DOES IMMIGRANT DIVERSITY AFFECT PRODUCTIVITY? THE SPANISH EXPERIENCE

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Abstract

The massive waves of migration that emerge as a part of the recent globalization process have attracted a growing attention in the field of economic geography. Traditionally, concern over this matter has focused on the possible effects of replacing more expensive native workers with a cheaper workforce made up of immigrants. However, recent literature points out that this evaluation may be incomplete, as it ignores the potential benefits in regional development derived from a greater cultural diversity related to immigration. The aim of this work is to fill this gap by analysing the role of migration diversity in technological diffusion and productivity at a regional level for the specific case of Spain. To do so, we based our research on three different diversity indexes, as proposed by Kemeny and Cooke (2018) and Alesina *et al.* (2003). The model is estimated by instrumental variables techniques taking into account the potential simultaneity between migration diversity and worker's productivity. The results confirm that a greater diversity of immigrants' birthplaces leads to an improvement in productivity and local worker's capabilities. Additionally, our findings reveal the importance of skilled labour (national or foreign) to encourage worker's productivity and to ensure a sustainable economic development.

Keywords: migration diversity, regional development, productivity, Spain.

JEL Classification: F63, J61, C26, O4, R23.

1. INTRODUCTION

During last decades, international migration has experienced deep changes. According to Arango (2000), migration has become more global and diverse in terms of origins and destination countries. For this author, Asia, Africa and Latin America have replaced Europe as the main regions of origin of migrants. In this sense, the case of Spain is especially outstanding. From the end of the twentieth century to the early years of the twenty-first century, this country has gone from being a net source of migrants to a net recipient, becoming Europe's main target country for immigrants and the second most important destination in the world, after the US (Alamá-Sabater, Alguacil and Bernat-Martí, 2017).

Coinciding with the Spanish economic "boom", the entry of migrants into the country was absolutely remarkable. Spain went from having a total foreign population of 2% in the year 2000 to approximately 12% in 2011 (Martí Romero, 2015). The economic expansion and the creation of new jobs attracted a massive number of immigrants seeking employment opportunities (Alamá, Alguacil and Bernat, 2014).[1] However, the economic crisis that started in 2008 and manifested in Spain primarily as an employment crisis led to a radical change in the Spanish migration model (Parella and Petroff, 2014). The proportion of immigrants coming for economic reasons became less relevant and the weight of immigration from developed countries motivated by socioeconomic reasons increased (Arango *et al.*, 2009; Alamá, Alguacil and Bernat, 2014). Regional location preferences varies also during this period, with coastal provinces (including Cantabria and Andalusia) played a more important role in the attraction of immigrants (Alamá-Sabater, Alguacil and Bernat-Martí, 2017). Similarly, the variety of immigrants' countries of birth differs geographically: regions as Madrid, Catalonia, the Valencian Community and Andalusia show clearly a higher diversity of immigrants' birthplaces. In the case of Madrid and Catalonia, this was probably due to the large supply of work available in different sectors and with different skill requirements. For the Valencian Community and Andalusia, the

[1] For nearly a decade, Spain's GDP grew yearly by an average 3.9%, which meant a drop in the unemployment rate from 20.6% in 1997 to 8.2% in 2007.

relevance of both the tourist sector and an intensive agriculture, together with the good weather, may explain this higher diversity of immigrants in terms of country of origin (Otero, 2010). The aim of this work is precisely to analyse how this migrant diversity encourage competitiveness and worker's productivity at a regional level in Spain during the years from 2008 to 2016.

Given the recent concern in the European political debate about the effects that the entry of new residents can have on economic and social aspects, it seems relevant to investigate to what extent greater birthplace diversity may influence regional development and competitiveness. The literature in this respect suggests that there may be a positive correlation between immigrant diversity and productivity (Alesina *et al.*, 2003; Ottaviano and Peri, 2006; Kemeny and Cooke, 2018). For Lewis and Peri (2014), immigrant diversity may increase worker productivity by enabling the combination of different skills, ideas and perspectives. According to Hong and Page (2004), diversity of human capital increases creativity and helps members to solve problems and generate new ideas. Conversely, other authors argue that the relationship between immigrant diversity and productivity may be ambiguous. For instance, Lee (2013), who examined the cultural diversity within the groups of workers of a company, argued that this group-level diversity may lead to lower confidence among workers and poor communication between people, either by discrepancies in the language, misunderstandings or discriminatory attitudes, as some individuals may subconsciously favour members of their own nationality.

Empirically, we contribute to go further into this debate in several ways. First, for the first time, three immigrant diversity indexes, as proposed by Kemeny and Cooke (2018) and Alesina *et al.*(2003), have been implemented for the case of Spain to analyse the connections between migration diversity and regional competitiveness. We did so by focusing on the years after the economic crisis that began at the end of 2007, thus taking into account the changes that occurred in the immigration patterns with the new macroeconomic scenario. Second, we estimated the model by two-stage least squares (2SLS) using Instrumental Variables (IV) regression techniques. As previously mentioned by the literature, the most productive regions can also be those that attract more immigrants

from different backgrounds (Ottaviano and Peri, 2006), thus giving rise to a potential endogeneity problem. To deal with this, we based our work on Gagliardi (2015) and Ottaviano and Peri (2006) and calculated the "predicted" change in the number of immigrants in each region during the period analysed as the instrumental variables. Finally, we tested the robustness of our results by estimating an additional model in which regional competitiveness was proxied by the wages of the total national and foreign population, instead of considering only the nationals' productivity. To do so, we used a database on the 17 Spanish regions (Autonomous Communities) between 2008 and 2016 from the Spanish National Statistics Institute (INE) and the Ministry of Education, Culture and Sports.

The results obtained are in line with those from previous studies, confirming the positive and significant effect of greater diversity of immigrants' birthplace on worker productivity. This illustrates the limitations of ignoring the relevance of heterogeneity of human capital when analysing the economic effects of migration. Moreover, our outcomes confirm a beneficial impact of a higher rate of young population and skilled labour (whether national or foreign) on regional development.

The rest of the paper is organized as follows. Section 2 reviews the literature on the economic consequences of migration diversity. Section 3 shows the construction and analytical decomposition of our migration diversity indexes. The next section, Section 4, provides some stylized facts analysing the relation between immigration diversity and productivity for the Spanish case. Section 5 explains the data source and the econometric model, including the description of the variables and the theoretical model used to design and interpret our estimation strategy. Section 6 presents the estimation results. Finally, Section 7 concludes with a policy discussion and suggestions for future research on the topic.

2. IMMIGRATION DIVERSITY AND PRODUCTIVITY: AN OVERVIEW OF THE LITERATURE

The economic effects of immigration have been widely analysed in many empirical papers. Motivated by a growing concern in modern economies about a substitution effect from

more expensive native workers to cheaper immigrant workers, primary attention has been paid to the impact of immigration on the labour market of destination regions. Questions like whether immigrants harm or improve the employment conditions and opportunities of native workers have been analysed in depth in the literature, with evidence yielding a mixed and confusing set of results (Borjas, 2003). For some authors this ambiguity indeed reflects a non-significant effect of migration on the receiving economy (Smith and Edmonston, 1998; Friedberg and Hunt, 1995).

After the recent waves of immigrants to the OECD countries, migration has become a phenomenon that concerns many countries in the developed world (Boubtane et al., 2015). Therefore, it is not surprising to find that a significant number of studies that analyse this phenomenon focus on the macroeconomic effects of this movement using time-series or panel data analysis. For Ortega and Peri (2009), for instance, migration in the OECD countries during the period 1980 to 2005 increased employment and capital stock, although the effects on total factor productivity are negligible. Boubtane et al. (2013), however, showed a significant relationship between immigration and GDP per capita for 22 OECD countries over the period 1987-2009. Using time-series analysis, Morley (2005) found a long-run causality from GDP per capita to immigration but not the other way round. Other authors, such as Zorlu and Hartog (2005), Longhi et al. (2010) and Ottaviano and Peri (2012) have considered that the work offered to natives involves jobs in which they could be replaced by immigrants and so, as a consequence of the arrival of large numbers of immigrants, competitiveness and wages can be reduced.

In recent years, and probably motivated by the greater availability of data, a new perspective, focused on the heterogeneity of immigrants, has been incorporated into this debate, namely, the possibility that greater diversity might have positive effects on workers' productivity in destination markets. In Table 1, we present a detailed list of papers that analyse the impact of immigrant diversity on regional economic performance.

INSERT TABLE 1 HERE

According to this literature, people born in different countries complement each other in the labour market, thus immigrant diversity could increase the competitiveness of workers by

enabling the combination of different skills, ideas and perspectives. The seminal paper on this matter is Ottaviano and Peri (2006). By using panel data from different American Metropolitan Statistical Areas (MSAs) through cultural heterogeneity indexes, these authors confirmed the positive impact of immigration in productivity. The fractionalization index calculated by Ottaviano and Peri (2006) had previously been used by Alesina *et al.* (2003), who built a Herfindahl index of population diversity based on people's birthplaces to determine the relationship between diversity migration and productivity. However, this index has some limitations. According to Alesina *et al.* (2013) and Kemeny and Cooke (2018), it can be biased by the presence of a larger proportion of immigrants in a region. To overcome these limitations, we used two additional indexes: the Entropy Index, first used by Taagepera and Ray (1977), and the Alesina Index, proposed by Alesina *et al.* (2013).

