (2016) report that good German writing skill reduces a pay gap between native and foreign born in Germany by one third.

Thus, we can summarize that earlier literature heavily discussed difference in human capital attainments across immigrants and natives as one of the major drivers of observed differential in earnings. However, highlighted factors mostly left a substantial part of immigrant-native pay gap unexplained (Beyer 2016, Dustmann 1993). We anticipate it to potentially arise from (i) limited explanation power of education and language skill, as they only partly reflect human capital; (ii) ignoring actual utilization of individual competencies at work as a mean to generate positive wage returns to own abilities. These arguments are extensively addressed in this paper.

3. Data and Method

3.1. Data and Sample

Empirical analysis relies on cross-section data from Program of International Assessment of Adult Competencies (PIAAC) survey for 15 countries. The selection of countries is based on availability of data required for the analysis. Namely, we retained only countries fulfilling two criteria: (1) availability of major variables used in analysis, namely, literacy and numeracy skill scores; (2) share of immigrants in total country sample is sufficiently large (more than 4%[3]). Hence, the final set of countries includes: Belgium, Czech Republic, Denmark, Estonia, Finland, France, Great Britain, Greece, Ireland, Italy, Netherlands, Norway, Slovenia, Spain and Sweden[4]. National samples are weighted to population in a relevant year. The survey was conducted in two rounds. The first round was performed in 2011 and 2012 and included all analysed countries except Greece and Slovenia. The latter countries were surveyed in 2014-2015. Along with a rich set of variables on socio-demographic background, employment history and self-assessed employment characteristics, PIAAC provides

[3] Threshold was chosen arbitrary, as there is a considerable variation of share of immigrants across countries and the lowest shares are under 4%.
[4] Swedish public use data file does not disclose earnings related variables. Hence, Sweden is excluded from pay gap analysis.

test scores in three skill domains – literacy, numeracy and problem solving in technology rich environment.

Following the definition used in PIAAC dataset, literacy skill is defined as "understanding, evaluating, using, and engaging with written text to participate in society, to achieve one's goals, and to develop one's knowledge and potential" (OECD 2013, p.3). Numeracy ability is viewed as "the ability to access, use, interpret and communicate mathematical information and ideas, in order to engage in and manage the mathematical demands of a range of situations in adult life" (Ibid.). In this paper the data on individual problem-solving skill is not used mainly, because problem solving part was completed by respondents who have at least some computer experience and performed a computer-based test, while two other test domains were conducted by all respondents (either in paper- or in computer-based survey). Including problem solving domain would reduce out sample by approximately 30%. Furthermore, France, Italy and Spain did not disclosed problem solving test scores in publicly used data files. Hence, we focus on dynamics and wage effects of literacy and numeracy skills, scaled from 0 to 500 points[5].

The second factor of interest – intensity of skill use at work – encounters three domains. Namely, a degree of skill utilization at work is derived as a frequency of skill use based on a set of background questions related to certain skill domain. PIAAC database provides derived skill use measures. However, to capture all available aspects of skill application, we derive a skill use scale, following Allen et al. (2013). Namely, we define use of literacy skill as an average of eight reading components and four writing components. The scale for numeracy skill use at work is approximated with six numeracy components. Each component refers to a self-reported frequency of conducting certain activity, requiring reading, writing or numeracy ability and ranges from 1 (never) to 5 (every day)[6]. Frequency of skill use does not need to reflect employees' productivity and does not need to tell about the actual efficiency of skill use. Thus, they reflect solely complexity and skill-intensity of respondents' jobs, as well as a degree of individual effort. The detailed list of background question used to derive the skill use measures is enclosed in Appendix.

Similarly, to use of literacy and numeracy skills, we define ICT skill use scale. Albeit we do not use a problem-solving skill in our human capital definition, we account for ICT use at work, primarily, because ICT use is defined broader than problem solving and strongly relates to literacy and numeracy skills. Furthermore, substantial share of jobs involves basic computer command or requires Internet use, especially among medium and high-level positions. Thus, ICT skill use coupled with intensity of literacy and numeracy application at work better reflects complexity of tasks workers are responsible for.

[5] For detailed technical description of PIAAC dataset see: OECD (2013). "Technical Report on the Survey of Adult Skills (PIAAC)", *OECD Publishing*. http://www.oecd.org/site/piaac/_Technical%20Report_17OCT13.pdf

[6] All background questions used to derive skill use measures provide ordinal responses as follows: 1 – "never use"; 2 – "use less than once a month"; 3 – "use less than once a week, but at least once a month"; 4 – "use at least once a week, but not every day"; 5 – "use every day".

As we rely on quite broadly defined self-reported questions to derive skill use levels, we recognize several limitations. Firstly, respondents may misreport their true skill use. Since each question appeals to both nature (complexity and skill-intensity) of job and individual effort exerted at work, we can expect response bias to go both ways. Generally, respondents should have higher propensity to overstate their true effort at work, rather than understate it. However, certain group of workers may tend to report lower skill use frequencies, especially if they are employing different types of skills simultaneously and, hence, may put less emphasis on certain domain. Furthermore, since background questions and ordinal answers are quite broad, respondents may reply with less precision, resulting in higher standard errors. Since both highlighted issues do not imply correlated deviations, they should not bias our estimates.

