The Impact of Immigration on the Portuguese Labour Market

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Dissertation submitted in partial fulfilment of requirements for the MSc in Economics - Major in Macroeconomic Policy, at the Universidade Católica Portuguesa, December 2022.

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Abstract

This dissertation examines the impact of immigration on the Portuguese labour market. Namely, on the average wage and wage distribution of natives, and on the employment rate, unemployment rate, and labour force participation rate of natives. Studies on the effects of immigrants on the labour market in Portugal are still scarce. The subject has become growingly important with the increase in immigration over the past two decades. The analysis is framed into a pure spatial theoretical model, without pre-allocation of workers into skill groups, and uses a dataset from a quarterly sample survey that characterizes the labour market in Portugal between 2003 and 2019. The impact of immigrants on natives is estimated through an instrumental variable approach using a difference-in-difference strategy. The analysis shows that immigration does not have a significant impact on natives' wages, but tends more towards a negative impact, especially in the lowest percentiles. In addition, immigrants negatively impact the labour force participation rate of natives, which is mainly driven by the negative impact on the employment rate of natives. In terms of heterogeneity, men are more negatively affected by immigrants than women, and natives with low education are also more harmed when compared to natives with higher levels of education.

O Impacto da Imigração no Mercado de Trabalho Português

Mariana Cardoso dos Santos

Resumo

Esta dissertação analisa o impacto da imigração no mercado de trabalho português. Nomeadamente, no salário médio e distribuição salarial dos nativos, e na taxa de emprego, taxa de desemprego, e taxa de participação na força de trabalho dos nativos. Os estudos sobre os efeitos dos imigrantes no mercado de trabalho em Portugal são ainda escassos. O tema tornou-se cada vez mais importante com o aumento da imigração nas últimas duas décadas. A análise enquadra-se num modelo teórico espacial puro, sem pré-alocação de trabalhadores por grupos de competências, e utiliza uma base de dados de um inquérito amostral trimestral que caracteriza o mercado de trabalho em Portugal entre 2003 e 2019. O impacto dos imigrantes sobre os nativos é estimado por meio de uma abordagem de variável instrumental usando uma estratégia de diferença em diferença. A análise mostra que a imigração não tem um impacto significativo nos salários dos nativos, mas tende mais para um impacto negativo, especialmente nos percentis mais baixos. Além disso, os imigrantes impactam negativamente a taxa de participação na força de trabalho dos nativos, que é impulsionada principalmente pelo impacto negativo na taxa de emprego dos nativos. Em termos de heterogeneidade, os homens são mais afetados negativamente pelos imigrantes do que as mulheres, e os nativos com baixa escolaridade também são mais prejudicados quando comparados aos nativos com maior escolaridade.

Palavras-chave: Imigração, Impacto, Salários, Distribuição Salarial, Emprego, Trabalho

Acknowledgments

I would like to thank my dissertation advisor, Professor Hugo Reis, for all the guidance, help and availability for regular meetings during the last few months.

I thank my mother for all her support and belief in me during my academic journey. I am grateful for her continuous incentive to always strive for higher achievements.

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1. Introduction

The impact immigrants have on societies has been a long-standing debate, particularly the consequences that higher levels of immigration can have on the labour market. Immigration can potentially affect natives' employment and wages, which has a tremendous impact on their lives. Simultaneously, immigration policies have been the subject of disagreement, leading to extreme viewpoints and opposing policies.

The phenomenon of immigration in Portugal has recently undergone significant changes. The foreign-born population residing in Portugal increased by 5.8 percentage points between 2000 and 2019, reaching 10.8% of the resident population in 2019 (OECD, 2022a). Additionally, there have been changes in the immigrants' countries of origin. The share of immigrants from Brazil grew substantially in this period and it is the most represented country, achieving 24.90% of the foreign-born population in 2021. Also, the number of foreign-born people from Eastern European countries has increased. The majority of immigrants are from the working-age population.

Studies on the impact of immigration on wages and employment present different and opposite conclusions. In addition to little effects (e.g., Card, 2001; Kim, 2021), the impacts ranged from negative (e.g., Dustmann et al., 2017; Elstad & Heggebø, 2021) to positive (e.g., Boucher et al., 2022; Ortega & Verdugo, 2014) effects. The main approaches used are the national skill-cell (e.g., Borjas, 2003), spatial (e.g., Dustmann et al., 2013), mixed (e.g., Glitz, 2012), and structural (e.g., Manacorda et al., 2012). In Portugal, studies on these effects are still scarce and were mainly concentrated on the wage gap between natives and immigrants (e.g., Carneiro et al., 2012; Cabral & Duarte, 2013). Additionally, some studies have been carried out on a major labour supply shock that occurred in 1975 with the return to Portugal of *retornados* from the former Portuguese colonies (e.g., Mäkelä, 2017; Bohnet et al., 2022). For these reasons, it is fundamental to study the impact of immigration on the Portuguese labour market. This dissertation is mainly based on the changes in immigration in Portugal and the scarcity of literature on this topic.

This dissertation studies the impact of immigration on the average wage of natives and along the wage distribution of natives. Furthermore, it estimates the consequences of immigration on the employment rate, unemployment rate, and labour force participation rate of natives. The analysis is carried out between 2003 and 2019 using the Portuguese Labour Force

Survey (*Inquérito ao Emprego* - quarterly sample survey conducted by *Instituto Nacional de Estatística*) as the main dataset and is based on a theoretical framework of a pure spatial model without pre-allocating workers into skill groups, following Dustmann et al. (2013). The spatial approach uses regional changes in immigrants' inflows to measure the effect of immigration on natives' wages. The theoretical model predicts that immigrants will exert downward pressure on wages on the locations of the wage distribution "where the relative density of immigrants is higher than the weighted relative density of natives" (Dustmann et al., 2013, p.155). The estimation is performed using a difference-in-difference method and an instrumental variable approach using the immigrant-native ratio from Census 2001 as an instrument. The estimated model regresses differences overtime of the ln real net hourly wage in percentiles across NUTS II regions in Portugal on times dummies, changes on the ratio of immigrants to natives across regions and time, and changes in the average age of natives and immigrants, in the ln ratio of high to low skilled natives and of medium to low skilled natives, and of the average years in Portugal of immigrants as controls. Using the instrumental variable estimation method, the effect of immigration on the average wage of natives is estimated, along with the effect of the distribution of wages for several percentiles and percentiles groups. Moreover, the impact of immigration for the employment rate, the unemployment rate, and the labour force participation rate of natives is estimated. To analyse heterogeneity, the same analysis is replicated for women and men, and for groups with different levels of education.

The criteria for defining an immigrant differ depending on the country or organization. The definition used in this dissertation is the country of birth. Therefore, an immigrant is a person born in a country other than Portugal, so a foreign-born[1].

The main results indicate that there is no significant impact of immigrants on the average wage of natives. The effect along the wage distribution does not vary much and the coefficients are very close to zero, despite not being statistically significant. However, the estimated coefficient for the impact on the average wage between the 10th and 30th percentiles is statistically significant (-0.157 percent). This result is in line with the theoretical model's prediction since the relative density of immigrants is higher than the one of natives on these percentiles. Immigration also seems to have a negative impact on the employment rate and participation rate of natives, with statistically significant results of -0.668 percentage points and -0.671 percentage points, respectively. Employment appears to be driving the impact on the

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[1] The estimation was also performed using the nationality criteria and similar results are reached, especially on the analysis of employment and participation rate.

participation rate. In terms of heterogeneity, immigrants negatively impact the employment and participation rates of men more than women. One percentage point (p.p.) increase on the immigrant-native ratio, decrease the female employment rate of natives by 0.504 p.p. and the male employment rate of natives by 0.733 p.p.. The effect is more negative with lower levels of education, ranging from -0.199 p.p. for natives with less than the 9th grade to -0.081 p.p. for natives with more than the 12th grade. There is also evidence of the downgrading of recent immigrants in the Portuguese labour market.

This dissertation makes three main contributions to the literature. First, it contributes to the literature on the impact of immigration on wages and employment. It uses a pure spatial approach to estimate these effects that is robust in the presence of downgrading of immigrants and that does not pre-allocate workers into skill groups. Second, it contributes to the literature on the impact of immigration on wage distribution, which is still scarce, with few studies conducted in other countries (e.g., Choe & Kerm, 2018; Edo, 2020; Hammer & Hertweck, 2022). Third, this dissertation contributes to enrich the empirical research and literature on the impact of immigration on the Portuguese labour market, which is also short. In addition, as far as my knowledge, it presents the first wage distribution analysis of the effect of immigration in Portugal. In particular, it contributes with an analysis of the recent phenomenon of immigration in the Portuguese labour market. Few studies have been made about the last two decades of immigration in Portugal, focusing mainly on the wage gap between natives and immigrants.

The rest of the dissertation proceeds as follows. Section 2 presents the literature review. Section 3 describes the latest developments on immigration in Portugal. Section 4 provides the theoretical framework. Section 5 describes the data used, sampling, data cleaning procedures and descriptive statistics. Section 6 presents the empirical model and methodology. Section 7 provides the results on the impact of immigration on natives' wages, wage distribution, employment rate, unemployment rate, and labour force participation rate. Section 8 presents the robustness checks. Section 9 concludes.

2. Literature Review

Immigration has several impacts on a country's economy. From a political perspective, it can give rise to conflicting individual preferences and debates over immigration policies (e.g., Scheve & Slaughter, 2001; Clemens et al., 2018; Lessem, 2018). Furthermore, immigration impacts firms' decisions, namely in offshoring (see Olney, 2012; Olney & Pozzoli, 2021), market power (see Amior & Stuhler, 2022), and productivity (e.g., Peri, 2012). Several other consequences have been studied.[2] This dissertation focuses on studying the impact of immigration on the labour market, namely on the wages and employment of natives.

The literature on the effects of immigration on the wages of natives is vast and contradictory. Studies present a negative impact (e.g., Dustmann et al., 2017), a positive impact (e.g., Boucher et al., 2022) and little effects (e.g., Card,1990; Card, 2001). Several papers have tried to explain the reasons for the different results on the impact of immigrants on the average wage of natives. Dustmann et al. (2016) claim that despite apparently trying to measure the same, these studies are measuring different parameters and taking into consideration different assumptions. In doing so, Dustmann et al. (2016) divide the empirical literature into four groups according to the approach implemented: the national skill-cell approach, the spatial approach, the mixed approach and the structural approach. We will closely follow this classification of the literature. The national skill-cell approach measures the wage impact at the national level. In contrast, the spatial and mixed approaches measure it at the local labour market level. All methods use the variation of immigrants' inflows to estimate this impact. The national skill-cell approach estimates the relative impact of immigration on wages for different experience groups within education cells (e.g., Borjas, 2003). The spatial approach estimates the total effect of immigrants on wages using regions within skill groups (e.g., Dustmann et al., 2013). The mixed approach, as the name suggests, uses regions and education-experience groups, estimating the relative wage impact of immigration across education groups (e.g., Glitz, 2012).

A possible factor for these mixed results is the internal migration of natives, i.e., smaller in-migration and higher out-migration levels in regions with greater immigration values. Internal migration of natives diminishes the impact of immigration on wages at the local labour market level. This results in biased estimates from the methods that use the local labour market level (Borjas, 2006; Dustmann et al., 2016; Borjas & Edo, 2021). Another element is the degree of substitutability between natives and immigrants assumed in each estimation approach. This

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[2] See Dustmann & Frattini (2014) for fiscal effects and Cortes (2008) for the impact on prices of immigration.

topic is controversial. Several studies conclude that immigrants have a greater impact on natives with similar skills since they are closer substitutes of natives in terms of education and occupational distribution. Low-skilled immigrants have a higher degree of substitutability for low-skilled natives and a lower degree of substitutability for high-skilled natives. However, even studies that use the national skill-cell approach, which relies heavily on this assumption, find that immigrants and natives can be in the same education-experience cell and be imperfect substitutes (Steinhardt, 2011; Bratsberg et al., 2014; Ortega & Verdugo, 2014; Kim, 2021). Thus, the structural approach (e.g., Manacorda et al., 2012) attempts to address this potential bias by allowing natives and immigrants to be imperfect substitutes within education-experience groups (Dustmann et al., 2016). However, this approach cannot totally reject the perfect substitutability assumption, since the estimates are sensitive to the specification and assumptions used (Kim, 2021). The structural approach's literature finds little impact on natives' wages, but strong negative effects on the wages of previous immigrants (Ottaviano & Peri, 2012; Piyapromdee, 2021). Moreover, one important concept is downgrading. Downgrading is the situation where workers work in an occupation which is below their education and experience levels. This may lead to the concentration of immigrants at the bottom of the wage distribution (Dustmann et al., 2013). Consequently, it creates a misclassification in approaches that assume that downgrading of immigrants does not happen and that their skills are fully transferable between countries, as is the case of the national skill-cell and mixed approaches. It can also cause estimation problems to the structural approach, resulting in biased estimates (Dustmann et al., 2016). Other reasons include sampling error. Sampling error can cause attenuation bias, hence a smaller estimated impact on wages (Aydemir & Borjas, 2011).

