A spatial approach to the impact of immigration on wages: Evidence from Spain

Abstract:

On the basis of a spatial wage-curve equation, this paper analyses the effect of immigration on average wages across Spanish provinces (NUTS 3) over the period 2004-2015. To do so, a Spatial Panel Durbin Model is estimated. The results reveal that there exists a small negative effect, which is mainly determined by the presence of spillovers. Moreover, they reveal that the average wage of a particular province depends positively on its productivity level and the share of the manufacturing industry, and negatively on its rate of unemployment and the share of the service sector.

Keywords: wages, immigration, spatial effects, Spanish provinces.

JEL codes: C23, R23, O15

1. Introduction

Nowadays, immigration has become a prominent feature of the economic and social landscape of many European countries. This has raised several issues, among which the consequences on the labour market opportunities and wages of native workers stand out. Consequently, a large body of literature has been devoted to the study of the impact of immigration on wages. The vast majority of studies that have tried to quantify this effect focuses on the United States (Grossman, 1982; Butcher and Card, 1991; Altonji and Card, 1991; Card, 2001; Borjas, 2003; Orrenius and Zavodny, 2007; Ottaviano and Peri, 2012), but there are also some works for countries such as the United Kingdom (Dustmann et al., 2005, 2013; Nickell and Saleheen, 2009; Manacorda et al., 2012), Germany (De New and Zimmermann, 1994; Pischke and Velling, 1994; Winter-Ebmer and Zimmermann, 1999; Brücker and Jahn, 2008; D'Amuri et al., 2010) and Austria (Winter-Ebmer and Zimmermann, 1999).

Although it has not been analysed in-depth yet, the immigration-wages issue has also become relevant in Spain in the last few years. This is so because in scarcely a decade and a half the country has become one of the major recipients of migrants in Europe (Carrasco et al., 2008; Reher and Requena, 2009); as reflected in Table 1, foreign population in Spain grew by 55.8% over the study period (2004-15). However, and to the best of our knowledge, there are only two papers (Carrasco et al., 2008; González and Ortega, 2011) estimating the effects of immigration on wages in Spain; neither of these two papers finds a significative impact of immigration on wages.

INSERT TABLE 1 AROUND HERE

Bearing all these considerations in mind, the contribution of this paper is twofold. Firstly, it has to be mentioned that, regardless the country under study, none of the papers devoted to the assessment of the effect of immigration on wages pays any attention to the spatial dependence that may exist in the proposed models. This paper intends to shed some light on this issue and, in particular, to detect whether there are or not spatial spillovers[1] in wage determination. Secondly, to address the immigration-wages issue our paper uses Spain as a sort of laboratory, this way filling the gap that exists in the empirical literature.

[1] The importance of using spatial econometrics to capture spillover effects among neighbours has recently being pointed out by, among others, Bruna et al. (2016) and Andersson et al. (2016).

For reasons given above, this is a really interesting case study, especially now because of the economic crisis and the fact that it produced an undoubted side effect: a cut in wages.

To accomplish these aims, the paper estimates a spatial wage equation for 46 Spanish provinces[2] over the period 2004-15. Apart from the standard variables involved in a wage-curve equation –such as unemployment, productivity and industry mix-, and in order to assess the impact of immigration on wages, the stock of foreigners in each Spanish province (as a percentage of the total population of that province) is also included as an explanatory variable.

The remainder of the paper is organised as follows. Section 2 provides a succinct literature review. Then, Section 3 describes the data employed, specifies the model, estimates it and discusses the results. Finally, Section 4 summarizes the main conclusions of the paper and offers some policy remarks.

2. Literature review

The immigration phenomenon and its impact on the labour market of the receiving countries have been widely researched in the economic literature. Although the bulk of these studies[3] has traditionally focused on the US, a fact justified by the wealthy data sources on the issue and the experience gained from previous waves of immigration,[4] in the last decade there has been some research devoted to various European countries.

Starting with, the seminal paper by Grossman (1982) uses 1970 data and estimates a production function to compute elasticities of substitution between the stock of immigrants and the native workforce in order to determine the effect of immigrants on factor prices. The paper concludes that a 10% increase in the number of employed immigrants reduces native wages by 1%. Butcher and Card (1991) provide evidence on the effects of immigration based on changes in the distributions of wages over the period 1979-89. They calculate the effect of higher immigration on the various percentiles of the

[2] The provinces belonging to the regions of Navarre and the Basque Country, together with Ceuta and Melilla, have been excluded from the sample for data availability reasons.

[3] For recent surveys see Okkerse (2008) and Longhi et al. (2005, 2010).

[4] Although the US has traditionally been a country of immigrants, and most studies find little support for this idea, there is still the fear that the newcomers take jobs away from natives, displace them, and/or depress their wages (Friedberg and Hunt, 1995).

wage distribution, controlling for the overall population growth rate, the fraction of immigrants initially living in each city and the initial level of wages in the city. The paper finds little indication of an adverse wage effect of immigration, either cross-sectionally or within cities over time.