Other authors that highlight the favourable effect of immigrant diversity in terms of economic development and wages are Kemeny and Cooke (2018) and Bove and Elia (2017). The first found that urban immigrant diversity produces positive and nontrivial spillovers. Similarly, Bove and Elia, after studying the diversity of immigrants through indexes of fractionalization and polarization for different countries in the period between 1960 and 2010, claimed that there is a positive effect between immigrant diversity and greater GDP growth per capita, especially in developing countries. For some authors, like Wadhwa *et al.* (2008), this positive correlation is further magnified if only skilled immigrants are considered.

Although, as mentioned above, many empirical works emphasize the possibility of a positive relationship between migration diversity and regional development, the evidence on this matter remains quite ambiguous. For instance, Longhi (2013) argued that the positive correlation between diversity in English Local Authority Districts and workers' wages found in cross-sections disappears when we consider panel estimations. Other works find a negative influence of diversity in productivity, thus contemplating the relationship between natives and foreigners as more of a substitution than of a complementary nature. According to this literature, cultural diversity at the group level may lead to lower confidence among workers and poor communication between people, due to discrepancies

in the language, misunderstandings or discriminatory attitudes, as some individuals may subconsciously favour members of their own nationality (Lee, 2013). Borjas and Doran (2012) claimed that researchers whose mathematical research programmes included Soviet researchers underwent a reduction in productivity and significantly reduced their number of publications.

Related to this approach are also those works that analyse the spillovers of migration diversity in terms of innovation, ideas generated and economic performance. According to Lewis and Peri (2014), the evidence suggests that immigration induces natives to specialize in more complex jobs, which complements immigrants' skills, and that it induces higher levels of innovation, both of which may contribute to the observed impacts on productivity. Using data from more than 200 British firms, Gagliardi (2015) showed how an increase in the stock of human capital due to the arrival of skilled immigrants fosters innovation, giving rise to an increase in the level of knowledge which is accessible to local firms through the labour market. Similarly, for Hong and Page (2004), the diversity of human capital increases creativity and helps members to solve problems and generate new ideas.

Finally, an issue that has been underexplored within this literature is whether highly productive workers have a particular preference for diversity (Kemeny and Storper, 2012; Moretti, 2013). If that is the case, there might be a problem of reverse causality and endogeneity, since more productive regions can also be the ones that attract more immigrants from a wider range of nationalities. As an exception, we can mention the following studies that analyse the relationship between diversity migration and labour productivity considering the possibility of a reverse causality: Bakens *et al.* (2013), Trax et al. (2015) and Kemeny and Cooke (2018). In this paper, we seek to contribute to this strand of the literature by investigating to what extent greater immigration diversity influences worker productivity in Spain at a regional level, taking the potential reverse causality and other relevant factors into account.

3. MEASURING IMMIGRATION DIVERSITY

To measure the diversity of immigrants, we use several indexes based on the Herfindahl diversity index[2]. In particular, this work uses three indexes as proposed by Kemeny and Cooke (2018) in which the diversity of immigrants is measured according to their place of birth: Fractionalization Index (FI), Entropy Index (EI), Alesina Index (AI). Each index captures diversity in a different way, giving more weight to the share of immigrants or to the variety (number of birthplaces).

Before explaining the indexes, a few considerations must be discussed, as Alesina *et al.* (2013) suggested. First, there is a limitation because illegal immigration is not captured in the statistical data measured. Second, diversity has been defined according to the place of birth of the immigrants and, therefore, according to this definition, a small child who immigrates with his or her parents will be considered an immigrant despite having received the education and culture of the host country.

Most of the empirical studies on migration diversity employ the Fractionalization Index (see, for instance, Alesina *et al.*, 2003, 2013; Ottaviano and Peri, 2006 and Bove and Elia, 2017). This index, based on the Herfindahl Index, measures the probability that two migrants, randomly selected from the population of a specific host region, were born in different countries. Specifically, this index can be written as,

$$Fractionalization_j = 1 - \sum_{r=1}^{R} s_{rj}^2 \qquad (1)$$

where s ($0 \leq s \leq 1$) is the proportion of residents in a region who were born in country r and R represents the maximum number of countries captured in the population. In our case R = 114 including natives. When the index is close to zero this indicates low diversity, while the closer it is to one, the higher the heterogeneity of the population of the region will be, having as its maximum value $\left(1 - \frac{1}{R}\right) = \left(1 - \frac{1}{114}\right)$.

[2] As Parrotta et al. (2012) mentioned, the Herfindahl index allows us to combine two measures within one single index: the "richness", or number of categories within the region, and the "equitability", or evenness of the individual categories.

As an alternative to the FI, Kemeny and Cooke (2018) used the Entropy Index, which has also been used by authors like Wang (2012), Sturgis *et al.* (2014) and Wright *et al.* (2014).[3] Like the Fractionalization Index, it measures the probability that two randomly selected individuals were born in different countries. However, for these authors this index provides a more accurate measure of diversity when the groups of different nationalities are of different sizes.

$$Entropy_j = -\sum_{r=1}^{R} s_{rj} \cdot \ln(s_{rj}) \qquad (2)$$

The Entropy Index reaches its maximum value, when $Entropy_j = \ln(R)$, in the case that the population is totally heterogeneous. Conversely, EI reaches its minimum value, when $Entropy_j = 0$, which implies complete homogeneity or no diversity, with all population members in the same group.

Finally, we use the Alesina Index (Alesina *et al.*, 2013), as proposed by Kemeny and Cooke (2018). As these authors explained, the FI can be biased by the presence of a large proportion of immigrants in a region even if those immigrants do not come from a wide range of countries of origin. That is, this index gives greater weight to depth than to breadth. To overcome this limitation, Alesina *et al.* (2013) suggest measuring diversity strictly among those born abroad in a given place, instead of capturing heterogeneity among all individuals: natives and immigrants. Namely, it captures all residual diversity from differences between immigrants only.

$$Alesina_j = \sum_{r=2}^{R} \left[\frac{s_{rj}}{(1 - s_1)} \cdot \left(1 - \frac{s_{rj}}{(1 - s_1)}\right)\right] \cdot (1 - s_1)^2 \qquad (3)$$

where s_1 indicates the share of natives.

[3] Entropy, as a mathematical construct, was first introduced into social sciences by Theil (1967, 1972) to solve political problems involving the distribution of seats and votes among various parties and then by Taagepera and Ray (1977) as an index of concentration.

In contrast to the first two indexes, which are estimated for the entire population, the AI will not be influenced by the large number of natives in each region as it uses a measure of immigrant-only fractionalization. This approach is able to solve the extent to which the effects arise due to the sole presence of foreign-born individuals, instead of its heterogeneity. Thus, unlike indexes estimated over the entire population as with the FI or EI, the authors explained that the immigrant-only fractionalization measure will not be influenced by the single large group of native workers. Nevertheless, since AI accounts for the likelihood of meeting and interacting with those from other groups, estimates using this measure include the share of foreign-born workers in the total number as a control.

4. IMMIGRATION, BIRTHPLACE DIVERSITY AND PRODUCTIVITY: THE CASE OF SPAIN

Large-scale migration inflows are a relatively recent phenomenon in Spain. Indeed, until the last two decades of the previous century, this country was eminently a source of emigrants (Izquierdo, Jimeno and Lacuesta, 2015). At the beginning of the 20th century, Spain was behind the most developed European countries in terms of industrialization and urban development what leads to many Spaniards to emigrate to South American countries and North Africa (Alamá-Sabater, Alguacil and Bernat-Martí, 2014; Bover and Velilla, 1999). Throughout the 1960s and 1970s, and after the Spanish Civil War, when over 500,000 people left the country, given the poor economic conditions and political restrictions in Spain, mass emigration to Europe took place (Bover and Velilla, 1999).

However, this trend changed dramatically from the early 1990s, and most remarkably after 1997, when immigration flows in Spain began to increase significantly (Izquierdo, Jimeno and Lacuesta, 2015). For nearly a decade Spain's GDP grew yearly by an average 3.9%, which meant a drop in the unemployment rate from 20.6% in 1997 to 8.2% in 2007. In just a few decades, fuelled by this economic "boom", Spain shifted from being a sending country to a receiving country in terms of migration, becoming one of the main destinations for international migration (González-López *et al.*, 2010). As can be seen in Figure 1, in 1998 the foreign population represented only 1.6% of the total population, while by 2016

this percentage had risen to almost 10%. The percentage of immigrants in the total population reached a peak of 12.2% during the years 2010 and 2011, even after the beginning of the global crisis in 2008.

During the expansion, immigrants – mostly Europeans, closely followed by Latin Americans and Africans (Moroccans) – moved to Spain in search of more and better employment opportunities without drawing any kind of distinction between the types of position they could be employed in (Izquierdo, Jimeno and Lacuesta, 2015; Alamá-Sabater, Alguacil and Bernat-Martí, 2017). Moreover, despite its low importance until the end of the 20th century, as of 2008, the presence of Asians, especially those from China, increased notably (Delle Femmine and Alameda, 2017). The beginning of the crisis led to a sudden shift in this trend. Immigrants coming from developing economies lost importance with respect to those from developed countries (Alamá-Sabater, Alguacil and Bernat-Martí, 2017). Connected with this behaviour were also the new locational preferences and the nature and heterogeneity of immigrants across regions.