Most studies on this topic focus on the impact of immigration on the mean wage, ignoring the effect along the distribution of wages. Dustmann et al. (2013) presented a pioneer method to estimate the consequences of immigrants on the wage distribution of natives without pre-allocating workers into different skill groups. Studies applying this estimation method on several countries present again very different results (see Edo, 2020, for France; Hammer & Hertweck, 2022, for Germany; Pravitasari & Damayanti, 2019, for Indonesia). Some articles look not only to the wage distribution but also at the medium-run and short-run effects separately, finding temporary negative effects (see Edo, 2020; Hammer & Hertweck, 2022). Depending on the country analysed, the concentration of immigrants along the distribution is also different. Some studies find overrepresentation at the bottom (Yasenov, 2019) or at the top and bottom of the distribution (Favre, 2011; Dustmann et al., 2013.; Choe & Kerm, 2018).

Other estimated methods have been applied, namely the Recentered Influence Function (RIF) (e.g., Choe & Kerm, 2018; Lin & Weiss, 2019), proposed by Firpo et al. (2009).

As it is the case for wages, the literature on the impact of immigration on the employment of natives finds very different results, with positive effects (e.g., Ortega & Verdugo, 2014; Boucher et al., 2022), negative impacts (Dustmann et al., 2017; Elstad & Heggebø, 2021) and little effects (Card, 1990; Card, 2001; Kim, 2021). On employment, substitutability between natives and immigrants plays a role as well. Less educated immigrants affect more strongly and negatively youth employment rates than natives in general, since they present similar education levels (e.g., Smith, 2012). In addition, there is evidence that the employment of native skilled workers by the receiving countries' firms increases with the hiring of skilled immigrant workers (Kerr et al., 2015).

Few studies have been made about the impact of immigration on the Portuguese labour market. The literature is mostly around two main subjects: the impact of *retornados* in the 1970s and the wage gap between immigrants and natives. On the first topic, after the end of the colonial war in 1974, around half a million Portuguese returned to Portugal (the so-called *retornados*), the majority having born in Portugal. It constituted a labour supply shock on the Portuguese labour market (Bohnet et al., 2022). The literature finds no effects on employment (Carrington & De Lima, 1996) or negative effects, with females being more penalized than males (Mäkelä, 2017; Bohnet et al., 2022). On the second topic, on average, the wages of immigrants are lower than the ones of natives, yet growing at a higher rate (Duarte & Cabral, 2010). Cabral & Duarte (2013) use the Gelbach and Oaxaca-Blinder decompositions to explain the wage gap between immigrants and natives. Their dataset is a matched employer-employee database between 2002 and 2008. The authors find that the wage gap among workers is mostly driven by the returns on the characteristics of immigrants, namely education and experience, which are lower than natives with similar skills. This suggests that skills are not perfectly transferable between countries. Additionally, the wages of immigrants do not fully converge to the wages of natives of similar skill levels as the years working in Portugal increase[3]. Damas de Matos (2017) concludes that job mobility of immigrants to companies with higher wage premiums represents 30% of the wage assimilation in the first years in the country (Damas de Matos, 2017) . Additionally, Carneiro et al. (2012) conclude that, in the first years, the wage gap is largely attributable to downgrading and segregation of immigrants in occupations and firms characterized by lower wages. Martins (2018) evidence a high degree of complementarity

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[3] Cabral & Duarte (2016) find very similar results.

between immigrants and workers on hiring and firing. Furthermore, using the same database, Cabral & Duarte (2014) studied the impact of nominal and real rigidities on immigrants and natives. The difference between the two groups is not sizeable, but immigrants are more prone to institutional rigidity and potential negative impact on employment. One cause for this is related to the fact that a significant share of immigrants earns the minimum wage.

The present dissertation builds on the pure spatial approach, closely following Dustmann et al. (2013). It measures the effect of immigration on natives' wages using geographical variations of immigrant inflows without pre-allocating workers into different skill groups. This model has the advantage of being the only one robust in the presence of downgrading of immigrants and the one which presents relevant estimates for policy purposes (Dustmann et al., 2016). Moreover, few papers have done the analysis on the wage distribution and, as far as my knowledge, none for Portugal. It was also studied the effect on employment, unemployment and labour force participation rates.

3. Immigration in Portugal

Since the end of the 1990s and the beginning of the 2000s, immigration in Portugal has accelerated and has changed the paradigm of migration in the country. As explained in section 1, in this dissertation the criteria of the country of birth is used for an individual to be considered an immigrant. Figure 1 displays the evolution of the foreign-born population as a percentage of the total population between 2000 and 2019. In 2000, 5% of the resident population in Portugal was foreign-born, which increased to 10.80% in 2019. Except for 2006 and 2014, this indicator increased every year compared to the previous one.

Figure 1 – Evolution of the foreign-born population as a percentage of total population in Portugal
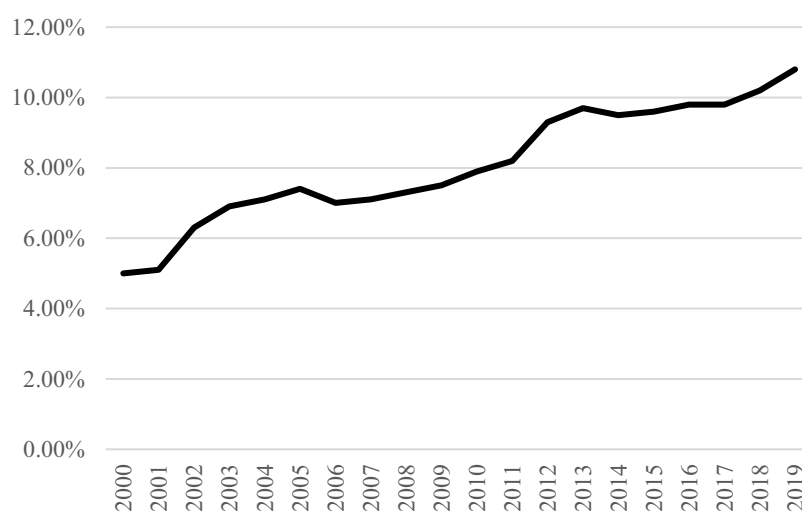
Source: Data from OECD (2022a)
Note: The Figure presents the evolution of the foreign-born population as a percentage of total population in Portugal in each year between 2000 and 2019.

According to *Recenseamentos da População e da Habitação- Censos*, Portugal registered a foreign-born resident population of 651472, 871813, and 1089023, in 2001, 2011, and 2021, respectively. Área Metropolitana de Lisboa, Norte and Centro are the NUTS II[4] regions which concentrated a higher number of immigrants during this period (Instituto Nacional de Estatística, 2002, 2012, 2022a). The countries of origin of immigrants have also changed. In 2021, Brazil was the country most represented in the foreign-born resident population in Portugal. The percentage of foreign-born residents with Brazil as place of birth has increased a lot in the last years, recording 7.66%, 16.02% and 24.90%, in 2001, 2011, and 2021, respectively. PALOP[5] countries, namely Angola, Mozambique, Cape Verde and Guinea-Bissau, are during the period some of the most represented countries of origin, along with some European countries, such as France, Germany and United Kingdom. In the last decade, there is an increase in immigrants from Eastern European countries. For example, Ukraine, represented 3.09% of the foreign-born population in 2021. Another highly represented country is Venezuela (Instituto Nacional de Estatística, 2002, 2012, 2022). According to Census 2021, 53.27% of the

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[4] NUTS II includes the following regions: Norte, Centro, Área Metropolitana de Lisboa, Alentejo, Algarve, Região Autónoma dos Açores and Região Autónoma da Madeira.
[5] PALOP (Portuguese-speaking African countries) includes Angola, Cape Verde, Guinea-Bissau, Mozambique, São Tomé e Príncipe and Equatorial Guinea.

foreign-born population resident in Portugal were women and 81.61% of this population were between 15 and 64 years old (Instituto Nacional de Estatística, 2022).

Moreover, the employment rate of foreign-born is higher than native, as can be seen in Figure 2, between 2000 and 2021. However, the unemployment rate of foreign-born is also higher than the one of natives (see Figure A1 in the Appendix). The labour force participation rate is higher as well for immigrants, which can reflect the fact that most immigrants are part of the working-age population (see Figure A2 in the Appendix).

Figure 2 – Native-born employment rate and Foreign-born employment rate in Portugal

Source: Data from OECD (2022b, 2022c)
Note: The Figure presents the native-born employment rate and the foreign-born employment rate. The native-born employment rate is the share of employed natives between 15 and 64 years old in the total population of natives between 15 and 64 years old. The foreign-born employment rate is the share of employed foreign-born between 15 and 64 years old in the total population of foreign-born between 15 and 64 years old.

4. Theoretical Framework - Dustmann et al. (2013)

This dissertation follows closely the theoretical model of Dustmann et al. (2013). This model of labour market equilibrium rests on several assumptions. It assumes a nested constant elasticity of substitution (CES) production function of a profit-maximizing firm, which produces one single output, y, and uses several labour types, i ($i = 1, ..., L$), with full employment of workers, and capital, K, in the production process. l_i is the labour supplied by the ith labour type, with l_i^0 standing for native labour of each type i and l_i^1 standing for immigrant labour of each type i. The world market fixed price of the output is normalized to 1. The production function is given by $y = [\beta H^s + (1 - \beta)K^s]^{\frac{1}{s}}$, with $H = [\sum_i \alpha_i l_i^\sigma]^{\frac{1}{\sigma}}$ and where β stands for the relative productivity of labour and capital, H is the aggregate of purely labour inputs, s is the elasticity of substitution between capital and labour (with $s \leq 1$), α_i is the productivity of the ith labour type and σ is the elasticity of substitution between the different types of labour (with $\sigma \leq 1$).

Another assumption is that labour of the same type i supplied by natives and immigrants are perfect substitutes and equally productive, with $l_i = l_i^0 + l_i^1$. The market clearing condition is $l_i = n_i$, $\forall i$ with n_i being the supply of labour of the ith labour type, which is composed of labour of natives and immigrants, with $n_i = n_i^0 + n_i^1$. The first order conditions equalize w_i, the real wage of the ith labour type, with the marginal productivity of labour, and ρ, the price of capital, equals the marginal productivity of capital. Therefore, the equilibrium change in the log real wage of natives caused by a change in the immigrant-native ratio in the labour force, m, is given by:

$$\frac{d \ln w_i}{d m}\bigg|_{m=0} = (\sigma - 1)\left(\frac{\pi_i^1}{\pi_i^0} - \emptyset \sum \omega_j \frac{\pi_j^1}{\pi_j^0}\right),$$

where π_i^1 is the fraction of immigrant labour of the ith labour type, π_i^0 is the fraction of native labour of the ith labour type, $\emptyset$ is a parameter which is conditional on the labour share, the degree of capital mobility across the different labour types and the substitutability between capital and labour, and ω_j is the weight on the aggregate labour of the ith labour type.

Since $(\sigma - 1)$ is negative and assuming that $\emptyset=1$ (if capital is perfectly mobile (i.e., the elasticity of capital supply is infinite), there is perfect substitutability between capital and

labour, or the capital share is equal to zero) , then the impact on the wages of natives in the ith labour type is negative if the ratio of the proportion of immigrant workers to native workers for each ith labour type is greater than the weighted average of the same ratio in all the distribution of labour types. Moreover, if $\pi_i^1 = \pi_i^0$, $\forall$ i (this is, if the fraction of immigrant workers is the same as of native workers in all percentiles), the impact of immigration on natives' wages across all the distribution of labour types is zero. If $\emptyset < 1$ (which happens when capital is imperfectly mobile and imperfectly substitutable to labour), the first-order effect is negative on the mean wage of natives. The relative negative effect on wages will be stronger on the ith labour types where the immigrants' inflows are larger. Additionally, immigration can exert a positive effect on the wages of natives if immigrants are paid less than their added value to production and this surplus returns to native workers if profits are zero. This is also known as the "immigration surplus' argument". For this is necessary that capital is mobile and immigrants' labour is sufficiently different from natives' labour in its skill distribution[6]. Additionally, it is assumed rank insensitivity, i.e., ranks in the wage distribution remain the same with immigration.