A few studies have focused on the effect of immigration on wages within occupations and/or skill groups. That is the case of Altonji and Card (1991), who using data from the 1970 and 1980 US Censuses and adopting an IV approach, analyse the wage effects on less-skilled natives. The results reveal that a 1% increase in the foreign share of population in a city reduces the wages of unskilled natives by a maximum of 1.2%. Furthermore, Card (2001), also using IV estimates, studies the effects of immigrant inflows on the labour market outcomes of six different occupation groups; the paper shows that a 10% increase in the immigrant inflows between 1985 and 1990 reduced wages of low-skilled service native workers in traditional gateway cities like Miami and Los Angeles by 1-3%. Similarly, Camarota (1997), using data from the 1991 Current Population Survey and comparing the wages of natives in occupations with different proportions of immigrants, finds that a 1% increase in immigration reduces the weekly earnings of low-skilled native workers by 0.8%. For his part, Borjas (2003), defining skill groups in terms of educational attainment and work experience and using an IV approach, concludes that US immigration between 1980 and 2000 lowered average native wages by about 3% and the wages of the least-educated natives by 9%.

Another work on this issue is Orrenius and Zavodny (2007). By using data on natives' wages within occupations groups in the US for the period 1994-2000, they prove that larger immigrant inflows reduce average wages among natives working in manual labour occupations, the least skilled group, but do not appear to have a significant negative effect among natives in professional and service occupations, in which workers tend to be more skilled. More recently, Ottaviano and Peri (2012) calculate the effects of immigration on the wages of native US workers of various skill levels by estimating elasticities of substitution across different groups. They find that from 1990 to 2006, immigration had a small positive effect on both the wages of native workers with no high school degree (between 0.6% and 1.7%) and on average native wages (0.6%).

Within this strand of literature, some studies for European countries, although fewer in number than those for the US, should also be highlighted. Dustmann et al. (2005) analyse the impact of immigration on the British labour market by skill groups for the period

1983-2000. By using OLS, IV as well as GMM estimators, their results provide little evidence that immigration has had any impact on aggregate employment, unemployment and wages, although there seem to exist some differences according to education. As for wages, immigration seems to have led, if anything, to slightly positive effects. Dustmann et al. (2013) estimate the wage effects along the distribution of native wages in the UK during the period 1997-2005, defining skill by the position in the wage distribution. Their results, obtained by applying OLS and IV estimates, suggest that immigration depresses wages below the 20th percentile of the wage distribution but leads to slight wage increases in the upper part of it. They also found that the average effects of immigration on wages are slightly positive. Another paper that provides evidence on the impact of immigration on wages in Britain is Nickell and Saleheen (2009). By using occupation as a proxy for skills over the period 1992-2006 and the OLS and GLS estimators, the results reveal that the immigrant-native ratio has a small negative impact on average wages, with the biggest impact registered in the semi-skilled/unskilled services sector; namely, for this group a 10% rise in the proportion of immigrants is associated with a 5% reduction in pay. Finally, Manacorda et al. (2012) consider the period 1975-2005; starting from a multi-level Constant Elasticity of Substitution (CES) production function and using two education groups (university and secondary), the study shows that immigration over the last 30 years has had, on average, little discernible effect on natives' wages in Britain.

Apart from the studies for the US and the UK, some others have been conducted for the case of Germany.[5] First, De New and Zimmermann (1994) examine the wage functions of white- and blue-collar natives in a random effects panel model estimated by 2-stage GLS, over the period 1984-89. They demonstrate that foreigners negatively affect average wages (a 1% point increase in the share of foreign labour implies a reduction of 4.1% in the hourly wage). A further breakdown reveals that relatively small gains are made by white-collar employees with less than 20 years of experience (3.5%), while the wages of blue-collar employees decline by 5.9%. A second study, by Pischke and Velling (1994), making use of a dataset of county-level variables over the period 1985-89 and using IV estimates, finds no significant adverse effect of immigration on either natives

[5] Although dealing with a slightly different topic, the paper by Niebuhr et al. (2012) estimates the effects of labour mobility (including not only migration but also commuting) on regional wages and unemployment in Germany from 1995 to 2005. Its findings suggest that labour mobility tends to reduce unemployment disparities, whereas evidence with respect to regional wages is rather weak.

employment, unemployment or wages. The paper by Brücker and Jahn (2008), based on a wage curve approach for the period 1980-2004 and using 2SLS and GMM, finds moderate wage and employment effects (a 1% increase in the German labour force through immigration increases the aggregate unemployment rate and reduces average wages by less than 0.1%). More recently D'Amuri et al. (2010), by using a labour market equilibrium model over the period 1992-2001, find that immigration had very little adverse impact on native wages although, contrary to expected, the effect is negative on the highly educated and positive on the less educated workers.

Furthermore, the study of Winter-Ebmer and Zimmermann (1999) examines the effects of immigration change on wage growth in Austria and Germany over the period 1986-94. By applying IV and weighted regression techniques with the sectoral employment shares as weights, the authors show that, in Austria, immigration exerted a small negative impact on native wages (a 1% increase in immigration reduces native wages by 0.16%), this effect being lower in already low-wage industries. No negative effect, however, was found for Germany.