In the years before the economic crisis, the vast majority of migrants in Spain were young and came from less developed countries, probably motivated by the hope of finding a new or better job. They therefore tended to choose regions with greater economic activity as their destination, and thus they were distributed in cities along the Mediterranean coast in the central and northern regions with higher employment rates and immigrant incomes (Alamá-Sabater, Alguacil and Bernat-Martí, 2017). In contrast, after the financial crisis, the number of the new residents in Spain rapidly decreased and the decision to locate in Spanish provinces seemed to be determined more by non-economic factors, such as good weather or a better lifestyle. In consequence, there was a greater presence of immigrants from countries with a high Human Development Index (HDI) located in the coastal regions (Alamá-Sabater, Alguacil and Bernat-Martí, 2017). Nevertheless, in some regions, such as Andalusia, the migration of non-skilled labourers to work in agricultural areas still predominates.

Concerning the birthplace diversity of immigrants, as can be seen in Figure 2, where we represent the different diversity indexes as computed in previous section, these significantly

vary along regions. We observe a wider range of immigrant in Madrid and Catalonia. According to Otero (2010), this is because their capital city, Madrid and Barcelona, respectively, are important financial and business centres in Europe. Moreover, due to the large supply of the tertiary sector in these regions, the presence of Ibero-Americans and Africans is also quite significant. If we focus on the Valencian Community and Andalusia, we observe that both regions also have high diversity indexes. There is an important presence of foreigners from the European Union in the two regions. One of the reasons that leads a variety of citizens to migrate to these regions is the good weather and the tourist facilities. In the case of Andalusia, there is also a strong presence of individuals from Africa, especially those with low qualifications, who seek jobs in intensive agriculture. Ibero-Americans are concentrated in Alicante and those from non-EU Europe are more common in Castellón and Valencia (both of them in the Valencian Community). In these regions, the Romanian population is particularly relevant. They mostly arrived before the crisis in search of job opportunities in the construction and tourism sectors. The high diversity of immigrants found in the Balearic and Canary Islands is probably due to the large supply of work found in the services sector, given the great importance that the tourism sector has in both cases. However, in regions like Extremadura, Asturias or Navarra there seems to be less diversity in terms of immigrant's birthplace.

INSERT FIGURE 2 HERE

As before mentioned, the purpose of this paper is to analyse how the degree of heterogeneity in migration in a region influences its competitiveness. As the economic literature has highlighted, several factors enhance regional development. According to Aguayo and Guisán (2008), not only physical and human capital determine the level of productivity of a region, but also a greater social capital, which includes elements of social trust, political trust and other positive elements that generate a social environment to support productive initiatives and cooperation. In this study, we use real wage per capita as a proxy of worker productivity or competitiveness. In Figure 3, we appreciate important differences in wages between Spaniards and non-nationals. The native population has the highest wages, followed by European citizens, since migrant flows of skilled workers

usually predominate among European countries (Mahroum, 2001). Among non-nationals, those from Latin America seem to be among the worst paid.

INSERT FIGURE 3 HERE

However, considering the average wage cost of the entire population, we observe that it changes significantly across regions and over time (see Figure 4). Throughout all the sample period, wages are higher in the Basque Country, Navarre, Madrid and Catalonia. These last two regions coincide with those with the highest index of immigrant diversity (see Figure 2). In addition, regions with low wages are those in which the supply of unskilled labour is higher due to the relevance of agriculture. Accordingly, we find lower wages in Extremadura, Galicia, Castilla and León, Castilla La Mancha and Andalusia, regions with high agricultural and livestock activity.

INSERT FIGURE 4 HERE

The foregoing stylized facts reveal that that there has not only been a change in the migration inflows of Spain, by which it has gone from being a sending country to a receiving country, but also a qualitative change in terms of the diversity of the new residents. In general, as the descriptive evidence shows, those regions where we find higher wages per capita are also those with a greater presence of different nationalities. This positive relationship between productivity and birthplace diversity in Spain is also confirmed by the upward slopes shown in Figure 7, where the log of wage is represented with respect to the different diversity indexes.

INSERT FIGURE 5 HERE

5. DATA AND ECONOMETRIC MODEL

5.1 Data and Variables

In order to analyse the effect that the diversity of immigration has on workers' productivity in Spain, we used information from the 17 Spanish regions (Autonomous Communities) covering the period 2008 and 2016. The sample period was selected with the purpose of

evaluating the connections between immigrants' diversity and productivity both during the crisis and afterwards.

Generally, the analysis of the existence of spillovers from immigrant diversity is not an easy task given the restrictions in terms of data availability. In our case, we built a database using data from both the Spanish National Institute of Statistics (INE) and the EDUCAbase (from the Ministry of Education, Culture and Sports), which has allowed us to carry out the study at a NUTS 2 level. Table 2 contains a detailed explanation and the source of the variables used.

INSERT TABLE 2 HERE

Following previous literature, productivity has been proxied here by national real wages. Other authors, such Kemeny and Cooke (2018), and Ottaviano and Peri (2006), have also used this variable as an approximation of worker productivity. Particularly, we employ the average annual gross wage per Autonomous Community. Alternatively, as a robustness test, we have measured productivity as the real wages of the total population, that is, considering both immigrants and nationals .

As our main regressor, the diversity of migration has been computed here by three different indexes: Fractionalization Index, Entropy Index and Alesina Index, which have been calculated as explained earlier in Section 3. Consistent with previously literature, several characteristics of the region were considered as additional control variables. In line with Ottaviano and Peri (2006), here we include total population to capture the scale of the region. Moreover, following Gagliardi (2015), the proportion of young population has been included as an additional regressor. According to the United Nations (2015), young people are a positive force for productivity when they are provided with the knowledge and opportunities necessary to thrive, because they have skills acquired during their education that allow them to contribute to economic productivity. Additionally, we introduce the unemployment rate of the natives to capture the employment opportunities offered by each

region as in Gagliardi (2015). The weight of this variable is especially relevant for the so-called labour immigrants.[4]

Finally, given the relevance that human capital has on productivity, as initially highlighted in the seminal paper by Lucas (1988), in this work, we have included this variable considering both national human capital and imported human capital. The first has been proxied by the share of population that has reached high educational levels[5]. This variable has also been used Bove and Elia (2017) and Alesina *et al.* (2013). Similarly, Saks *et al.* (2015) found a robust positive relation between higher education and an increase in productivity and wages. Nonetheless, such as mentioned by Nathan (2015), this higher human capital may also be due to the entrance of skilled migration. According to this author, the arrival of skilled people has a significant and positive impact on the labour market of the destination countries. In our work, this variable has been proxied by the percentage of immigrants that arrived from countries with high or very high levels of Human Development Index as a proxy of skilled immigrants. In Table A.1 and A.2 in the Appendix, we present the main statistics and correlation matrix of these variables. As can be appreciated, we obtain a high positive correlation between higher education and the share of immigrants coming from countries with high HDI indicating that those regions with more skilled workers are also the ones that attract immigrants from more developed countries.

[4] According to the International Organization for Migration (www.iom.int), international labour migration is defined as the movement of people from one country to another for the purpose of employment.

[5] For the coding of the variable "high education" in the EPA, until 2013 the National Classification of Education 2000 (CNED-2000) was applied, which is compatible with the International Standard Classification of Education 1997 (ISCED-97). As of 2014, a series rupture when the new National Classification of Education 2014 was applied (CNED-2014), compatible with the International Standard Classification of Education 2011 (ISCED-2011). Source: Ministry of Education, Culture and Sports.
The information is found in EDUCAbase, a database provided by the Spanish Ministry of Education, Culture and Sports that collects the data from the Exploitation of the educational variables of the Labour Force Survey offered by the INE. This survey represents a synthesis of information based on the educational variables of the Labour Force Survey and the Community Labour Force Survey.

5.2 Estimation methodology

For the estimation of the productivity spillovers derived by a higher birthplace diversity, we employ a panel data methodology. This allowed us to account for both time effects and unobserved individual heterogeneity. As previously mentioned, to do so, we used data from the 17 Spanish Autonomous Communities (NUTS 2) during the period between 2008 and 2016.

Following the recent literature, we analyse how the aggregate birthplace diversity influences worker productivity, after controlling for other regional factors such as total population, young population, share of population with higher education, natives' unemployment and the share of immigrants arriving in each region from countries with a high or very high level of human development. More specifically, the estimated equation takes the following form:

$$\begin{aligned} ln(wage_{c,t}) = \beta_0 + \beta_1\ ln(birthplace\_index_{c,t})^k + \\ + \beta_2\ ln(popul_{c,t}) + \beta_3 ln(youngpop_{c,t}) + \beta_4 ln(higheduc_{c,t}) \\ + \beta_5 ln(unemnat_{c,t}) + \beta_6 ln(shareHDI_{c,t}) + \varepsilon_c + \varepsilon_t + \varepsilon_{c,t} \end{aligned} \quad (4)$$

where *c* stands for each Autonomous Community and *t* denotes time, specifically, each year analysed; $wage_{c,t}$ indicates the average real wage of the national population of each region; $birthplace\_index_{c,t}$ represents the different indexes we have used to measure diversity; where $k \in [1,3]$ indicates each of the three indexes calculated; $popul_{c,t}$ and $youngpop_{c,t}$ indicate the population and young population enumerated in each region; $higheduc_{c,t}$ shows us what percentage of the total population has higher education, ; $unemnat_{c,t}$ constitutes the unemployment rate of the natives; and finally $shareHDI_{c,t}$ allows us to control for what part of the foreigners come from countries with high and very high HDI. All these variables are expressed in natural logarithms. Thus, the coefficients that accompany the explanatory variables will indicate the elasticity of the dependent variable with respect to the independent variables.

