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# The Economic Impact of Migration – Productivity Analysis for Spain and the UK<sup>1</sup>

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## ABSTRACT

As a consequence of increased internationalization over the past 20 years labour has become increasingly mobile, and yet the implications for firm and industry performance have been largely ignored. This paper explores the direct economic consequences of immigration on host nations' productivity performance at a sectoral level. We consider its impact in two very different European countries, Spain and the UK. Whilst the UK has traditionally had a substantial in-flow of migration, for Spain, the phenomenon is much more recent. The paper provides an overview of the role played by immigration on per capita income, highlighting the importance of demographic differences. We then go on to analyze the role of migration on productivity using two different approaches: *i*) growth accounting methodology and *ii*) econometric estimation of a production function. Our findings indicate that migration has had very different implications for Spain and the UK, migrants being more productive than natives in the UK but less productive than natives in Spain. This may in part be a function of different immigration policies, particularly related to the skill requirements on entry, but also in part a feature of the host nations' ability to 'absorb' foreign labour.

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## **1. Introduction**

In an era of global labour markets migration can be seen both as a source of invaluable human resources as well as a threat to the relative economic status of the native workforce. The majority of economic literature that considers migration has largely focussed on wage and employment effects on native labour. In many of these studies, micro data has been used to explore the characteristics of migrants and their impact on native employment and wages in the total economy and often at a regional level (for surveys, see Friedberg & Hunt 1995, Borjas 1999, for US studies see e.g. Card 1990, 2001 and 2005, Card & DiNardo 2000, Borjas 2003, and for evidence on Europe, see Angrist and Kugler 2003; Dolado and Vázquez, 2007). Similarly, there has been work on migrants' instantaneous impact on wage distribution and the complementarity or substitutability of migrants and natives in the total economy (Grossman 1982, Manacorda et al 2006, Ottaviano and Peri 2006). In one study of the UK Manacorda et al. 2006 finds that migrants and natives are imperfect substitutes. A similar result is obtained by Carrasco, Jimeno and Ortega (2007), for the Spanish case. It remains, however, uncertain whether these aggregated findings carry through to sectoral or firm level or to occupational labour markets. The effects of migration at the industry level are largely unexplored, as indeed is its impact on performance indicators, such as productivity.

Migration may have an impact on economic growth through a number channels, which are largely dependent on the characteristics of the migrants:

- labour market demographics may change, which will ultimately affect labour participation, activity and employment rates
- Migrants may be more productive than natives since they represent a selected group of workers, especially in the presence of selective immigration policy
- low skilled migrant labour may contribute to the expansion of activities related to traditionally low value added and productivity, which can ultimately affect industry growth and national productivity
- Migrants may have skills that are scarce in the native population and these skills complement native skills in production

- Migrants may influence TFP growth through their contribution to innovation (Mattoo et al 2005) or increased knowledge spillovers (Moen 2005)

It is clear from these possible channels that the impact of migration on host country productivity will be dependent on the characteristics of those migrating which highlights the importance of immigration policy. With these possible channels in mind, we wish to explore whether relative productivity differences exists between migrants and natives and if they vary between industries. Also, to what degree is there substitutability or complementarity between migrants and natives? Does it vary between industries? Is there a measurable link between TFP growth and the use of migrant labour? To what extent we can control for differences in labour composition between migrant and native labour? In this work we examine some of these issues for the UK and Spain. We adopt both a growth accounting and an econometric approach using a specially constructed industry panel data.

The UK and Spain offer contrasting case studies since they have distinctly different histories as recipient countries of immigration, and therefore offer interesting comparisons. The UK has experienced significant inflow of immigrants since the Second World War. Spain on the other hand has seen mass immigration only relatively recently. It is likely that in these countries migrants differ in their characteristics and sectoral distribution as well as in their contribution to productivity.

The paper is organized as follows: Section 2 briefly outlines the data sources used in this analysis, section 3 presents an overview of recent trends in migration in Spain and the UK and its impact on per capita income growth. Section 4 provides an analysis of the migrant impact on output and productivity growth using the growth accounting methodology. Section 5 addresses similar issues but using the econometric estimation of a production function. In section 6 we conclude.

## **2. Data sources**

The data used are from two sources. The EUKLEMS database provides the information on output, employment, capital, energy, materials and service inputs which have been used to calculate multi-factor productivity using standard growth accounting techniques

(Jorgenson, Gollop and Fraumeni, 1987)<sup>3</sup>. This dataset has been augmented with shares of migrant and native labour (including information on the characteristics of migrant workers, such as age and qualifications) in different industries. These data are derived from the *Labour Force Survey (LFS)*, in the case of the UK and the *Encuesta de Población Activa (EPA)* for Spain.

*The Labour Force Survey (hereafter LFS)*<sup>4</sup> records detailed characteristics of individuals, including employment and migrant status, education and skills, wages and various measures of on the job training which can be used as individual records or summarised by industry. For the UK, we use the LFS to calculate shares of migrant (migrant being defined as someone whose country of origin is not the UK) labour in each industry for 1984-2005. For Spain, the information for the number of migrants, as well as their characteristics, comes from the EPA for the period 1996-2005. These shares have been applied to the number of hours per industry from the EUKLEMS database in order to obtain migrant and native labour input. The data on the relative wages of migrants and nationals for Spain have been obtained for 2002 from the *Encuesta de Estructura Salarial* (Spanish Wage Structure Survey). This survey provides information according to nationality, and not to country of origin, as in the UK, while EPA provides information for both concepts.

### **3 Migration in Spain and the UK**

Whilst the UK has a long established tradition of immigration, in Spain it is a more recent phenomenon. In fact, Spanish statistics have only included data on migrants on a regular basis since the 1990s, a result of the enormous changes, both politically and economically. Traditionally, what little migration there was into Spain, came largely from Northern Europe, particularly from Britain. However, from 1992-2000, the number of migrants from developing nations increased dramatically.

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<sup>3</sup> Further information on the harmonisation and construction of these data is available at <http://euklems.net>

<sup>4</sup> The access to the LFS micro data that were used in employment, hours and labour composition calculations was granted by 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. The LFS data are Crown copyright.

Whilst the UK has tended to have a steady flow of migrant workers, trends in migration patterns highlight the shift from the 1960s and 1970s from Commonwealth countries such as India and Australia, to a significant rise in European migration into the UK. Most recently (and covered to a lesser extent in our analysis) has been the rise in Eastern European migration, the expansion of the EU in May 2004, which has been well documented in the media. Longer term trends in both emigration and immigration have been reviewed and analyzed in Hatton (2005), who uses the International Passenger Survey. He finds that rising inequality at home, skills selective policies overseas and the effect of UK immigration policy since 1996 have both had significant impacts on net immigration. Salt and Millar (2006), using a combination of data sources, report on UK migration trends since 2000 and find that those migrating from developed economies are less likely to remain in the UK than those from developing countries. They find evidence to suggest that the ‘foreign inflow is now more concentrated in the lower skilled end of the labour market’ (p342). However, overall they note that UK policy is a highly selective system, based on both occupations and nationality.

Thus, we see that migration in both countries has undergone significant changes and is at record levels. Figure 1 illustrates the strong upturn of immigration in Spain and, to a lesser extent, the UK. In 1992, 7.4% of the UK population was born outside this country, while in Spain the corresponding figure was much lower, at 1.9%. By 2005, however, the situation had changed, rising to 10.1% in UK compared to 13.1% in Spain.