Focusing on our case-study, to the best of our knowledge only two papers have addressed the issue of the impact of immigration on wages in the Spanish labour market.[6] Carrasco et al. (2008), by using data from the 1991 and 2001 Censuses of Population and the 2002 Wage Structure Survey, and carrying out OLS and IV estimates, conclude that there is no significant negative impact of immigration on either the employment rate or the wages of native workers. In the same vein, the study developed by González and Ortega (2011) for the period 2001-06 adopts a correlation approach and IV estimates; the results, reinforcing those obtained by Carrasco et al. (2008), suggest that the relatively unskilled migration inflows neither affect the wages nor the employment rates of unskilled workers in receiving regions.

In conclusion, there is an ample literature in this field (summarised in the table included in Appendix A), the general thought being that immigration has no effects or very small negative effects on wages (Longhi et al., 2005). However, and despite migrations have

[6] Nevertheless, other papers analysing different aspects of the Spanish labour market can be highlighted; Amuedo-Dorantes and De la Rica (2008), which studies the impact of immigration on Spanish natives' income in terms of the net immigrant surplus as a percentage of the national GDP, and Amuedo-Dorantes and De la Rica (2010), which investigates the immigrants' responsiveness to employment opportunities relative to natives.

explicit geographical components, there is not a single paper that has addressed this issue by adopting a spatial econometric perspective. Additionally, the number of papers for the Spanish case is very small. As mentioned before, this paper aims at contributing to the existing literature in regards to these two respects.

3. The effect of immigration on wages: An empirical analysis

This section is aimed at trying to capture the impact of the stock of foreigners relative to total population on the average Spanish wages at provincial level. To do so, it first discusses the data, then (and after confirming the existence of spatial dependence) specifies a spatial model, next the model is estimated and, finally, the results obtained are discussed.

3.1. Data and model specification

As our starting point, we consider an extended traditional wage-curve equation[7] such as:

$$WAGE_{it} = \alpha_1 UNEM_{it-1} + \alpha_2 PROD_{it-1} + \alpha_3\, IMMIGR_{it-1} + \alpha_4\, CONST_{it-1} + \alpha_5\, IND1_{it-1} + \alpha_6\, IND2_{it-1} + \alpha_7\, SERV1_{it-1} + \alpha_8\, SERV2_{it-1} + \alpha_9\, SERV3_{it-1} + \mu_i + \mu_t + \varepsilon_{it} \quad (1)$$

where *i* denotes province and *t* year; μ_i and μ_t refer to provincial fixed effects and time fixed effects, respectively, which are included to reduce the omitted variables bias,[8] and ε_{it} is the error term.[9]

As can be seen, the endogenous variable is the provincial wage ($WAGE$),[10] collected from the statistics published by the 'Tax Administration National Agency' (AEAT in

[7] See, for instance, the papers by García-Mainar and Montuenga-Gómez (2003) and Ramos et al. (2015) for estimates of wage curves for Spain.

[8] The inclusion of temporal dummies is mandatory because of the economic crisis outbreak; as our sample period is quite small, it is not convenient to split it into two sub-periods.

[9] Although, due to the lack of data on wages and other variables at a highly disaggregated geographical level, the analysis is carried out for the administrative regions NUTS 3 (provinces), we agree that, as shown in Rubiera-Morollón and Viñuela (2013) and Viñuela et al. (2014), the use of analytical regions and more disaggregated data at spatial level would be recommended. It could avoid the presence of the Modifiable Areal Unit Problem (MAUP), as analytical areas are internally more homogeneous and spillovers are proved to appear at a very local level.

[10] To deflate nominal variables the Consumer Price Index has been used. 2011 is taken as the base year.

Spanish). Generally speaking, provincial wages increased until 2008/09 and, because of the economic crisis, they decreased afterwards up to 2013/14; in 2015, an increase in wages was recorded in all provinces.

As exogenous variables, firstly we include, as in any wage equation, the unemployment rate ($UNEM$), which was taken from the 'Spanish Survey of Economically Active Population' published by the 'Spanish National Statistics Institute' (INE). Because of the economic crisis, provincial unemployment rates sharply increased in 2008 and kept increasing from then to 2013. From this year onwards, unemployment rates started to decrease in most provinces.

Apart from unemployment, which obviously should keep an inverse relationship with wages, we include the following additional explanatory variables:

- Productivity ($PROD$), since, together with the unemployment rate, is theoretically considered as one of the most important factors shaping the level of wages. As it is clear, a significant and positive coefficient is expected for productivity. $PROD$ was computed as the ratio between the Gross Domestic Product (GDP) and total employment, both taken from the 'National Accounts at Regional Level' (INE).[11] Data reveal a slowdown or even decrease in productivity in all provinces after the outburst of the economic crisis.
- The share of employment in the construction ($CONST$), industry ($IND1-2$) and service ($SERV1-3$) sectors, collected from the 'National Accounts at Regional Level' (INE).[12] As provincial wages are computed as the (weighted) average of wages paid in different sectors, it seems reasonable to think that some of the wage differences among provinces are due to differences in the employment structure across them. Table 2 provides information about the sectors and branches considered.