Let ε_c represent time-invariant permanent differences across regions, and let ε_t be the time effects that affect the regions identically in each period. Finally, $\varepsilon_{c,t}$ is the random error term with a mean of zero, which is assumed to be independent across countries and over time.

The decision as to whether to consider unobserved region-specific effects as fixed or random is made based on the Hausman test. Fixed effects allow for unobservable factors, i.e. omitted variables that can be correlated with the explanatory variables, which vary between the individual entities and do not change over time, whereas random effects indicate that the exact value at the origin that each individual may have is not sure, but it is considered that it will probably gravitate around a central value. Hausman illustrated that the difference between the coefficients of fixed and random effects $(\beta_{fe} - \beta_{re})$ might be used to prove the null hypothesis that the random error term and the explanatory variables are not correlated.[6] Moreover, an autocorrelation test proposed by Wooldridge (2002)[7] was used to test autocorrelation problems in the models. The null hypothesis of this test is that there is no autocorrelation; if it is rejected, it can be concluded that it exists. Robust standard errors are calculated to eliminate potential heteroscedasticity and autocorrelation of the panel data.

For comparative purposes and to address the problem of both endogeneity and reverse causality, we estimated the coefficient of the model using the 2SLS methodology. The plausibility of both the potential positive impact of an increase in the migration diversity on productivity and the possibility of regions with a higher productivity attracting immigrants from a greater number of countries has been documented in the literature (Ottaviano and Peri, 2006). As authors like Kemeny and Cooke (2018) have explained, more productive

[6] From modern econometrics it is known that if the individual effects are correlated with the other regressors in the model, the fixed effect model is consistent, and the random effects model is inconsistent. Conversely, if the individual effects are not correlated with the other regressors in the model, as established under the null hypothesis in the Hausman test, both random and fixed effects are consistent and random effects are efficient. See Greene (2012) for more details.

[7] The Wooldridge method uses the residuals of a regression of first differences, observing that if u_{it} is not serially correlated, then the correlation between the differentiated u_{it} errors for period t and t-1 is equal to -0.5. In fact, the Wooldridge test is designed to prove this equality. For a more extensive discussion of this test, see Wooldridge, (2002).

regions can also be the ones that attract a wider range of immigrants of different nationalities. That is, regions may experience an increase in the average wage of a positive economic shock, which attracts immigrants disproportionately and therefore witnesses an increase in diversity. If these two bidirectional causalities occur, the measured impact of diversity on wages and incomes would be biased upwards (Ottaviano and Peri, 2006). This makes it necessary to consider the likelihood of a reverse causality in our analysis employing instrumental variables.

6. MAIN RESULTS

6.1 Fixed effects estimation

Table 3 presents the estimates of Eq. 4 using the fixed effects (FE) estimation methodology. As can be seen at the bottom of this table, the Hausman test statistic suggests that in all cases the fixed effects model is preferred to the random effects model. In addition, from the Wooldridge test for autocorrelation, we can conclude that the data do not have first-order autocorrelation.

INSERT TABLE 3 HERE

The coefficients in Table 3 are shown sequentially for the three alternative measures of migration diversity (FI, EI and AI, respectively). The most outstanding result of these regressions refers to the significance of the indexes of cultural diversity in the three regressions, this result being consistent with our main hypothesis of the existence of a positive productivity spillover from greater immigration heterogeneity. Specifically, the estimated coefficients imply that, on average, an increase in the Fractionalization Index of 10 percentage points leads to a rise in national wage of 1.49 percentage points, keeping other regional factors constant. A higher impact is seen with the Entropy Index, as an increase by 10 percentage points will predict a growth in national wages of 1.96 percentage points, *ceteris paribus*. However, this effect is significantly smaller when we consider the Alesina Index. In this case, a higher index, around 10 percentage points, implies an increase of 0.8 percentage points in wages. The smaller value of this last index may be explained by the very nature of the Alesina Index. As shown previously, this index calculates the

diversity strictly among those born abroad in a given place, instead of capturing heterogeneity among all individuals.

Coefficients on other control variables show the expected signs. We find that, except for population and unemployment, all of them have a significant effect on productivity. The lack of significance of population may be due to the inclusion of other variables, such as a young population, that may capture in some way the scale of the region. As can be seen in Table 3, the results from all the regressions suggest a positive and significant influence of a greater proportion of young population in productivity. Specifically, an increase of 10 percentage points in the rate of young population in each regions increases the average wage for nationals above 8 percentage points. Similarly, our estimates verify the beneficial impact of skilled labour on productivity. In particular, an increase of 10 percentage points in the percentage of the population with higher education will result in a rise in wages by 3 percentage points. The presence of migrants arriving from countries with a high or very high HDI also appears to be positively correlated with national wages. According to our estimates, with a share of 10 points higher, productivity will increase by approximately 4 percentage points. In contrast, the unemployment rate for natives seems to have a non-significant influence on national wages.

As a robustness check, we re-estimated the previous model using the total wage of the population as a dependent variable, considering the earnings from both immigrants and nationals. Accordingly, the estimated equation now takes the following form:

$$\begin{aligned}&\ln(wagetot_{c,t})\\&= \beta_0 + \beta_1\ ln(birthplace\_index_{c,t})^{k} +\\&+ \beta_2\ ln(popul_{c,t}) + \beta_3 ln(youngpop_{c,t}) + \beta_4 ln(higheduc_{c,t})\\&+\ \beta_5 ln(unemnat_{c,t}) +\ \beta_6 ln(shareHDI_{c,t}) + \varepsilon_c + \varepsilon_t + \varepsilon_{c,t}\end{aligned} \qquad (5)$$

where $wagetot_{c,t}$ represents the real wage of the total population and the subscripts and the rest of the variables have the same definition as previously in Eq. 4. Following the results of the Hausman test, the coefficients have been estimated once again through the FE methodology. The estimates are presented in Table 4.

INSERT TABLE 4 HERE

In general, the estimates obtained in these regressions confirm our previous outcomes, although now only two of the three diversity indexes (EI and AI) are significant. The lack of significance of the FI might be justified by the fact that, as pointed out by the literature, the Fractionalization Index might be overrated because the presence of a large proportion of immigrants in a region, even when these immigrants do not come from a wide range of countries of origin. Note, however, that the value and sign of the coefficient on indexes are similar to those previously estimated. An increase in the Fractionalization index and in the Entropy index of 10 percentage points are associated with an increase in the average wage of the total population by 1.34 and 1.82 percentage points respectively, whereas the same increase in the Alesina Index will imply a rise in the wage by 0.73 percentage points.

The estimates for the other control variables confirm the beneficial influence that a greater young and skilled population has on productivity; as well as the positive productivity spillover of an increase in immigration from countries with a high or very high HDI. Regarding the unemployment rate of natives, we found now the expected significant influence. The estimated coefficients indicate a decrease of approximately 0.8 percentage points in total wages due to a rise of 10 percentage points in the unemployment rate. Finally, as can be seen at the bottom of the table, in all cases the Wooldridge test for autocorrelation shows us that data do not have first-order autocorrelation.

6.2 Endogeneity and instrumental variable (IV) approach

As mentioned above, the FE estimation takes into account unobserved heterogeneity among regions; however, it does not consider a potential simultaneity problem or reverse causality. Nonetheless, as pointed out by Cadena *et al.* (2013) and Lewis and Peri (2014), among others, the location of immigrants is not a random selection. In contrast, this may depend on the local economic outcomes. Consequently, whenever the amount of diversity of immigrants in a region and its economic performance are interrelated, we need to be cautious in our estimations in order to avoid upward biased estimates. To overcome this, we employ 2SLS techniques by using an instrumental variable (IV) whose exogenous variation

affects migration diversity in a region, but not the total worker productivity. Thus, this variable allows us to isolate that portion of the correlation between diversity and wages that is due to the causal effect of diversity in wages (Ottaviano and Peri, 2006).

As a previous step, in Table 5, we check the bidirectional relationship between the diversity indexes and productivity through the Wu-Hausman endogeneity test[8]. This test allowed us to determine whether the covariance between the indexes used as independent variables and the error term $\varepsilon_{c,t}$ was equal to zero. Under the null hypothesis of no endogeneity, ordinary least squared (OLS) estimation is consistent and efficient, while 2SLS is also consistent, but inefficient. But if endogeneity exists, an IV estimation methodology is required to guarantee consistent estimations. The results obtained confirm that the diversity indexes are endogenous in the three regressions.