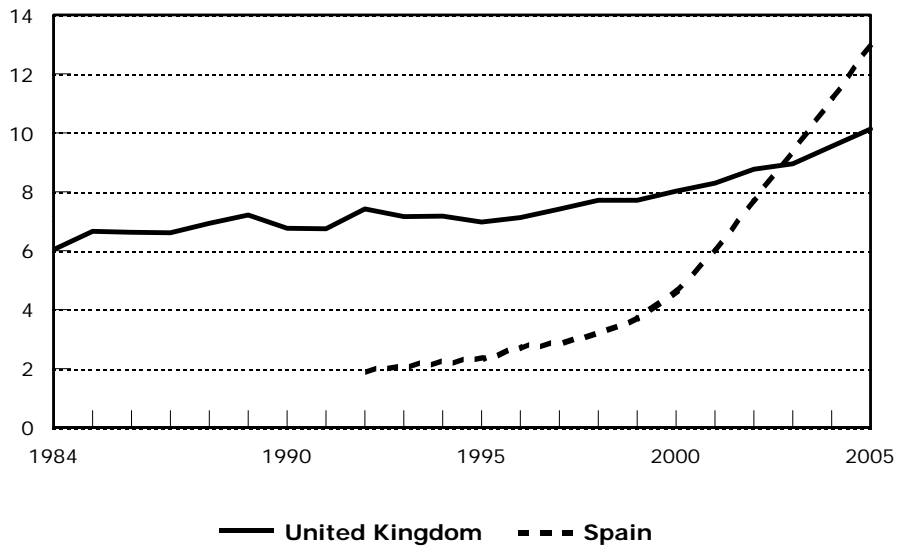


Figure 1 Percentage of migrants in total employment. UK vs. Spain.

Migrants classified according to their country of origin. Source: EPA (INE) and LFS (ONS)

Such a marked increase has affected population and employment growth (as seen in table 1) and consequently, also per capita income and productivity. Of the total population growth in Spain (1.2% per year) during the period 1996-2005, migrants contributed 1 percentage point, but in terms of employment growth its contribution was higher (1.7 percentage points of the 4.5% employment growth can be attributed to migrants). In the most recent period, 2000-2005, the contribution of migration was even more marked - 1.4 percentage points for population growth and 2.2 percentage points for employment growth. These figures are in stark contrast with the UK where population and employment growth were much more modest (0.3% for population and 0.9% for employment in period 1996-2005). Despite the modesty of employment and population growth in the UK, the contribution of migrant labour was larger than that of natives.

	Population			Employment		
	1996-2005	1996-2000	2000-2005	1996-2005	1996-2000	2000-2005
<b>Spain</b>						
Total	1.23	0.58	1.61	4.54	4.67	4.18
Migrants	1.01	0.35	1.40	1.72	0.66	2.19
Non-migrants	0.22	0.24	0.21	2.82	4.00	1.99
<b>United Kingdom</b>						
Total	0.28	0.28	0.28	0.93	1.21	0.70
Migrants	0.31	0.22	0.38	0.42	0.32	0.49
Non-migrants	-0.03	0.06	-0.10	0.51	0.89	0.21

Table 1. Contributions to population and employment growth migrants and non-migrants. Migrants classified according to their country of origin. Source: EPA (INE) and LFS (ONS).

In both countries the demographics of the labour market have also been altered by immigration. The consequences of these flows in three key variables are illustrated by Figure 2. Panel a) shows the proportion of working age migrants in the total population of migrants (equivalently for non migrants). In both countries the ratio of working age population to total<sup>5</sup> is higher in the case of migrants than in natives. This is especially true in the case of UK, where the difference between migrants and non-migrants is more than ten percentage points higher.

The influence of immigration in the activity rates has been rather different in the two countries (panel b). In Spain the strong increase of migration flows since the mid-nineties has significantly boosted activity rates from a traditionally low level<sup>6</sup>. Note that in the most recent years, the differences between migrants and non-migrants in this variable are more than twenty percentage points. Conversely, in the UK the difference between these two groups is not only minor but also of the opposite sign, with activity rates higher for the non-migrants. Finally, panel c) shows that for both countries, the employment rate has been lower for immigrants in the most recent years. In the Spanish case it is interesting to note that the strong upsurge of immigration has been accompanied by a more than noticeable drop in the unemployment rate.

<sup>5</sup> Where working age population is defined as 16 years and over.

<sup>6</sup> A second source has been increased participation of women in the labour market



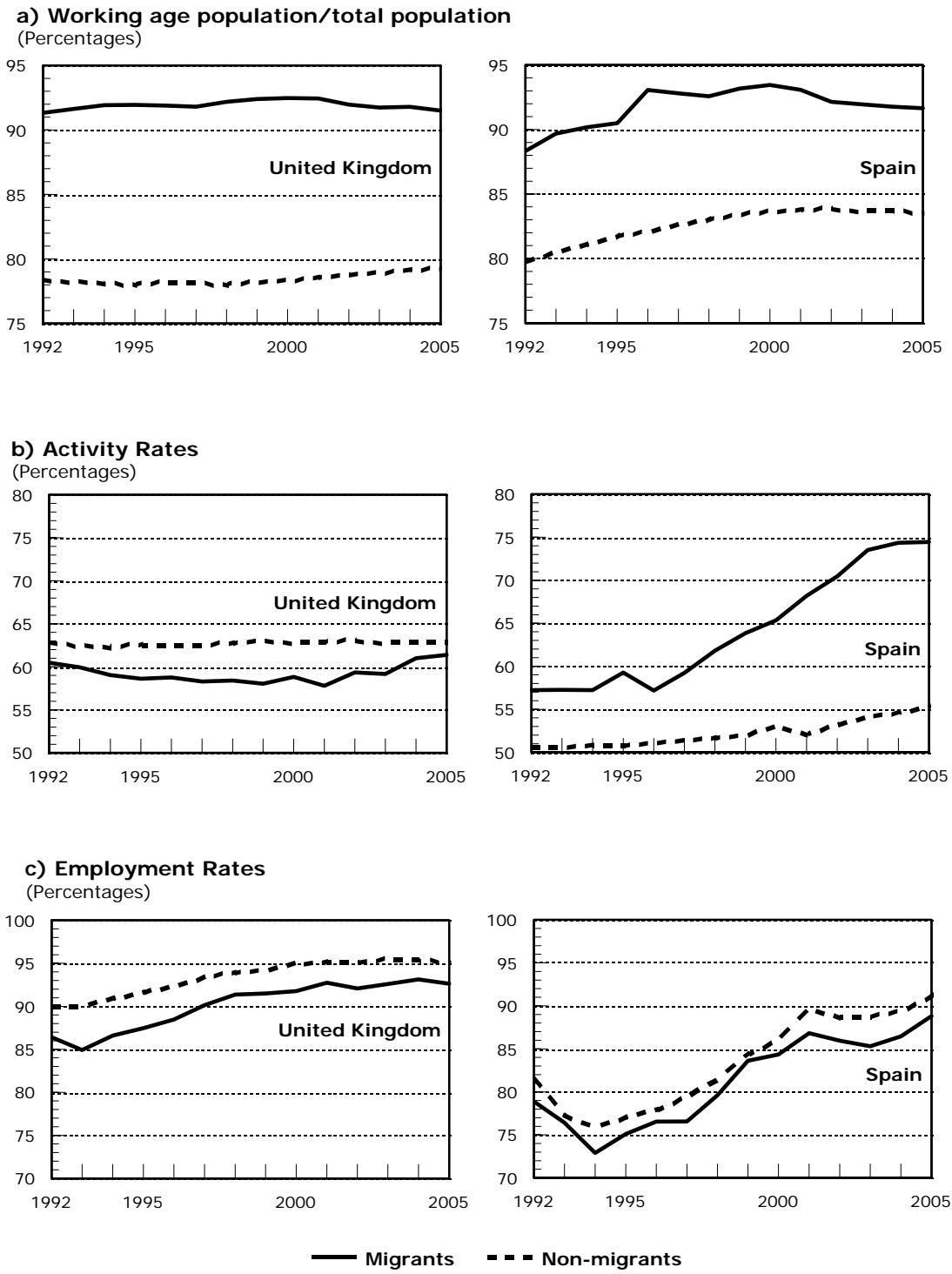


Figure 2. Migrants and non-migrants. UK vs. Spain.

