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The economic impact of migration: productivity analysis for Spain and the UK

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Abstract Over the past 20 years labour has become increasingly mobile and whilst employment and earnings effects in host countries have been extensively analysed, the implications for firm and industry performance have received far less attention. This paper explores the direct economic consequences of immigration on host nations' productivity performance at a sectoral level in two very different European countries, Spain and the UK. Whilst the UK has traditionally seen substantial immigration, for Spain the phenomenon is much more recent. Our findings from a growth accounting analysis show that migration has made a negative contribution to labour productivity growth in Spain and a negative but negligible contribution in the UK. This difference is driven by a positive impact from migrant labour quality in the UK. This finding broadly holds across all sectors, but we note considerable variation in magnitudes. Labour productivity growth has a neutral contribution from migrant labour in construction and personal services in the UK, whilst in every case in Spain the effect is negative, most strongly in agriculture. Using an econometric approach to production function estimation we observe a positive long term effect on total factor productivity from migrant workers in the UK and a negative effect in Spain. Our findings suggest that either the UK is better at assimilating migrants or is more selective in terms of who is permitted to migrate.

Keywords Migration · Productivity · Growth accounting · Production function

JEL Classification J61 · O40 · O57

1 Introduction

In an increasingly mobile world, the movement of labour has become a major source of concern for (less skilled) native workers as their economic position may become threatened. This is increasingly relevant as we see a decline in employment opportunities now experienced throughout Europe. Research has attempted to quantify the impact that immigration has on wages, employment levels and growth. Empirical findings suggest that the winners and losers are largely determined by skill differences between domestic and foreign workers (c.f. Dustmann et al. 2008). The current paper adds to the emerging literature by exploring the direct effect of migrants on productivity through their contributions to labour quality and quantity. The impact of foreign labour on performance is likely to depend crucially on the skills set of the migrants, which is largely determined by government policies on immigration. The purpose in this paper is to consider the effects of recent immigration on industry productivity for two contrasting European countries using both growth accounting and econometric estimation. In the UK, relatively steady flows of migrant labour have been observed since the Second World War. Spain, in contrast, has experienced exceedingly rapid growth in migration in the past two decades. We explore how these differences have fed into productivity effects.

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Our main data source is the productivity accounts database, EUKLEMS. This provides detailed industry data on output, employment, hours worked, capital, energy, materials and service inputs. We augment this with immigration data derived from national Labour Force Surveys (the LFS for the UK[1] and EPA for Spain). Wage data for individuals enable us to take account of differences between native and immigrant labour, based on the assumption that wages broadly reflect marginal product. We use growth accounting to separate the quality and quantity impacts of immigrants on productivity. We also assess their impact on total factor productivity (TFP) by using an econometric production function estimation approach; this also enables us to consider the dynamic impact since the long run and short run is likely to be an important distinction. We believe that this dual approach is helpful in understanding the role that immigration plays in productivity performance.

The paper is structured in the following way: we begin by summarising the existing literature on the ways in which migrant labour may affect productivity and interact with other production inputs. Section 3 describes the industry data used for the UK and Spain. In Sect. 4 we provide an outline of the growth accounting methodology, factoring in labour composition. Here we present findings for Spain and the UK, assuming that migrants influence labour productivity through their quality as well as through increasing total hours. In Sect. 5, we estimate the impact that migrants have on industry TFP using econometric methods. Using both the growth accounting and econometric estimation of the production function enables us to reach a better understanding of the productivity effect of migrant labour. In the final section, we consider the implications of our findings for Spain and the UK.

2 Immigration and productivity

From a neoclassical perspective, immigrant labour may be regarded as no different to native labour, except in terms of the skills they embody. Thus, the two are considered to be perfectly substitutable within a skills group. Increased immigration would therefore have the same effect as a rise in the labour supply, creating downward pressure on wages and raising output. In reality however, migrants are not easily substitutable for natives (Izquierdo et al. 2009); it is often difficult to align the measurement of skills between native and migrant labour and there are other, less quantifiable characteristics that make migrant labour different to native workers.

Considerable efforts have been devoted to explaining the characteristics of migrants and their impact on native employment and wages in the total economy, much of which has been carried out using micro data. European evidence is presented by Angrist and Kugler (2003) and Dolado and Vázquez (2007). There have also been studies on migrants' instantaneous impact on the wage distribution and the complementarity or substitutability of migrants and natives in the total economy. In a study of the UK, Manacorda et al. (2006) find that migrants and natives are imperfect substitutes. Similar results are obtained by Amuedo-Dorantes and de la Rica (2008) for Spain. Bauer and Kunze (2004) analyse firm level data and find that most workers from EU countries are used to complement high skilled domestic labour, but non-EU migrants are hired to address shortages of high-skilled labour.

Migrant labour is likely to affect productivity through various channels. The most obvious impact, explored here, is through their individual skills. Immigrants may also play a significant role in spreading the use of technology[2] as well as contributing to innovation. However, immigration also has the potential to change the way in which firms conduct business and influence the development of industrial structure as they affect the relative price of inputs, (making capital relatively more expensive) and therefore the choice of production technology. Dustmann et al. (2008) demonstrate how an increase in (low skilled) labour supply can foster capital accumulation and shift the output mix towards the production of goods that use unskilled workers more intensively (the Rybczynski effect).