INSERT TABLE 5 HERE

Accordingly, to deal with the problem of endogeneity, we next estimate our model by 2SLS. The instrument used in our regressions is a type of diversity index that was initially proposed by Ottaviano and Peri (2006), which later became a standard instrument in literature, as in the case of Gagliardi (2015). According to Ottaviano and Peri (2006), immigrants tend to settle, at least initially, where other immigrants from the same country already reside. In consequence, this index is constructed as the "predicted" change in the number of immigrants from each country in each region during the period 2008-2016. By construction, the predicted change does not depend on any specific regions economic shock during the observed period.

First, the growth rate of immigration is calculated for each group of immigrants according to their birthplace[9]. Thus, using the same notation as in the previous indexes, we have:

$$(g_r)_{y1-y2} = \frac{(s_{rj})_{y2} - (s_{rj})_{y1}}{(s_{rj})_{y1}} \qquad (6)$$

[8] To compute this test, we add the residuals from the reduced-form of the endogenous variables as additional regressor in the structural equations.

[9] This has been calculated from year to year since 2009, since as it does not have information for 2007.

where g_r is the growth rate of immigrants born in country *r*, y_1 represents year 1 and y_2 represents year 2.

Second, from the above equation, we calculate the "attributed" share of people born in country *j* and residing in autonomous community *c* in year 2:

$$\left(\widehat{s_{rj}^{c}}\right)_{y2} = \left(g_{rj}^{c}\right)_{y2} \cdot \left[1 + \left(g_r\right)_{y1-y2}\right] \quad (7)$$

As a final stage, we obtain a diversity index, *div*, through the attributed share of foreign-born individuals:

$$\widehat{div}_{c,y2} = 1 - \sum_{i} \left(\widehat{s_{rj}^{c}}\right)_{y2}^{2} \quad (8)$$

As Ottaviano and Peri (2006) explained, the variable *div* is independent of any specific shock in a region during the period, since the attributed diversity for each Autonomous Community in year 2 is built using the participation of the Autonomous Community in year 1 and the national growth rates of $y_1 - y_2$ of each group of immigrants[10]. Thus, this variable would meet the exogeneity requirements needed for a good instrument. However, an additional criterion is necessary for an instrument to be valid: relevance. Accordingly, Table 6 presents the OLS estimates of the effect of *div* on the diversity indexes to verify the instrument relevance. The results obtained confirm that the instrumental variable (*div*) is significantly and positively correlated with the diversity index in all cases.

INSERT TABLE 6 HERE

Subsequently, Table 7 illustrates the 2SLS estimations of these specifications. As in the previous estimation, the three diversity indexes (FI, EI and AI) are now positive and statistically significant in the explanation of the average wage, suggesting that an increase in the diversity of immigrants is associated with higher productivity. In particular, similarly to the FE estimates, we find that when the Fractionalization Index rises by 10 percentage points, national wages go up 8.36 percentage points. In the regression of the Entropy Index, outcomes are similar with a coefficient of 7.86 percentage points. Now the effect that an increase in the Alesina Index has on productivity is lower than those obtained with the

[10] Consequently, 17 observations corresponding to the year 2008 have been lost.

previous indexes, although higher than that achieved through the regression with fixed effects. Besides, the results of the 2SLS regressions confirm the expected benefits derived by a higher rate of young and educated population as well as the productivity spillovers of a higher proportion of skilled immigrants.

INSERT TABLE 7 HERE

6.3 Robustness analysis

Next, for robustness, we perform a similar analysis considering the productivity of total workers (including non-native ones) as a dependent variable. Similarly, the problem of a non-random selection in the location of immigrants is analysed through the Wu-Hausman endogeneity test. Results in Table 8 confirm the endogenous nature of the three diversity indexes in the explanation of the total wages. Accordingly, we estimate the model by 2SLS using the predicted change in the number of immigrants coming from each country as the instrumental variable.

INSERT TABLE 8 HERE

The estimations shown in Table 9 verify our previous conclusions. Again, the three diversity indexes are positive and statistically significant. Furthermore, the roles of the other control variables in the explanation of total wages are similar to those obtained previously.

INSERT TABLE 9 HERE

To sum up, our estimates consistently confirm a positive and largely significant relationship between regional immigrant diversity and worker productivity (for total and nationals). Moreover, these outcomes are robust to both the unobserved regional heterogeneity and to the presence of a possible interconnection between the economic effects of a greater diversity of immigrants and the relevance that the economic conditions may exert on the attraction of a more diverse range of non-residents. Finally, we prove the important role of an increase in young and trained workforce, whether national or foreign, to encourage competiveness and regional development.

7. CONCLUSION

Despite its late incorporation into the massive waves of worldwide immigration, Spain has nowadays become one of the European countries that receives most foreigners. The importance that this phenomenon has had in recent times, particularly in the developed world, has fuelled the debate about their economic effects. Traditionally, the literature in this regard has paid special attention to the potential substitution effect from more expensive native workers to a cheaper workface made up of immigrants. However, more recently, and probably motivated by the greater availability of data and a broader view of the phenomenon, a new perspective focusing on the diversity of immigrants has been incorporated into this debate. According to this literature, birthplace diversity may increase productivity by enabling the combination of different skills, ideas and perspectives.

The aim of this work is to provide a robust estimation of the impact of migration diversity on technological spillovers and productivity in Spain at a regional level. In particular, we try to analyse how birthplace diversity has affected efficiency and workers' productivity in this economy during the period from 2008 to 2016. To study this question, we based our analysis on three different diversity indexes: the first, Fractionalization Index, reflects the probability that two randomly selected individuals from a population belong to different groups. The second, Entropy Index provides a more accurate measure of diversity when the constituent groups are of different sizes. Finally, the third, Alesina Index measures diversity strictly among those born abroad in a given place, instead of capturing heterogeneity among all individuals, natives and immigrants. In contrast to most of the previous literature and following the recommendations of Kemeny and Cooke (2018), we take into account the potential simultaneity between migration heterogeneity and economic performance by estimating the model through 2SLS. We instrumentalize the migration diversity using information on the "predicted" change in the number of immigrants from each country in each AC (exogenous variable that fulfils the IV requirements), as proposed by Ottaviano and Peri (2006).

The results suggest a positive and significant correlation between migration diversity and native workers' productivity. This result is robust to both the unobserved regional

heterogeneity and the presence of a two-way connection between productivity and migration diversity. Moreover, the outcome remains when the wages of the total population (without distinguishing between natives and immigrants) is used as a dependent variable. This verify our main hypothesis of a positive productivity spillover from a greater migration diversity, which illustrates the danger of focusing on one single side of the coin in the political debate, when evaluating the consequence of migration. For a complete evaluation of this phenomenon governments and policy makers should also take should also take into account the cultural diversity derived from migration. Our findings further confirm the beneficial influence of a higher proportion of young and skilled population. The productivity spillovers of a higher proportion of immigrants form countries with high or very high human development index has been also tested. Therefore, given that more highly skilled labour may come from the entry of more trained workers, when data availability allows, more research should be conducted to take this issue into account before making a definitive evaluation of the total impact that heterogeneous immigration may have on recipient economies.

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APPENDIX

Table A.1. Main Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Wage	153	3115	0.125	2910	3723
Fractionalization	153	-1749	0.517	-2799	-0.949
Entropy	153	-0.534	0.462	-1521	0.216
Alesina	153	-4870	1090	-7120	-3103
Population	153	0.626	0.899	-1153	2134
Young Population	153	-3071	0.125	-3359	-2787
High Education	153	2806	0.406	1684	3576
Natives unemployment	153	-1466	0.200	-1891	-0.721
ShareHDI	153	-0.344	0.129	-0.709	-0.148
Predicted Diversity	136	-7967	0.546	-9312	-6810

Source: Authors' own elaboration based on INE data.

Table A.2. Correlation matrix

	Wage	Population	Young Population	High Education	Natives unemploy.	ShareHDI
Wage	1.000					
Population	0.147	1.000				
Young Population	-0.357	0.1785	1.000			
High Education	0.666	-0.075	-0.307	1.000		
Natives unemploy.	-0.384	0.283	0.297	-0.216	1.000	
ShareHDI	-0.416	0.04	-0.100	0.619	0.124	1.000

Source: Authors' own elaboration based on INE data.

TABLES

Table 1. Overview of studies on the impact of migrant diversity on economic performance.