We acknowledge several limitations arising from using a cross-section data for analysis of immigrants' human capital dynamics, it's utilization at work and related wage effects. Firstly, the data may encounter a sizeable cohort effect (Borjas 1985 and 2015). Immigrants arriving now may be substantially different from earlier cohorts in a set of characteristics. To ensure that post-migration skills dynamics is not related to heterogeneous characteristics across cohorts, we check whether cohorts are balanced in a set of background traits. Thus, the analysis of skills' dynamics controls for a wide set of socio-demographic and employment characteristics to ensure that skills' variation over years in a host country is not associated with cross-cohort differences in background characteristics.

3.2. Empirical Method

Our methodological approach includes several empirical tests, addressing the hypotheses posed in the introductory part of the paper. Since PIAAC data report cognitive skill scores in each domain as a set of ten plausible values, we rely on a full set of plausible values for both literacy and numeracy skills when referring to proficiency in our analysis. To account for sampling error and correctly estimate mean population values, we incorporate a final population weight. Skill measurement errors are ruled out using 80 replication weights under the Jackknife replication methodology. Hence, each regression output incorporating skill measures as ten plausible values is a result of 810 replications.

First, we empirically analyse immigrant cognitive skill dynamics over immigration tenure in all 15 European countries under observation:

$$CS_i = \alpha + \gamma_1 I_i + \gamma_2 (I_i * YSM_i) + \gamma_3 (I_i * YSM_i^2) + \beta' X_i' + \varepsilon_i , \quad (1)$$

where dependent variable CS_i corresponds to either the literacy or numeracy test score; dummy variable I_i takes value 1 if the respondent is foreign-born; variable YSM_i corresponds to the number of years the immigrant has spent in the host country; and

ε_i represents an error term. The main effects of interest are captured by coefficient γ_1, standing for immigrant skill disadvantage immediately after arrival, and γ_2, as it reflects the average increase in skill level associated with each additional year of the host-country stay. To attribute the time effect to immigrants catching up, we need to compare immigrants with host-country stays of different durations to natives with similar backgrounds and observable characteristics. Therefore, we increase a set of additional controls, denoted by vector X_i', from demographic and educational characteristics solely in the basic model, to a complete specification with language used at home, occupation, industry and job training[7].

Next, we introduce a measure for skill use intensity at work and then analyse whether it contributes to explaining the immigrant-native pay gap. Our analysis will tackle the immigrant-native wage gap. We will model individual hourly wage, controlling for literacy or numeracy skill, literacy, numeracy and ICT skill use at work, as well as a broad set of background and employment controls to ensure maximal comparability of immigrants and natives in terms of observable traits. We model the problem in the following way[8,9]:

$$W_i = \zeta + \lambda I_i + \tau CS_i + v'SUW' + \omega' X_i' + \varepsilon_i, \quad (2)$$

where W_i stands for individual hourly wage. The vectors of the coefficients of skill use at work (SUW') capture the wage effects of skill application in a certain domain. Following our rationale, we can conclude that the utilization of skills at work is associated with the wage rate directly through the complexity of tasks and the effort exerted. Coefficient λ stands for a residual immigrant-native pay gap and is an estimate of major interest. Variation of coefficient λ across model specifications with only background controls, and with skill level and skill use measures included step-by-step, will indicate a relative importance of the aforementioned controls in explaining the immigrant-native pay gap.

The application of the Jackknife replication methodology to correctly estimate standard errors with 80 replication eights, does not allow us to simultaneously cluster standard errors. Although, as we use a pooled sample for the main analysis, clustering standard errors at the country level would be a natural choice, as it accounts for the

[7] As a robustness check, we extend model (1) by adding skill use at work variables. This accounts for potential correlation between years since migration and extent of skill use, thereby allowing us to reduce the omitted variable bias.

[8] We acknowledge potential multicollinearity issue, as cognitive skills and their use at work may correlate. However, empirical estimations of model (3) performed later in the paper will verify that multicollinearity concern is of minor importance.

[9] We performed additional estimations of model (2), extended by a set of interaction terms between immigrant and cognitive skill levels, immigrant and skill use at work. The estimates revealed that immigrants do not earn additional wage premium to their cognitive skills or their use at work, compared to natives. Results are available upon request.

interdependencies of observations within the country sample. To additionally verify the stability of our conclusions based on the models with non-clustered standard errors, we replicate the same analysis for each country separately. Therefore, we test whether the same pattern observed in the pooled sample holds when we disaggregate the dataset into fifteen country sub-samples.

4. Empirical Results

4.1. Descriptive Evidence

This section presents descriptive evidence on main characteristics and average skill test scores of immigrants and natives.