A number of papers have explored the extent to which the skills of the labour force determine the production technology of industry (Lewis 2005). The endogenous selection of technologies more intensive in the use of unskilled labour—a kind of directed technical change—has been highlighted by Acemoglu (2002). Lewis (2005) finds this empirically using US manufacturing firm data which show a negative impact on productivity and automation from migrant labour. Other studies have found that immigration can boost capital levels. Quispe-Agnoli and Zavodny (2002) find that immigration results in lower labour productivity in both low skilled and high skilled sectors in the US, despite the boost to capital. They conclude that productivity increases at a lower rate in states that experience higher levels of immigration. González and Ortega (2011) obtain similar results for Spain. They analyse the Spanish experience over the period 2001–2006 using regional and industrial data. They find significant change in the output mix toward low-skills industries but a general

[1] Office for National Statistics. Social and Vital Statistics Division and Northern Ireland Statistics and Research Agency. Central Survey Unit, Labour Force Survey 1984–2005 Colchester, Essex: UK Data Archive [distributor].

[2] We thank an anonymous referee for clarifying this channel.

increase of low-skill migrant labour within each industry, rejecting the Rybczynski effect. They conclude that an abundance of low skilled labour is likely to drive the adoption of technology that is most suited to a low skilled workforce (González and Ortega 2011). This is a cause for concern if it locks industries into a path of low skill and low productivity (Lewis 2005).

An alternative perspective focuses mainly on high skilled migrants who are likely to have a positive impact on the transmission of new ideas and technologies (Huber et al. 2009). They may have skills that are scarce in the native population which complement native skills in production or influence the adoption of technology (Lewis 2005). In addition, they may influence TFP growth through their contribution to innovation (Mattoo et al. 2005) or through increased knowledge spillovers (Moen 2005). Paserman (2008) finds that migrant shares are negatively associated with TFP in low technology sectors in Israel, but positively in high technology manufacturing sectors. Accetturo et al. (2009) analyze a sample of manufacturing firms in Italy for the period 1996–2007. They find that investment in machinery increases in response to immigration from developing countries, particularly in low technology industries.

Thus, empirical evidence suggests that (low-skilled) migration tend to decrease TFP growth and increase capital accumulation. This is consistent with the Spanish experience in recent years, where there have been high rates of investment accompanied by stagnant TFP (Mas and Robledo 2010). Finally, migrants may be more (or less) productive than natives as a direct result of institutional structures since they represent a select group of workers defined by a selective immigration policy.

Immigration may affect production in a variety of ways and the characteristics of migrants are crucial in determining the effect they have on productivity. The aim of this paper is to disentangle some of these effects, namely the productivity impact through the quality and quantity of migrant labour and the impact on productivity, by using both growth accounting methods to consider the contribution migrants make to labour productivity growth and econometric estimation methods to disentangle their impact on TFP. Both methods have their limitations but we believe that presenting both approaches using the same data is a fruitful way of exploring the issue.

3 Data sources

The EUKLEMS database provides information on output, employment, capital, energy, materials and service inputs. This database has been constructed to calculate multi-factor productivity growth using growth accounting techniques (Jorgenson et al. 1987).[3] The EUKLEMS data cover the EU27 countries. Some of the series run from 1970 to 2005, however, for some variables and countries the series are shorter. For the purposes of this analysis, we use data from 1996 onwards for Spain and the UK only. For the UK, the series used for the econometric estimation runs from 1984. We limit our analysis to these two countries because of additional data requirements and because they offer an interesting contrast within the European experience. The latest year available in the vintage of EUKLEMS used here was 2005.[4] EUKLEMS data for Spain and the UK have been augmented with shares of migrant and native labour (including information on the characteristics of workers, such as age and qualifications) in different industries for Spain and the UK. Our period of analysis was largely determined by migrant data availability. For Spain, numbers of immigrants were negligible prior to 1996. It is important to acknowledge that the period 1996–2005 relates to a noticeable period of relative economic boom for both countries.

In measuring the number of migrants, no single data source for any country is likely to capture it all. Migrants may not stay long term; they do not always feature in official data sources, particularly if entry is not legal. This is thought to be a larger problem in Spain than in the UK, given its geographical features and location, and indeed, Spain has in the past held 'amnesties' for illegal immigrants. In addition, classifying migrants on the basis of their skills is complicated by the lack of clear correspondence between education systems. This is further aggravated by the fact that migrants often enter the labour force in a lower skilled occupation than they are 'qualified' for. Our analysis is based on similar datasets in Spain and the UK, of legally registered individuals and therefore any limitations to the data are thought to be relatively consistent across the two countries.

For the UK, the LFS[5] contains detailed characteristics of individuals, including employment and migrant status,[6] education and skills, wages and various measures of on the job training which can be used as individual records or summarised by industry. We use the LFS to calculate shares of migrant labour in each industry for 1984–2005 and for the wage rates for migrants and non-migrants. For

[3] Further information on the harmonisation and construction of EUKLEMS is available at http://www.euklems.net.

[4] EUKLEMS has been updated since this release. See the EUKLEMS website for further details.

[5] The LFS data have been accessed via the UK Data Archive, whose assistance is gratefully acknowledged. The original data creators, depositors or copyright holders, the funders of the Data Collections and the UK Data Archive bear no responsibility for their further analysis or interpretation. LFS data are Crown copyright.

[6] Identified by the variable 'country of origin'.

Spain, the information for the number of migrants, as well as their characteristics, comes from the EPA for the period 1996–2005. The data on the relative wages of migrants and nationals for Spain used in growth accounting have been obtained for the period 1996–2005 from the *Continuous Sample of Working Histories 2008* (*CSWH* "Muestra Continua de Vidas Laborales con Datos Fiscales 2008", see Izquierdo et al. (2009) for a description). This database is a representative sample of social security administrative records. We use information on 769,377 individuals employed under the Social Security General Regime. Information is provided on nationality, not on the country of origin as in the UK. The EPA provides data on both.