Migrants classified according to their country of origin. Source: EPA (INE) and LFS (ONS)

These observed changes to labour market demographics have had consequences for per capita income and labour productivity. Here we provide some insight as to its impact on

per capita income, while the next two sections concentrate on labour productivity using two complementary methodologies.

GDP per capita may be decomposed into four components as in equation [1]:

$$\underbrace{\frac{Y}{N}}_{GDPpc} = \underbrace{\frac{WAP}{N} \cdot \frac{AP}{WAP} \cdot \frac{L}{AP}}_{demography} \cdot \underbrace{\frac{Y}{L}}_{productivity} \quad [1]$$

Equation [1] is an identity, where Y is Gross Value Added (GVA) at constant prices; N is total population; WAP, the working age population; AP, the active population; and L represents employment. The result of this decomposition for both countries is presented in figure 3. The graph shows a decomposition of *actual* per capita income in three demographic variables (age, activity and employment) and labour productivity. Spanish per capita income growth has been fuelled by demographic changes, indicated by the sharp improvements in the employment ratio, and also by the increase in the activity rate, while the contribution of labour productivity has been negative. Conversely, UK per capita income growth has been barely affected by demographic changes where we see an increase in the activity rate being the only significant influence. The main source of UK per capita income growth has been through productivity. Thus, although a relative newcomer in terms of migration flows the demographic impact of migration has the most important role in economic growth, while in the UK, productivity growth is the driving force.

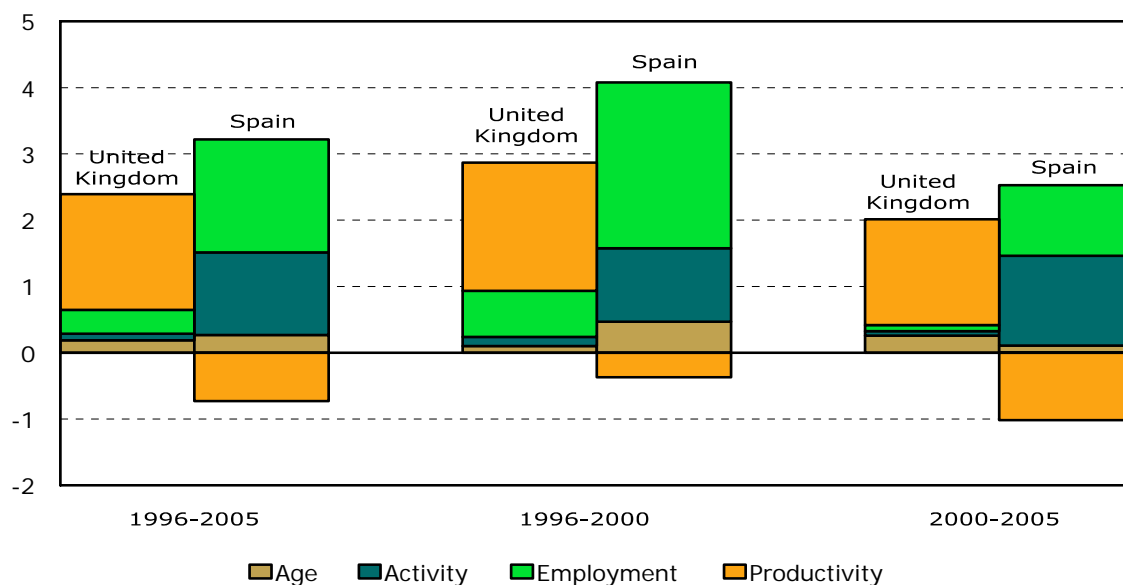


Figure 3 Contributions to per capita value added growth (percentages). Source: EUKLEMS database, March 2008, <http://www.euklems.net>, EPA (INE) and LFS (ONS) and own calculations.

In order to quantify the impact of migration in per capita income growth, we construct a *virtual* economy for UK and Spain, and compare it with the *actual* one<sup>7</sup>. The information for the *actual* economy was presented in figure 3, above. The *virtual* alternative is constructed by assuming that all the demographic characteristics of those in the non-migrants group in each country apply to migrant labour in each country. By this we compute the impact on GDP per capita growth of the different behaviour in the labour market, *assuming that labour productivity remains unchanged*. Relaxing this assumption is discussed in subsequent sections.

Our results are presented in Figure 4 where Panel a) shows the contributions to GDP growth of the three demographic characteristics in the two countries under the *virtual* assumption, while panel b) shows the differences between the *actual* and *virtual* scenarios. This graph illustrates the importance of migration in Spanish economic growth through demographic variables, compared with the UK, which has a long established tradition of migration. Our results show that if the whole of the Spanish population had the same structure in terms of working age ratio, activity and

<sup>7</sup> This approach is a modified version of the statistical model developed by Stockman (1988), Costello (1993) and Marimon and Zilibotti (1998) and departs by the approach followed by Dolado and Vasquez (2007) chapter 1.

employment rates (that is to say, if the increased labour market participation exhibited exactly the same characteristics as the existing native population) per capita income growth would have been 0.4 percentage points lower 1996-2005, and 0.6 percentage points lower 2000-2005, largely as a result of higher migrants activity rates. In the UK, this assumption has only very minor changes, 0.05 percentage points 1996-2005 and 0.07 percentage points 2000-2005.

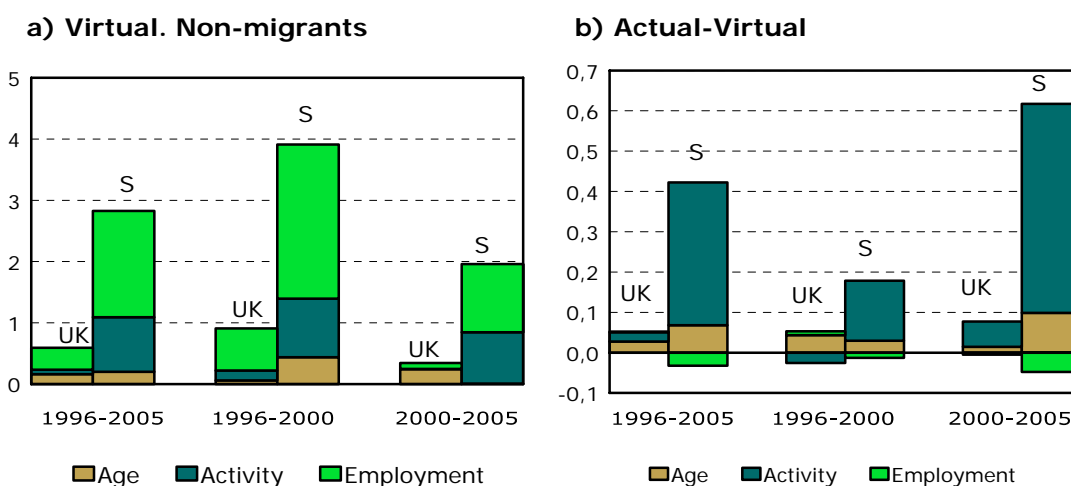


Figure 4. Contributions to per capital value added growth, actual and virtual scenario. Source: EUKLEMS database, March 2008, <http://www.euklems.net>, EPA (INE) and LFS (ONS) and own calculations.

Thus, our findings suggest, other things being equal, that migrant labour (because of its higher activity rates) increased per capita income in Spain noticeably, but this is barely true for the UK. This assumes that productivity of migrant labour exactly matches that of native workers. There are a number of reasons why we would not expect this to be the case. There are likely to be language and cultural differences and different standards in education and training experiences compared with native workers. In addition, selective entry policies arguably should also be designed to maximize the benefit from additional foreign workers.