Authors	Year of Publication	Focus	Data	Years	Diversity Measure	Results
Alesina, Devleeschauwer, Easterly, Kurglat, Wacziarg	2003	Effects of ethnic, linguistic, and religious heterogeneity on the quality of institutions and growth.	190 countries	Data from different sources between 1960-1995	Ethnic, linguistic, and religious fractionalization	Ethnic and linguistic fractionalization variables, more so than religious ones, are likely to be important determinants of economic success, both in terms of GDP growth, other measures of welfare and policy quality and the quality of institutions.
Hong and Page	2004	Analyse if groups of diverse problem solvers can outperform groups of high-ability problem solvers	Three different group composition (Result of computational experiments)	-	Demographic characteristics, cultural identities and ethnicity, and training and expertise	When selecting a problem-solving team from a diverse population of intelligent agents, a team of randomly selected agents outperforms a team comprised of the best-performing agents.
Ottavino, Peri	2006	Economic consequences, specifically productivity, of the growing diversity of American cities	160 Standard MSA's from USA	1970-1990	Percentage of foreing-born and a fractionalization index	Higher wages and higher rents for US natives are significantly correlated with higher diversity
Wadhwa, Saxenian, Rissing and Gereffi	2008	Relation between highly skilled immigrants to USA engineering and technology-related industries nationwide.	28.000 engineering and technology companies in USA	1995-2005	Birthplace of the key founders of the companies	Skilled immigrants have contributed significantly to the USA economic growth over time as those firms in which the founders were both skilled immigrants and Americans contributed substantially both to job and wealth creation in the USA.
Borjas, Doran	2012	Effect on productivity on those mathematicians whose research overlapped with that of the Soviets.	Works published by mathematicians in the USA in one of the 63 different fields in which at least one author of the Soviet Union.	1970-1989	Mathematicians in the USA born in the Soviet Union.	Those mathematicians whose research programs involved Soviet researchers suffered a reduction in productivity and their publications were considerably reduced.
Alesina, Harnoss and Rapopot	2013	Impact on the economic prosperity of the birthplace diversity	Immigrantion data from 195 countries	1990-2000	Birthplace diversity index	The diversity of skilled immigration relates positively to economic develpment
Bakens, Mulder and Nijkamp	2013	Impact of cultural diversity on local economies	61.738 individual workers/homeowners	1999-2008	Cultural fractionalization	There is a negative impact of cultural diversity on local housing markets likely driven by a causal effect between the presence of immigrants and neighborhood quality that outweighs a positive effect of immigrant-induced diversity in consumption goods.

Source: Authors' own elaboration.

Table 1 (cont). Overview of studies on the impact of migrant diversity on economic performance.

Authors	Year of Publication	Focus	Data	Years	Diversity Measure	Results
Gagliardi	2013	Effect of an increase in the stock of human capital due to skilled immigration on the innovative performance of recipient economies.	211 british firms in two periods	2002-2004 and 2004-2006	British travel to work areas (TTWAs) as key to address the impact of immigration	Those areas experiencing the most inflows of skilled immigrants are those benefiting from the availability of these new sources of individual incorporated knowledge.
Lee	2013	Two effects: a firm effect, with diversity at the firm level improving knowledge sourcing or ideas generation, and a city effect, where diverse cities helping firms innovate.	2.223 SMEs in UK	2004, 2005	Share of the members or directors of companies that were born outside the United Kingdom	Average city diversity is unimportant compared to firm level diversity. Diverse firms in London tend to innovate more while those in other large cities innovate relatively less.
Longhi	2013	Impact that cultural diversity has on individual wages in England	353 English districts	2002-2007	Ethnic fractionalization	Cultural diversity is positively associated with wages, but only when cross-section data are used, while panel data estimations show no impact of diversity.
Lewis and Peri	2014	Effect that immigration has on urban and regional economies focusing on productivity and labor markets.	Depending on the estimation (for USA): 284 Metropolitan, 50 states, 333 occupations or seven schooling groups.	2011	Immigrants' share of employment	Immigration is associated with higher wages and with higher productivity as it induces natives to specialization in more complex jobs which complement immigrants' skills.
Trax, Brunow and Suedeskum	2015	Effect that cultural diversity has on total factor productivity	11.343 establishment-year observations (7.241 manufacturing and 4.102 service observations)	1999–2008	The share of foreigners in a plant of total workforce and cultural fractionalization	Larger share of foreign workers (either in the establishment or in the region) does not affect productivity, but there are spillovers associated with the degree of fractionalization of the group of foreigners into different nationalities.
Bove and Elia	2017	Relation between cultural diversity and economic growth	Migrant stock data from 135 countries	1960-2010	Index of fractionalization and polarization	Both indices have a distinct positive impact on real GDPpc. The effect of diversity seems to be more consistent in depeloping countries.
Kemeny and Cooke	2017	Effect of immigrant diversity on productivity. Diversity impact at both city and workplace scales.	Employer–employee data from 29 states of USA	1991-2008	Fractionalization index, Entropy index, Alesina index	Immigrant diversity in USA cities and workplaces has an independent positive influence on workers productivity. Moreover, the authors conclude that spillovers from imigrant diversity are consistent across workers occupying

Table 2. Definition and data sources

Variable	Description	Data Source
Wage	Log of the average annual gross salary per Autonomous Community	Active Population Survey available in the Spanish National Institute of Statistics (INE)
Fractionalization	Log of a birthplace index based on Kemeny and Cooke (2017)	Author's calculations based on the Spanish National Institute of Statistics (INE)
Entropy	Log of a birthplace index based on Kemeny and Cooke (2017)	Author's calculations based on the Spanish National Institute of Statistics (INE)
Alesina	Log of a birthplace index based on Kemeny and Cooke (2017)	Author's calculations based on the Spanish National Institute of Statistics (INE)
Population	Log of total population by Autonomous Community	Statistics of the Continuous Register available in the Spanish National Institute of Statistics (INE)
Young Population	Log of the share of young population, considering as young population those aged between 15 and 29 years	Statistics of the Continuous Register available in the Spanish National Institute of Statistics (INE)
High Education	Log of the share of population that has superior studies to the 2nd stage of Secondary Education	EDUCAbase database from the Ministry of Education, Culture and Sports
Natives Unemployment	Log of the unemployment rate of the native population by Autonomous Community	Active Population Survey available in the Spanish National Institute of Statistics (INE)
ShareHDI	Log of the share of immigrants arrived in each Autonomous Community that come from countries with a high or very high level of human development.	Migration Statistics available in Statistics National Institute and Human Development Reports of the United Nations Development Program
ldiv	Log of a birthplace index based on Ottaviano and Peri (2006)	Author's calculations based on the Spanish National Institute of Statistics (INE)

Source: Authors' own elaboration.


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Table 3. Estimation results of Wage using Fixed Effects estimation: 2008-2016

	(1)	(2)	(3)
	Fractionalization	**Entropy**	**Alesina**
Fractionalization	**0.149***		
	(0.0879)		
Entropy		**0.196****	
		(0.0971)	
Alesina			**0.0813****
			(0.0407)
Population	-0.0352	-0.0430	-0.0284
	(0.354)	(0.351)	(0.352)
Young Population	0.803***	0.813***	0.816***
	(0.124)	(0.122)	(0.123)
High Education	0.302***	0.301***	0.299***
	(0.0391)	(0.0388)	(0.0390)
Natives Unemployment	-0.0685	-0.0657	-0.0687
	(0.0461)	(0.0460)	(0.0458)
ShareHDI	0.380**	0.397***	0.398***
	(0.150)	(0.147)	(0.148)
Constant	6.493***	6.370***	6.666***
	(0.568)	(0.527)	(0.590)
Observations	153	153	153
R-squared	0.848	0.849	0.849
Number of Autonomous Communities	17	17	17
Regional FE	YES	YES	YES
Year FE	YES	YES	YES
Hausman Test	31.68	33.85	33.76
	(0.0045)	(0.0022)	(0.0022)
Wooldridge test for autocorrelation	2.451	2.417	2.369
	(0.1370)	(0.1396)	(0.1433)

Note: Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1. For the Hausman test and the Wooldridge test for autocorrelation, we report the p-values in parentheses.

Table 4. Estimation results of Total Wage using Fixed Effects estimation: 2008-2016

	(1) Fractionalization	(2) Entropy	(3) Alesina
Fractionalization	**0.134**		
	(0.0879)		
Entropy		**0.182***	
		(0.0971)	
Alesina			**0.0733***
			(0.0408)
Population	0.0733	0.0673	0.0796
	(0.354)	(0.352)	(0.352)
Young Population	0.842***	0.854***	0.855***
	(0.124)	(0.123)	(0.123)
High Education	0.284***	0.282***	0.281***
	(0.0391)	(0.0389)	(0.0391)
Natives Unemployment	-0.0800*	-0.0771*	-0.0802*
	(0.0462)	(0.0460)	(0.0458)
ShareHDI	0.420***	0.441***	0.437***
	(0.150)	(0.147)	(0.148)
Constant	6.505***	6.404***	6.662***
	(0.569)	(0.527)	(0.591)
Observations	153	153	153
R-squared	0.848	0.849	0.849
Number of Autonomous Communities	17	17	17
Regional FE	YES	YES	YES
Year FE	YES	YES	YES
Hausman Test	33.03	35.58	35.30
	(0.0029)	(0.0012)	(0.0008)
Wooldridge test for autocorrelation	1.306	1.301	1.275
	(0.2698)	(0.2709)	(0.2756)

Note: Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1. For the Hausman test and the Wooldridge test for autocorrelation, we report the p-values in parentheses.