A potential weakness of our analysis is that we are unable to take full account of the characteristics of self employed migrants. In the EUKLEMS data the average number of hours and wages of self employed are typically assumed to be the same as those of employees as data on hours and wages of self employed are not available. We also assume that the hours of work are the same for migrants as for natives and the share of migrants of all employed individuals by sector is used for calculating the share of migrant hours. However, self employment is known to be a popular mode of entry to foreign labour markets, in part because of the discrimination migrants often face. For the UK at least, whilst entrepreneurship is higher amongst migrants they tend to have relative low wages and employ relatively few workers (Clark and Drinkwater 2010). Therefore, it is possible that both the fact that a larger share of migrants is self-employed and that self-employed migrants differ from self-employed natives are potential sources of bias in the estimates of relative wages and hours worked by migrants. Despite this caveat, we believe that we have used the available data in the best possible way.

4 Growth accounting

We begin with the 'Sources of Growth' model developed in Solow (1957) in which output is assumed to be a function of two inputs, capital (K) and labour (L), using their factor cost shares to weight their contribution. Any residual is assumed to be TFP—a combined measure of efficiency and ignorance. Caselli (2005) and Jorgenson (2005) build on this and explore some alternatives to pure factor accumulation, taking account of differences in income per worker over time and across economies. These include improvements in factor measurement (particularly the quality of both human and physical capital) and in accounting for the sectoral composition of output or the potential non-neutrality of efficiency differences. Using this methodology, we incorporate a specific refinement to the definition of human capital by allowing labour composition to vary between native and migrant workers. Immigration alters both the quantity and the quality of labour.

We assume a standard production function, as in Barro and Sala-i-Martín (2003)[7]

$$Y = F(T, K, L^*, L) \tag{1}$$

where Y is output, T is the level of technology, K is the stock of capital, L^* is the number of hours worked by nationals and L the number of hours worked by immigrants. Taking logs and derivatives with respect to time we get:

$$dlnY = g + \left(\frac{F_K K}{Y}\right) \cdot dlnK + \left(\frac{F_{L^*} L^*}{Y}\right) \cdot dlnL^* + \left(\frac{F_L L}{Y}\right) \cdot dlnL$$

where F_K, F_L and F_{L^*} are the factor marginal products and g is the growth due to technical change (TFP growth). Assuming that factors are paid according to their marginal productivity:

$$dlnY = g + \left(\frac{RK}{Y}\right) \cdot dlnK + \left(\frac{W^* L^*}{Y}\right) \cdot dlnL^* + \left(\frac{WL}{Y}\right) \cdot dlnL$$

where R is the amount paid to each unit of capital, W^* is the hourly wage paid to nationals and W the wage paid to immigrants. The contribution of each factor to output growth is the rate of growth of that factor multiplied by its share on total output/value added. Defining L^T as the total number of hours worked ($L^T = L^* + L$):

$$dlnY = g + \left(\frac{RK}{Y}\right) \cdot dlnK + \left(\frac{W^* L^*}{Y}\right) \cdot (dlnL^* - dlnL^T) + \left(\frac{WL}{Y}\right) \cdot (dlnL - dlnL^T) + \left(\frac{W^* L^* + WL}{Y}\right) dlnL^T \tag{4}$$

In order to estimate the contribution of migrant workers to output growth within this framework we consider their impact through both the quantity and the quality of labour. The contribution from quality can be obtained from the previous equation as the effect of changes in the mix of types of labour:

$$\left(\frac{W^* L^*}{Y}\right) \cdot (dlnL^* - dlnL^T) + \left(\frac{WL}{Y}\right) \cdot (dlnL - dlnL^T) \tag{5}$$

The effect of the increase of the amount of labour can be obtained as the rate of growth of the total number of hours worked multiplied by the labour share in total output:

[7] See page 433.

$$\left(\frac{W^*L^* + WL}{Y}\right) dlnL^T \tag{6}$$

Therefore the impact of migrant workers through their effect on the quantity of labour can be estimated as:

$$\left(\frac{W^*L^* + WL}{Y}\right) dlnL^T - \left(\frac{W^*L^* + WL}{Y}\right) dlnL^* \tag{7}$$

The quantity effect of migrant labour is the differential rate of growth of total hours worked due to migrants multiplied by the labour income share in total output. The total contribution of immigration on output growth is obtained by adding together both contributions (quantity and quality contributions).

Assuming that migration has no direct effect on TFP growth (g) or on capital accumulation ($dlnK$) we can also use the growth accounting framework to estimate the migrants' total contribution to labour productivity growth.[8] Assuming constant returns to scale and that factor inputs are paid according to their marginal productivity we can break down observed growth of labour productivity into components associated with changes in TFP, the capital-labour ratio and the labour mix:

$$\begin{aligned} dlnY - dlnL^T = {} & g + \left(1 - \frac{W^*L^* + WL}{Y}\right) \cdot (dlnK - dlnL^T) \\ & + \left(\frac{W^*L^*}{Y}\right) \cdot (dlnL^* - dlnL^T) \\ & + \left(\frac{WL}{Y}\right) \cdot (dlnL - dlnL^T) \end{aligned} \tag{8}$$

Therefore the effect of a changing capital-labour ratio on labour productivity is:

$$\left(1 - \frac{W^*L^* + WL}{Y}\right) \cdot (dlnK - dlnL^T) \tag{9}$$

The difference between receiving migrants or not may be specified as:

$$\begin{aligned} & \left(1 - \frac{W^*L^* + WL}{Y}\right) \cdot (dlnK - dlnL^T) \\ & - \left(1 - \frac{W^*L^* + WL}{Y}\right) \cdot (dlnK - dlnL^*) \end{aligned} \tag{10}$$

And therefore, the migrant quantity effect on labour productivity is:

$$\begin{aligned} & - \left\{ \left(1 - \frac{W^*L^* + WL}{Y}\right) \cdot (dlnL^T) \right. \\ & \left. - \left(1 - \frac{W^*L^* + WL}{Y}\right) \cdot (dlnL^*) \right\} \end{aligned}$$

An increasing quantity of migrants tends, *ceteris paribus*, to decrease the capital-labour ratio and labour productivity. From Eq. (8) we can see that the migrant quality effect on labour productivity growth is simply the same migrant quality effect on output growth shown above in Eq. (5).