#### 4 The growth accounting approach to evaluating the productivity impact of migration

Productivity is typically studied either by applying growth accounting or by estimating a production function econometrically. Both approaches have their advantages and shortcomings. Growth accounting is based on the potentially restrictive assumptions of perfect competition and constant returns to scale. TFP is considered to be what is left unexplained, but cost shares or output elasticities are determined flexibly based on the data rather than constrained to be the same across years or units of observation (in this case, industries) as is the case in econometric estimations.

Applying growth accounting techniques, the contribution to growth between periods  $t-1$  and  $t$  of each input is equal to the rate of growth of the quantity used of that input multiplied by the average share of the income of that input in total income. Therefore, we can define the contribution to output growth from the increases in total hours worked (labour quantity contribution) as:

$$\frac{W_t + W_{t-1}}{2} [\ln H_t - \ln H_{t-1}] \quad [2]$$

where  $W_t$  is the labour income share in total income in period  $t$  and  $H_t$  is the number of hours worked in period  $t$ . We also obtain the contribution to output growth from the changes in the labour mix (labour quality contribution) from:

$$\frac{W_t + W_{t-1}}{2} \sum_i \left( \frac{\omega_{it} + \omega_{it-1}}{2} \right) \left[ \ln \frac{H_{it}}{H_t} - \ln \frac{H_{it-1}}{H_{t-1}} \right] \quad [3]$$

where  $\omega_{it}$  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.

In order to estimate the contribution of migrant workers to output growth within this framework we will consider their impact through both the quantity of labour and the quality of labour. This last contribution can be obtained from equation [3] by considering two types of labour: migrants and non-migrants. The “quantity effect” of

migrants will depend on their effect on the growth of hours worked. If we denote the hours worked by nationals as  $H^*$  then we can obtain that contribution as:

$$\frac{W_t + W_{t-1}}{2} [\ln H_t - \ln H_{t-1}] - \frac{W_t + W_{t-1}}{2} [\ln H_t^* - \ln H_{t-1}^*] \quad [4]$$

The total contribution of immigration on output growth is obtained by adding both contributions (quantity and quality contributions of migrants).

Assuming that migration has no effect on TFP growth or on capital accumulation we can also use the growth accounting framework to estimate the migrants' total contribution to labour productivity growth. The first component of that contribution would be a quantity effect: the negative effect of migrant labour through diminishing the capital-labour ratio:

$$-\left[ \left( 1 - \frac{W_t + W_{t-1}}{2} \right) [\ln H_t - \ln H_{t-1}] - \left( 1 - \frac{W_t + W_{t-1}}{2} \right) [\ln H_t^* - \ln H_{t-1}^*] \right] \quad [5]$$

The second is simply the quality effect from the standard growth accounting equation specified in [3]

Full growth accounting results, distinguishing migrant labour from native labour, obtained for the total economy in the UK and Spain are shown in Table 2 for different periods<sup>8</sup>. The GVA growth and the contributions of total labour, ICT capital, Non-ICT Capital and TFP are directly obtainable from EUKLEMS.

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<sup>8</sup> 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 *Encuesta de Estructura Salarial (Structure Wage Survey)* the source of the wages data.

	UK					SPAIN		
	1987-96	1996-00	2000-05	1987-05	1996-05	1996-00	2000-05	1996-05
GVA growth	2.50	3.15	2.29	2.58	2.67	4.29	3.02	3.58
VAConH	0.12	0.74	0.48	0.35	0.59	2.50	1.53	1.96
VAConKIT	0.59	1.03	0.56	0.67	0.77	0.58	0.28	0.41
VAConKNIT	0.66	0.79	0.49	0.64	0.62	1.41	1.49	1.45
TFP Euklems	0.81	0.07	0.37	0.54	0.24	-0.50	-0.77	-0.65
<b>Migrants</b>								
Quantity	0.04	0.17	0.33	0.15	0.26	0.28	1.07	0.72
Quality	0.00	0.02	0.04	0.02	0.03	-0.05	-0.18	-0.12
Total	0.04	0.19	0.38	0.17	0.29	0.23	0.89	0.60

Table 2. Total Economy. GVA growth accounting (% annual)

We see that the contribution of migrant labour to economic growth is quite modest in the UK for the whole period 1987-2005. This is mainly due to the fact that the growth rates of total hours worked with or without migrants are very similar. Therefore, the average quantity effect on growth is just an additional 0.1% each year. It is thought that this is because migrants were already a very significant share of total labour in the 1980s. Furthermore, the quality effect is even smaller and very close to zero. This is unsurprising since the shares of migrants and non-migrants in total hours worked are roughly constant over the period. As a result the total effect of migrants on the GVA growth in the UK over the period 1987-2005 is positive but small, just 0.17%.

The picture changes if we consider subperiods (1987-1996; 1996-2000; 2000-2005). Still both quantity and quality effects are almost negligible for the period 1987-1996. However, the total contribution to value added growth over the period 1996-2000 is 0.19% and it grows to 0.38% in the final period 2000-2005. For the period 1996-2005, the total contribution of migrants is 0.29%. These are small but significant contributions. The main source of these positive value added growth contributions is the quantity effect, i.e. over this period there is an increase in the share of migrant labour in total hours worked that contrasts sharply with the stagnation or even decrease during the previous years. The quantity effect accounts for as much as 0.17% for the period 1996-2000; 0.33% for the period 2000-2005; and 0.26% for the whole period 1996-2005. The rest comes from a smaller but positive quality effect during that period: 0.02%; 0.04%

and 0.03%, respectively. Migrants increase their share in total labour and their wages (and productivity) are also somewhat higher than those of nationals.

In Spain the picture differs considerably, largely a result of virtually no immigration from abroad to speak of until the late 1990s. Spain was the source of much migration towards other countries during the 1950s and the 1960s. Thus we expect to find the impact of migrants much higher than in the UK given that the migrants share in total hours worked in Spain increases sharply from 1% in 1996 to 11% by 2005.

From table 2 we see that the estimated contribution of migrants was 0.60% on average over the period 1996-2005. Furthermore, this contribution increases over time from 0.23% (1996-2000) to 0.89% (2000-2005). The main source of this sizeable contribution is the large increase of migrant labour in Spain. This is 0.28% (1996-2000) and grows to 1.07% over the 2000-2005 period. For the whole period we estimate an average annual effect of 0.72% on value added growth.

The quantity effect is dampened by the relatively lower productivity of migrants in Spain compared to national workers, revealed by the wage data. The very increase of migrant share in total hours worked tends to lower the average labour productivity in Spain. The quality effect is always negative: -0.05% (1996-2000); -0.18% (2000-2005) and an average of -0.12% for the whole 1996-2005 period. However it should be borne in mind that overall for the period 1996-2005, one sixth of the GVA growth in Spain is due to migrant contributions and for the 2000-2005 this contribution increases to roughly one third of total growth.

A feature of migrant labour is that it tends to be concentrated in certain industries. There are big differences among industries in terms of their overall patterns of growth and specifically in terms of the role played by migrants on their performances. Table 3 shows the results for an eight sector breakdown of the market economy: agriculture; manufacturing; construction; trade; hotels and restaurants; finance, insurance, real state and business services; transport and communication; and community, social and personal services. Table 3 shows growth rates in GVA and migrant contributions 1996-2005 and 2000-2005 subperiods.