Table 5. Estimation results of Wu-Hausman endogeneity test

	(1) Fractionalization	(2) Entropy	(3) Alesina
Residuals1	-0.217**		
	(0.0908)		
Residuals2		-0.202**	
		(0.0847)	
Residuals3			-0.0942**
			(0.0398)
Fractionalization	0.126		
	(0.0830)		
Entropy		0.106	
		(0.0760)	
Alesina			0.0533
			(0.0361)
Population	0.0337*	0.0345*	0.0343*
	(0.0195)	(0.0199)	(0.0196)
Young Population	-0.200	-0.0457	-0.127
	(0.267)	(0.207)	(0.240)
High Education	-0.0504	0.0298	-0.0104
	(0.183)	(0.150)	(0.168)
Natives Unemployment	-0.155***	-0.175***	-0.164***
	(0.0512)	(0.0471)	(0.0492)
ShareHDI	-0.0707	-0.0685	-0.0698
	(0.101)	(0.102)	(0.102)
Constant	2.988***	3.466***	3.329***
	-1.028	(0.868)	(0.892)
Observations	136	136	136
Number of CCAA	17	17	17

Note: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 6. Estimation results of relevance condition of the IV

	(1) Fractionalization	(2) Entropy	(3) Alesina
Predicted Diversity	0.0725***	0.0772***	0.170***
	(0.0237)	(0.0210)	(0.0512)
Population	0.872**	0.823**	1.761**
	(0.372)	(0.330)	(0.804)
Young Population	-0.501***	-0.451***	-1.117***
	(0.111)	(0.0988)	(0.241)
High Education	0.0581*	0.0434	0.127*
	(0.0349)	(0.0310)	(0.0754)
Natives Unemployment	-0.0174	-0.0169	-0.00496
	(0.0462)	(0.0409)	(0.0997)
ShareHDI	-0.747***	-0.607***	-1.526***
	(0.122)	(0.108)	(0.263)
Constant	-3.278***	-1.828***	-8.144***
	(0.488)	(0.433)	(1.054)
Observations	136	136	136
R-squared	0.929	0.928	0.930
Number of CCAA	17	17	17
Regional FE	YES	YES	YES
Year FE	YES	YES	YES

Note: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 7. Estimation results of wage using IV through 2SLS

	(1) Fractionalization	(2) Entropy	(3) Alesina
Fractionalization	**0.836***		
	(0.463)		
Entropy		**0.786***	
		(0.410)	
Alesina			**0.357***
			(0.190)
Population	-0.560	-0.478	-0.460
	(0.632)	(0.573)	(0.580)
Young Population	1.128***	1.062***	1.107***
	(0.252)	(0.212)	(0.234)
High Education	0.248***	0.263***	0.251***
	(0.0606)	(0.0529)	(0.0573)
Natives Unemployment	-0.0532	-0.0544	-0.0659
	(0.0659)	(0.0620)	(0.0629)
ShareHDI	0.943**	0.796**	0.863**
	(0.406)	(0.315)	(0.353)
Constant	9.097***	7.791***	9.264***
	(1.783)	(1.082)	(1.797)
Observations	136	136	136
Number of CCAA	17	17	17
Regional FE	YES	YES	YES
Time effect	YES	YES	YES

Note: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 8. Estimation results of Wu-Hausman endogeneity test

	(1) Fractionalization	(2) Entropy	(3) Alesina
Residuals1	-0.230**		
	(0.0910)		
Residuals2		-0.216**	
		(0.0850)	
Residuals3			-0.100**
			(0.0399)
Fractionalization	0.122		
	(0.0832)		
Entropy		0.100	
		(0.0764)	
Alesina			0.0511
			(0.0363)
Population	0.0338*	0.0347*	0.0344*
	(0.0196)	(0.0202)	(0.0198)
Young Population	-0.195	-0.0351	-0.121
	(0.267)	(0.208)	(0.241)
High Education	-0.0923	-0.00999	-0.0520
	(0.183)	(0.150)	(0.168)
Natives Unemployment	-0.168***	-0.189***	-0.177***
	(0.0513)	(0.0473)	(0.0493)
ShareHDI	-0.0442	-0.0398	-0.0428
	(0.102)	(0.103)	(0.102)
Constant	2.953***	3.459***	3.295***
	(1.031)	(0.872)	(0.894)
Observations	136	136	136
Number of CCAA	17	17	17

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

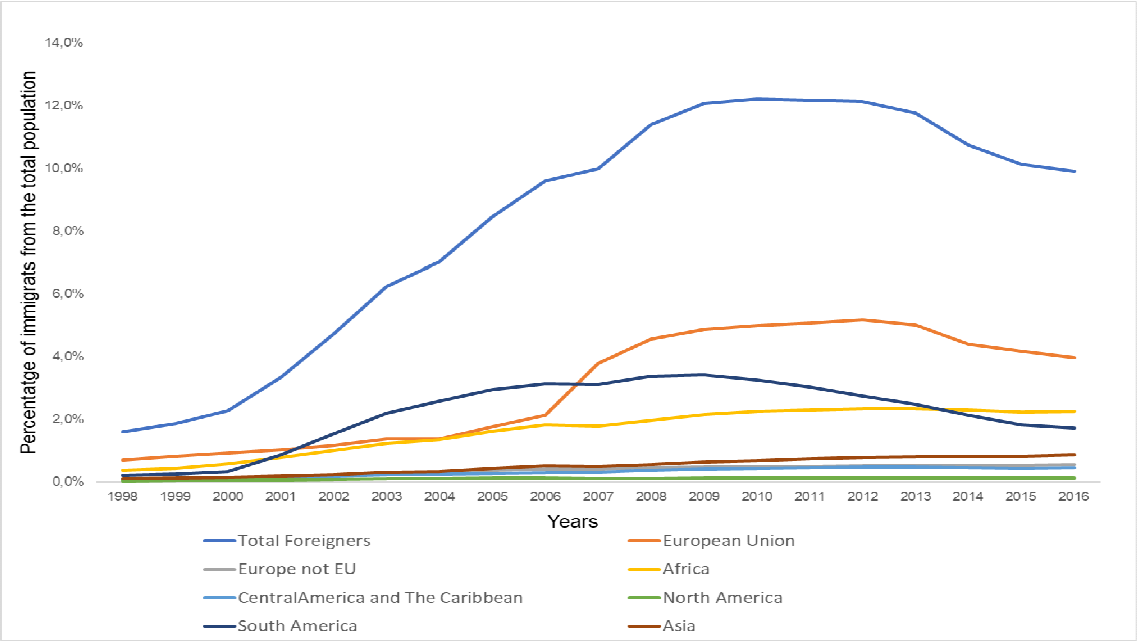
Table 9. Estimation results of total wage using IV through 2SLS

	(1) Fractionalization	(2) Entropy	(3) Alesina
Fractionalization	**0.889***		
	(0.472)		
Entropy		**0.836****	
		(0.415)	
Alesina			**0.380****
			(0.194)
Population	-0.524	-0.437	-0.418
	(0.644)	(0.580)	(0.590)
Young Population	1.199***	1.130***	1.177***
	(0.257)	(0.214)	(0.238)
High Education	0.226***	0.242***	0.230***
	(0.0618)	(0.0536)	(0.0584)
Native Unemployment	-0.0675	-0.0688	-0.0810
	(0.0672)	(0.0628)	(0.0640)
ShareHDI	1.036**	0.879***	0.951***
	(0.414)	(0.319)	(0.359)
Constant	9.394***	8.006***	9.572***
	(1.818)	(1.096)	(1.830)
Observations	136	136	136
Number of CCAA	17	17	17
Autonomous Community effect	YES	YES	YES
Time effect	YES	YES	YES
Instrumental Variables	YES	YES	YES

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

FIGURES

Figure 1. Immigrant population in Spain over the total population 1998-2016.



Source: Authors' own elaboration based on INE data.