The continuous-time formulation in Eqs. (1)–(11) is useful conceptually, but we modify it in order to implement it on discrete-time data for our empirical analysis using the Törnqvist (1936) approach of measuring the growth rate between two points in time, t and $t + 1$, by logarithmic differences and weighting by the arithmetic averages of the factor shares at times t and $t + 1$.

Full growth accounts are shown in Table 1.[9] Gross value added (GVA) growth and the contributions of total labour, ICT capital, Non-ICT capital and TFP are directly obtainable from EUKLEMS.

The total migrant contribution to value added (GVA) growth over the period 1996–2000 in the UK is around 6 %, increasing to around 17 % in the final period 2000–2005. Overall, the total contribution of migrants is around 11 % of GVA growth. The main source of the positive value added growth contribution is the quantity effect, i.e. over this period there is an increase in the share of migrant labour in total hours worked. The quantity effect increases over the two periods, accounting for 5.4 % of GVA growth in the earlier period, increasing to 14 % by the second period. The rest comes from a smaller but positive quality effect during those periods.

In Spain the picture looks considerably different, given the sharp increase in the migrant share of total hours worked. The estimated contribution of migrants to GVA growth accounted for almost 15 % of total growth. Furthermore, this contribution increases over time. In relative terms, this represents a change from 5.4 to 25.5 % of GVA growth. The source of this sizeable contribution is the quantity effect, which represents a change from 6.5 to 35.4 % of GVA growth. The quantity effect is dampened by the lower productivity of migrants in Spain compared to national workers. The increase in the migrant share of total hours worked tends to lower the average labour productivity in Spain. The quality effect is always negative, with an average of −0.19 % for the whole 1996–2005 period. The different sign attached to the quality effect in Spain compared to the UK is due to marked differences in the human capital of migrants. Data for 2005 reveals that education levels are higher for migrant workers in the UK; the share of university graduates is 16 percentage points

[8] We acknowledge this as a limiting assumption to make our framework workable. It is likely that migrants will affect TFP growth and the use of capital directly as they alter the relative input mix.

[9] In this section the Spanish data for migrants refers to nationality, instead of country of origin as in the previous section. The reason is that nationality is the criteria used by the *Continuous Sample of Working Histories* the source of the wages data.

Table 1 Percentage contribution of inputs to GVA growth, total economy

	United Kingdom			Spain		
	1996–2000	2000–2005	1996–2005	1996–2000	2000–2005	1996–2005
GVA growth	3.15	2.29	2.67	4.29	3.02	3.58
Contribution of total labour	1.26	0.87	1.04	2.80	2.02	2.37
Contribution of ICT capital	1.03	0.56	0.77	0.58	0.28	0.41
Contribution of non ICT capital	0.79	0.49	0.62	1.41	1.49	1.45
TFP contribution	0.07	0.37	0.24	−0.50	−0.77	−0.65
Migrants contribution						
Quantity	0.17	0.33	0.26	0.28	1.07	0.72
Quality	0.02	0.04	0.03	−0.05	−0.30	−0.19
Total	0.19	0.38	0.29	0.23	0.77	0.53

Source: EUKLEMS database, March 2008, http://www.euklems.net, EPA (INE), Muestra Continua de Vidas Laborales con Datos Fiscales 2008 and LFS (ONS) and own calculations

Quantity, quality and total represent the contributions estimated in this paper from the increasing quantity of migrant workers; their impact on the average quality of labour and the addition of those two effects to the annual GVA growth

higher for migrants than natives, whereas migrants in Spain are relatively low skilled. In Spain the share of university graduates is about 6 percentage points lower for migrants than natives.

The 2.67 % annual GVA growth in the UK over the period 1996–2005 (in Table 1) is the result of the growth in each industry and the industrial composition of its economy. Table 2 shows growth rates in GVA and the migrant contributions to growth for an eight sector breakdown of the market economy for the period 1996–2005. There are big differences between industries in terms of their overall patterns of growth and specifically in terms of the role played by migrants.

Table 2 shows that, for the UK, the migrant contribution is especially strong in the hotels and restaurants and transport and communications sectors. In both sectors, this contribution is well above the 0.29 % estimated for the total economy (see Table 1). On the other hand, construction and agriculture show the lowest absolute contributions to growth from migrant labour. The remaining industries (manufacturing; trade; and community, social and personal services) experience contributions to growth from migrant labour very similar to the total economy. In all industries, contributions are mainly driven by the quantity effect. The labour quality effect is comparatively small (around 0.03 %), although this is higher in hotels and restaurants and transport and communications.