	<b>GVA</b>		<b>Migrants</b>	
<b>UK 1996-2005</b>		<b>Quantity</b>	<b>Quality</b>	<b>Total</b>
Agriculture	0.87	0.15	0.02	0.17
Manufacturing	0.04	0.23	0.03	0.26
Construction	2.23	0.12	0.02	0.14
Trade	3.29	0.26	0.03	0.29
Hotels and restaurants	3.26	0.65	0.08	0.73
Finance, insurance, real state and business services	4.68	0.25	0.03	0.28
Transport and communication	5.71	0.45	0.06	0.51
Community, social and personal services	1.75	0.26	0.03	0.29
<b>UK 2000-2005</b>				
Agriculture	0.32	0.22	0.03	0.25
Manufacturing	-0.60	0.42	0.05	0.48
Construction	3.11	0.28	0.04	0.31
Trade	3.52	0.23	0.03	0.27
Hotels and restaurants	3.37	0.89	0.11	1.00
Finance, insurance, real state and business services	3.89	0.30	0.04	0.34
Transport and communication	2.72	0.47	0.06	0.53
Community, social and personal services	2.26	0.32	0.04	0.37
	<b>GVA</b>		<b>Migrants</b>	
<b>SPAIN 1996-2005</b>		<b>Quantity</b>	<b>Quality</b>	<b>Total</b>
Agriculture	-0.86	0.77	-0.13	0.64
Manufacturing	2.20	0.53	-0.09	0.44
Construction	5.94	1.58	-0.25	1.33
Trade	3.68	0.46	-0.08	0.38
Hotels and restaurants	3.05	1.65	-0.26	1.39
Finance, insurance, real state and business services	4.59	0.33	-0.06	0.27
Transport and communication	4.53	0.40	-0.07	0.33
Community, social and personal services	3.42	0.82	-0.14	0.68
<b>SPAIN 2000-2005</b>				
Agriculture	-2.18	1.11	-0.18	0.93
Manufacturing	0.84	0.82	-0.14	0.68
Construction	5.91	2.51	-0.39	2.11
Trade	2.62	0.66	-0.11	0.55
Hotels and restaurants	2.01	2.38	-0.37	2.01
Finance, insurance, real state and business services	4.46	0.46	-0.08	0.38
Transport and communication	3.14	0.59	-0.10	0.49
Community, social and personal services	3.40	1.20	-0.20	0.99

Table 3. GVA growth accounting across industries (% annual), continued.

In the UK, for the whole period 1996-2005, the migrant total contribution is especially noteworthy in hotels and restaurants (0.73%) and transport and communication (0.51%), in both cases, the contribution of migrant labour is well above the 0.29% estimated for the total economy. On the other hand, construction (0.14%) and agriculture (0.17%)

show the lowest migrant's contributions to growth. The other industries (manufacturing, trade; and community, social and personal services) are very similar to the total economy. In all industries, the contributions are mainly driven by the quantity effect because the labour quality effect is always very small, being usually 0.02% or 0.03% (although a bit higher in hotels and restaurants (0.8%) and transport and communication (0.51%)). It is interesting to note that even in the industries where the migrant contribution is high, it represents only 22.5% of total growth (hotels in restaurants) and 9.8% (transport and communications).

For the most recent period (2000-2005) our estimates show a somewhat higher contribution from migrants (except in trade) although the overall picture, in terms of differences between industries, is very similar. Hotels and restaurants (1%) and transport (0.53%) show the highest contributions, whereas agriculture (0.25%), trade (0.27%) and construction (0.31%) show the lowest ones. The quality effects are slightly bigger than for the whole 1996-2005 period (for example being 0.11% in hotels and restaurants), but even so our results are mainly driven by the quantity effect.

It is interesting to note that differences across industries are more perceptible in Spain. Looking at the whole period 1996-2005 we can see industries where the migrant total contribution is 1 percentage point higher than in others. Again, hotels and restaurants is the sector with the highest migrant's contribution (1.39%). In contrast with the UK, however, construction shows also a very high contribution (1.33%). Finance (0.27%), trade (0.38%) and transport (0.33%) have the lowest contributions. All other industries lie somewhere in between. We note a very asymmetric effect of immigration across industries in Spain and also the differences with respect to the UK experience. In comparative terms contributions are generally higher than in the UK (agriculture, +0.47%; construction, +1.19%; hotels and restaurants, +0.65%) except in finance and transport. Similarly to the UK case the main source of the migrants' contribution is the quantity effect, however the negative quality effect dominates in Spain, more so than in the UK and is negative for all industries (as high as -0.26% in some sectors).

In the last subperiod, 2000-2005, the migrants' contribution increases in every industry. As a consequence we can see migrants' contributions over 2% in construction and hotels and restaurants, whereas the lowest contribution (finance) is 0.38%. The

increases are significant because the migrants' contributions within each industry for the subperiod 2000-2005 are some 40-60% higher than for the whole period 1995-2005.

Using equations [3] and [5] we can estimate also the migrants' total contribution to labour productivity growth. We assume that migration does not have an effect on TFP growth or on capital accumulation. The results from this approach are shown in Table 4.

	UK					SPAIN		
	1987-96	1996-00	2000-05	1987-05	1996-05	1996-00	2000-05	1996-05
LP growth	2.19	2.09	1.62	2.01	1.83	0.37	0.58	0.48
<b>Migrants</b>								
Quantity	-0.02	-0.08	-0.13	-0.06	-0.11	-0.16	-0.64	-0.43
Quality	0.00	0.02	0.04	0.02	0.03	-0.05	-0.18	-0.12
Total contribution	-0.01	-0.05	-0.09	-0.04	-0.07	-0.21	-0.82	-0.55

Table 4. Total Economy. Labour productivity growth accounting (% annual).

For the UK the impact of migrant workers on labour productivity growth is negligible over the whole period 1984-2005 (-0.07%), although we see some increase in the negative impact in later years, -0.09% for period 2000-2005. In Spain we find a more sizeable and more negative effect, -0.55% for the whole period 1996-2005, especially in the last five years. From a contribution of -0.21% for the period 1996-2000 it increases to -0.82% for the period 2000-2005.

The results by industry in Table 5 show some significant differences in Spain, but for the UK, the magnitude is always quite small, below 0.2% even in sectors where the contribution is most relevant. For the period 1996-2005 these are finance (-0.17%), hotels and restaurants (-0.11%), transport (-0.07%) and trade (-0.07%). For 2000-2005, the size of the contribution is similar although slightly higher. The negative sign is due to the positive quality effect being dominated by the quantity effect (i.e. dampening of capital deepening).

	<b>Labour Productivity</b>	<b>Migrants</b>		
		<b>Quantity</b>	<b>Quality</b>	<b>Total</b>
<b>UK 1996-2005</b>				
Agriculture	3.93	-0.05	0.02	-0.03
Manufacturing	3.41	-0.06	0.03	-0.03
Construction	1.25	-0.02	0.02	0.00
Trade	2.65	-0.11	0.03	-0.07
Hotels and restaurants	0.99	-0.19	0.08	-0.11
Finance, insurance, real state and business services	1.51	-0.20	0.03	-0.17
Transport and communication	4.63	-0.13	0.06	-0.07
Community, social and personal services	-0.01	-0.03	0.03	0.00
<b>UK 2000-2005</b>				
Agriculture	4.32	-0.06	0.03	-0.03
Manufacturing	4.38	-0.12	0.05	-0.06
Construction	2.29	-0.04	0.04	0.00
Trade	3.26	-0.09	0.03	-0.06
Hotels and restaurants	1.17	-0.26	0.11	-0.15
Finance, insurance, real state and business services	1.02	-0.24	0.04	-0.19
Transport and communication	1.81	-0.13	0.06	-0.07
Community, social and personal services	-0.12	-0.04	0.04	0.01
<b>SPAIN 1996-2005</b>				
Agriculture	0.12	-0.95	-0.13	-1.07
Manufacturing	0.93	-0.29	-0.09	-0.38
Construction	-1.71	-0.59	-0.25	-0.84
Trade	0.84	-0.22	-0.08	-0.30
Hotels and restaurants	-1.35	-0.70	-0.26	-0.95
Finance, insurance, real state and business services	0.01	-0.42	-0.06	-0.47
Transport and communication	1.62	-0.39	-0.07	-0.46
Community, social and personal services	0.57	-0.19	-0.14	-0.33
<b>SPAIN 2000-2005</b>				
Agriculture	-0.95	-1.36	-0.18	-1.54
Manufacturing	1.34	-0.44	-0.14	-0.58
Construction	-0.22	-0.95	-0.39	-1.35
Trade	0.51	-0.32	-0.11	-0.43
Hotels and restaurants	-1.33	-1.05	-0.37	-1.42
Finance, insurance, real state and business services	0.89	-0.59	-0.08	-0.67
Transport and communication	0.58	-0.58	-0.10	-0.68
Community, social and personal services	0.30	-0.29	-0.20	-0.49

Table 5 Labour productivity growth accounting across industries (% annual).