INSERT TABLE 2 AROUND HERE

- The stock of foreigners relative to total population ($IMMIGR$). This variable is included to test the hypothesis of whether the relative stock of foreigners has put

[11] Given that we are analysing the effect of immigration on wages, we consider that labour productivity is more relevant than total factor productivity.

[12] In order to avoid multicollinearity problems, the share of employment in agriculture has not been included in the equation.

downward pressure on provincial wages in Spain. Data on the officially registered foreign population have been specifically collected from the 'Municipal Register' databank (INE). Figure 1 displays the geographical distribution of the relative stock of foreigners for the initial and final years of the sample. The data have been normalised with respect to the national average (Spain=100) in such a way that Spanish provinces are classified as those having a relative stock of foreigners between 0-50%, 50-100%, 100-150% and more than 150% of the national average. As can be appreciated, the bulk of foreigners tends to be located in the Central and Eastern Spanish provinces, although foreigners in 2015 tend to be more concentrated in the North-eastern part of the country.

INSERT FIGURE 1 AROUND HERE

It is important to recall that, as usual, all explanatory variables included in equation (1) are lagged one year in order to capture the fact that their potential effects on provincial wages are not immediate.[13] Additionally, the dependent variable together with $PROD$ and $IMMIGR$ are expressed in logs; consequently, their estimated coefficients will be interpreted as elasticities, while those associated with the rest of variables will be interpreted as semi-elasticities. For additional information, Table 3 presents the descriptive statistics of the variables included in equation (1).

INSERT TABLE 3 AROUND HERE

Once the initial model has been specified, the next step is to test for the presence of spatial dependence in it because, if this were to happen, the results of an aspatial approach could be inconsistent (see e.g. LeSage and Pace, 2009). To do so, we first estimate equation (1) by OLS and test for the presence of spatial dependence, for which we apply the robust Lagrange multiplier (LM) tests: the robust LM-LAG, whose null hypothesis is the absence of substantive dependence, and the robust LM-ERR, whose null hypothesis is the absence of residual spatial autocorrelation. The results, displayed in the first two rows of Table 4, reveal that both hypotheses are rejected at the 1% level. Thus, there is spatial dependence (mainly substantive dependence) in the estimation and, therefore, the model based on equation (1) would not yield plausible results.

[13] In any case, we have also performed the estimation using two lags (available upon request) and the results are very similar. The only difference is that the direct effect of the productivity becomes slightly significant.

INSERT TABLE 4 AROUND HERE

Subsequently, to determine the appropriate spatial model we follow the general-to-specific approach. Specifically, we perform the Likelihood Ratio (LR) tests to examine whether the Spatial Durbin Model (SDM) can be reduced to a Spatial Autoregressive Model (SAR) or a Spatial Error Model (SEM). As shown in the last two rows of Table 4, the results indicate that both hypotheses can be rejected at the 1% level. Thus, the SDM, enabling us to model spatial spillovers arising from the dependent as well as from the explanatory variables, arises as the preferred specification to analyse the effect of immigration on average wages across Spanish provinces. Hence, our final SDM model is as follows:

$$WAGE_{it} = \alpha_1 UNEM_{it-1} + \alpha_2 PROD_{it-1} + \alpha_3 IMMIGR_{it-1} + \alpha_4 CONST_{it-1} + \alpha_5 IND1_{it-1} + \alpha_6 IND2_{it-1} + \alpha_7 SERV1_{it-1} + \alpha_8 SERV2_{it-1} + \alpha_9 SERV3_{it-1} + \rho \sum_j W_{ij} WAGE_{jt} + \theta_1 \sum_j W_{ij} UNEM_{jt-1} + \theta_2 \sum_j W_{ij} PROD_{jt-1} + \theta_3 \sum_j W_{ij} IMMIGR_{jt-1} + \mu_i + \mu_t + \varepsilon_{it} \quad (2)$$

where ρ is the spatial autoregressive coefficient and the term $\sum_j W_{ij} WAGE_{jt}$ is the spatial lag of wages; θ_1, θ_2 and θ_3 are the coefficients linked to the spatial lags of the explanatory variables $UNEM_{it-1}$, $PROD_{it-1}$ and $IMMIGR_{it-1}$. Additionally, W_{ij} is the so-called spatial weight matrix, whose elements reflect the intensity of the interdependence between provinces *i* and *j*, and which has been row-standardised. Here we follow Elhorst et al. (2013) and Chatterjee (2017) and choose the spatial weight matrix that best describes the data, being the criterion of selection the (highest in absolute terms) value of the log-likelihood function in the estimation: in our case, it turns out to be the exponential distance ($exp^{-distance}$) matrix.[14]

3.2. Estimation results and discussion

[14] Anyway, the results obtained with different distance matrices –namely, inverse of the distance, inverse of the square of the distance, matrices considering different cut-offs, as well as matrices taking into account a different number of neighbouring provinces- are quite similar. These results are available from the authors.