Tables 1 and 2 present the summary of demographic characteristics, measured in the samples of immigrants and native-born. The results suggest that gender representation is comparable across natives and immigrants, similarly to the age structure of the samples and marital status. The native speaker characteristic implies that the language used to conduct the test corresponds to the language used at home. As expected, in most of analysed countries the shares of native speakers conducted the test in their home language are considerably higher among natives. However, in Estonia, Greece, Ireland, and Spain, the shares of native speakers are 88.2%, 40.6%, 45.9% and 56.6% correspondingly. Estonia is a clear outlier due to the technical features of the PIAAC survey, as it allowed to conduct the test either in Estonian, or in Russian, due to historically large Russian minority (OECD 2013). Thus, Estonian immigrants who responded on the questions had possibilities to do that in Russian language whether it was their home language and/or this language was most comfortable for their response. Since the public use files do not disclose the detail language command variables, the data does not allow to test whether the test language is the major factor. However, since the average duration of the host country stay is the highest for immigrants in Estonian sample (36.7 years), we can safely assume that indeed the native speaker variable captures both, those speaking Estonian and Russian at home.

Table 1. Background demographic characteristics of immigrants

Country	Male %	Average age	Cohabiting %	Native speaker %	Years since migration	Education %			N
						Basic	Medium	High	
Belgium	48,0	40.1 (0.476)	77,3	33,7	18.4 (0.527)	64,6	19,4	16,0	790
Czech Republic	46,3	41.9 (0.873)	76,4	22,7	24.1 (1.302)	70,4	2,5	27,2	420
Denmark	48,2	37.6 (0.265)	75,4	9,7	16.5 (0.282)	59,9	13,7	26,5	3022
Estonia	42,8	50.9 (0.381)	81,7	88,2	36.7 (0.415)	48,6	25,8	25,6	919
Finland	48,3	37.8	83,7	19,4	14.3	63,6	8,9	27,4	231

Country	Male %	Average age	Cohabiting %	Native speaker %	Years since migration	Education %			N
						Basic	Medium	High	
		(0.824)			(0.652)				
France	50,0	44.0 (0.464)	78,1	26,5	24.9 (0.584)	75,4	5,7	18,9	795
UK	49,3	37.4 (0.540)	69,6	29,6	15.9 (0.626)	51,3	12,0	36,7	948
Greece	45,7	37.1 (0.751)	68,1	40,6	23.5 (0.651)	69,4	14,8	15,7	427
Ireland	48,8	36.0 (0.395)	66,0	45,9	13.6 (0.423)	40,6	35,0	24,4	1191
Italy	46,2	37.0 (0.644)	66,5	13,6	15.7 (0.723)	90,0	2,5	7,5	425
Netherlands	47,4	41.6 (0.584)	75,7	18,9	21.8 (0.617)	70,6	1,7	27,6	462
Norway	53,8	37.6 (0.477)	75,1	5,4	13.8 (0.484)	49,3	14,0	36,7	635
Slovenia	52,2	45.1 (0.543)	83,0	9,1	25.5 (0.683)	88,2	5,2	6,7	534
Spain	46,9	37.7 (0.431)	68,5	56,6	12.4 (0.427)	76,1	7,5	16,4	786
Sweden	47,4	40.3 (0.545)	74,3	9,0	18.3 (0.539)	63,5	13,3	23,3	740

Note: The estimates are weighted by the final population weight.
Source: Own calculations based on the PIAAC data.

In terms of the educational characteristics, there are systematic differences across countries. We find that in majority of analysed countries immigrants are more often holding higher education degree. Among others, in Czech Republic, 27.2% of immigrants hold bachelor degree or higher, while only 15.6% of natives. Similarly, in the UK, 36.7% of immigrants are highly educated, whereas only 21.4% of natives hold the same degree. Spain, Slovenia and Italy are the only countries where the share of highly-educated immigrants is lower than the share of highly-educated natives. However, due to the data limitations, we cannot distinguish the country where the degree was obtained.

Table 2. Background demographic characteristics of natives

Country	Male %	Average age	Cohabiting %	Native speaker %	Education %			N
					Basic	Medium	High	
Belgium	50,8	42.0 (0.148)	75,4	95,5	60,9	24,3	14,7	9168
Czech Republic	50,6	40.5 (0.210)	68,7	99,5	80,3	4,1	15,6	11742
Denmark	50,6	41.5 (0.140)	76,5	98,4	64,8	20,3	14,9	11548
Estonia	48,6	38.4 (0.168)	69,3	99,8	59,1	19,7	21,2	6660
Finland	50,4	41.6 (0.207)	81,1	99,5	59,7	18,5	21,8	5228

Country	Male %	Average age	Cohabiting %	Native speaker %	Education %			N
					Basic	Medium	High	
France	48,7	40.3 (0.188)	70,9	96,1	72,9	10,1	17,0	6105
UK	49,9	40.5 (0.251)	64,6	97,3	65,9	12,7	21,4	7858
Greece	49,5	41.5 (0.262)	67,1	99,0	66,7	16,2	17,1	4489
Ireland	49,0	39.6 (0.245)	63,4	98,2	53,5	28,7	17,7	4771
Italy	50,4	41.6 (0.269)	63,9	96,8	86,8	0,8	12,4	4161
Netherlands	50,6	40.9 (0.217)	75,3	94,8	69,2	3,5	27,3	4620
Norway	50,7	40.5 (0.226)	75,6	98,2	56,5	14,1	29,4	4310
Slovenia	51,2	41.0 (0.207)	67,5	97,3	75,3	10,4	14,3	4758
Spain	50,7	41.8 (0.196)	68,9	99,6	68,0	10,0	22,1	5183
Sweden	51,4	40.7 (0.251)	76,1	96,3	63,9	16,9	19,1	3727

Note: The estimates are weighted by the final population weight.
Source: Own calculations based on the PIAAC data.