In Spain the migrants' contribution to labour productivity is always negative and quite sizeable: between -0.38% and -1.07% depending on the industry for the whole period 1996-2005 and between -0.43% and -1.54% for the period 2000-2005. The industries with the poorest performance (agriculture, construction and hotels and restaurants) are characterized by negative contributions from migrant workers. The share of migrant labour and productivity seem to be closely (inversely) related across Spanish industries,

even more so in the last five years. The negative contribution of migrants increases in every industry during the last period 2000-2005.

Thus, using the growth accounting methodology to analyze the contribution that migrant labour makes to value added growth suggests that the impact is very sector dependent and is much larger in Spain than in the UK. In Spain we find a significant and negative relationship between the share of migrant workers and productivity. This may in part be indicative of industry life cycle pressures, where in mature industries, cost cutting forces firms to pay as little as possible for labour, e.g. agriculture.

Table 6 summarizes the main results obtained from this and the previous section. It highlights both, the importance of Spanish migrant's demography on total per capita income growth as compare to the UK, and the negative impact of migration on productivity in the two countries.

	a) growth rates		b) percentage points		
	SPAIN	UK	SPAIN	UK	
<b>Per capita GDP growth</b>	<b>2,49</b>	<b>2,39</b>	<b>Per capita GDP growth</b>	<b>100</b>	<b>100</b>
<b>Contribution of migrants</b>			<b>Contribution of migrants</b>		
Age	0,07	0,03	Age	2,73	1,15
Activity	0,35	0,02	Activity	14,24	0,97
Employment	-0,03	0,00	Employment	-1,31	0,06
Productivity	-0,55	-0,07	Productivity	-22,10	-2,92
<b>Total</b>	<b>-0,16</b>	<b>-0,02</b>	<b>Total</b>	<b>-6,44</b>	<b>-0,75</b>

Table 6. Total Effect of Migration on per capita Income. 1996-2005

The first result is the reflection of migration being a new and rapid growing phenomenon in Spain, while in the UK has developed along a much longer time span. The lesson to be learnt from the contrasting experiences of the two countries is that the positive impact of migration *via* demographic changes will most probably vanish in the near future. Concerning productivity performance, in both countries the impact of migration has been negative, but 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, while in the UK the negative quantity effect has been much lower as well as compensated by a positive quality effect.

## 5 Econometric estimation of the impact of migration on productivity

In contrast to growth accounting methodologies econometric studies allow for additional factors thought to influence productivity to be added directly to the specification. However, a certain form of production technology has to be assumed and the parameters of the model are forced to be equal across units (firms/industries) and/or over time. We first estimate the Cobb Douglas production function, since its log linear form allows for straightforward estimation, where the coefficients reflect output elasticities of inputs. This is defined as:

$$\ln(Y_{it}) = \ln A_{it} + \beta_1 \ln K_{it} + \beta_2 \ln L_{it} + \varepsilon_{it} \quad [6]$$

In the case of constant returns to scale these sum to one and equal the cost shares of inputs. Additional regressors can be added to estimate their effect on total factor productivity,  $A$  and the error term may include dynamic components in addition to industry specific fixed effects, for example an autoregressive component in our General Method of Moments (GMM) estimation. In our analysis we use the log of share of migrants of the people employed in each industry as an additional regressor to capture the productivity impact of migrant labour on TFP. We estimate this standard specification by using Ordinary Least Squares (OLS), fixed effects and first differenced regressions.

In the context of production function estimation, a major issue is how to obtain consistent estimates of the coefficients as estimating production functions involves several well known potential problems. It has long been recognised that inputs are endogenous<sup>9</sup>, that productivity shocks are persistent and that inputs may be dependent on past or current shocks. In our case there are no obvious “external” instruments for migrant labour input to resolve potential endogeneity. GMM methodology that uses a

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<sup>9</sup> For plant level analysis various solutions have been suggested, see for example Olley and Pakes 1996, Levinsohn and Petrin 2003, for an overview see Griliches and Mairesse 1995.

set of lagged levels as instrument for differences proposed by Arellano and Bond (1991) is widely used to solve this problem. Blundell and Bond (2000) suggest using lagged differences as additional instruments for levels which produces consistent estimates as long as certain additional moment conditions are satisfied (the GMM system method). In addition to the standard regressions we experiment with a dynamic specification by using these methods. As in Blundell and Bond (2000) we assume the error term is AR(1) process and for the actual estimation use a specification where lagged output and inputs are included as regressors. The migrant labour share as well as the other inputs are instrumented in a similar fashion to lagged output. The actual coefficients of interest are calculated as minimum distance estimators from a transformed model where lagged output and input variables and migrant share are included as regressors.<sup>10</sup>

A limitation of our data is that the number of units observed is not very large and therefore the instrument matrix becomes large compared to the number of observations, which introduces several potential problems to the estimates and tests used (Roodman 2006). In these data the number of instruments becomes much larger than the number of units. There are also well known problems of using GMM in finite samples.

In order to explore a more flexible functional form, we also estimate a Translog production function by using migrant and native labour input as separate inputs. This enables us to obtain estimates of the elasticity of substitution between migrant and native labour input. Estimated coefficients from Cobb-Douglas have a straightforward interpretation as they represent output elasticities and in the presence of constant returns to scale also cost shares of the inputs. The Translog production function, on the other hand, is very flexible and can be derived as an approximation of any production function (Taylor's expansion).<sup>11</sup>

The Translog production function is defined as (Christensen et al 1973):

$$\ln(Y) = \beta_0 + \sum_i \beta_i \ln(X_i) + \sum_i \sum_j \beta_{ij} \ln(X_i) \ln(X_j) + \varepsilon \quad [7]$$

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<sup>10</sup> For both estimations we use Roodman's (2006) xtabond2 procedure in Stata.

<sup>11</sup> For applications of Translog function, see e.g. Hitt and Snir 1999 and Heyer, Pelgrin and Sylvain 2004, for a discussion on the use in the context of substitution of different types of labour, see Hamermesh and Grant 1979.

Where  $Y$  is output,  $X_i$  are inputs (in our case capital, native labour and migrant labour) and  $\varepsilon$  error term.

We are interested in the substitutability of inputs in production. By definition, inputs are substitutes if a decrease in the price of an input leads to decrease of the use of another input. Similarly, if decline in the price of a factor decreases the demand for another factor, these factors are complements. Several measures of substitutability have been developed (for a discussion see e.g. Blackorby and Russell 1989). The measure we apply is the Allen (partial) elasticity of substitution (AES). AES measures the percentage change in the demand for a factor relative to change in the price of the other input given that other factors adjust to their optimal levels.