Focussing on Spain in Table 2, we note that differences across industries are more perceptible than in the UK. Whilst hotels and restaurants is a sector that sees a substantial contribution to GVA growth, transport and communications see less of a contribution from migrant labour. Contributions from migrants to GVA growth in construction on the other hand, are very important in Spain, in

Table 2 GVA growth accounting across industries (% annual)

	United Kingdom 1996–2005				Spain 1996–2005			
	GVA	Migrants			GVA	Migrants		
		Quantity	Quality	Total		Quantity	Quality	Total
Agriculture	0.87	0.15	0.02	0.17	−0.86	0.77	−0.19	0.57
Manufacturing	0.04	0.23	0.03	0.26	2.20	0.53	−0.15	0.39
Construction	2.23	0.12	0.02	0.14	5.94	1.58	−0.41	1.17
Trade	3.29	0.26	0.03	0.29	3.68	0.46	−0.12	0.34
Hotels and restaurants	3.26	0.65	0.08	0.73	3.05	1.65	−0.41	1.24
Finance, insurance, real state and business services	4.68	0.25	0.03	0.28	4.59	0.33	−0.08	0.25
Transport and communication	5.71	0.45	0.06	0.51	4.53	0.40	−0.11	0.30
Community, social and personal services	1.75	0.26	0.03	0.29	3.42	0.82	−0.21	0.60

Source: EUKLEMS database, March 2008, http://www.euklems.net, EPA (INE), Muestra Continua de Vidas Laborales con Datos Fiscales 2008 and LFS (ONS) and own calculations

Table 3 Percentage contributions to labour productivity growth, total economy

	United Kingdom			Spain		
	1996–2000	2000–2005	1996–2005	1996–2000	2000–2005	1996–2005
Labour productivity growth	2.09	1.62	1.83	0.37	0.58	0.48
Migrants contribution						
Quantity	−0.08	−0.13	−0.11	−0.16	−0.64	−0.43
Quality	0.02	0.04	0.03	−0.05	−0.30	−0.19
Total migrants contribution	−0.05	−0.09	−0.07	−0.21	−0.94	−0.62

Source: EUKLEMS database, March 2008, http://www.euklems.net, EPA (INE), Muestra Continua de Vidas Laborales con Datos Fiscales 2008 and LFS (ONS) and own calculations. Labour productivity measured as gross value added per hour worked

contrast to the UK. Finance, trade and transport have the lowest contributions. All other industries lie somewhere in between. In comparative terms contributions are generally higher in Spain than in the UK except in finance and transport. As in the UK, the main source of the migrants' contribution is the quantity effect; however unlike in the UK, the quality effect is negative for all industries.

Using Eqs. (5) and (11) we decompose the migrants' total contribution to labour productivity growth (see Table 3). The impact of migrant workers on labour productivity growth in the UK is negative but small over the whole period 1996–2005. In Spain we find a more sizeable negative effect.[10]

Table 4 shows the contributions to labour productivity growth by sector. Overall, the UK experiences a negative or neutral contribution from migrant labour, regardless of industry, consistent with the aggregate picture. The negative sign is largely the result of the positive quality effect being dominated by the quantity effect (i.e. dampening of capital deepening). In Spain the migrants' contribution to labour productivity is always negative, lying between −0.35 and −1.14 % depending on the industry (in relative terms the size is quite significant). Industries such as agriculture, construction and hotels and restaurants are characterized by large negative contributions from migrant workers. Thus, the results suggest that the impact is very sector dependent and is much larger in Spain than in the UK.

Our findings show that migrants have been an important source of output growth in both countries over the period 1996–2005. Overall, we see in both countries that the impact of migration on productivity has been negative, although this is much more pronounced in Spain than in the UK. In the case of Spain, the negative impact has been the result of the combined quantity and quality effects, whereas in the UK the negative quantity effect has been much lower as well as being compensated by a positive quality effect.

[10] According to the estimates of Conde-Ruiz et al. (2008) using a shift-share methodology, the contribution of migrants on labour productivity growth was −0.51 % for the period 2000–2006.

The decomposition shows that the main contribution in both countries is due to an increase in the volume of labour as a result of immigration. This effect is largest in Spain, where a more intense period of immigration was experienced. However, there are clear differences between Spain and the UK in terms of the change in the quality of labour as a result of immigration. Migration has substantially dampened labour productivity growth in Spain, as a result of the negative quality effect.

Growth accounting at an industry level reveals patterns that differ considerably and highlights the usefulness of looking at a more detailed sectoral breakdown. Whilst sectors such as finance and trade experienced very little, if any, output growth as a result of migrant input, industries such as construction and hotels and restaurants (in the UK) show important contributions to growth from migrants.

5 Econometric estimation of the impact of migration on productivity

Growth accounting methodologies offer considerable insight into the role that migrant labour plays in determining productivity growth through changes in the amount of labour input and its quality. However, growth accounting is an identity where the association between inputs and outputs is given and the contribution of each input is determined by its income share and growth rate. Growth accounting does not allow for random variation in inputs and output, nor does it distinguish between the short and long run effects of migration. Econometric estimation can go some way in shedding further light on these issues, although the direction of causality is not always easy to establish. In the growth accounting analysis presented in the previous section the impact of the migrant share of labour on industry productivity was solely determined through the number of migrants and their measurable quality: however, it is likely that the number of migrants also influences productivity beyond the measured amounts of inputs, for reasons discussed in Sect. 2. These effects on TFP are likely to occur in the long run rather

Table 4 Percentage contributions to labour productivity growth across industries

	United Kingdom 1996–2005				Spain 1996–2005			
	Labour productivity	Migrants			Labour productivity	Migrants		
		Quantity	Quality	Total		Quantity	Quality	Total
Agriculture	3.93	−0.05	0.02	−0.03	0.12	−0.95	−0.19	−1.14
Manufacturing	3.41	−0.06	0.03	−0.03	0.93	−0.29	−0.15	−0.43
Construction	1.25	−0.02	0.02	0.00	−1.71	−0.59	−0.41	−1.00
Trade	2.65	−0.11	0.03	−0.07	0.84	−0.22	−0.12	−0.35
Hotels and restaurants	0.99	−0.19	0.08	−0.11	−1.35	−0.70	−0.41	−1.10
Finance, insurance, real state and business services	1.51	−0.20	0.03	−0.17	0.01	−0.42	−0.08	−0.50
Transport and communication	4.63	−0.13	0.06	−0.07	1.62	−0.39	−0.11	−0.49
Community, social and personal services	−0.01	−0.03	0.03	0.00	0.57	−0.19	−0.21	−0.41

Source: EUKLEMS database, March 2008, http://www.euklems.net, EPA (INE), Muestra Continua de Vidas Laborales con Datos Fiscales 2008 and LFS (ONS) and own calculations

than as an instantaneous response to annual changes in the volume of migrant labour.