Tables 3 and 4 present average employment characteristics across immigrants and natives. The average employment rate varies considerably across countries; however, immigrant-native differences are not substantial in majority of analysed countries. The only exceptions are Denmark and Sweden, which have higher employment rate of natives, and Italy, where more immigrants, than natives are employed (63.6% relative to 55.4%). Occupation profiles vary significantly, with higher proportions of respondents holding high (skilled) positions among natives. The largest immigrant-native gap is observed in Italy, while the only country where immigrants have slightly larger share of high-level positions than natives is Czech Republic (36.4% relative to 34.2%).

Table 3. Background employment characteristics of immigrants

Country	Employed %	Occupation %			Training at work %	Skill use at work, (0-no use, 5-more than 80% use)			Average hourly wage, $US PPP adjusted
		High	Medium	Low		Reading	Writing	Numeracy	
Belgium	67,4	33,3	25,6	17,2	19,0	2,4	2,0	2,6	17,2
Czech Republic	65,7	36,4	13,1	38,6	31,2	2,5	2,6	2,7	8,8
Denmark	62,9	34,1	26,8	16,6	25,4	2,5	2,1	2,6	20,7
Estonia	65,7	33,7	16,8	33,8	24,2	2,4	2,2	2,6	8,2

Country	Employed %	Occupation %			Training at work %	Skill use at work, (0-no use, 5-more than 80% use)			Average hourly wage, $US PPP adjusted
		High	Medium	Low		Reading	Writing	Numeracy	
Finland	64,6	26,8	31,4	25,5	31,6	2,7	2,5	2,4	15,5
France	58,3	27,1	26,7	26,7	9,4	2,2	1,9	2,6	14,6
UK	68,1	36,7	34,9	13,8	30,9	2,7	2,3	2,7	17,7
Greece	51,2	15,1	33,8	28,4	7,1	1,9	2,0	2,4	9,1
Ireland	60,3	33,8	32,6	20,4	26,2	2,7	2,3	2,7	19,0
Italy	63,6	12,7	29,3	38,7	9,6	1,7	1,6	2,6	11,6
Netherlands	62,7	39,3	29,2	15,3	31,2	2,6	2,0	2,6	18,2
Norway	76,4	37,5	33,4	15,9	33,3	2,7	2,2	2,6	21,6
Slovenia	57,9	25,2	16,5	40,9	17,2	2,1	2,0	2,5	7,2
Spain	56,6	19,0	32,3	20,1	17,7	1,9	1,8	2,5	11,2
Sweden	65,4	31,4	34,2	21,4	21,1	2,6	2,2	2,5	n.a.

Note: The estimates are weighted by the final population weight.
Source: Own calculations based on the PIAAC data.

Table 4. Background employment characteristics of natives

Country	Employed %	Occupation %			Training at work %	Skill use at work, (0-no use, 5-more than 80% use)			Average hourly wage, $US PPP adjusted
		High	Medium	Low		Reading	Writing	Numeracy	
Belgium	70,3	47,1	25,9	18,8	28,6	2,7	2,2	2,7	20,3
Czech Republic	65,6	34,2	25,2	32,0	37,4	2,5	2,7	2,7	9,0
Denmark	74,8	43,6	27,8	18,0	38,8	2,8	2,3	2,7	23,7
Estonia	72,9	42,6	20,1	27,7	37,1	2,6	2,4	2,7	10,1
Finland	70,4	38,9	28,7	23,6	43,8	2,8	2,7	2,6	18,7
France	64,7	40,3	26,1	22,9	17,8	2,5	2,3	2,6	15,2
UK	71,2	37,6	35,8	16,5	37,7	2,9	2,4	2,7	18,6
Greece	48,9	30,7	37,0	23,5	8,2	2,2	2,3	2,5	10,5
Ireland	61,4	35,4	34,1	22,3	30,0	2,8	2,4	2,6	22,5
Italy	55,4	32,1	29,4	27,3	13,5	2,4	2,2	2,7	15,4
Netherlands	78,1	51,6	29,3	11,0	42,6	2,8	2,2	2,7	20,2
Norway	79,2	45,5	34,2	16,2	33,1	2,9	2,3	2,6	24,9
Slovenia	57,8	44,8	21,6	28,5	24,8	2,7	2,5	2,8	9,3
Spain	58,7	31,6	33,1	21,9	26,4	2,4	2,2	2,6	14,6
Sweden	75,4	44,8	29,3	20,8	34,6	2,7	2,3	2,5	n.a.

Note: The estimates are weighted by the final population weight.
Source: Own calculations based on the PIAAC data.

As expected, the extent of skill use differs significantly across immigrants and natives. We document that, on average, native-born use their skills more intensively, compared to immigrants. However, the mere differences in skill use are of relatively small magnitude. In terms of wage level, immigrants have lower average earnings, relative to natives, in all analysed countries. The higher rough immigrant-native gap in hourly earnings is in Italy (3.8 EUR), while the smallest in Czech Republic (0.2 EUR).