Here we estimate the SDM model (equation 2) by maximum likelihood,[15] for which we use the Driscoll-Kraay standard errors robust to general forms of spatial and temporal dependence. Table 5 displays the results.

INSERT TABLE 5 AROUND HERE

It is worth to start by mentioning that all of the goodness of fit measures that are comparable between the aspatial model (equation 1) and the spatial model (equation 2), namely the logarithm of maximum likelihood (LIK), the Akaike's Information Criterion (AIC) and the Schwartz's Criterion (SC), demonstrate that the spatial model achieves a better fit.[16] As regards the spatial lag of the dependent variable, its associated coefficient results positive and statistically significant (0.466), this reinforcing the idea that the OLS model (equation 1) was misspecified. The finding suggests that the wage of each province is closely related to that of its neighbours; in other words, it confirms the existence of spatial linkages between provincial wages. Two facts could be, among others, behind this effect. First, a higher wage in the surrounding provinces makes it more appealing and likely for a local worker to move there; this, somehow, exerts pressure on the local employers to increase the wage they pay in order to attract or retain their employees. Second, wages in neighbouring provinces constitute a proxy for spatial spillover effects such as agglomeration advantages, through which industry clusters emerge with a higher level of wages and productivity (Longhi et al., 2006).

Regarding the rest of variables, there seem to be negative effects of immigration and unemployment on wages, while productivity does not seem to affect wages. With respect to their three spatial lags, they result statistically significant and show the expected signs: negative in the case of the unemployment and the relative stock of foreigners, which means that a high value in these variables in provinces other than *i* leads to decreases in the wage of province *i*, and positive for the productivity, which indicates that higher productivity in neighbouring provinces increases the wage of a considered province. As for sectors, manufacturing industry and one of the branches of services (basically trade, information and communication activities) exert a positive (negative) effect on wages. Finally, although not reported in the table, it is important to point out that both time effects

[15] Shapiro-Wilk test for normality supports the use of ML.

[16] The results for the aspatial model are at readers' disposal.

(μ_t) and provincial fixed effects (μ_i) are mostly significant;[17] regarding the former, its decline over the crisis is a clear indicator of the toll that it has taken on wages.

Having said that, we should clarify that the point estimates reported in Table 5 should be interpreted with caution, as they are only a preliminary step to obtain both the direct and indirect effects of the different variables on wages (LeSage and Pace, 2011). This is so because a SDM model allows us to consider global spillovers. As a result of a Leontief expansion, spillovers arising from spatial lags of the dependent variable allow for spillovers to neighbours, neighbours to neighbours, and so on, coming back in the end to the area they originated from. In other words, this means that a change in an explanatory variable at any province will be transmitted to all other provinces, including the feedback effects.

Table 6 shows the average direct and indirect effects. The first ones are interpreted as the effect of a change in a particular explanatory variable in province *i* on the dependent variable of that same province; the indirect (spillover) effects capture the cumulative effect of the changes in a variable in provinces other than *i* on the wage of any province *i* through wages of the rest of provinces. The sum of both direct and indirect effect is the so-called total effect.

A relevant result with respect to our key variable is that the the total effect is negative; that is, an increase in the relative stock of foreigners has a negative impact on the wage of any particular Spanish province. More precisely, the results suggest that an increase of 1% in the relative stock of foreigners reduces the average wage of any particular province by 0.220%, of which a reduction of 0.165% is due to the indirect effect and a decrease by 0.055% comes from the direct one.

INSERT TABLE 6 AROUND HERE

As regards the rate of unemployment, an increase of one per cent in this variable in either the province itself or in the rest of provinces has a negative and statistically significant impact on the average wage of that province (-0.086% and -0.507%, respectively). Paying attention to the productivity, the results reveal that, as expected, it has a positive influence on provincial wages (a total effect of 0.256%). The direct effect of productivity, however,

[17] The inclusion of provincial fixed effects in equation (2) was supported by the Hausman test, as it rejects the null hypothesis. The results obtained also concurred with the importance of including fixed effects to control for the heterogeneity caused by the crisis.

does not result statistically significant. Although partially unexpected, this result is not in contradiction with those obtained in previous studies; e.g. Maza and Villaverde (2009) showed that the effect of productivity on wages in Spain is only notable when there is an outstanding increase in the former. As for the industry mix, the following conclusions can be drawn: firstly, manufacturing seems to have a small positive impact on the average provincial wage (total effect of 0.006), this effect being shared by direct and indirect effects evenly; secondly, the coefficients linked to branch $SERV1$ result negative and statistically significant (total effect of -0.003), while those on $SERV2$ and $SERV3$ are nonsignificant.

In a nutshell, one clear conclusion emerges from the previous analysis: spatial spillovers (or indirect effects) matter a lot. From an economic point of view, the importance of spillovers can be justified by the existence of *'differentiated spatial behaviours in response to changes in labour activity'* (Viñuela et al., 2010, p. 502). There also exist spatial interactions across labour markets such as the commuting flows that help us understand the larger magnitude of the indirect effect in relation to the direct one (Viñuela et al., 2010; Viñuela and Fernández-Vázquez, 2012).