5. Data, Sampling and Descriptive Statistics

5.1 Data

The main dataset of the dissertation is the Portuguese Labour Force Survey (LFS) (*Inquérito ao Emprego)* for the years between 2003 and 2019[7], which is a quarterly sample survey conducted by *Instituto Nacional de Estatística* (INE). The survey seeks to characterize the labour force resident in Portugal, namely the employed, unemployed and inactive populations. The sample is composed by individuals residing in family households. There is a rotating scheme where households remain in the sample for six consecutive quarters. Data relating to the labour market, education and health are collected only for individuals in the household aged between 16 and 89 years old, while demographic information is collected for all individuals in the household. This information includes several variables used in the dissertation, such as region of resident (according to NUTS II), sex, age, country of birth,

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[6] The full set of derivations can be found in Appendix B of Dustmann et al. (2013). The same analysis for a more general model can be found in Appendix A of Dustmann et al. (2013). With this general model, the same qualitative conclusions are reached.

[7] In this case, we have used two waves of the LFS: one from 1998 to 2010, and another one from 2011 to 2019.

highest educational attainment level achieved, usual weekly working hours and net monthly wage. Each individual is assigned a weight according to its representativeness in the Portuguese population. It has a legal basis within the framework of the European Union and follows a set of harmonization requirements, in accordance with European regulations (Instituto Nacional de Estatística, 2022b).

Additionally, data from *Recenseamentos da População e da Habitação- Censos* were used to construct the instrumental variable of the ratio of immigrants to natives for each NUTS II region in Portugal. The Population Census covers the entire Portuguese population and not just a sample like LFS. Besides, it focuses on the characterization of the population in all its dimensions, while the LFS is more focused on the labour market. Censuses take place every ten years and are conducted by INE. The last Census took place in 2021 (Instituto Nacional de Estatística, 2022c).

The Consumer Price Index (CPI) values for each quarter and NUTS II region were also used. To calculate the CPI of each quarter by NUTS II region, the average monthly CPIs of each quarter was computed. The monthly CPI values per NUTS II were calculated by INE, using 2012 as the base year.

5.2 Sampling and Data Cleaning

The analysis is made over all quarters of the period between the first quarter of 2003 and the fourth quarter of 2019. It was decided not to include the quarters of 2020 in the analysis (last year with data available) so that the study would not have into account the effect of the COVID-19 pandemic, due to its extraordinary nature. The variables used for each individual were the following: year and quarter of the survey, fix identification of the individual, NUTS II region of residence, sex, age, country of birth, occupation for employed individuals, type of contract for employed individuals, labour status, usual weekly working hours for employed individuals, the highest education level achieved, net monthly income from the main activity for employees, weight, and years since the arrival to Portugal for immigrants. Data were harmonized to account for differences, not only between series but also between some years. A detailed description of the harmonization process can be found in the Appendix on "Harmonization of data from the LFS".

In addition to these variables, several others were created using the dataset. A variable was created dividing the individuals into employed, unemployed and inactive, according to

their category in the variable regarding labour status.[8] The variable "Educational attainment" was created following the educational attainment levels of Eurostat: low, medium and high. Low education corresponds to less than primary, primary, and lower secondary education. Medium corresponds to upper secondary and post-secondary non-tertiary education. High education corresponds to tertiary education (Eurostat Statistics Explained, 2022). Correspondence with the variable referring to the highest education level achieved is as follows: low education (categories 1-4), medium education (categories 5 and 6), and high education (all other categories)[9].A variable of years of schooling was also created, having as reference the *Quadro de Qualificações* of *Direção Geral do Ensino Superior* (Direção Geral do Ensino Superior, 2022). After harmonizing the data, the classification of occupation for employed individuals by the CPP-10 was converted to groups of occupation according to the major groups of ISCO-08, which are very similar to the former. The groups are 1) Armed forces occupation; 2) Managers; 3) Professionals; 4) Technicians and associate professionals; 5) Clerical support workers; 6) Service and sales workers; 7) Skilled agricultural, forestry and fishery workers; 8) Craft and related trades workers; 9) Plant and machine operators, and assemblers; 10) Elementary occupations. The variable "number of years in Portugal" for immigrants was created from the variable "years in Portugal" before 2011 and from the variable "year of arrival in Portugal" from 2011 onwards. Usual hours worked per month were computed using usual weekly working hours and assuming 4.3 weeks per month[10]. The net hourly wage was calculated by diving the net monthly wage by the number of usual monthly working hours. The variable of the real net hourly wage was created by dividing the net hourly wage by the division of the CPI by 100, using the CPI for the respective quarter and NUTS II region, with 2012 as the base year.

The analysis of this dissertation is restricted to the working-age population, i.e., with an age comprised between 16 and 64 years old[11]. The analysis is also restricted to the observations which have information on sex, NUTS II region of residence and country of birth. This is the sample used to perform the analysis on the impact of immigrants on the employment rate, unemployment rate and labour force participation rate of natives. Additional restrictions are set

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[8] The description of the variable concerning labour status can be found in the Appendix on "Harmonization of the data from the LFS".

[9] The description of the variable concerning the highest education level achieved can be found in the the Appendix on "Harmonization of the data from the LFS".

[10] The average number of weeks in a month is 4.3 .

[11] According to OECD, the working age population is the population with an age between 15 and 64 years old. However, since the minimum age to be able to work in Portugal is 16, it seems more appropriate to consider as working age population from 16 years old onwards.

on the analysis of the impact of immigration on natives' wages. The analysis only includes employees[12]. Moreover, it only includes individuals with weekly working hours between 15 and 50 hours. Furthermore, we only keep the observations whose real net monthly wage[13] is equal to or higher than 80% of the real net monthly minimum wage[14] in each year and equal to or lower than 49879.79 euros[15] in real terms. These last two restrictions are enforced to eliminate outliers that otherwise could bias the results. The sample used to perform the analysis on the impact of immigration on natives' wages is called "Wage Sample" and the sample used to analyse the impact of immigration on employment, unemployment and labour force participation rates is named "Employment Sample"[16].

5.3 Immigrants in the wage distribution and Downgrading

The theoretical model indicates that the downward impact of immigration on wages will be higher where the relative density of immigrants exceeds the weighted relative density of natives in the wage distribution of natives (Dustmann et al., 2013). This is closely related to the concept of downgrading, i.e., due to the lack of perfect transferability of skills across countries, workers work in occupations that are below their levels of education and experience. Thus, to link the theoretical model and the empirical analysis, it is necessary to characterize natives and immigrants by checking the existence of downgrading and see what is the position of immigrants on the wage distribution.

Table 1 presents some characteristics of natives and immigrants in the analysed period and for the "Wage Sample"[17]. The percentage of men and women is similar between natives and immigrants but with a slightly higher percentage of men for natives and women for immigrants. The average age is also similar, but, on average, immigrants are about one year younger. As for the type of contract, immigrants have more precarious contracts with higher percentages of fixed-term employment and service contracts and a difference of around 10

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[12] The only ones with information on net monthly wage.

[13] The real net monthly wage is calculated by dividing the net monthly wage by the division of the CPI by 100, using the CPI of the respective quarter and NUTS II region, with 2012 as the base year.

[14] The values considered for the monthly minimum wage are the following (in euros): 356.6 (in 2003), 365.6 (in 2004), 374.7 (in 2005), 385.9 (in 2006), 403 (in 2007), 426 (in 2008), 450 (in 2009), 475 (in 2010), 485 (between 2011 and 2014), 505 (in 2015), 530 (in 2016), 557 (in 2017), 580 (in 2018), 600 (in 2019). The net monthly minimum wage is calculated taking into account a *Taxa Social Única* (TSU) of 11%. The real net monthly minimum wage is computed by dividing the net monthly minimum wage by the division of the CPI by 100, using the CPI of the respective quarter and NUTS II region, with 2012 as the base year.

[15] 49879.79 euros is the upper limit set by INE on the question regarding the net monthly wage of employees. Only the third and fourth quarters of 2017 have values reported that exceed 49879.79 euros.

[16] The "Wage Sample" has 899513 observations and the "Employment Sample" has 1913850 observations.

[17] It was decided to use the "Wage Sample" since the focus here is on wages.

percentage points in permanent employment contracts compared to natives. In terms of educational attainment, immigrants have a higher education than natives. The percentage of natives is always higher until the 6 years of schooling and lower from the 9 years of schooling onwards compared to immigrants. Table A1 in the Appendix displays the same characteristics only for the years 2003, 2011 and 2019, so that it is possible to visualize their evolution. A similar pattern can be found. The average age between natives and immigrants has been approaching and in 2019 both are around 40 years old. Immigrants have higher education in general, but the percentage of natives with higher education has been increasing and with less education decreasing, with improvements in all categories of years of schooling.

Table 1 – Main characteristics of natives and immigrants (2003-2019)

	Natives	Immigrants
Gender (%)		
Male	51.06	48.18
Female	48.94	51.82
Average age	39.76	38.62
Type of contract (%)		
Permanent employment	81.89	72.82
Fixed-term employment	16.46	24.46
Service contract (*recibos verdes* or similar)	1.64	2.71
Educational attainment (%)- years of schooling completed		
0 years	1.65	1.35
4 years	18.14	5.86
6 years	17.34	11.06
9 years	21.39	22.09
12 years	21.26	31.73
Tertiary	20.23	27.91
Educational attainment (%)- groups of education		
High education	19.76	26.95
Medium education	21.71	32.69
Low education	58.52	40.36

Source: Computed using data from the LFS
Note: The Table presents the weighted percentage of each gender, average age, percentage of each type of contract, percentage of each educational attainment by years of schooling completed and groups of education of Eurostat (high, medium and low) for natives and immigrants between 2003 and 2019. It was used the "Wage Sample".

Moreover, as will be explained in detail in section 6, the estimation process relies on the "variation of the stock of immigrants between two subsequent years" (Dustmann et al, 2013, 153). Therefore, the most recent immigrants propel this variation. For this reason, it is also important to distinguish between earlier immigrants and recent immigrants. Earlier immigrants

are defined as foreign-born who have been in Portugal for two years or more and recent immigrants are foreign-born who have been in Portugal for less than two years.

Table 2 shows the occupational distribution of natives, earlier immigrants and recent immigrants in 2018 and 2019. 48.81% of recent immigrants work in the categories with the three lowest average wages (Elementary occupations; Agriculture, forestry and fishery; Services and sales), which contrasts with 35.26% of earlier immigrants and 31.75% of natives. Although immigrants generally have a higher level of education than natives, they work in occupations with lower wages.

Table 2 – Occupational distribution in 2018 and 2019

	Natives	Earlier immigrants	Recent immigrants	Average wage
Occupations (%)				
Armed forces	0.41	0.40	0.00	6.514
Managers	3.28	4.38	3.81	8.341
Professionals	19.03	20.94	10.95	7.628
Technicians	12.55	11.58	6.67	5.618
Clerical support	10.60	10.55	8.33	4.449
Service and sales	19.76	19.77	22.62	4.005
Agriculture, forestry and fishery	1.56	1.55	1.43	3.633
Craft and trades	13.01	10.38	15.00	4.155
Plant and machine operators	9.36	6.50	6.43	4.053
Elementary occupations	10.43	13.94	24.76	3.567

Source: Computed using data from the LFS

Note: The Table presents the weighted occupational distribution of natives, earlier immigrants and recent immigrants in years 2018-2019 pooled. Average wage is the weighted average of the real net hourly wage for each occupation in years 2018-2019. It was used the "Wage Sample".

Within each educational attainment group, we can also observe, in Table 3, that recent immigrants tend to be in occupations with lower average wages. For example, the percentage of highly educated individuals working in the three lowest-paying occupations is 25.08%, 10.65% and 5.06% for recent immigrants, earlier immigrants and natives, respectively. The same for the low-skilled individuals, with 55.38%, 53.07% and 39.94% for recent immigrants, earlier immigrants and natives, respectively.