Table 5 presents the average skill scores across immigrants and natives. The estimated immigrant-native gaps differ across countries; however, the common feature is that the immigrants attained lower skill scores in both literacy and numeracy domains. The largest gaps in literacy and numeracy scores are documented in Sweden (53.6 and 56.2 points respectively), and in Finland (51.1 and 51.8 points). The smallest disparities are observed in Ireland (4.7 points in literacy and 0.9 points in favour of immigrants in numeracy) and Greece (6 and 2.9 points in literacy and numeracy respectively). Thus, the results verify that literacy and numeracy skills are interrelated.

Table 5. Average cognitive skill scores across countries

Country	Natives				Immigrants			
	Literacy		Numeracy		Literacy		Numeracy	
Belgium	278,3	(0,869)	283,01	(0,809)	241,6	(3.290)	248,7	(3.520)
Czech	274,2	(0,983)	276,2	(0,922)	268,1	(5.423)	264,3	(6.514)
Denmark	275,2	(0,664)	282,6	(0,777)	237,6	(1.958)	245,4	(2.182)
Estonia	278,9	(0,766)	275,2	(0,551)	256,2	(1.486)	259,9	(1.603)
Finland	290,6	(0,651)	285,3	(0,711)	239,5	(4.104)	233,5	(3.924)
France	266,8	(0,585)	259,8	(0,663)	229,5	(1.818)	215,5	(2.284)
UK	275,6	(0,993)	265,8	(0,983)	254,9	(3.371)	238,3	(3.482)
Greece	254,4	(1,107)	252,1	(1,038)	248,4	(3.709)	249,2	(3.502)
Ireland	267,5	(0,916)	255,4	(1,124)	262,8	(2.015)	256,3	(2.132)
Italy	252,7	(1,123)	248,7	(1,099)	228,2	(3.406)	231,6	(3.704)
Netherlands	289,4	(0,692)	286,3	(0,735)	246,8	(3.023)	239,4	(3.050)
Norway	283,5	(0,616)	284,5	(0,752)	245,4	(2.540)	238,1	(3.113)
Slovenia	259,7	(0,776)	262,1	(0,967)	232,3	(2.620)	225,4	(3.040)
Spain	254,8	(0,702)	248,6	(0,624)	232,2	(2.593)	227,2	(2.567)
Sweden	288,6	(0,774)	288,9	(0,924)	235,0	(1.843)	232,7	(1.881)

Note: Average skills are measured using 10 plausible values and weighted by the final population weight. Standard errors are estimated using 80 replication weights and Jackknife replication methodology.
Source: Own calculations based on the PIAAC data.

4.2. Cognitive skills, their use at work and immigrant-native wage gap

In this section, we present the empirical results on immigrant skill dynamics and a role of skill level and intensity of skill use in explaining the immigrant-native wage gap. We start by analysing immigrant cognitive skill dynamics. Table 6 presents estimations of

the average increase in literacy and numeracy skills over time since immigration, following the functional form specified in equation (1). The table reports the coefficient of the *Immigrant # Years since migration* intercept term across all analysed countries[10]. The model estimated in Table 6 controls for an extensive list of demographic and occupation controls, which are largely capturing the cohort effects.

Due to the relatively small sample sizes across countries, we found statistically significant skill dynamics only in five countries, while in the rest the dynamics is only economically significant. Thus, only in Finland, Norway, Sweden, and Denmark, immigrants tend to improve their skills over years spent in the host country. The strongest association is documented in Finland, namely 6.1 points increase in literacy and 5.9 points increase in numeracy, associated with one additional year spent in the host country. The result is not surprising, given that immigrants' training and labour market integration is paid particular attention in Finland (Sarvimäki and Hämäläinen 2016). In the rest of the Nordic countries, the dynamics of skill improvement is relatively slower, however, still considerable, compared to other analysed countries. Surprisingly, in Estonia, the coefficients of skill dynamics are negative. Thus, immigrants tend to experience skill downgrading rather than upgrading. Thus, one extra year spent in the host country is associated with 1.9 decrease in literacy skill and 1.8 in numeracy skill.

Table 6. Effect of immigration tenure[A] on skill level

Country	Literacy score		Numeracy score	
	β/se	R^2	*β/se*	R^2
Belgium	0.356 0.85	0.477	0.273 0.97	0.451
Czech Republic	0.21 2.26	0.653	0.861 2.48	0.749
Denmark	1.085 0.50**	0.314	1.283 0.52**	0.289
Estonia	-1.947 0.71***	0.162	-1.882 0.80**	0.218
Finland	6.112 1.75***	0.381	5.86 1.89***	0.357
France	0.447 0.6	0.475	0.677 0.67	0.51
UK	0.883 0.84	0.321	0.674 0.8	0.353
Greece	-1.232 2.21	0.478	-1.148 2.32	0.433
Ireland	1.095 0.67	0.283	0.813 0.69	0.275
Italy	1.026 1.27	0.319	0.903 1.21	0.283

[10] Complete estimation results for each country are available upon request.