Having commented all the results, we turn our focus to the hypothesis outlined at the beginning of the paper. The findings make clear the existence of a negative -although weak- effect of immigration on wages, and the importance of spillovers. The aim now is to go one step further and decompose the previous summary measures of direct and indirect effects into the responses of the average wage to a change in the stock of immigrants for each pair of provinces. To do so, a decomposition of the matrix of effect estimates associated to the relative stock of foreigners is carried out.

So, in the estimated SDM model the matrix of effect estimates for the $IMMIGR_{it-1}$ variable, $S(W)$, takes the following form:

$$S(W) = V(W) * (I_n\alpha_3 + W\theta_3) \tag{3}$$

where $V(W)$ stands for the spatial multiplier:

$$V(W) = (I_n - \rho W)^{-1} \tag{4}$$

being ρ the spatial autoregressive coefficient, α_3 and θ_3 the estimated coefficients linked to the $IMMIGR_{it-1}$ variable and its spatial lag and I_n the identity matrix of order 46*46. The main-diagonal elements of this matrix (see Appendix B) represent the own-partial

derivatives (and their average is the average direct effect shown in Table 6) while its off-diagonal elements represent the cross-partial derivatives (and the average of their cumulative sum from each row is the average indirect effect shown in Table 6) (LeSage and Pace, 2009).[18]

Looking at the matrix, it can be seen that, for each individual province, the highest value corresponds to the diagonal, that is, to the direct effect.[19] From the analysis of the cross-partial derivatives, a distinctive feature arises: whatever the province that is chosen, and being all the province-to-province indirect effects negative in magnitude, the ones with the highest values in absolute terms correspond to provinces located in the surrounding area of the province under consideration. Apart from this, it happens that, in all cases, Madrid is placed within the provinces with the highest spillover effects, which means that the immigration to Madrid seems to play an important role in the downward pressure exerted over the wage of any other province. Taken as a whole, these findings cast some light on the relevance of direct and indirect effect: the first one is, separately, the most important one, while the spillover effects (especially those of neighbouring provinces), when jointly considered, turn out to be of utmost importance to determine the impact of immigration on the average wage.

4. Conclusions and policy remarks

The impact of immigration on the wages of native workers has been widely studied in the economic literature. Nevertheless, so far, the empirical evidence is not entirely conclusive (though it tends to find small negative effects) and it is mostly devoted to the case of the United States. This paper is concerned with filling two gaps in this area of research. On the one hand, to account for the potential existence of spatial spillovers, an issue highly neglected in the literature. On the other, to analyse the Spanish case due to the fact that, even though this country has experienced substantial increases in the number of foreigners during the last decade, there is still scant evidence about the relationship

[18] To be precise, the indirect effects are the result of averaging the indirect effect of each of the 46 provinces, being each of them, in turn, the result of adding up each of the indirect effects between pairs of provinces (that is, each province has 45 indirect effects with the rest of provinces).

[19] The only exceptions are the islands Tenerife and Las Palmas. In each of these two cases, the highest value corresponds to Las Palmas and Tenerife, respectively; the direct effect is the second highest value.

between immigration and wages. To accomplish these aims, the paper estimates a Spatial Durbin Model for Spanish provinces over the period 2004-15.

The results reveal that the average wage of each Spanish province is closely related to that of its neighbouring provinces. Additionally, they show that an increase in the relative stock of foreigners appears to have a small negative impact on provincial wages, which is mainly determined by the presence of spillover effects coming from the rest of provinces. However, a more thorough analysis of this variable discloses that, when all the effects are considered individually, the change in wages in each province is mainly affected by changes in its own stock of immigrants.

As for the rest of explanatory variables included in the model, the findings show that the rate of unemployment, productivity and industry mix are relevant to determine average wages. More precisely, an increase (decrease) in the rate of unemployment (productivity) leads to a reduction in provincial wages. Moreover, it seems that provinces with a higher (lower) share of manufacturing activity (trade, information and communication activities) present higher wages. By combining these results with the one showed in the previous paragraph, an additional conclusion can be drawn: the reduction of wages in Spain during the crisis period has not been triggered by immigration but rather by the sharp increase in unemployment rates and the slowdown in productivity. In any case, it is also worth mentioning that the decline in the time fixed effects (μ_t) after 2008 reinforces the negative effect of crisis on wages.

Summing up, the main finding of this paper is that the fear that migrants are "cutting our wages" is, at least for the case of Spain, very much misplaced. To put it into figures, according to our results, if the stock of foreigners relative to the total population had not increased by 3.2% during the sample period, the average wage in 2015 would have been 9.4 euros higher, which is 1,341.1 rather than 1,331.7 euros (0.7%). Although this is a strong enough result, it is necessary to recall that it might be masking a significant effect of immigration on specific wage ranges and/or activities. This is clearly a topic for further research, were data available.