Unlike in the Cobb-Douglas production function, the AES is not constrained to be one in the Translog neither does it constrain the elasticity of substitution to be the same for all units. The elasticity of substitution is calculated as a function of the parameters of the production function. We use industry data rather than company data which may have implications for the coefficients and elasticities estimated. The elasticity of substitution in the case of the Translog production function depends on the values of the inputs and outputs and therefore is different for each observation. The AES is positive when the inputs are substitutes, negative when they are complements. When the AES is 0 the inputs are neither substitutes nor complements.

Because the values and therefore the standard deviation are actually different for each data point it is not clear what would be the right overall measure of substitution. Thus we estimate the Translog function and calculate the elasticities of substitution at different data points and examine the distribution rather than attempt to produce a single measure.

The composition of migrant labour is likely to be different from the native workforce and will develop differently. Thus, we calculate a separate labour composition index for each group and use it to adjust the labour input for the Translog estimation. Changes in labour composition for the UK are calculated at industry level as in equation [3] but the different types of labour include all combinations of gender, three age and three



education groups and the composition changes are calculated separately for migrants and non-migrants. Sample sizes limit disaggregation, so employment shares have been calculated at a seven industry breakdown and relative wages used for calculating wage shares separately for services. Total relative wages have been used for other industries and pre -1992 when the LFS did not include a wage information, wages from 1992 have been used. Trends of shares of different gender-age education-groups before 1992 have been used to extend the data backwards owing to sample limitations in the pre-1992 LFS.

For Spain, only shares by education groups were available and the labour composition index is based on these, rather than division by gender, sex and education. Relative wages for Spain for natives and migrants with different levels of education were only available for 2002 and have been applied to the whole period. Information on the levels of labour and capital services were also available<sup>12</sup> in 1997 in 26 market industries. An index of capital services has been used to extend the capital service levels to cover the whole period studied. Labour services in 1997 were split into migrant and non-migrant services by using information on labour composition and shares of hours of migrants and natives (for Spain, shares from 2000 were used). The composition index described above and changes in hours were used to construct a full series of labour services.

We first estimate Cobb-Douglas specification<sup>13</sup> using standard regression methods. Different combinations of measures of input and output are used:

- hours unadjusted for labour composition and capital stock
- capital and labour services levels (excludes non market services)
- capital and labour service indices (only used in fixed effects and first difference estimations)<sup>14</sup>

For each specification we test the hypothesis that there are constant returns to scale, or that the sum of the coefficients equals one. The results of the Cobb Douglas specification are presented in table 7.

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<sup>12</sup> Estimates based on EUKLEMS source data.

<sup>13</sup> We also estimated Cobb Douglas specification by assuming migrant and native labour as separate inputs. The results implied similar conclusions and quality adjustment does not seem to have a large impact on the migrant labour output elasticity. These results are available on request.

<sup>14</sup> Cross industry differences are not meaningful for indices. Capital and labour service indices are also available for non-market industries

For the UK, the specifications based on levels give us reasonable estimates of output elasticity and constant returns to scale cannot be rejected in any of the OLS specifications. Using different combinations of variables makes little difference so we report estimations with capital stock and unadjusted hours and capital and labour services (levels or index depending on specification). The coefficient on the migrant share variable is small and not statistically significant and it is negative in first difference estimation for specifications with capital and labour levels. For specification with unadjusted hours and capital stock estimation also fixed effects estimate is negative. For estimation with indices where all 30 industries are included the coefficients are positive but insignificant.

Our findings suggest that for the UK, migrant labour is generally associated with higher productivity when levels of productivity and the use of migrant labour are examined, although the effect is not strong. Within industries, changes in migrant share do not have a significantly positive effect. Clearly variation within an industry observed during the period of analysis is not enough to capture the contribution of migrant share if indeed there is any.

Variable	UK			Spain		
	OLS	Fixed effects	First differences	OLS	Fixed effects	First differences
ln(capital services)	0.428*** (0.057)	0.571*** (0.13)	0.328*** (0.092)	0.372*** (0.097)	0.278* (0.15)	0.431*** (0.077)
ln(labour services)	0.473*** (0.061)	-0.00520 (0.11)	0.157** (0.074)	0.544*** (0.087)	0.413* (0.21)	0.201** (0.079)
ln(migrant share)	0.0782 (0.13)	0.0354 (0.022)	-0.00401 (0.0063)	-0.0632*** (0.022)	-0.00295 (0.0022)	-0.00169** (0.00069)
Constant	-1.376** (0.60)	0.374 (0.82)	0.0164 (0.010)	-1.807*** (0.60)	-0.0158 (0.88)	0.0365*** (0.0097)
Obs	572	572	546	260	260	234
R-squared	0.92	0.76	0.32	0.91	0.73	0.30

Variable	UK			Spain		
	OLS	Fixed effects	First differences	OLS	Fixed effects	First differences
ln(capital stock)	0.402*** (0.039)	0.662*** (0.15)	0.461*** (0.11)	0.416*** (0.054)	0.268* (0.13)	0.343*** (0.088)
ln(total hours)	0.483*** (0.053)	0.0534 (0.086)	0.135** (0.062)	0.475*** (0.062)	0.409** (0.16)	0.363*** (0.13)
ln(migrant share)	0.0848 (0.16)	-0.0128 (0.057)	-0.00900 (0.15)	-0.0428 (0.027)	-0.00255 (0.0022)	-0.252 (0.16)
Constant	-2.246*** (0.76)	-2.112 (1.33)	0.0276** (0.012)	-2.655*** (0.79)	-0.558 (1.05)	0.0185** (0.0068)
Obs	660	660	630	300	300	270
R-squared	0.90	0.74	0.28	0.88	0.78	0.33

Variable	UK		Spain	
	Fixed effects	First differences	Fixed effects	First differences
ln(index of capital services)	0.513*** (0.13)	0.291*** (0.086)	0.305** (0.11)	0.395*** (0.075)
ln(index of labour services)	0.0436 (0.11)	0.158** (0.068)	0.345** (0.15)	0.278*** (0.100)
ln(migrant share)	0.0360 (0.040)	0.0382 (0.15)	-0.00285 (0.0021)	-0.257* (0.15)
Constant	2.121*** (0.45)	0.0209* (0.012)	1.590** (0.60)	0.0149** (0.0071)
Obs	660	630	300	270
R-squared	0.72	0.26	0.77	0.31

Robust standard errors in parentheses; \*\*\* p<0.01, \*\* p<0.05, \* p<0.1  
All estimations include year dummies.

Table 7. Estimates of Cobb Douglas production function

For Spain the coefficients of migrant share are negative (though not always significant), which would suggest that low productivity sectors or sectors experiencing negative productivity shocks use more migrant labour. The coefficient in the OLS levels specification is more negative and significant than in the other specifications when service levels data are used. This also implies that the levels of productivity are

significantly lower in those sectors that use migrant labour. For the OLS coefficients the hypothesis of constant returns to scale is accepted, but for FE and FD estimates it is rejected.

System GMM estimates for UK and Spain from the dynamic specification are presented in table 8<sup>15</sup>. The number of instruments is large compared to the number of units which weakens the credibility of the estimates; moreover, the instruments do not pass the Sargan test for validity of instruments. The coefficients for labour input are smaller than in the OLS and FD estimations and the coefficients for migrant share do not reveal patterns significantly different from the standard estimations. The large size of the autoregressive coefficient suggests that the data are highly persistent.

Variable	UK		Spain	
	Capital and labour services	Capital stock and hours	Capital and labour services	Capital stock and hours
AR coefficient	0.997*** (0.002)	0.998*** (0.002)	1.016*** (0.003)	1.015*** (0.003)
Capital	0.366*** (0.041)	0.480*** (0.049)	0.484*** (0.095)	0.361*** (0.070)
Labour	0.125*** (0.033)	0.106*** (0.032)	0.082 (0.076)	0.251*** (0.066)
Migrant share	0.003 (0.008)	0.005 (0.008)	-0.000 (0.002)	-0.001 (0.002)
Observations	546	600	234	270
Sargan test p value	0.000	0.000	0.004	0.002

Robust standard errors in parentheses; \*\*\* p<0.01, \*\* p<0.05, \* p<0.1  
All estimations include year dummies.