Country	Literacy score		Numeracy score	
	β/se	R^2	*β/se*	R^2
Netherlands	-0.732 0.89	0.437	-1.016 0.91	0.447
Norway	2.245 0.78***	0.401	2.975 0.84***	0.403
Slovenia	0.377 0.78	0.315	0.298 0.9	0.389
Spain	-0.558 0.77	0.277	-0.229 0.85	0.28
Sweden	1.966 0.66***	0.375	1.709 0.75**	0.357
Pooled sample	0.764 0.31**	0.345	0.642 0.32**	0.35

[A] The effect of immigration tenure is captured by an interaction term between the immigrant dummy and the continuous variable of years since migration.
Note: Estimates based on PIAAC public use country data files. Measures of literacy and numeracy skills are estimated using 10 plausible values for each skill domain. Sample is weighted using final population weight. Standard errors estimated using 80 replication weights and applying Jackknife replication methodology.
***, **, * Indicate parameters significant at 1%, 5% and 10% levels respectively.
Source: Own calculations based on the PIAAC data.

The testing results vary across countries. Namely, we found positive and statistically significant association between skill levels and years spent in the host country only in the Nordic countries. This finding could reflect the relatively stronger host-country support of the immigrants' integration, social and labour market assimilation. The number of state programs are also implemented to improve immigrants' qualification and equip them with skills needed by the host labour market, including the language command.

Next, we focus on a second major aspect of our research, an extent of skill use at work. We refer to skill use at work as a factor that independently from skill level correlated with labour market returns. We empirically test how skill level and skill use at work affect immigrant-native pay gap. Our rationale here is that increasing a stock of skills is not sufficient to explain immigrant-native pay disparity. Skills yield positive wage returns only when utilized at work, meaning that respondent accessed sufficiently complex and rewarding job, as well as that he invests a decent effort into his work. Both are to a large extent captured by a frequency of skill use at work in our model and may differ across immigrant and natives, translating into their wage disparity.

Table 4 discloses estimates of immigrant-native wage gap (coefficient of the *Immigrant* dummy), following specification (2)[11]. We separately estimated models with literacy and numeracy skill controls due to their high correlation and technical features

[11] Complete estimation results for each country are available upon request.

of estimation process[12]. Models M2 and M4 account for literacy skill, while models M3 and M5 incorporate numeracy skill. The pure effect of skill level is captured by models M2 and M3, while the effect of the skill use at work is elicited by models M4 and M5. The point estimate of immigrant dummy in M1 stands for a raw pay gap, when neither skill itself, nor use of skill is accounted for.

Table 7. Immigrant-native wage gap[A] w.r.t skill level and intensity of skill use

Country	M1[a]		M2[b]		M3[c]		M4[d]		M5[e]	
	β/se	R^2	*β/se*	R^2	*β/se*	R^2	*β/se*	R^2	*β/se*	R^2
Belgium	-0.071 0.01***	0.35	-0.05 0.02**	0.35	-0.051 0.02**	0.35	-0.053 0.03	0.30	-0.051 0.03	0.30
Czech Republic	-0.108 0.05**	0.21	-0.103 0.06*	0.22	-0.099 0.06*	0.22	-0.095 0.08	0.19	-0.078 0.07	0.19
Denmark	-0.074 0.01***	0.29	-0.054 0.02**	0.30	-0.054 0.02**	0.30	-0.032 0.03	0.32	-0.033 0.03	0.32
Estonia	-0.097 0.02***	0.31	-0.083 0.03***	0.31	-0.085 0.03***	0.32	-0.098 0.05**	0.29	-0.103 0.05**	0.30
Finland	-0.088 0.02***	0.45	-0.074 0.03**	0.45	-0.072 0.03**	0.46	-0.06 0.03*	0.45	-0.056 0.03	0.45
France	-0.023 0.01**	0.31	-0.009 0.02	0.32	0 0.02	0.32	-0.004 0.03	0.33	0.002 0.03	0.33
Great Britain	-0.018 0.01*	0.42	0.008 0.02	0.43	0.014 0.02	0.43	-0.006 0.02	0.43	-0.003 0.02	0.43
Greece	0.052 0.02***	0.36	0.052 0.05	0.36	0.052 0.05	0.36	0.018 0.09	0.40	0.017 0.09	0.40
Ireland	-0.111 0.01***	0.20	-0.107 0.04**	0.20	-0.109 0.04***	0.20	-0.101 0.04***	0.20	-0.103 0.04***	0.20
Italy	-0.099 0.01***	0.29	-0.093 0.04**	0.29	-0.091 0.04**	0.29	-0.034 0.07	0.33	-0.04 0.07	0.33
Netherlands	-0.048 0.01***	0.23	-0.005 0.05	0.24	-0.009 0.05	0.24	-0.015 0.05	0.29	-0.016 0.05	0.29
Norway	-0.084 0.01***	0.28	-0.063 0.03**	0.29	-0.059 0.03**	0.29	-0.038 0.03	0.33	-0.034 0.03	0.33
Slovenia	-0.025 0.02	0.37	-0.012 0.03	0.39	-0.003 0.03	0.40	0.026 0.04	0.37	0.034 0.04	0.38
Spain	-0.104 0.02***	0.31	-0.084 0.04**	0.31	-0.08 0.04**	0.31	-0.048 0.06	0.28	-0.045 0.06	0.28
Pooled sample	-0.057 0.01***	0.42	-0.038 0.01***	0.42	-0.034 0.01***	0.42	-0.021 0.01	0.41	-0.018 0.01	0.41

[A] Immigrant-native wage gap is measured by the coefficient of immigrant dummy variable

[12] Simultaneous including of literacy and numeracy scores result in 20 possible combinations of plausible values (10 for literacy and 10 for numeracy), which, given population and replication weights, yields 810^2 replications required to correctly calculate point estimates and standard errors. However, we conducted a number of robustness checks with literacy and numeracy included simultaneously in several specifications. The results are comparable to models with only literacy, or only numeracy controlled for.