Production function estimation is not without its problems; inputs are endogenous as they are chosen simultaneously with output levels, productivity shocks are persistent and inputs may be dependent on past or current shocks. As with many studies of productivity, establishing the direction of causality is an issue and endogeneity is particularly pertinent when analyzing the effect of migration on productivity in the Spanish case. The sharp increase of immigration in Spain in the late 1990s was mainly driven by a massive expansion of the non-tradable sectors of the economy. The lack of international competition in these sectors as well as low interest rates maintained persistent growth of demand and hence enabled low productivity firms to survive.

Whilst the more sophisticated econometric procedures aim to correct for problems of endogeneity our findings should be interpreted with some sensitivity to the causes of the economic processes at work. Another shortcoming of the econometric approach is that the parameters need to be constrained to be equal across industries and/or years in order to obtain estimates. Using the Pooled Mean Group (PMG) method we allow for the short term impacts of the inputs and migrant share to vary across industries but constrain the long term impacts to be equal. We believe this is the best way to utilise the panel dimension of the data. This approach also addresses the problem of non-stationarity, which may result in spuriously significant coefficients in the absence of any actual relationship between the dependent variable and the independent variables.

Econometric estimation of the production function is sensitive to the specification of the functional form. Here we use the Cobb Douglas production function which is easy to estimate in logarithmic form. Whilst concerns have been raised about its suitability—Antras (2004) for example, suggests that the implicit assumption about the elasticity of substitution being equal to one does not hold for the US—we believe that using the Cobb Douglas specification is suitable for our purposes, not least because our main aim is not to estimate the elasticity of substitution between capital and labour or the speed or nature of technological change but rather find links between migrant share and overall productivity.

The Cobb-Douglas production function is defined as:

$$LnY_{it} = lnA_{it} + \beta_1 lnK_{it} + \beta_2 lnL_{it} + \varepsilon_{it} \tag{12}$$

where Y is measured as GVA K and L denote capital and labour respectively, A includes the explanatory variables that impact on TFP.

In order to separate long run and short run effects in this specification we adopt an error correction model (ECM).[11] We further assume an autoregressive distributed lag (ARDL) model for the production function:

$$y_{it} = \sum_{j=1}^{p} \lambda_{ij} y_{i,t-j} + \sum_{j=0}^{q} \delta'_{ij} X_{i,t-j} + \mu_i + \varepsilon_{it} \tag{13}$$

Which can be re-written in the error correction form:

$$y_{it} = \varphi_i \left(y_{i,t-1} - \theta'_{it} X_{it} \right) + \sum_{j=1}^{p-1} \lambda^*_{ij} \Delta y_{i,t-j} + \sum_{j=0}^{q} \delta'_{ij} \Delta X_{i,t-j} + \mu_i + \varepsilon_{it} \tag{14}$$

The coefficient φ reveals how strongly the dependent variable reacts to the deviation from the long term level.

[11] Applying the Im, Pesaran and Shin test (2003) for unit roots, the test fails to reject the null hypothesis for the UK data. We also test the Spanish data for unit roots though the series is relatively short for time series estimation and the results are less convincing. For the dependent variable and labour services non-stationarity seems likely but for the capital variables and migrant share the evidence is mixed.

The PMG Estimator allows for the long term coefficients to be homogenous and for the short term coefficients to vary across units (Pesaran et al. 1999).[12] This approach has been used elsewhere by O'Mahony and Vecchi (2005).

Endogeneity problems are usually resolved with the use of instrumental variables that are unrelated to productivity shocks or current output but related to the variable of interest.[13] Pesaran and Shin (1999), however, have shown that the ARDL can produce consistent estimates even if the regressors are endogenous as long as the lag order is appropriate. According to the Akaike and Bayesian information criteria three lags is was the most suitable lag length for the UK data and those results are reported here. For the Spanish data we can only use one lag due to the limited length of the series. Therefore some caution has to be exercised when interpreting the results for Spain, especially taking into consideration the demand factors that led to the substantial migration wave whilst allowing for the persistence of lower productivity amongst Spanish producers.

In order to highlight the differences between standard regression methods and PMG we also conduct fixed effects (FE) and first difference (FD) estimations. These methods specifically extract the relationship between short term changes in the output and the explanatory variables rather than reflect the long term correlation between levels of productivity and the explanatory variables. In addition, if the explanatory variables are dependent on past productivity shocks and the true process is dynamic, the FE and FD estimates may also suffer from a bias arising from correlation between the error term and the explanatory variables.

We calculate a separate labour composition index for migrants and non-migrants and use it to adjust the labour input. Changes in labour composition are calculated as

$$\frac{W_t + W_{t-1}}{2} \sum_i \left(\frac{\omega_{it} + \omega_{it-1}}{2} \right) \left[\ln \frac{H_{it}}{H_t} - \ln \frac{H_{it-1}}{H_{t-1}} \right] \qquad (15)$$

where W_t is the labour share of total income in period t, ω_{it} is the share of type-i workers in total labour income in period t and H_{it}/H_t is the share of the workers of type i in total hours worked. For the UK the different types of labour include all combinations of gender, three age and three education groups. For Spain, only shares by education groups were available and the labour composition index is based on these, rather that division by gender, sex and education.[14] Information on the levels of labour and capital services was also available[15] in 1997 in 26 market industries. An index of capital services and the labour composition index described above have been used to extend the service levels to cover the whole period studied. The results of these specifications are presented in Table 5. For the PMG estimation, the estimates presented are those of the long run coefficients.