Table 3 – Occupation by educational attainment in 2018 and 2019

	High education		
	Natives	**Earlier immigrants**	**Recent immigrants**
Occupations (%)			
Armed forces	0.58	0.66	0.00
Managers	8.63	10.31	9.80
Professionals	66.04	56.69	31.70
Technicians	12.07	9.70	14.21
Clerical support	6.37	8.57	11.47
Service and sales	4.67	6.76	16.17
Agriculture, forestry and fishery	0.06	0.46	1.08
Craft and trades	0.81	1.79	3.13
Plant and machine operators	0.44	1.63	4.61
Elementary occupations	0.33	3.43	7.83

	Medium education		
	Natives	**Earlier immigrants**	**Recent immigrants**
Occupations (%)			
Armed forces	0.96	0.72	0.00
Managers	2.66	3.21	3.40
Professionals	4.40	3.13	0.48
Technicians	21.87	17.76	6.77
Clerical support	19.05	15.89	14.02
Service and sales	27.39	26.64	25.53
Agriculture, forestry and fishery	0.42	1.60	1.00
Craft and trades	9.80	11.12	14.80
Plant and machine operators	7.92	8.07	11.11
Elementary occupations	5.53	11.75	22.90

	Low education		
	Natives	**Earlier immigrants**	**Recent immigrants**
Occupations (%)			
Armed forces	0.17	0.27	0.00
Managers	0.91	1.07	4.69
Professionals	0.50	0.17	0.00
Technicians	6.79	5.94	0.00
Clerical support	6.53	5.76	0.97
Service and sales	21.26	22.37	18.35
Agriculture, forestry and fishery	2.41	1.83	0.00
Craft and trades	25.95	21.50	32.82
Plant and machine operators	19.20	12.21	6.14
Elementary occupations	16.27	28.87	37.03

Source: Computed using data from the LFS

Note: The Table presents the weighted occupational distribution of natives, earlier immigrants and recent immigrants by educational attainment groups of Eurostat in 2018-2019. It was used the "Wage Sample".

Tables 2 and 3 support the existence of downgrading of recent immigrants in the Portuguese labour market. This indicates that the choice for a pure spatial model was right, since it is the only one robust in the presence of downgrading (Dustmann et al., 2016).

Using the kernel density estimation[18], Figure 3 displays the actual and predicted density of recent immigrants on the wage distribution of natives. The density of immigrants is higher than the density of natives from percentile 10 to percentile 40 and lower from the percentile 40 onwards, except from percentile 55 to 65. Therefore, we should expect that natives' wages would be more impacted between percentiles 10 and 40 and between percentiles 55 to 65. Also, we can conclude that immigrants are overrepresented on the bottom of the distribution. The same result can be found on the literature, e.g. Yasenov (2019). However, based on the educational attainment of recent immigrants, this result was not expected. The difference between the predicted and actual density lines shows just that. With recent immigrants predicted to be more concentrated from the percentile 40 onwards and less concentrated until the percentile 40. The predicted values are calculated using the educational attainment and age of recent immigrants[19]. Figure 3 also supports the existence of downgrading.[20] Carneiro et al. (2012) and Cabral and Duarte (2012) also find evidence of downgrading for Portugal. Figure A3 in the Appendix shows the actual density of immigrants on the wage distribution of natives for each NUTS II region, which present similar distributions.

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[18] The kernel estimates are computed in the log of the odds of the position in the native distribution.

[19] The estimation is performed using a flexible log wage regression with five age categories, four educational categories, the interaction between these two variables and quarter dummies. Estimation is made for females, males and several years.

[20] It was also computed the Duncan index of dissimilarity on occupations for recent immigrants and natives. The effective index over age-education cells is 24.90 (i.e., in order to achieve the same occupational distribution of natives, 24.9% of recent immigrants would have to change their occupation) and across wage cells is 14.89.

Figure 3 – Actual and predicted density of recent immigrants in the wage distribution of natives
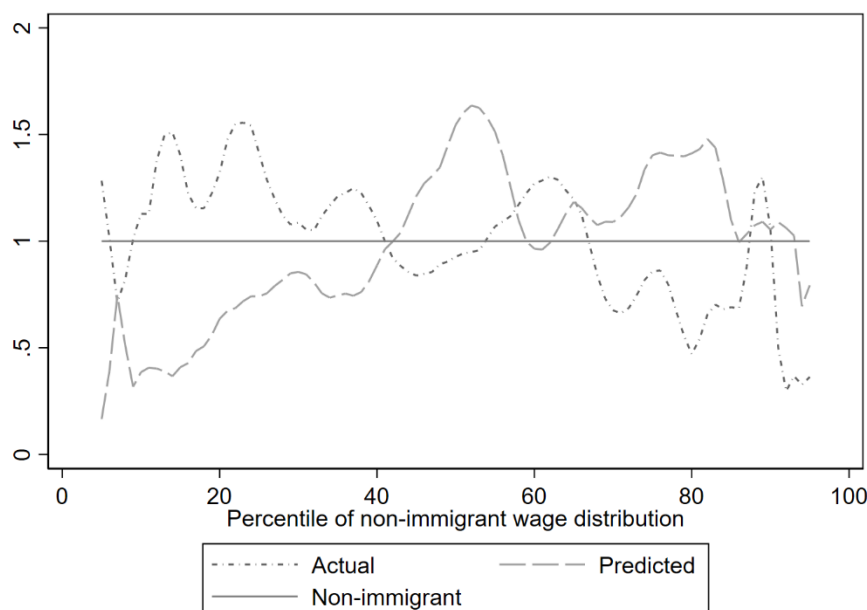
Source: Computed using data from the LFS

Note: The Figure presents the predicted and actual density of recent immigrants along the wage distribution of natives as compared to the native wage distribution. The densities plotted are based on kernel estimates. The estimation was done using weights. It was used the "Wage Sample".

5.4 Descriptive Statistics

Table 4 reports some descriptive statistics on all variables used in estimating the impact of immigration on the average wage of natives between 2003 and 2019. It was used the "Wage Sample" between the 10th and 90th percentiles[21]. The real net hourly wage is, on average, lower than the constructed wage index. On average, natives are two years older than immigrants. The mean ratio of immigrants to natives is 0.099 (that is, almost one in every ten individuals is an immigrant) and the average years in Portugal of immigrants is 22.249 years.

Table A2 in the Appendix presents the descriptive statistics for 2003, 2011 and 2019. There is an increase over the years in the average wage of natives, in the immigrant-native ratio and in the average number of years an immigrant has been in Portugal. There is also an approximation of the average age of natives and immigrants, with an increase in the average age of immigrants. Table A3 in the Appendix reports descriptive statistics on immigrants' inflows. Table A4 in the Appendix presents the statistics for the full "Wage Sample", which is

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[21] The detail explanation of this estimation can be found in section 6.

used in the estimation along the wage distribution of natives and by percentiles' groups, with similar values.

Table 4 – Descriptive Statistics: "Wage Sample" between the 10th and 90th percentiles

	Mean	Standard Deviation
Ln real net hourly wage	1.484	0.096
Ln wage index	1.546	0.096
Immigrant-native ratio	0.099	0.063
Annual change in immigrant-native ratio	0.003	0.014
Average age of natives	39.923	1.709
Average age of immigrants	37.853	3.078
Ln ratio of high to low skilled natives	-1.197	0.639
Ln ratio of medium to low skilled natives	-0.991	0.487
Average years in Portugal of immigrants	22.249	4.784

Source: Computed using data from the LFS

Note: The Table presents descriptive statistics (mean and standard deviation) on all variables used in the estimation of the impact of immigration on the average wage of natives across all NUTS II regions and between 2003 and 2019. The statistics were computed using weights. It was used the "Wage Sample" between the 10th and 90th percentiles.

Table 5 presents some descriptive statistics on the impact of immigration on employment, unemployment and participation on the labour force rates of natives between 2003 and 2019[22]. The sample used is the "Employment Sample"[23]. The average employment, unemployment and participation rates are 60.84%, 6.64% and 67.48%, respectively. The employment rate of women is lower than that of men by around 9 p.p. .The participation rate is higher for men but the unemployment rate has similar values for both genders. Table A5 in the Appendix presents the descriptive statistics of the same analysis, but using education's groups. Table A6 in the Appendix displays the descriptive statistics for 2003, 2011 and 2019, which show a clear drop in the employment rate and an increase in the unemployment rate during the financial crisis, in 2011. Table A7 in the Appendix reports the descriptive statistics on immigrants' inflows.

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[22] The detail explanation of this estimation can be found in section 6.

[23] The descriptive statistics using the additional restrictions of the "Wage Sample" present similar results.

Table 5 – Descriptive Statistics: "Employment Sample"

	Mean	Standard Deviation
Employment Rate	60.837	4.167
Unemployment Rate	6.640	2.635
Participation Rate	67.477	3.064
Female Employment Rate	56.142	3.840
Male Employment Rate	65.646	6.338
Female Unemployment Rate	6.413	2.317
Male Unemployment Rate	6.881	3.130
Female Participation Rate	62.555	3.911
Male Participation Rate	72.527	4.465
Immigrant-native ratio*100	9.152	6.059
Annual change in immigrant-native ratio*100	0.340	0.974
Average age of natives	40.256	1.222
Female average age of natives	40.597	1.221
Male average age of natives	39.900	1.251
Average age of immigrants	37.149	3.252
Ln ratio of high to low skilled natives	-1.695	0.658
Female ln ratio of high to low skilled natives	-1.409	0.648
Male ln ratio of high to low skilled natives	-2.058	0.697
Ln ratio of medium to low skilled natives	-1.229	0.437
Female ln ratio of medium to low skilled natives	-1.113	0.427
Male ln ratio of medium to low skilled natives	-1.351	0.463
Average years in Portugal of immigrants	20.984	4.182

Source: Computed using data from the LFS

Note: The Table presents descriptive statistics (mean and standard deviation) on variables used in the estimation of the impact of immigration on employment, unemployment and participation on the labour force rates (%) of natives between 2003 and 2019. The statistics were computed using weights. It was used the "Employment Sample".

6. Empirical Model and Methodology

Following the theoretical model explained in section 4, the derived empirical model as proposed by Dustmann et al. (2013) is:

$$\ln W_{prt} = a_{pr} + b_{pt} + c_p X_{rt} + (\sigma - 1)\varphi_{prt}\, m_{rt} + \varepsilon_{prt}$$

where W_{prt}[24] is the pth percentile of the native wage distribution in region r and time t, a_{pr} is the region effects, b_{pt} is the time effects, X_{rt} are the controls for age and skills of the native labour force, and ε_{prt} is the random error. Here, the different skill types i correspond to different locations, p percentiles, on the wage distribution of natives. $(\sigma - 1)\varphi_{prt} m_{rt}$ measures the impact of immigration. If we assume that $\varphi_{prt} = \varphi_p$ (constancy across regions and time), then the impact of m_{rt} on $\ln W_{prt}$ is given by a constant parameter γ_p at each point p of the native wage distribution, which represents the percentage change on the wages of natives of the pth percentile of the native wage distribution in region r and time t when the immigrant-native ratio, m_{rt}, changes by one percentage point. Therefore, from the theoretical and empirical framework, the parameter γ_p should be lower in the percentiles of the native wage distribution where the density of immigrants is higher and vice-versa. The density of immigrants on the wage distribution is displayed in Figure 3.

The implementation of the model is done through a difference-in-difference approach, estimating the following model:

$$\Delta \ln W_{prt} = \beta_t + \Delta X_{prt} + \gamma_p \Delta\, m_{rt} + \Delta\varepsilon_{prt}$$

where $\Delta \ln W_{prt}$ are the differences over time of the ln real net hourly wage in percentiles across the NUTS II regions in Portugal, β_t represents time dummies[25], ΔX_{prt} are the changes in the average age of natives and immigrants, in the ln ratio of high to low skilled natives and of

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[24] W_{prt} is w_i from the theoretical model in section 4, with i being the smallest value satisfying the condition $\sum_{j \leq i} \pi_j^0 \geq 100p$.

[25] Assuming that capital is perfectly mobile between regions, the price of capital is the same in all regions. The impact of immigration is absorbed by the time effects. Therefore, the region effects are controlled by differentiating and the inclusion of time dummies.

medium to low skilled natives, and of the average years in Portugal of immigrants[26], Δm_{rt} are the changes on the ratio of immigrants to natives across regions and time and $\Delta \varepsilon_{prt}$ is the changes on the random error term. An instrumental variable (IV) estimation was performed using the 2001 ratio of immigrants to natives from Census for each region interacted with year dummies as an instrument for the immigrant-native ratio. In addition, an OLS estimation is computed as other specification. Two types of regression were computed for each estimation method: "Baseline" and "All controls". The "Baseline" uses only the year dummies variable. "All controls" refers to the use of the changes on the average age of natives, average age of immigrants, ln ratio of high to low skilled natives, ln ratio of medium to low skilled natives, average years in Portugal of immigrants as controls, combined with the year dummies.