[a] M1 controls for immigrant status, gender, age, age squared, education level, language used at home, occupation, industry, job training.
[b] M2 controls for literacy score additionally to M1
[c] M3 controls for numeracy score additionally to M1
[d] M4 controls for literacy, numeracy and ICT skill use at work additionally to M2
[e] M5 controls for literacy, numeracy and ICT skill use at work additionally to M3
Note: Dependent variable is log of individual hourly wage. All models additionally control for gender, age, age squared, education level, language used at home, occupation, industry, job training and country of residence. Estimates based on a pooled sample of PIAAC public use data files for 14 countries. Measures of literacy and numeracy skills are estimated using 10 plausible values for each skill domain. Sample is weighted using final population weight. Standard errors estimated using 80 replication weights and applying Jackknife replication methodology.
***, **, * Indicate parameters significant at 1%, 5% and 10% levels respectively.
Source: Own calculations based on the PIAAC data.

Generally, the results indicate the substantial variation in immigrant-native wage gap magnitudes and factors behind it. The common feature for most of countries is that controlling for the skill level and, most importantly, intensity of the skill use at work drastically reduces economic and statistical significance of wage gap. Stepwise inclusion of main controls allows to differentiate several groups of countries, depending on the effect of skill level and their application at work.

Thus, we can distinguish five different patterns describing immigrant's-native wage gap

- Great Britain and Slovenia are the only countries where the raw wage gap (model M1) is insignificant and economically very small. Further inclusion of skill level controls and skill use at work variables does not the significance of estimates. It suggests that immigrants and natives possess comparable skill levels and utilize them to the similar extents, which yield comparable wage rates.
- In Greece, the raw pay gap is initially positive and significant (5.2%), implying that immigrants earn on average more than natives, given that they have comparable demographic and occupation profile. Adding literacy (M2) or numeracy (M3) skills turn the pay gap insignificant, suggesting that the significant raw gap stem from the difference in skills of immigrants and natives, potentially favouring higher wage of immigrants. Controlling for skill use at work (M4, M5) drastically decline economic significance of estimates, suggesting that immigrants may utilize skills more intensively, compared to natives.
- The third group of countries is characterized by the initially negative wage gap, which turns statistically insignificant when cognitive skills are accounted for (France, Netherlands). It implies, that immigrants possess lower cognitive skills, compared to natives, which triggers their wage penalty. Adding skill use controls does not affect statistical significance, albeit economic significance further declines. Hence, there are certain differences in skill use across immigrants and natives, however, they do not reflect on the pay gap systematically.

- The largest group of countries is characterised by the initially negative wage gap, which remains statistically significant when controlling for the skill level, however, turns insignificant when adding skill use intensity controls (Belgium, Czech Republic, Denmark, Finland, Italy, Norway, Spain). This finding shows that indeed immigrant-native pay disparity originates from differences in application of skills at work across immigrants and natives. This difference eventually reflects on earnings profile, since intensity of skill use captures two aspects: (i) nature of performed job; (ii) individual effort invested into work.
- Estonia and Ireland are the only countries in our sample, where the wage penalty of around 10% persists even when controlling for both skill level and skill use at work. It suggests that immigrants in these countries are potentially different from their peers in other states in a five number of unobserved characteristics. Furthermore, immigration history and path-dependence could be another factor, which explain persistent pay gap, especially in the context of Estonia.

Overall, the results support our assumption that skill use at work acts as an important driver of immigrant-native pay disparity, as it directly associates with wage level through nature of job and effort exerted at work. Both components may drastically differ between immigrant and native population. Firstly, immigrants may have more restricted access to positions with skill-requiring tasks, which is more likely to generate higher wage returns, than job with low skill involvement. Secondly, immigrants may more often face difficulties when opting for career progression, compared to otherwise similar natives. Thirdly, immigrants may simply have lower motivation to put effort into job, either due to realized labour market difficulties and low expectancy of further career development, or due to low social and cultural assimilation, feeling of isolation from society and other psychological factors.

5. Conclusions

This paper contributes to analysis of immigrant-native wage gap and factors behind it in 15 European countries. Earlier literature discusses differences in human capital attainments across immigrants and natives as one of the major drivers of observed differential in earnings. However, previous studies relied on formal education or, at best, host-country language proficiency as measures of individual human capital. In our paper, we develop this argument further and incorporate cognitive skills in literacy and numeracy domain to approximate individual human capital profile. Furthermore, we argue that several labour market disadvantages may persist despite immigrants' true skills and abilities. Difficulties of labour market entry and access to complex, challenging and rewarding positions, result in occupation-qualification mismatch and slower career progression, compared to natives. This will lead to persistent wage penalty, which may to large extent offset positive wage returns to improvement in human capital. This issue constitutes a focal point of our research.