Even accepting that the results obtained in a study of this nature can depend critically on both place and time, it is still possible to draw some lessons and/or policy implications from this unique case study; these should be, however, taken with due caution.

First of all, it is important to stress that our findings, although specific for the Spanish case, are in line with those most often found in the literature (Longhi et al., 2005) and that, as such, could be somehow considered as a rule of thumb: the effects of immigration on average wages, either negative or positive, tend to be rather small. Therefore, there does not seem to be any strong reason for being scared about the effects of immigration on wages. Consequently, and with the caution previously referred to, the first political lesson that can be drawn is that the effects of immigration on wages should not be used by national governments as an argument in the design of immigration policy, let alone to pursue policy measures to strengthen controls over immigration flows. In the same vein, we agree with Peri (2014) in that there is no room for policies aimed at reducing potential losses for native workers and/or taxing firms that hire immigrants.

This being said, the literature agrees that although the impact of immigration on average wages is small, it clearly affects its distribution, as wages of low-skill workers tend to be more negatively affected than others. This should have clear policy implications. On the one hand, it suggests the advisability of conducting immigration policies aimed explicitly at selecting immigrants depending on their skill level and, as far as possible, favouring the high-skilled group. On the other hand, it supports the idea that there is an urgent need to assist high-skilled immigrants when it comes to validating their studies to Spanish standards, as otherwise they will probably end up working in jobs for which a lower level of education is required. Should we make more progress in this direction, the effect of immigration on wages could be even lower as these workers could find better jobs.

Although not directly linked to the potential, but not likely, negative effect of immigration on wages, what is openly needed is a system that helps to overcome other problems usually associated with immigration. Needless to say that, concerning this, the existence of inefficiencies in the job matching process clearly stands out. In other words, it would be advisable that immigrants are integrated into the labour market according to the specific requirements of the sectors of activity in each province. To accomplish this goal, the improvement of information channels to best match the availability of vacancies and the number of job seekers in both sender and receiver provinces is mandatory. This would be especially important among foreigners because, on the one hand, they have less knowledge about the country, which implies less capacity to detect job opportunities and, on the other, they are more prone to move as foreigners have weaker family ties.

Finally, and especially to face economic downturns as the one that Spain has gone and is still going through, the promotion of a somewhat modified version of the typical circular migration scheme (trying to make easier regular movements of immigrants across provinces) might be welcome; without any doubt, if the matching process previously mentioned were improved, the chances of achieving this goal would be much higher. There are two important strong points linked to this type of approach: first, it is generally accepted as a "win-win-win situation" (Constant et al., 2013) helping to loosen social tensions emerging in economic recession phases; second, it could be particularly useful among low-skilled workers.

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Table 1: Foreign population in Spain (2004-2015)

Year	Number	Annual growth (%)	% total population
2004	3,034,326	-	7.0
2005	3,730,610	22.9	8.5
2006	4,144,166	11.1	9.3
2007	4,519,554	9.1	10.0
2008	5,268,762	16.6	11.5
2009	5,648,671	7.2	12.1
2010	5,747,734	1.7	12.3
2011	5,751,487	0.06	12.2
2012	5,736,258	-0.3	12.2
2013	5,546,238	-3.3	11.8
2014	5,023,487	-9.4	10.8
2015	4,729,644	-5.8	10.2

Source: INE and own elaboration.

Table 2: Disaggregation of the industry mix

Sector	Disaggregation
$CONST$	Construction
$IND1$	Extractive industry; electricity, gas, steam and air conditioning supply; water supply, sewerage, waste management and remediation activities.
$IND2$	Manufacturing industry.
$SERV1$	Wholesale and retail trade; repair of motor vehicles and motorcycles; transportation and storage; accommodation and food service activities; information and communication activities.
$SERV2$	Financial and insurance activities; real estate, professional, scientific and technical activities; administrative and support services activities.
$SERV3$	Public administration and defense; compulsory social security, health, social and cultural services.

Source: INE.

Table 3: Descriptive statistics of variables

Variable	Mean[(2)]	Stand. Dev.	Min	Max
$WAGE$[(1)]	17.311	2.253	13.000 (Jaén)	24.472 (Madrid)
$UNEM$	16.350	4.507	9.567 (Soria)	26.788 (Cádiz)
$PROD$[(1)]	52.910	3.705	47.142 (Badajoz)	61.586 (Madrid)
$IMMIGR$[(1)]	8.807	5.305	2.482 (Córdoba)	21.348 (Alicante)
$CONST$	10.602	1.421	7.789 (Barcelona)	13.639 (Ávila)
$IND1$	1.373	0.457	0.700 (Valladolid)	3.524 (León)
$IND2$	12.708	4.801	4.384 (Tenerife)	22.076 (La Rioja)
$SERV1$	29.436	4.351	22.003 (Soria)	44.147 (Las Palmas)
$SERV2$	10.381	2.464	7.174 (Cuenca)	19.967 (Madrid)
$SERV3$	27.706	2.721	22.595 (Castellón)	33.803 (Salamanca)

Note: [(1)] These three variables are expressed in logs in equation (2). [(2)] Computed as the mean of the provincial means. *Source:* INE, AEAT and own elaboration.