In this dissertation, the preferred estimation is the one using the instrumental variable method and "All controls". Two different measures of wages are used, named "Average Wage" and "Wage Index". The "Average Wage" is the real net hourly wage and "Wage Index" is an index of the weighted sum of the real net hourly wage in each educational attainment group of Eurostat (high education, medium education, low education).

The estimation of the impact of immigration on the rates of employment, unemployment and participation on the labour force of natives follows a very similar estimation equation with two main differences: $\ln W_{prt}$ is replaced by the employment rate, unemployment rate and labour force participation rate of natives[27], and m_{rt} is the immigrant-native ratio multiplied by 100 to facilitate the interpretation. In the estimation of these equation it was used the seven NUTS II regions of Portugal and the years between 2003 and 2019. For the estimation of the impact of immigration on wages of natives is used the "Wage Sample" and for the impact of immigration on the employment rate, unemployment rate and participation on the labour force rate of natives is used the "Employment Sample". The sample weights of the LFS are always used, so all the results are weighted. Standard errors are clustered by NUTS II region.

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[26] The variable of the average years in Portugal of immigrants across regions, time and percentiles is not used in the estimation of Dustmann et al. (2013) but it seems important to include it as control. It presents to be a statistically significant variable in most estimations.
[27] Employment rate of natives=(working-age employed natives/working-age population of natives)*100. Unemployment rate of natives=(working-age unemployed natives/working-age population of natives)*100. Participation on the labour force rate of natives= ((working-age employed natives + working-age unemployed natives)/working-age population of natives)*100. The working-age population of natives comprises natives between 16 and 65 years old. The sample is already restricted to the working-age population.

7. Results

7.1 Impact of immigration on natives' wages

The estimation of the impact of immigration on the wage distribution of natives is showed in Table 6. The coefficients for the 10th, 25th, 50th, 75th, and 90th percentiles are estimated using the sample "Wage Sample" and the "Average Wage". At these percentiles the results are not statistically significant[28] and OLS estimates provide a less negative (or more positive) impact than IV estimates. Also, the effect when accounting for all controls using the instrumental variable approach is less negative than the baseline. The F-statistic for the significance of excluded instruments from the first stage regression of the estimation using the 2001 immigrant-native ratio interacted with year dummies and all controls (IV All controls) is 79.489, which provides evidence of the strength of the instrument.

Table 6 – Impact of immigration on the wage distribution of natives

	Preferred estimation	Other specifications		
	IV **All controls**	OLS Baseline	OLS All controls	IV Baseline
10th Percentile	-0.075	-0.052	-0.062	-0.127
	(0.115)	(0.151)	(0.154)	(0.180)
25th Percentile	0.038	0.115	0.230	-0.074
	(0.210)	(0.265)	(0.263)	(0.195)
50th Percentile	0.009	0.225	0.374	-0.130
	(0.224)	(0.362)	(0.342)	(0.313)
75th Percentile	-0.306	0.018	0.106	-0.644**
	(0.334)	(0.497)	(0.382)	(0.279)
90th Percentile	-0.081	0.094	0.484	-0.440
	(0.362)	(0.502)	(0.384)	(0.558)
Observations	112	112	112	112

Standard errors are in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Source: Computed using data from the LFS

Note: The Table presents the estimated coefficients of the impact of immigration on the 10th, 25th, 50th, 75th and 90th percentiles of the wage distribution of natives between 2003 and 2019 using the "Average wage". "Average Wage" refers to the real net hourly wage. The "Baseline" uses only the year dummies variable. "All controls" refers to the use of changes on the average age of natives, average age of immigrants, ln ratio of high to low skilled natives, ln ratio of medium to low skilled natives, average years in Portugal of immigrants as controls, combined with the year dummies. The statistics were computed using weights and standard errors are clustered by NUTS II region. It was used the "Wage Sample".

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[28] With the exception of the coefficient of the 75th percentile, using the baseline IV regression, at a 5% significance level.

For a better understanding of the results, a graphical representation is plotted in Figure 4, with the wage distribution of all 5 by 5 percentiles from the 10th to the 90th percentiles using the instrumental variable estimation with all controls of the "Average Wage". Analysing Figure 4, it seems that the impact of immigration does not vary much according to the wage percentile. With the 95% confidence interval, in each percentile it is not possible to conclude whether the impact is positive or negative, but it seems that all percentiles have coefficients close to zero. The exception is the 15th percentile, where over the 95th confidence interval the coefficient is always negative, indicating a result in line with the one predicted in the theoretical model. At the 15th percentile, the relative density of immigrants is higher than the one of natives (see Figure 3), so immigrants should exert downward pressure on the wages of natives in this percentile. This seems to be corroborated by the empirical analysis.

Figure 4 – Impact of immigration along the wage distribution of natives

Source: Computed using data from the LFS

Note: The Figure shows the estimated coefficients of all 5 by 5 percentiles between 10th and 90th percentiles of the impact of immigration along the wage distribution of natives between 2003 and 2019, using the instrumental variable estimation with all controls of the "Average Wage". "Average Wage" refers to the real net hourly wage and "All controls" refers to the use of changes on the average age of natives, average age of immigrants, ln ratio of high to low skilled natives, ln ratio of medium to low skilled natives, average years in Portugal of immigrants as controls, combined with the year dummies. The statistics were computed using weights and standard errors are clustered by NUTS II region. It was used the "Wage Sample".

In order to better understand the impact of immigration on the wage distribution of natives, the impact was estimated using percentiles' groups, namely for the 10th-30th percentiles, 30th-50th percentiles, 50th-70th percentiles, and 70th-90th percentiles. The estimated coefficients

are showed in Table 7[29]. For the lowest percentiles (10th-30th percentiles), the coefficients are statistically significant at the 1% significance level for the IV estimation, baseline and with all controls. The impact is negative on both estimations (also when accounting for the standard errors). The coefficient for the 10th - 30th percentiles is -0.157 when using the preferred estimation. The estimate suggests that a 1 percentage point increase in the immigrant-native ratio led to a decrease of 0.157 percent on the real net hourly wage of natives comprised between the 10th and 30th percentiles. This result is consistent with the predictions of the theoretical model and the result of Figure 4.

Table 7 – Impact of immigration on the wage distribution of natives by percentiles' groups

	Preferred estimation	Other specifications		
	IV **All controls**	OLS Baseline	OLS All controls	IV Baseline
10th - 30th Percentiles	-0.157***	0.005	0.022	-0.242***
	(0.033)	(0.099)	(0.106)	(0.061)
30th - 50th Percentiles	0.166	0.294	0.469	0.045
	(0.233)	(0.305)	(0.295)	(0.305)
50th - 70th Percentiles	-0.036	-0.028	0.099	-0.253
	(0.160)	(0.196)	(0.147)	(0.224)
70th - 90th Percentiles	-0.352*	0.003	0.214	-0.635**
	(0.213)	(0.382)	(0.337)	(0.283)
Observations	112	112	112	112

Standard errors are in parentheses

*** p<0.01, ** p<0.05, * p<0.1*

Source: Computed using data from the LFS

Note: The Table presents the estimated coefficients of the impact of immigration on the wage distribution of natives between 2003 and 2019 by percentiles' groups using the "Average Wage". "Average Wage" refers to the real net hourly wage. The "Baseline" uses only the year dummies variable. "All controls" refers to the use of changes on the average age of natives, average age of immigrants, ln ratio of high to low skilled natives, ln ratio of medium to low skilled natives, average years in Portugal of immigrants as controls, combined with the year dummies. The statistics were computed using weights and standard errors are clustered by NUTS II region. It was used the "Wage Sample".

With regards to the impact of immigration on the average wage of natives, the estimation is similar to that explain in section 6, but instead of the percentiles the average is used. The sample used is the "Wage Sample". However, after careful consideration, it was decided to perform the analysis not for the entire sample, but only between the 10th percentile and the 90th percentile.

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[29] The first stage F-statistic of the estimation of the IV regression using all controls is the same as mentioned before.

The reason for this is that at the extremes of the distribution, mainly from the 90th percentile onwards, there are some very negative values, without any plausible justification for it. Thus, in order to have more reliable results, the analysis is performed only between the 10th and 90th percentiles of the wage distribution of natives[30].

Table 8 presents the estimated coefficients. The first stage F-statistic of the preferred estimation is the same as mentioned above. The coefficients for the average wage are positive for the OLS estimation and negative for the IV estimation, with the coefficient being smaller for the specification with all controls. However, taking into account the standard errors, the values in both estimations can be positive or negative, but they are always around zero. Similar results are found for the wage index. Furthermore, none of the estimates is statistically significant. Therefore, it is not possible to make inferences from these coefficients. Thus, it seems that immigration does not affect the average wage of natives in Portugal. The low number of regions, which are only seven[31], can explain this result. There is no dataset available that uses NUTS III or another more desegregated level of data in terms of regions for Portugal for the main variables used in this dissertation.

Table 8 – Impact of immigration on the average wage of natives

	Preferred estimation	Other specifications		
	IV **All controls**	OLS Baseline	OLS All controls	IV Baseline
Average Wage	-0.129	0.045	0.191	-0.344
	(0.150)	(0.275)	(0.239)	(0.221)
Wage Index	-0.205	0.166	0.336	-0.302
	(0.173)	(0.332)	(0.370)	(0.186)
Observations	112	112	112	112
First stage F-statistic	79.489			14.158

Standard errors are in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Source: Computed using data from the LFS

Note: The Table presents the estimated coefficients of the impact of immigration on the average wage of natives between 2003 and 2019. "Average Wage" refers to the real net hourly wage and "Wage Index" is an index of the weighted sum of the real net hourly wage in each educational attainment group (high, medium, low). The "Baseline" uses only the year dummies variable. "All controls" refers to the use of changes on the average age of natives, average age of immigrants, ln ratio of high to low skilled natives, ln ratio of medium to low skilled natives, average years in Portugal of immigrants as controls, combined with the year dummies. The statistics were computed using weights and standard errors are clustered by NUTS II region. It was used the "Wage Sample" between the 10th and 90th percentiles.

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[30] If we have done the analysis between the 5th and 95th percentiles, the coefficients of the IV estimation with all controls would be -0.121 for the average wage and -0.203 for the wage index, with standard errors of 0.168 and 0.160, respectively. For an analysis between the 1st and 99th percentiles, the coefficients would be -0.675 for the average wage and -0.798 for the wage index, with standard errors of 0.105 and 0.119, respectively.

[31] The number of regions is only 7, because NUTS II only divides the country into 7 regions for statistical purposes.

7.2 Impact of immigration on the employment rate, unemployment rate and labour force participation rate of natives

The coefficients of the estimated impact of immigration on the employment rate, unemployment rate and labour force participation rate are presented in Table 9. The sample used is the "Employment Sample".[32] The effects on the participation rate on the labour force are negative and statistically significant at the 1% significance level for all specifications. The estimated IV coefficient with all controls is -0.671. Therefore, for each 1 percentage point increase in the immigrant-native ratio, the labour force participation rate of natives decreases by 0.671 percentage points. The coefficients on the effect on the employment rate of natives are statistically significant at the 1% significance level. All estimations methods present a negative impact on the employment rate. The estimated coefficient using the preferred estimation is -0.668, which suggests that for each 1 percentage point increase in the immigrant-native ratio, the employment rate of natives decreased by 0.668 percentage points. In terms of the unemployment rate, none of the estimates are statistically significant, showing negative effects but very close to zero.

Table 9 – Impact of immigration on the labour force participation, employment, and unemployment rates of natives

	Preferred estimation	Other specifications		
	IV **All controls**	OLS Baseline	OLS All controls	IV Baseline
Participation Rate	-0.671***	-0.737***	-0.753***	-0.649***
	(0.074)	(0.075)	(0.086)	(0.094)
Employment Rate	-0.668***	-0.703***	-0.711***	-0.643***
	(0.120)	(0.103)	(0.072)	(0.131)
Unemployment Rate	-0.003	-0.034	-0.042	-0.007
	(0.058)	(0.068)	(0.076)	(0.042)
Observations	112	112	112	112

Standard errors are in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Source: Computed using data from the LFS

Note: The Table presents the estimated coefficients of the impact of immigration on the employment rate, unemployment rate and labour force participation rate of natives between 2003 and 2019. "All controls" refers to the use of changes on the average age of natives, average age of immigrants, ln ratio of high to low skilled natives, ln ratio of medium to low skilled natives, average years in Portugal of immigrants as controls, combined with the year dummies. The statistics were computed using weights and standard errors are clustered by NUTS II region. It was used the "Employment Sample".