Our results highlight the importance of distinguishing between the long and the short run responses and the differences across estimation methods. The coefficient for the logarithm of migrant share is positive and significant in the PMG specifications for the UK. This suggests that there is a positive relationship between migrant share and TFP in the long run which may be due to innovation or complementarities in production. The positive relationship between migrant share and productivity is, on the other hand, much less obvious in the short run. The FD estimate for the coefficient is actually negative though insignificant.

Conversely, the migrant share coefficient for Spain is negative and significant, indicating a clearly negative association between the use of migrant labour and TFP. The long run effect suggests that migrants are significantly less productive, which may be because of their unmeasured characteristics or because they are badly matched to their jobs. The FE and FD coefficients are similarly negative (although the FE estimate is not significant). This may be the result of more migrants being hired in response to negative productivity shocks in the short run or migrants having an instantaneously negative impact on TFP. The negative long run effect, however, is stronger than the FE and FD estimates, which suggests that a high immigrant share of labour contributes to sluggish productivity growth in a more profound manner.

The differences we observe between the two countries may partly be explained by their immigration systems: in the UK the immigration system (applicable to those from outside the EU) is selective and biased towards immigrants with skills which are in shortage domestically and highly skilled individuals. Migrants are selected on the basis of their contribution to productivity through knowledge, innovation, skills or by complementing native labour. Where immigration policies are less selective, as in Spain, migrants often work in sectors that are less attractive for nationals. Hiring more migrants may be a necessity for these sectors but it can also reduce their TFP, perhaps as a

[12] We used Blackburne and Frank's (2007) Stata procedure xtpmg.

[13] Methods have been developed where a set of instruments is constructed from existing variables, but unfortunately the sample size requirements for such methods are not met in the case of these data GMM methodology developed by Arellano and Bond (1991) can also correct for the biases of endogenous regressors. Our data, however, has too few units for this method to be particularly useful (Roodman 2006).

[14] Sample sizes limited the number of industries used in the labour quality index calculations; relative wages were also available for a limited number of years.

[15] We thank Professor Mary O'Mahony who provided the estimates based on the EUKLEMS source data.

Table 5 Production function estimates; log GVA the dependent variable, PMG, fixed effects and first differences estimates, UK and Spain

Variable	UK			Spain		
	Pooled mean group (1)	Fixed effects (2)	First difference (3)	Pooled mean group (4)	Fixed effects (5)	First difference (6)
ln(capital services)	0.164***	0.571***	0.328***	0.278***	0.278*	0.431***
	(0.0122)	(0.13)	(0.092)	(0.0188)	(0.15)	(0.077)
ln(labour services)	0.266***	−0.00520	0.157**	0.497***	0.413*	0.201**
	(0.0176)	(0.11)	(0.074)	(0.0496)	(0.21)	(0.079)
ln(migrant share)	0.310***	0.0354	−0.00401	−0.0112**	−0.00295	−0.00169**
	(0.0192)	(0.022)	(0.0063)	(0.00437)	(0.0022)	(0.00069)
Error correction coefficient (mean)	−0.266***			−0.522***		
	(0.0807)			(0.0934)		
Observations	494	572	546	234	260	234

The fixed effects and first difference estimations include year dummies

result of communication problems between locals and migrants or migrants' lack of specific knowledge of local circumstances and production technology in addition to the factors mentioned above. Finally, we acknowledge that despite the use of estimation methods to correct for endogeneity, the context of the migration flows should be borne in mind when interpreting these findings.

6 Conclusions

The productivity impact of migration is an under-researched area within the migration literature. Using industry level data for Spain and the UK for the period 1996–2005, we see this was a period of in-migration, especially in Spain, which historically had relatively low levels of migrant labour. In this paper we compare the direct effect of migrant labour using firstly a growth accounting approach. As a second step, we estimate the production function econometrically. Using the econometric approach enables us to test whether migrant labour has significant long term effects on TFP. Neither growth accounting nor econometric estimation is without its problems or limiting assumptions, but by using this dual approach, we are able to provide a range of evidence on the role that migrants have played in the productivity fortunes of the UK and Spain. In addition, with the appropriate econometric method we attempt to control for potential endogeneity in the system as far as possible given the available information.

In our growth accounting exercise, we are able to decompose migrant labour impact into quantity and quality effects. Our findings indicate that both countries experienced a positive impact on output growth in aggregate. With respect to the contribution to labour productivity growth, the total effect is negative in both countries as the impact on capital deepening is negative and larger in absolute value than the quality impact in the UK. An analysis by sector also highlights considerable heterogeneity across industries in both countries with finance, real estate and business services and hotels and restaurants experiencing the most negative overall impacts, driven by the quantity effect in the UK. In Spain, agriculture and construction sectors experienced the largest negative contribution to labour productivity growth.

The growth accounting methodology is based on assumption that migrants have no impact on TFP. Our econometric findings suggest that the long run impact on TFP in the UK is positive and in Spain is negative. According to these results the effects of migrants on total output and labour productivity found in the growth accounting exercise represent a lower limit of the real effect for the UK and an upper limit for Spain, notwithstanding estimation issues.

One possible explanation for the effects on TFP is the complementarity between migrant workers and other inputs and issues such as innovation and communication. These effects are unlikely to be the only impact that migrants have on the production process. Future work should aim to disentangle the causes that underlie these observed impacts.