The paper suggests and empirically tests two hypotheses. Firstly, we ask whether immigrants tend to increase their human capital over time spent in a host country. We specifically focus on cognitive components of human capital, namely literacy and numeracy abilities, as measured by PIAAC data. We find that, the estimated skill improvement varies considerably across countries. Only Nordic countries revealed economically and statistically significant increase in the test scores over the time spent in a host country. As we control for a comprehensive set of background and employment characteristics when measuring skill convergence, we admit that observed dynamics suggests gradual catch up of immigrants and narrowing immigrant-native skill gap over time. The differences in rates of catching up in literacy and numeracy skills are marginal.

Secondly, we ask if acquiring the same skill level as native-born is enough to offset the wage disparity relative to natives. The analysis of immigrant-native pay gap revealed that even when literacy or numeracy cognitive skills are controlled for, wage penalty remains in majority of analysed countries. This evidence reassures that even when having a similar skill level, along with comparable demographic, educational and employment profile, immigrants tend to earn less than natives.

It motivates a further analysis, focused on the extent to which immigrants utilize their skills at work. Our rationale is that frequency of literacy, numeracy and ICT skill use at work reflects complexity and challenge of position, which positively associate with reward level. Since we rely on broad occupation categories, controlling for skill use at work allows identifying if immigrants access jobs of complexity and wage reward similar as natives. However, frequency of skill use at work also reflects a degree of effort exerted at work. Our data in hand does not allow to disentangle these two effects behind observed intensity of skill use. However, robustness checks suggest that skill use variable indeed largely reflect complexity of job (more intensive skill use in higher occupational categories) and reward level associated with job (average earnings increase with an increase in skill use at work).

Once we account for literacy, numeracy and ICT skill use at work in wage regression, along with actual skill level, no statistically significant gap in earnings across immigrants and natives remain in all countries, except Estonia and Ireland. These findings prove that, despite similar cognitive skill level and background traits, immigrants and natives may apply their skills at work to different extend, yielding a difference in their wage returns. It seems reasonable to assume that labour market rewards skills when they are actively used at a workplace. Extent of skill utilization depends on objective nature of job (complexity and skill intensity) and subjective factors (personal motivation effort). We argue that both, job nature and effort components, may systematically differ across immigrants and natives, resulting in wage loss of immigrants.

The case of Estonia and Ireland may be considerably different from the rest of the European countries due to several factors. Firstly, both countries have a rather

specific immigration history. In case of Estonia, path-dependence could also play a role in shaping the labour market integration of current immigrants. Secondly, the definition of immigrants, applied in the PIAAC data, select different people into the immigrants' samples. In context of Estonia, immigrants, identified as those born abroad, could encounter both, children of previously displaced Estonians, who returned to the country after the restoration of independence, as well as minority population. Therefore, while in the rest of the countries, immigrants' sample captures predominantly economic migrants, Estonian and Irish samples may encounter different types of movers.

Thus, our findings, on the one hand, reassure that in Nordic countries, immigrants are prone to develop and improve their skill profile over time spend in a host country. This finding goes in line with earlier studies suggesting increased human capital investment, mostly though acquiring skills demanded and highly valued on host state labour market, as well as improvement of host-country language command. Consequently, immigrants tend to gradually catch up with natives and rule out wage disadvantage associated with their relatively weaker human capital profile. But, on the other hand, we documented that immigrants, even when attaining skills comparable to natives, less frequently use them at work. Acknowledging this difference in wage analysis turns immigrant-native pay gap statistically insignificant and, thus, suggest that disparity in skill use at work plays an important role in explaining immigrant-native pay disparity.

Thus, disparity in skill use at work indicates that immigrants are not sufficiently well assimilated in the European labour markets. Possible difficulties in labour market entry and in getting complex and challenging positions to a large extent explain immigrants' weak assimilation. Implementation and development of policy measures should consider that human capital improvements alone are not sufficient to ensure immigrants' labour integration if several labour market disadvantages persist. These may deter immigrants' efficient skill use and development at a workplace. Further policy measures should consider these indications, considering that the role of immigrants and their labour supply is remarkably increasing in European societies.

Appendix

Components (PIAAC background questions) used to construct literacy, numeracy, ICT use at work variables

	Literacy use	Numeracy use	ICT skills use
Skill use at work	A. Reading components: reading (1) directions or instructions; (2) letters, memos or mails; (3) newspapers or magazines; (4) professional journals or publications; (5) books; (6) manuals or reference materials; (7) financial statements; (8) diagrams, maps or schemes. B. Writing components: writing (1) letters, memos or mails; (2) articles; (3) reports; (4) filling in forms.	Tasks demanding numeracy skill include: (1) calculating costs or budgets; (2) using or calculating fractions or percentages; (3) using a calculator; (4) preparing charts graphs or tables; (5) using simple algebra or formulas; (6) using advanced math or statistics	Computer-based or Internet use related tasks include: (1) experience with computer at work; (2) using Internet for mail; (3) using Internet for work related information; (4) using Internet to conduct transactions; (5) using computer for spreadsheets; (6) using computer for Word; (7) using computer for programming language; (8) use computer for real-time discussions.

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