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[32] Similar results are found restricting the analysis between the 10th and 90th percentiles.

From these results, it seems that employment is driving the result of the labour force participation, with unemployment affecting less this measure. The F-statistic for the significance of excluded instruments is 64.912 for the estimated IV regression with all controls.

For a deeper understanding of the results, the impact was estimated separately for women and men. The first stage F statistic is 113.359 for female and 22.651 for male for the preferred estimation. The coefficients are presented in table 10.

Table 10 – Impact of immigration on the labour force participation, employment, and unemployment rates of female and male natives

	Preferred estimation	Other specifications		
	IV **All controls**	OLS Baseline	OLS All controls	IV Baseline
Female Participation Rate	-0.546***	-0.742***	-0.692***	-0.541***
	(0.094)	(0.120)	(0.141)	(0.116)
Male Participation Rate	-0.718***	-0.737***	-0.794***	-0.768***
	(0.133)	(0.106)	(0.119)	(0.141)
Female Employment Rate	-0.504***	-0.626***	-0.583***	-0.472**
	(0.182)	(0.134)	(0.156)	(0.196)
Male Employment Rate	-0.733***	-0.783***	-0.840***	-0.823***
	(0.104)	(0.125)	(0.139)	(0.133)
Female Unemployment Rate	-0.041	-0.116	-0.109	-0.070
	(0.114)	(0.088)	(0.100)	(0.093)
Male Unemployment Rate	0.015	0.046	0.046	0.055*
	(0.040)	(0.079)	(0.087)	(0.032)
Observations	112	112	112	112

Standard errors are in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Source: Computed using data from the LFS

Note: The Table presents the estimated coefficients of the impact of immigration on the labour force participation rate, employment rate, and unemployment rate of female and male natives between 2003 and 2019. "All controls" refers to the use of changes on the average age of natives, average age of immigrants, ln ratio of high to low skilled natives, ln ratio of medium to low skilled natives, average years in Portugal of immigrants as controls, combined with the year dummies. The statistics were computed using weights and standard errors are clustered by NUTS II region. It was used the "Employment Sample".

The labour force participation rate's results are all statistically significant at the 1% significance level. The coefficients for the IV regression with all controls are -0.546 and -0.718 for women and men, respectively. These results suggest that the decrease may be even "greater" for men, in terms of values, since their participation rate is higher than that of women (section 5). For every 1 percentage point increase in the immigrant-native ratio, it is estimated that the labour force participation rate of female natives decreases by 0.546 percentage points. For each

1 percentage point increase in the immigrant-native ratio, it is estimated that the labour force participation rate of male natives decreases by 0.718 percentage points. Regarding the employment rate, results are statistically significant at a 1% significance level across all specifications for women and men. The results show a larger negative impact on men. For each 1 percentage point increase in the immigrant-native ratio, the employment rate of native women is estimated to decrease by 0.504 percentage points (using IV all controls). And, for every 1 percentage point increase in the immigrant-native ratio, the employment rate of native men is estimated to decrease by 0.733 percentage points (using IV all controls). As in the case of the labour force participation rate, the impact on men is higher than on women and the employment rate is also higher than on women (section 5). For the preferred estimation method, the results of the impact on the unemployment rate are close to zero, but negative for women and positive for men. However, the estimates are not statistically significant.

Additionally, the impact of immigration was computed according to the highest level of education achieved.

Table 11 – Impact of immigration on the labour force participation, employment, and unemployment rates for education groups

Preferred estimation: IV All controls				
	Less than 9th grade	9th grade	12th grade	More than 12th grade
Participation Rate	-0.254**	-0.217***	-0.139***	-0.061*
	(0.102)	(0.036)	(0.026)	(0.036)
Employment Rate	-0.199*	-0.224***	-0.164***	-0.081***
	(0.116)	(0.018)	(0.031)	(0.027)
Unemployment rate	-0.055*	0.007	0.025*	0.020
	(0.030)	(0.037)	(0.014)	(0.013)
Observations	112	112	112	112

Standard errors are in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Source: Computed using data from the LFS

Note: The Table presents the estimated coefficients of the impact of immigration on the employment rate, unemployment rate and labour force participation rate according to the highest level of education achieved between 2003 and 2019 using IV All controls. The categories are less than 9th grade, 9th grade, 12th grade, and more than 12th grade. "All controls" refers to the use of changes on the average age of natives, average age of immigrants, average years in Portugal of immigrants as controls, combined with the year dummies. The statistics were computed using weights and standard errors are clustered by NUTS II region. It was used the "Employment Sample".

Thus, in Table 11 we have the impact of immigration on the employment rate, unemployment rate and participation rate of natives with less than the 9th grade, with the 9th grade, with the 12th grade, and with more than the 12th grade[33].All the coefficients on the employment rate present a negative impact and are statistically significant at a 1% significance level, except for the "Less than 9th grade" category. It seems that the higher the level of education, the smaller the negative impact of immigration on the employment rate. The labour force participation rate shows a pattern similar to that of the employment rate. The negative impact on those with less education is greater on the participation rate than on the employment rate. Once again, it seems that employment drives the participation rate results.

8. Robustness Checks

Several robustness checks were performed using different instruments, and different sample sizes. First, we have used the 14th lag of the immigrant-native ratio and the predicted inflow by groups of countries[34] as instruments. Regarding the sample size we have restricted the sample between 2011 and 2019, and used the sample to individuals aged between 25 and 55 years old.

Robustness checks on the impact of immigration on the average wage of natives can be found in Table 12 and present similar results to the benchmark one. Table A8 in the Appendix reports the same robustness checks along the wage distribution and generally presents similar results as well, with just some exceptions.

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[33] It was also computed the same but with the educational attainment groups (high education, medium education, low education) of Eurostat instead. Similar results are found.

[34] A detail description of this instrument can be found in the Appendix on "Predicted inflow by groups of countries".

Table 12 – Robustness checks on the impact of immigration on the average wage of natives

Preferred estimation: IV All controls	
	Average Wage
Panel A: Different Instruments	
Benchmark	-0.129
	(0.150)
14th lag	-0.123
	(0.241)
Predicted inflow by groups of countries	-0.006
	(0.205)
Panel B: Different Samples	
Benchmark	-0.129
	(0.150)
2011-2019	-0.373***
	(0.087)
25-55 years old	-0.191
	(0.182)

Standard errors are in parentheses *** p<0.01, ** p<0.05, * p<0.1

Source: Computed using data from the LFS

Note: The Table presents the estimated coefficients of the impact of immigration on the average wage of natives using IV All controls and several different instruments and sample restrictions. "All controls" refers to the use of changes on the average age of natives, average age of immigrants, ln ratio of high to low skilled natives, ln ratio of medium to low skilled natives, average years in Portugal of immigrants as controls, combined with the year dummies. The statistics were computed using weights and standard errors are clustered by NUTS II region. It was used the "Wage Sample" between the 10th and 90th percentiles.

Table 13 presents the robustness checks of the impact of immigration on the employment, unemployment, and labour force participation rates of natives. The results are generally similar in sign and magnitude, especially for employment and participation rates. Exceptions are only the estimates using the 14th lag.

Table 13 – Robustness checks on the impact of immigration on the labour force participation, employment, and unemployment rates of natives

Preferred estimation: IV All controls			
	Employment Rate	Unemployment Rate	Participation Rate
Panel A: Different Instruments			
Benchmark	-0.668***	-0.003	-0.671***
	(0.120)	(0.058)	(0.074)
14th lag	0.834	-0.741**	0.093
	(0.417)	(0.342)	(0.411)
Predicted inflow by groups of countries	-0.497***	-0.061	-0.559***
	(0.106)	(0.079)	(0.111)
Panel B: Different Samples			
Benchmark	-0.668***	-0.003	-0.671***
	(0.120)	(0.058)	(0.074)
2011-2019	-0.860***	0.067	-0.793***
	(0.166)	(0.086)	(0.118)
25-55 years old	-0.523***	-0.300	-0.553***
	(0.098)	(0.062)	(0.068)

Standard errors are in parentheses ***
$p<0.01$, ** $p<0.05$, * $p<0.1$

Source: Computed using data from the LFS

Note: The Table presents the estimated coefficients of the impact of immigration on the employment rate, unemployment rate and labour force participation rate of natives using IV All controls and several different instruments and sample restrictions. "All controls" refers to the use of changes on the average age of natives, average age of immigrants, ln ratio of high to low skilled natives, ln ratio of medium to low skilled natives, average years in Portugal of immigrants as controls, combined with the year dummies. The statistics were computed using weights and standard errors are clustered by NUTS II region. It was used the "Employment Sample".

Finally, it was also performed the same estimations using the nationality criteria for immigrants, instead of the country of birth. Results are similar, especially for employment and labour force participation of natives. The coefficients for the employment rate and participation rate are -0.799 and -0.780, respectively. They are statistically significant at a 1% significance level. Figure A4 in the Appendix presents the impact of immigration along the wage distribution of natives, using the nationality criteria.

9. Conclusion

This dissertation aimed to estimate the impact of immigration on the Portuguese labour market, namely on wages and their distribution, and on the employment rate, unemployment rate and labour force participation rate of natives. Within the framework of a pure spatial theoretical model, a difference-in-difference approach was implemented and an instrumental variable estimation performed. The study was conducted between 2003 and 2019 using data from the LFS.

The results indicate that immigration does not have a significant impact on the average wage of natives and along the wage distribution. Therefore, we are not able to prove the theoretical model, but there is evidence that at least in the lowest percentiles the model's predictions are confirmed: where the relative density of immigrants is greater than that of natives, the negative impact on natives is also larger. This little impact of immigration on wages is in line with the results of several previous studies, e.g., Card (1990), Favre (2011) and Kim (2021).

Results on the effect of immigration on the employment rate and labour force participation rate are negative and statistically significant. The coefficients on the unemployment rate do not present significant results. Furthermore, immigrants impact more negatively the employment and participation rates of men. The results also suggests that the negative impact is decreasing the higher is the educational level of natives.

In addition, it was possible to prove the existence of downgrading of recent immigrants in Portugal. Therefore, proving that there is not a perfect transfer of education and experience when immigrants enter the Portuguese labour market, working on occupations below their skills levels. This supports the choice for a pure spatial model, the only robust in the presence of downgrading.

Regarding limitations of the analysis performed in this dissertation, one of the main limitations is the number of regions that serve as the basis for the spatial theoretical model. Unfortunately, there is no dataset with information on the main variables used (country of birth, working hours, wage) and a geographical division other than NUTS II, which only has seven regions. Otherwise, the results could potentially be more robust and significant. In addition, another potential limitation of this spatial approach is the internal migration of natives (natives who exit labour markets with higher in-migration levels), which, if it occurs, can bias the results, making them more positive (Borjas, 2006; Dustmann et al., 2016; Borjas & Edo, 2021).

The use of samples can also lead to measurement errors and minor negative impacts (Aydemir & Borjas, 2011).

This dissertation contributes to the literature on the impact of immigration on the Portuguese labour market with a comprehensive study on the effects of immigrants on wages and employment of natives in recent decades. This study helps to understand the effect of the increased share of immigrants on the resident population in Portugal and provides the first investigation into the impact along the wage distribution of natives. However, a more multidimensional analysis on the impact of immigration on the labour market, taking into account effects other than on wages and employment, is needed for policy implications.

For future research, the use of more disaggregated data on regions (for example, NUTS III) is critical for the robustness of the results. Also, it could be interesting to study the impact of new immigrants on immigrants that are already in Portugal. Moreover, it would be also interesting to take into account the potential spill-over effects of immigration policies or changes in the production mix of the country.