Figure 2a. Maps of the diversity indexes by regions in 2008

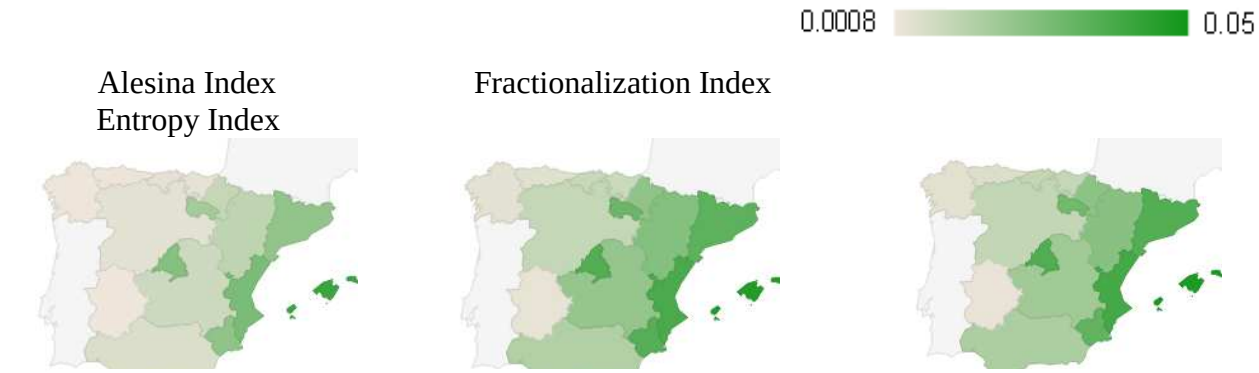
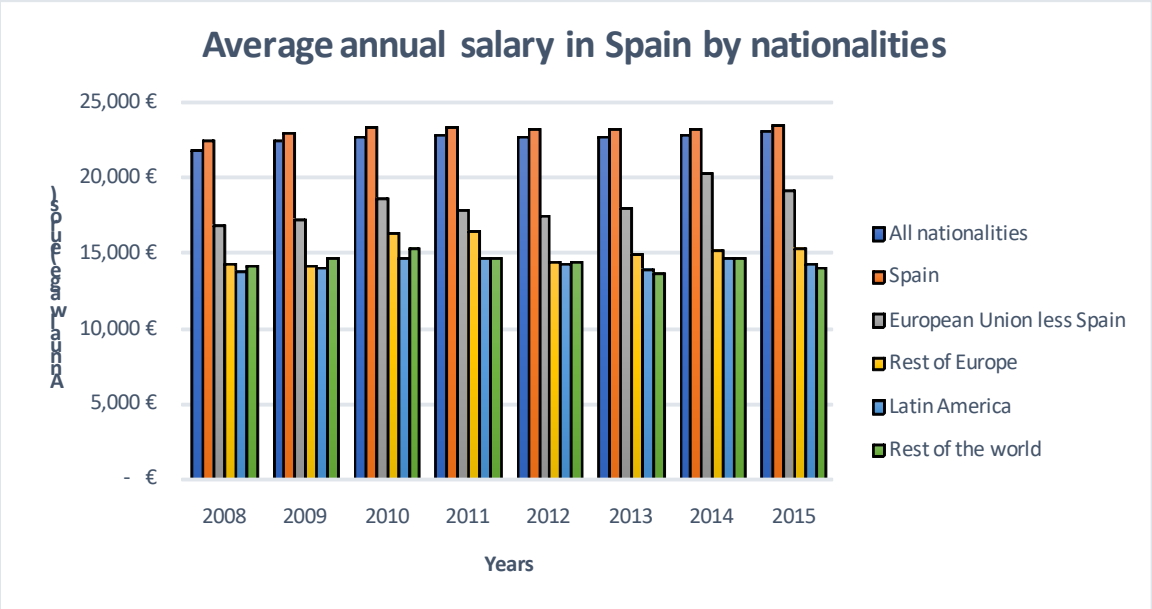


Figure 2b. Maps of the diversity indexes by regions in 2016

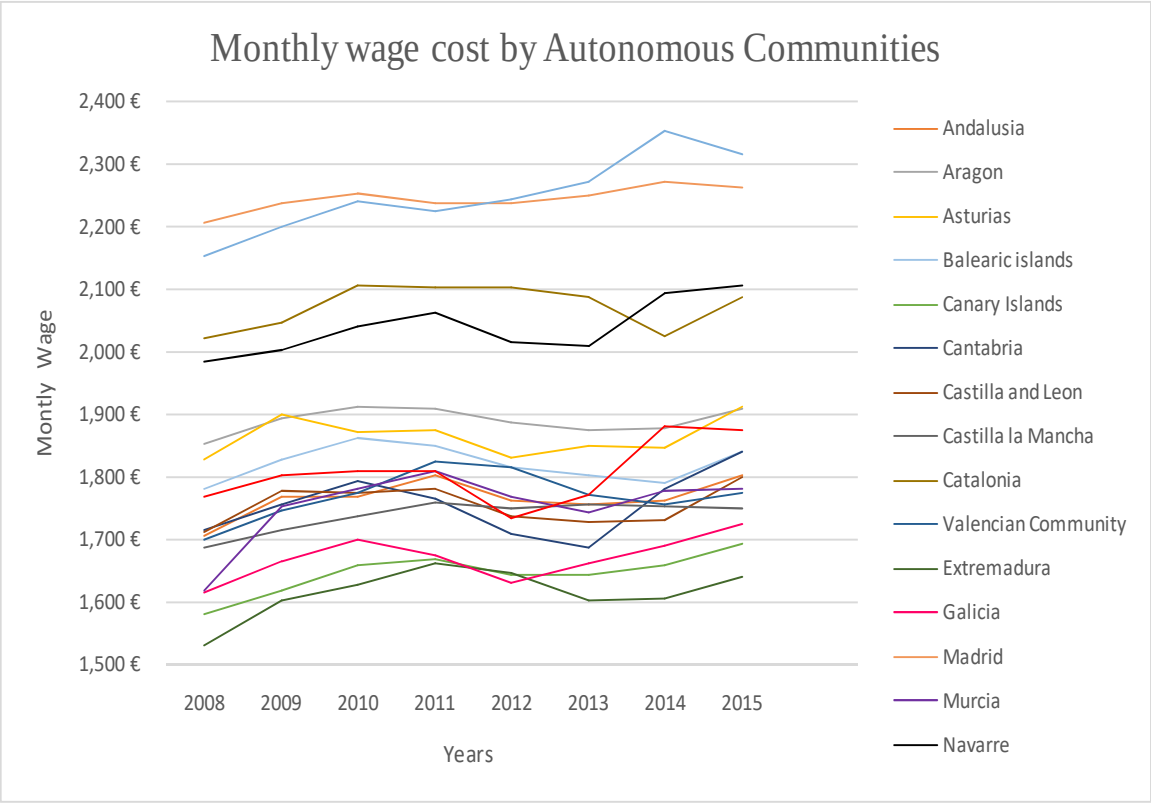
Source: Authors' own elaboration based on INE data.

Figure 3. Average annual wage in Spain by nationalities



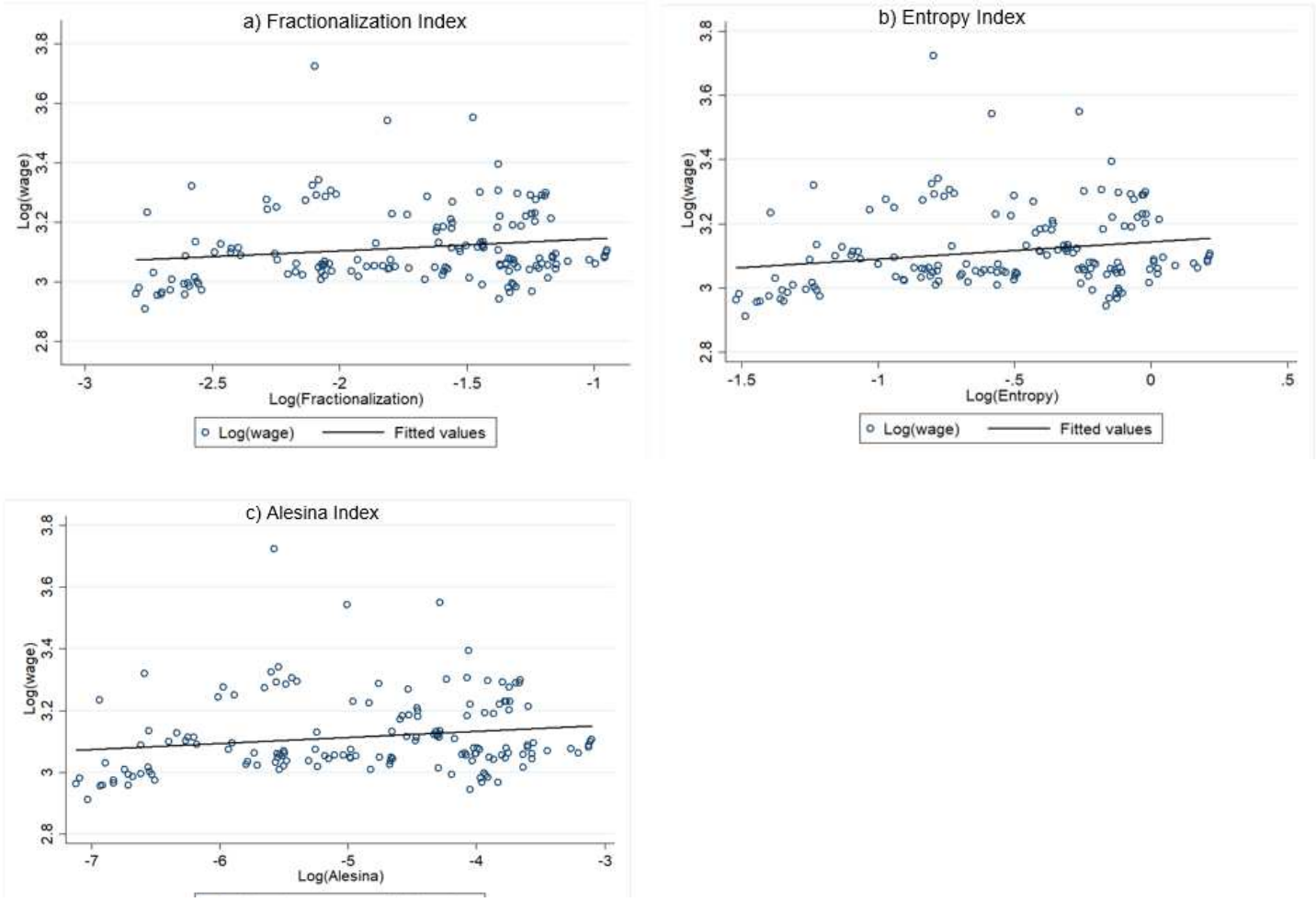
Source: Authors' own elaboration based on INE data.

Figure 4. Monthly wage cost by regions



Source: Authors' own elaboration based on INE data.

Figure 5. Relationship between birthplace diversity and productivity



Source: Authors' own elaboration based on INE data.