Table 4: Tests for spatial dependence

Tests	Statistic	*p*-value
Robust LM-LAG	62.61	0.00
Robust LM-ERR	41.95	0.00
LR test for Spatial Autoregressive Model	104.06	0.00
LR test for Spatial Error Model	130.05	0.00

Source: INE, AEAT and own elaboration.

Table 5: SDM model (2004-2015)

Dep. variable: $WAGE_{it}$	**Coefficients**
$UNEM_{it-1}$	-0.064** (0.026)
$PROD_{it-1}$	0.019 (0.023)
$IMMIGR_{it-1}$	-0.047*** (0.007)
$CONST_{it-1}$	0.001 (0.001)
$IND1_{it-1}$	-0.007 (0.006)
$IND2_{it-1}$	0.003*** (0.001)
$SERV1_{it-1}$	-0.002** (0.001)
$SERV2_{it-1}$	-0.000 (0.001)
$SERV3_{it-1}$	-0.001 (0.001)
$\sum_j W_{ij}\, WAGE_{jt}$	0.466*** (0.055)
$\sum_j W_{ij}\, UNEM_{jt-1}$	-0.253*** (0.046)
$\sum_j W_{ij}\, PROD_{jt-1}$	0.116*** (0.032)
$\sum_j W_{ij}\, IMMIGR_{jt-1}$	-0.070*** (0.016)
LIK	1619.827
AIC	-3215.653
SC	-3163.89
Number of observations	552

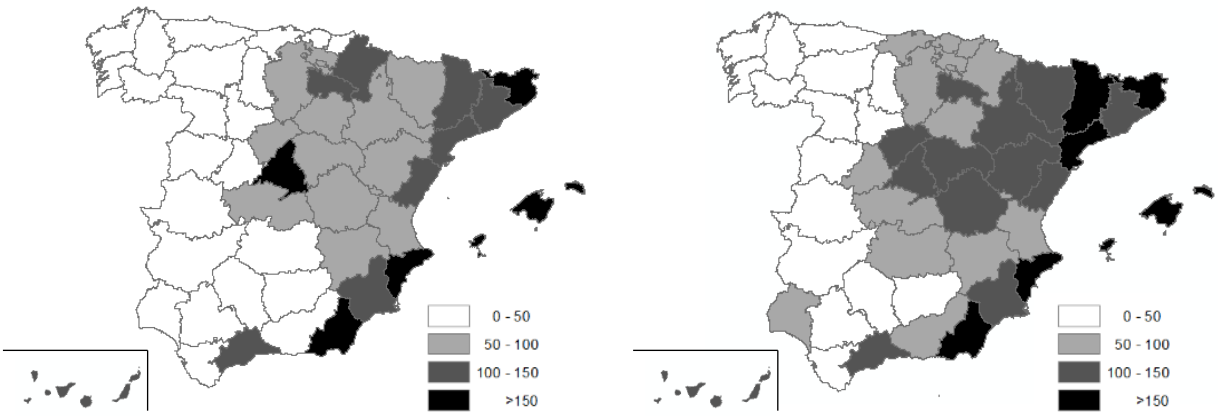
Notes: Results using the exponential distance matrix. Driscoll-Kraay standard errors in parenthesis. ***(**) Significant at 1%(5%). LIK: logarithm of maximum likelihood; AIC: Akaike information criterion; SC: Schwarz information criterion. Provincial and time fixed effects are included. *Source:* INE, AEAT and own elaboration.

Table 6: SDM model: Direct, indirect and total effects

Variable	**Direct effects**	**Indirect effects**	**Total effects**
$UNEM_{it-1}$	-0.086*** (0.029)	-0.507*** (0.039)	-0.593*** (0.040)
$PROD_{it-1}$	0.030 (0.021)	0.226*** (0.084)	0.256*** (0.093)
$IMMIGR_{it-1}$	-0.055*** (0.007)	-0.165*** (0.010)	-0.220*** (0.011)
$CONST_{it-1}$	0.001 (0.001)	0.001 (0.001)	0.002 (0.002)
$IND1_{it-1}$	-0.006 (0.005)	-0.005 (0.004)	-0.011 (0.010)
$IND2_{it-1}$	0.003*** (0.001)	0.003*** (0.001)	0.006*** (0.001)
$SERV1_{it-1}$	-0.002** (0.001)	-0.001** (0.001)	-0.003** (0.001)
$SERV2_{it-1}$	-0.000 (0.001)	-0.000 (0.001)	-0.000 (0.002)
$SERV3_{it-1}$	-0.001 (0.001)	-0.000 (0.001)	-0.001 (0.002)

Notes: Driscoll-Kraay standard errors in parenthesis. ***(**) Significant at 1%(5%). Results using the exponential distance matrix. Provincial and time fixed effects are included. Source: INE, AEAT and own elaboration.

Figure 1: Relative stock of foreigners (Spain= 100)



(a) Year 2004 *(b) Year 2015*

Source: INE and own elaboration.