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Appendix

Figure A1 – Native-born unemployment rate and Foreign-born unemployment rate in Portugal
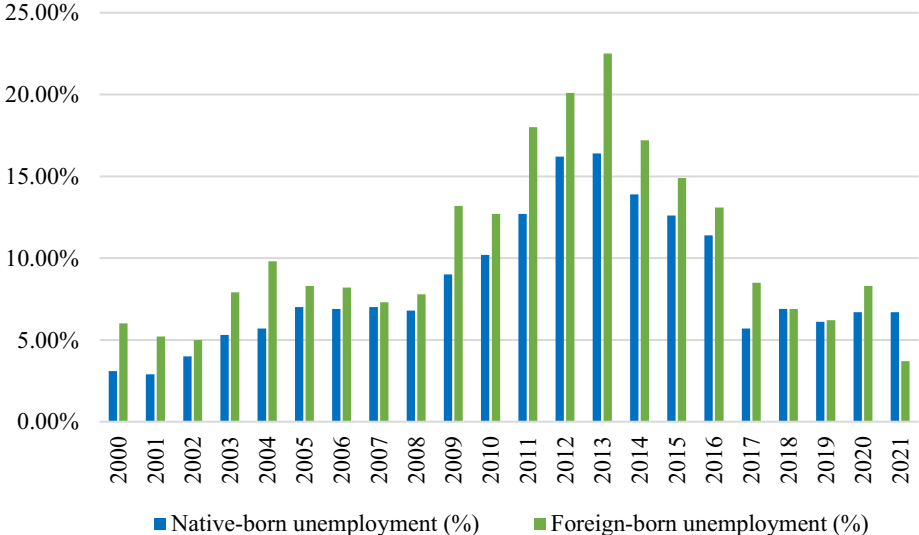
Note: The Figure presents the native-born unemployment rate and the foreign-born unemployment rate. The native-born unemployment rate is the share of unemployed natives between 15 and 64 years old in the labour force of natives between 15 and 64 years old. The foreign-born unemployment rate is the share of unemployed foreign-born between 15 and 64 years old in the labour force of foreign-born between 15 and 64 years old.

Figure A2 – Native-born participation rate and Foreign-born participation rate in Portugal
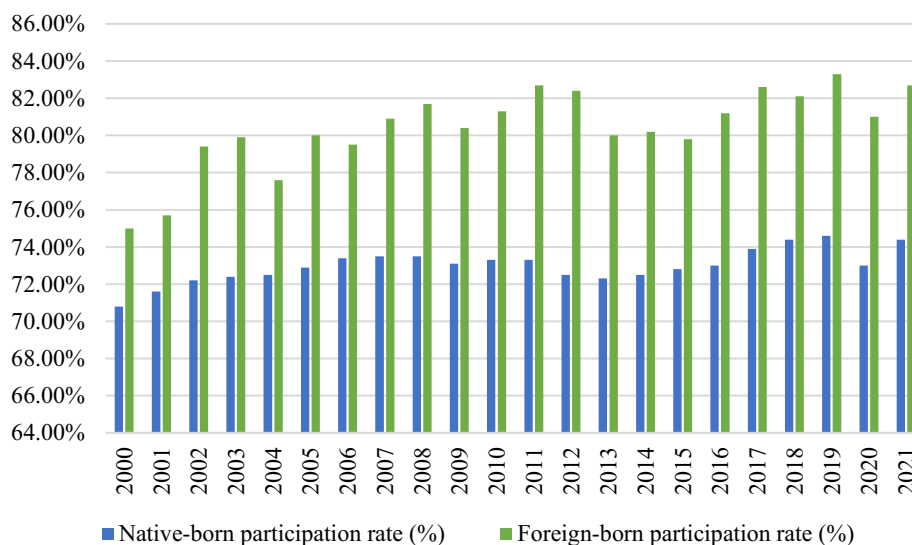
Source: Data from OECD (2022f, 2022g)
Note: The Figure presents the native-born participation rate and the foreign-born participation rate. The native-born participation rate is the share of employed and unemployed natives between 15 and 64 years old in the total population of natives between 15 and 64 years old. The foreign-born participation rate is the share of employed and unemployed foreign-born between 15 and 64 years old in the total population of foreign-born between 15 and 64 years old.

Harmonization of data from the LFS

After appending the data from the different quarters, several harmonizations of the variables had to be made to ensure that all variables refer to the same in all quarters.

On January 1, 2015, a new version of *Nomenclatura das Unidades Territoriais para Fins Estatísticos* (NUTS), NUTS 2013 entered into force. The only change at the level of NUTS II, the one used in the dissertation, was on the name of the region "Lisboa" that changed to "Área Metropolitana de Lisboa". Therefore, the designation for all the quarters before 2015 was changed accordingly. The list of countries and respective codes employed to designate the nationality and country of birth of each individual also suffered some changes throughout the quarters. It was adopted the international standard for country codes[35] ISO 3166-1 (ISO alpha 2). The proper harmonization was made for all quarters. The classification of occupations for individuals who are employed is implemented according to *Classificação Portuguesa das Profissões*. Before 2011 it followed the CNP- 94 and from 2011 onwards the version CPP-10.

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[35] This standard is also used by INE.

Therefore, an harmonization of the data was implemented and 9 categories were created, following the 1-digit group classification of CPP-10: 1) Armed Forces occupations; 2) Representatives of the legislative power and executive bodies, managers, directors and executive managers; 3) Specialists in intellectual and scientific activities; 4) Intermediate level technicians and professions; 5) Administrative staff; 6) Personal, security and safety service workers and vendors; 7) Farmers and skilled workers in agriculture, fisheries and forestry; 8) Skilled workers in industries, construction and craftsmen; 9) Installation and machine operators and assembly mechanics; 10) Unskilled workers.

Concerning the variables on the type of contract and labour status, their classification in all the quarters and respective years is very similar but with slight differences. For that reason, a harmonization was also implemented, according to the classification present in the LFS of 2019. The data on the type of contract is now grouped as 1) Permanent employment contract; 2) Fixed-term employment contract; 3) Service contract (recibos verdes or similar). The labour status was grouped in 8 categories: 1) Civil employee; 2) Career military; 3) Unemployed (looking for first job); 4) Unemployed (looking for new job); 5) Student 15 years old and more; 6) Domestic; 7) Retired; 8) Other inactive.

Furthermore, the variable concerning the highest education level achieved by the individual also has a varying classification depending on the year of the survey. Data was harmonized and 10 groups of education created, following the groups classification used in the LFS of 2019: 1) None or complete 1st or 2nd or 3rd schooling years; 2) Basic education - 1st cycle, that is complete 4th or 5th schooling years; 3) Basic education - 2nd cycle, that is complete 6th or 7th or 8th schooling years; 4) Basic education - 3rd cycle, that is complete 9th or 10th or 11th schooling years; 5) Secondary education, that is complete 12th schooling year; 6) Post-secondary education, that is education in non-higher technological specialization" 11 "Professional higher technical course; 7) Higher education - Bachelor's degree; 8) Higher education - Licentiate degree; 9)Higher education - Master's degree; 10) Higher education - PhD degree.

Moreover, during the period between 2004 and 2010, to employees that did not answer the question about their net monthly wage it was asked a second question. This second question focused not on the explicit net monthly wage but the indication of its position on a set of categories. The categories were less than 310 euros; from 310 to less than 600 euros; from 600 to less than 900 euros; from 900 to less than 1200 euros; from 1200 to less than 1800 euros; from 1800 to less than 2500 euros; from 2500 to less than 3000 euros; and 3000 or more euros.

To define the net monthly wage of these individuals, it was considered 90% of the value of the first interval, the double of the value of the last interval, and the midpoint (average of the lower and upper-class limits) for all the other intermediate intervals. Hence, the values considered for the net monthly wage for each category were, respectively and by the same order, 270 euros, 455 euros, 750 euros, 1050 euros, 1500 euros, 2150 euros, 2750 euros, and 6000 euros. The observations whose answer, to the question regarding the net monthly wage of employees and to the question asking to indicate in which interval the net monthly wage is, was "Do not know" or "Refuses" were changed to missing data on that variable. Likewise, the observations whose answer to the question regarding the usual weekly working hours was "Do not know" were changed to missing data on that variable.

Table A1 – Main characteristics of natives and immigrants for years 2003, 2011 and 2019

	2003		2011		2019	
	Natives	**Immigrants**	**Natives**	**Immigrants**	**Natives**	**Immigrants**
Gender (%)						
Male	53.90	50.21	50.21	46.68	48.68	47.06
Female	46.10	49.79	49.79	53.32	51.32	52.94
Average age	37.62	35.08	39.94	38.38	42.02	42.02
Type of contract (%)						
Permanent employment	83.86	66.97	80.76	72.97	81.92	73.41
Fixed-term employment	15.08	30.14	17.05	23.85	16.32	22.98
Service contract (*recibos verdes* or similar)	1.06	2.89	2.19	13.17	1.75	3.61
Educational attainment (%)- years of schooling completed						
0 years	3.37	1.94	1.54	1.72	0.58	0.78
4 years	29.39	9.52	10.79	4.76	7.74	2.83
6 years	22.93	15.71	15.85	12.24	11.05	6.30
9 years	18.35	24.16	24.30	20.71	20.55	18.61
12 years	15.20	28.53	21.53	32.34	29.40	36.20
Tertiary	10.76	20.14	20.99	21.70	30.68	35.29
Educational attainment (%)- groups of education						
High education	10.75	20.13	20.53	27.13	29.66	33.50
Medium education	15.20	28.53	21.99	33.34	30.42	37.99
Low education	74.04	51.33	57.48	39.43	39.92	28.51

Source: Computed using data from the LFS

Note: The Table presents the weighted percentage of each gender, average age, percentage of each type of contract and percentage of each educational attainment by years of schooling completed and groups of education of Eurostat (high, medium and low) for years 2003, 2011 and 2019. It was used the "Wage Sample".

Figure A3 – Density of recent immigrants in the wage distribution of natives by NUTS II
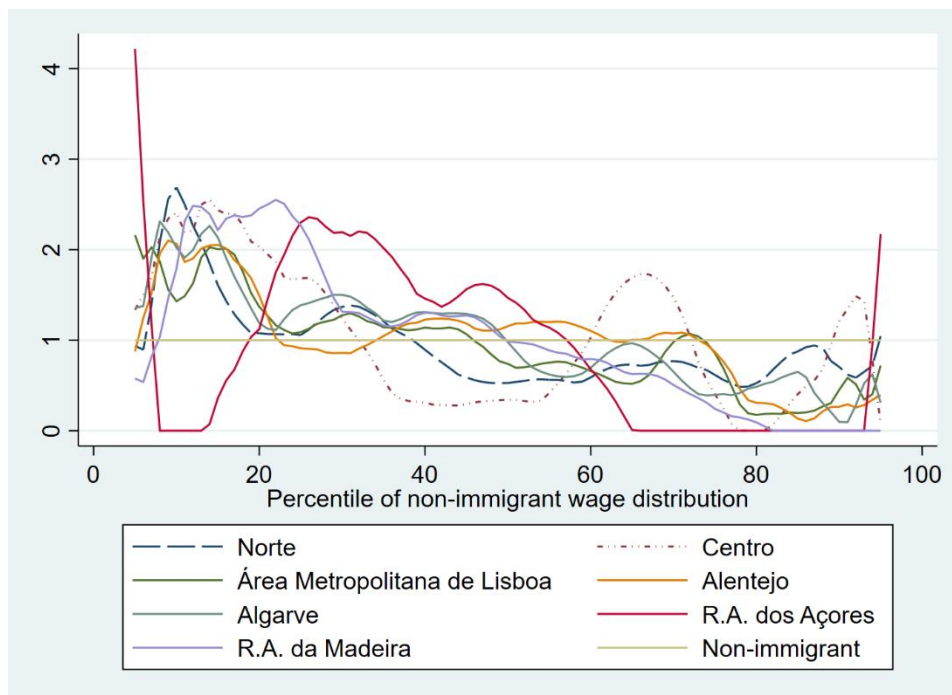
Source: Computed using data from the LFS

Note: The Figure presents density of recent immigrants along the wage distribution of natives as compared to the native wage distribution for each one of the NUTS II regions: Norte, Centro, Área Metropolitana de Lisboa, Alentejo, Algarve, Região Autónoma da Madeira and Região Autónoma dos Açores. The densities plotted are based on kernel estimates. The estimation was done using weights. It was used the "Wage Sample".