In addition, we acknowledge that our findings are not business cycle neutral. We cover a 10 year period during which Europe and much of the world saw little by way of economic downturns. Economic fluctuations might have a significant impact on the results as the economy always partly adjusts through changes in productivity. If migrant labour, for example, is laid off in the first instance and native labour hoarded, negative changes in migrant labour may seem to coincide with decreasing productivity in an

economic downturn. Similarly, if migrants are mainly hired at the height of a boom, smaller increments in productivity are associated with the use of migrant labour. However, we believe that the long term impacts observed in both analyses reflect more than just the impact of an economic boom.

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References

Accetturo A, Bugamelli M, Lamorgese A (2009) Welcome to the machine: firms' reaction to low skilled immigration, Bank of Italy (mimeo)

Acemoglu D (2002) Directed technical change. Rev Econ Stud 69(4):781–809

Amuedo-Dorantes C, de la Rica S (2008) Does immigration raises natives income? National and regional evidence from Spain. FEDEA, working paper 2008-17

Angrist J, Kugler A (2003) Protective or counter-productive? Labor market institutions and the effect of immigrations on EU natives. Econ J 113:F302–F331

Antras P (2004) Is the US aggregate production function Cobb-Douglas? New estimates of the elasticity of substitution. BE J Macroecon 4(1). Available at http://www.bepress.com/bejm/contributions/vol4/iss1/

Arellano M, Bond S (1991) Some tests of specification for panel data: Monte Carlo evidence and an application to employment equations. Rev Econ Stud 58(2):277–297

Barro RJ, Sala-i-Martín X (2003) Economic growth, 2nd edn. The MIT Press, Cambridge

Bauer T, Kunze A (2004) The demand for high-skilled workers and immigration policy. CEPR discussion paper 4274

Blackburne EF III, Frank MW (2007) Estimation of nonstationary heterogeneous panels. Stata J 7(2):197–208

Caselli F (2005) Accounting for cross-country income differences, chapter 9. In: Aghion Ph, Durlauf SN (eds) Handbook of economic growth, vol 1A. Elsevier, Amsterdam, pp 679–741

Clark K, Drinkwater S (2010) Recent trends in minority ethnic entrepreneurship in Britain. Int Small Bus J 28:136–146

Conde-Ruiz JI, García JR, Navarro M (2008) Immigration and regional growth in Spain. FEDEA, working paper 2008-08

Dolado JJ, Vázquez P (eds) (2007) Ensayos sobre los efectos económicos de la inmigración en España. Fundación de Estudios de Economía Aplicada, Madrid

Dustmann C, Glitz A, Frattini T (2008) The labour market impact of immigration. Oxford Rev Econ Pol 24(3):477–494

González L, Ortega F (2011) How do very open economies absorb large immigration flows? Recent evidence from Spanish regions. Labour Econ 18(1):57–70

Huber P, Landesmann M, Robinson C, Stehrer R, Novotny K (2009) Migration, skills and productivity, study carried out under the framework service contract B2/ENTR/05/091-FC; background study to the DG enterprise competitiveness report 2009, Vienna

Im KS, Pesaran MH, Shin Y (2003) Testing for unit roots in heterogeneous panels. J Econom 115(1):53–74

Izquierdo M, Lacuesta A, Vegas R (2009) Assimilation of immigrants in Spain: a longitudinal analysis. Labour Econ 16:669–678

Jorgenson DW (2005) Accounting for growth in the information age, chapter 10. In: Aghion Ph, Durlauf SN (eds) Handbook of economic growth, vol 1A. Elsevier, Amsterdam, pp 743–815

Jorgenson DW, Gollop F, Fraumeni BM (1987) Productivity and US economic growth. Harvard economic studies, 159. Harvard University Press, Cambridge

Lewis E (2005) Immigration, skill mix and the choice of technique. Fed Reserve Bank of Phila, working paper 05-8

Manacorda M, Manning A, Wadsworth J (2006) The impact of immigration on the structure of male wages: theory and evidence from Britain. Centre for Economic Performance discussion paper 754

Mas M, Robledo JC (2010) Productividad: una perspectiva internacional y sectorial. Fundación BBVA, Bilbao

Mattoo A, Maskus KE, Chellaraj G (2005) The contribution of skilled immigration and international graduate students to US innovation. The World Bank, Policy research working paper: 3588

Moen J (2005) Is mobility of technical personnel a source of R&D spillovers? J Labor Econ 23(1):81–114

O'Mahony M, Vecchi M (2005) Quantifying the impact of ICT capital on output growth: a heterogeneous dynamic panel approach. Economica 72(288):615–633

Paserman MD (2008) Do high-skill immigrants raise productivity? Evidence from Israeli manufacturing firms, 1990–1999. IZA discussion paper 3572

Pesaran MH, Shin Y (1999) An autoregressive distributed lag modelling approach to cointegration analysis. In: Strom S (ed) Econometrics and economic theory in the 20th century: the Ragnar Frisch Centennial symposium, chapter 11. Cambridge University Press, Cambridge

Pesaran MH, Shin Y, Smith R (1999) Pooled mean group estimation of dynamic heterogeneous panels. Am Stat Assoc 94:621–634

Quispe-Agnoli M, Zavodny M (2002) The effect of immigration on output mix, capital, and productivity. Fed Reserve Bank Atlanta Econ Rev First Quarter:1–11

Roodman D (2006) How to do xtabond2: an introduction to difference and system GMM in Stata. Center for Global Development working paper 103

Solow R (1957) Technical change and the aggregate production function. Rev Econ Stat 39(3):312–320

Törnqvist MA (1936) The Bank of Finland's consumption price index. Mon Bull Bank Finland 10:27–34