Table A2 – Descriptive Statistics: "Wage Sample" between the 10th and 90th percentiles on 2003, 2011 and 2019

	2003		2011		2019	
	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation
Ln real net hourly wage	1.456	0.110	1.489	0.089	1.538	0.082
Ln wage index	1.597	0.114	1.555	0.085	1.547	0.079
Immigrant-native ratio	0.068	0.051	0.110	0.077	0.121	0.074
Annual change in immigrant-native ratio	0.002	0.011	0.008	0.013	0.001	0.019
Average age of natives	37.556	1.223	39.941	0.762	42.062	0.618
Average age of immigrants	34.204	1.250	38.031	0.955	41.485	1.012
Ln ratio of high to low skilled natives	-2.150	0.418	-1.147	0.352	-0.503	0.438
Ln ratio of medium to low skilled natives	-1.606	0.266	-1.031	0.292	-0.349	0.255
Average years in Portugal of immigrants	17.294	2.727	22.361	3.114	26.239	2.981

Source: Computed using data from the LFS

Note: The Table presents descriptive statistics (mean and standard deviation) on the variables used in the estimation of the impact of immigration on average wage of natives on 2003, 2011 and 2019 across all NUTS II regions. The statistics were computed using weights. It was used the "Wage Sample" between 10th and 90th percentiles.

Table A3 – Descriptive statistics of immigrants' inflows ("Wage Sample" between the 10th and 90th percentiles)

	Mean (p.p.)	Standard deviation (p.p.)	Minimum (p.p.)	Maximum (p.p.)
2003-2004	0.42	1.22	-1.53	2.16
2004-2005	0.68	1.13	-1.02	2.65
2005-2006	0.19	0.59	-0.73	1.05
2006-2007	1.18	2.2	-0.46	5.62
2007-2008	1.20	1.5	-0.31	4.19
2008-2009	-0.25	0.64	-1.58	0.22
2009-2010	-0.1	1.31	-1.78	0.99
2010-2011	0.84	0.98	-0.79	2.6
2011-2012	0.08	0.014	-1.28	1.39
2012-2013	-0.37	1.10	-2.29	0.83
2013-2014	-0.64	1.84	-3.71	1.62
2014-2015	0.13	0.66	-0.93	1.22
2015-2016	0.31	1.11	-0.86	2.44
2016-2017	0.65	1.36	-0.97	3.08
2017-2018	0.80	1.94	-0.51	4.99
2018-2019	0.14	1.87	-1.49	4.21
Average 2003-2019	0.33	1.37	-3.71	5.62
2003-2019	5.29	3.29	2.46	12.03

Source: Computed using data from the LFS

Note: The Table presents descriptive statistics (mean, standard deviation, minimum and maximum in percentage points) on the immigrants' inflows. The statistics were computed using weights. It was used the "Wage Sample" between 10th and 90th percentiles.

Table A4 – Descriptive Statistics: Full "Wage Sample"

	Mean	Standard Deviation
Ln real net hourly wage	1.607	0.115
Ln wage index	1.695	0.130
10th Percentile	1.052	0.070
25th Percentile	1.152	0.078
50th Percentile	1.381	0.106
75th Percentile	1.726	0.113
90th Percentile	2.109	0.109
10th-30th Percentiles	1.118	0.069
30th-50th Percentiles	1.286	0.098
50th-70th Percentiles	1.512	0.107
70th-90th Percentiles	1.867	0.107
Immigrant-native ratio	0.099	0.063
Annual change in immigrant-native ratio	0.003	0.014
Average age of natives	39.923	1.709
Average age of immigrants	37.853	3.078
Ln ratio of high to low skilled natives	-1.197	0.639
Ln ratio of medium to low skilled natives	-0.991	0.487
Average years in Portugal of immigrants	22.249	4.784

Source: Computed using data from the LFS

Note: The Table presents descriptive statistics (mean and standard deviation) on all the variables used in the estimation of the impact of immigration wage distribution and percentiles groups. The statistics were computed using weights. It was used the "Wage Sample".

Table A5 – Descriptive Statistics: "Employment Sample" by education's groups

	Mean	Standard Deviation
Employment Rate Less 9th	61.365	3.689
Employment Rate 9th	62.002	4.176
Employment Rate 12th	61.428	4.511
Employment Rate More 12th	58.597	4.941
Unemployment Rate Less 9th	6.437	6.338
Unemployment Rate 9th	6.510	2.583
Unemployment Rate 12th	6.691	2.267
Unemployment Rate More 12th	6.869	2.811
Participation Rate Less 9th	67.801	4.465
Participation Rate 9th	68.513	3.079
Participation Rate 12th	68.120	3.231
Participation Rate More 12th	65.466	3.627

Source: Computed using data from the LFS

Note: The Table presents descriptive statistics (mean and standard deviation) on the variables used in the estimation of the impact of immigration on employment, unemployment and participation on the labour force rates of natives by education's groups between 2003 and 2019. Education's groups: less than 9th grade, 9th grade, 12th grade and more than 12th grade. The statistics were computed using weights. It was used the "Employment Sample".

Table A6 – Descriptive Statistics: "Employment Sample" on 2003, 2011 and 2019

	2003		2011		2019	
	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation
Employment Rate	64.003	3.362	58.348	3.497	63.252	2.807
Unemployment Rate	3.872	1.609	8.838	0.975	4.656	0.655
Participation Rate	67.875	3.208	67.186	3.231	67.908	2.899
Immigrant-native share	6.112	4.507	9.692	7.088	11.578	7.247
Annual change in immigrant-native share	0.309	0.945	0.429	0.717	0.591	1.540
Average age of natives	38.868	1.166	40.347	0.995	41.320	0.736
Average age of immigrants	33.121	2.593	37.611	1.290	41.147	0.924
Ln ratio of high to low skilled natives	-2.687	0.494	-1.630	0.377	-0.969	0.468
Ln ratio of medium to low skilled natives	-1.746	0.257	-1.295	0.298	-0.639	0.277
Average years in Portugal of immigrants	17.201	1.960	21.390	2.509	24.645	2.596

Source: Computed using data from the LFS

Note: The Table presents descriptive statistics (mean and standard deviation) on all variables used in the estimation of the impact of immigration on employment, unemployment and participation on the labour force rates of natives on 2003, 2011 and 2019. The statistics were computed using weights. It was used the "Employment Sample".

Table A7 – Descriptive statistics of immigrants' inflows ("Employment Sample")

	Mean (p.p.)	Standard deviation (p.p.)	Minimum (p.p.)	Maximum (p.p.)
2003-2004	0.29	0.56	-0.90	0.81
2004-2005	0.53	0.53	-0.09	1.31
2005-2006	0.16	0.47	-0.49	0.91
2006-2007	0.97	1.88	-0.97	4.60
2007-2008	0.91	1.00	-0.19	2.54
2008-2009	0.24	0.34	-0.43	0.64
2009-2010	0.05	0.63	-1.18	0.65
2010-2011	0.43	0.72	-0.44	1.62
2011-2012	0.47	0.76	-0.47	1.39
2012-2013	-0.07	1.07	-2.10	1.00
2013-2014	-0.08	1.28	-2.30	1.16
2014-2015	0.23	0.69	-0.55	1.24
2015-2016	0.02	0.58	-0.79	0.60
2016-2017	0.31	1.02	-1.10	1.80
2017-2018	0.42	1.45	-0.87	3.52
2018-2019	0.59	1.54	-0.68	3.91
Average 2003-2019	0.33	1.37	-3.71	5.62
2003-2019	5.29	3.29	2.46	12.03

Source: Computed using data from the LFS

Note: The Table presents descriptive statistics (mean, standard deviation, minimum and maximum in percentage points) on the immigrants' inflows. The statistics were computed using weights. It was used the "Employment Sample".

Predicted inflow by groups of countries

The instrument of the "Predicted inflow by groups of countries" follows closely Card (2001) and predicts the inflow of immigrants for each region and year without the effect of contemporary demand shocks, by allocating immigrants according to their group of countries taking into consideration the allocation of previous immigrants from the same group of countries in the past (Dustmann et al., 2013).

The groups of countries used are PALOP countries without Equatorial Guinea (Angola, Cape Verde, Guinea Bisssau, Mozambique, São Tomé e Príncipe), Brazil, European Union 15 (Austria, Belgium, Cyprus, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Spain, Malta, Netherlands, Sweden), European Union countries which are CEEC – Central and Eastern European countries (Bulgaria, Croatia, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovenia, Slovakia), Ukraine, Venezuela and Rest of the World. The base year is 2002.

The instrument is computed by diving the predicted inflow of new immigrants from group of country c in NUTS II region i in year t, $\sum_c \theta_{ci} M_{ct}$, by the number of natives in each region at time t-2, in this case, in 2000. θ_{ci} is the fraction of immigrants from area c in NUTS II region i in the base year of 2002 and M_{ct} is the number of new immigrants from area c in year t.

Table A8 - Robustness checks on the impact of immigration on wage distribution of natives

Preferred estimation: IV All controls					
	10th Percentile	25th Percentile	50th Percentile	75th Percentile	90th Percentile
Panel A: Different Instruments					
Benchmark	-0.075	0.038	0.009	-0.306	-0.081
	(0.234)	(0.210)	(0.224)	(0.334)	(0.362)
14th lag	0.141	-0.483	0.241	0.554	0.419
	(0.241)	(0.305)	(0.295)	(0.445)	(0.274)
Predicted inflow by groups of countries	-0.095	0.140	0.487	0.001	0.707
	(0.147)	(0.253)	(0.407)	(0.233)	(0.471)
Panel B: Different Samples					
Benchmark	-0.075	0.038	0.009	-0.306	-0.081
	(0.234)	(0.210)	(0.224)	(0.334)	(0.362)
2011-2019	0.036	0.116	-0.222	-0.565***	-0.653***
	(0.025)	(0.116)	(0.224)	(0.224)	(0.180)
25-55 years old	-0.138	0.074	-0.218	-0.423	-0.341
	(0.090)	(0.102)	(0.205)	(0.457)	(0.277)

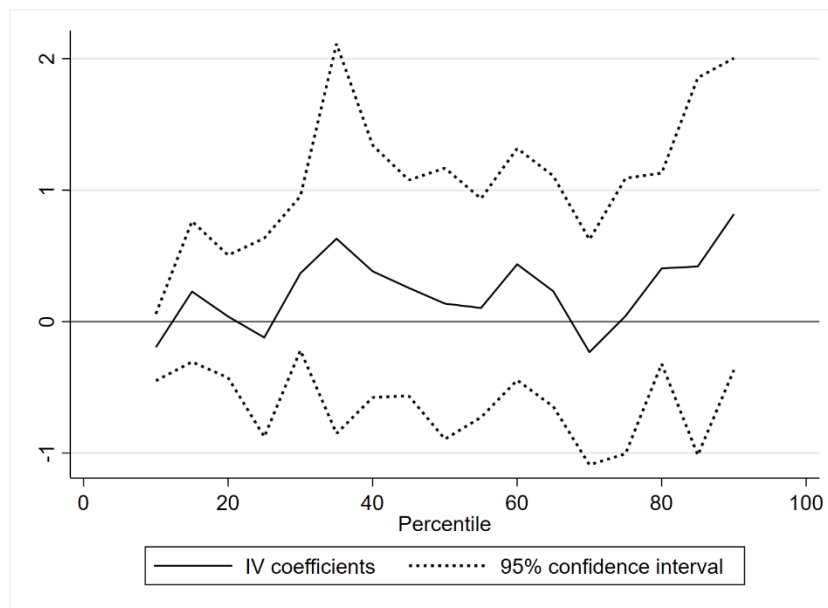*Standard errors are in parentheses*
*** $p<0.01$, ** $p<0.05$, * $p<0.1$

Source: Computed using data from the LFS

Note: The Table presents the estimated coefficients of the impact of immigration on the wage distribution of natives using IV All controls and several different instruments and sample restrictions. "All controls" refers to the use of changes on the average age of natives, average age of immigrants, ln ratio of high to low skilled natives, ln ratio of medium to low skilled natives, average years in Portugal of immigrants as controls, combined with the year dummies. The statistics were computed using weights and standard errors are clustered by NUTS II region. It was used the "Wage Sample".

Figure A4 - Impact of immigration along the wage distribution of natives using the nationality criteria

Source: Computed using data from the LFS

Note: The Figure shows the estimated coefficients of all 5 by 5 percentiles between 10th and 90th percentiles of the impact of immigration along the wage distribution of natives between 2003 and 2019, using the instrumental variable estimation with all controls of the "Average Wage". The nationality criteria was used instead of the country of birth. "Average Wage" refers to the real net hourly wage and "All controls" refers to the use of changes on the average age of natives, average age of immigrants, ln ratio of high to low skilled natives, ln ratio of medium to low skilled natives, average years in Portugal of immigrants as controls, combined with the year dummies. The statistics were computed using weights and standard errors are clustered by NUTS II region. It was used the "Wage Sample".