Table 8. System GMM estimates of Cobb Douglas production function.

As in the case of the UK, GMM estimates for Spain show significant persistence. The capital coefficient is realistic but the coefficients of labour input are small especially for labour services. The coefficient of migrant share is negative as in the OLS estimations but not significant. The instruments did not pass the Sargan test for overidentifying restrictions and according to the Arellano-Bond test there is still remaining autocorrelation in the errors. GMM estimations therefore do not provide significant improvements on the standard methods.

<sup>15</sup> We also calculated standard GMM estimates, but the coefficients were similarly unrealistic in the sense that the labour input coefficients were very small. Migration coefficients were similar but the AR coefficient was smaller in the Spanish case.

In the UK, the use of migrant labour seems to be weakly related to overall productivity. This may be indicative of migrant labour being rather similar to the native labour. We do not see any significant evidence that changes in productivity are related to contemporaneous changes in the use of migrant labour. If migrants are hired in response to productivity shocks this does not appear to occur simultaneously. In Spain, on the other hand, there is a clearly negative association between the use of migrant labour and productivity for levels of labour and capital services. This negative relationship also occurs within industries though the coefficients are generally less significant. This seems to imply that a decline in productivity is associated with increasing share of migrant workers. These results are in line with the ones obtained from the growth accounting exercise in the previous section.

The Cobb Douglas specification is limiting in the sense that elasticity of substitution is constrained to one. Thus we estimate a Translog specification (full results in the appendix) and test the hypothesis that all interaction terms are zero. In all specifications except fixed effects for unadjusted hours and capital stock this hypothesis is rejected, showing that the Cobb Douglas functional form does not adequately describe the relationship between inputs and output.<sup>16</sup>

The coefficients themselves in the Translog specification are not easily interpreted and therefore we calculate output elasticities for each input, presented in the appendix, and elasticities of substitution between migrant and native labour from the existing sample and examine the distribution. We then correlate the elasticities with migrant share (tables 9 and 10).

The median output elasticity in the UK for migrant labour input is positive (except in the FE specification of capital stock and unadjusted hours) but there are also implausible negative values in the lowest percentiles. On the other hand, the output elasticity of capital in FE specification using service levels is negative. This suggests that at least coefficient estimates in FE specifications are incorrect.

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<sup>16</sup> GMM estimates for Translog specification were unsatisfactory in the same way as in the Cobb Douglas case we do not report them here, but these results are available on request.

Median elasticities of substitution between migrants and natives in the UK are negative in most specifications but the median is close to zero while there are larger absolute values in both ends of the distribution. This suggests that migrant and native labour inputs are complements but there is clearly variation between industries and time periods. Complementarity between migrants and natives is not altogether unrealistic as the immigration system (with the exception of EU nationals) in the UK is selective and biased towards immigrants with skills in shortage and highly skilled individuals. With such a system migrants are likely to be selected on the basis of their complementing the native labour, rather than replacing them.

In Spain, the median output elasticity for migrant labour input is negative for the OLS coefficients in unadjusted hours and capital stock specification and larger than the output elasticity of native labour for OLS service levels specification. In the fixed effects specifications the output elasticities for migrants are realistic, but for labour and capital services the coefficient of native labour services is negative. In this case, the fixed effects estimation for unadjusted hours and capital stock seems to provide more realistic coefficient estimates for Spain.

	UK				Spain			
	OLS Service level	OLS Hrs& stock	FE service level	FE hrs& stock	OLS Service level	OLS Hrs& stock	FE service level	FE hrs& stock
1%	-0.152	-0.079	-0.194	-0.011	-3.846	-1.420	-2.799	-1.098
5%	-0.029	-0.011	-0.045	-0.003	-0.047	-0.013	-0.148	-0.458
10%	-0.014	-0.006	-0.020	0.000	-0.022	0.000	-0.051	-0.127
25%	-0.005	-0.002	-0.006	0.002	-0.008	0.001	-0.018	-0.040
<b>50%</b>	-0.002	-0.000	-0.002	0.004	-0.001	0.002	-0.005	-0.010
75%	0.000	0.000	-0.000	0.009	0.000	0.006	-0.001	-0.003
90%	0.007	0.004	-0.000	0.019	0.000	0.012	0.000	-0.001
95%	0.038	0.013	-0.000	0.066	0.000	0.032	0.003	-0.001
99%	0.165	0.092	0.370	0.125	3.898	0.697	7.967	8.708

Table 9. Distribution of elasticities of substitution of migrant and native labour

	<b>Estimation method</b>	<b>Elasticity of substitution migrant/native</b>	<b>Output elasticity of migrant labour input</b>
<b>UK</b>	OLS Capital and labour services	0.0872*	-0.8036*
	OLS Capital stock and hours	0.0977*	-0.8147*
	FE Capital and labour services	0.0263	0.0077
	FE Capital stock and hours	-0.1058*	0.2161*
<b>Spain</b>	OLS Capital and labour services	-0.0358	0.4285*
	OLS Capital stock and hours	0.1057	-0.5044*
	FE Capital and labour services	0.0182	0.1958*
	FE Capital stock and hours	0.0050	0.4170*

Table 10. Correlations between elasticities and migrant share \* significant at 95% level

Elasticities of substitution for Spain have medians small in absolute value with higher absolute values at both ends of the distribution, which was the case in the UK. For the fixed effects results, the elasticities of substitution are generally negative with some highly negative values at the lower end of the distribution. Thus, it seems that also in Spain migrant and native labour are complements in many industries. This conclusion partly contradicts previous results obtained by Carrasco, Jimeno and Ortega (2007) where they find a substitution relationship between migrants and non-migrants. However, they also warn that their finding is most likely overstated by the fact that migrants work in sectors less attractive for nationals.

We correlate the output elasticities and elasticities of substitution with migrant share and find that the output elasticities are negatively correlated with migrant share for some of the estimates (both OLS for the UK, OLS capital stock and hours estimates for Spain). This seems counterintuitive as industries which benefit most from using migrant labour are most likely to use them extensively. For Spain the fixed effects estimates which seem more realistic are positively correlated with the output elasticity. The correlation of the elasticity of substitution with the migrant share is positive (though not strong) for all estimates except the fixed effects estimation for unadjusted hours and capital stock for the UK and OLS for labour and capital services for Spain. Thus, even though overall migrants and natives are complements industries that use migrants to substitute natives tend to have higher levels of migrant labour input. For Spain, however, none of these correlations is statistically significant.

## 6 Conclusions

The UK and Spain have distinctly different histories of immigration – a long established tradition in the UK and a very new phenomenon in the Spanish case. Its novelty has had a profound impact on Spanish labor demographics, rejuvenating the labor force and increasing activity rates, thus contributing to per capita income growth. By contrast, the UK labor market has not experienced as significant changes in the most recent period analysed here. These different experiences suggest that, most likely, the links between productivity and the use of migrant labour have different patterns in these countries.

The growth accounting results show that migration is playing an increasingly important role in the economic performance of Spain. It has fostered GVA growth during recent years (contributing to the Spanish growth miracle) but, at the same time, it explains a great part of the poor evolution of labour productivity. Also noteworthy are the big differences across industries. For the UK the impact is always much smaller and there is no evidence of any negative effect on labour productivity. Spain and the UK seem to be two stories of migration quite different both quantitatively and qualitatively in their impact on productivity growth.

Estimating a Cobb-Douglas production function, using the migrant share of labour as an additional regressor, shows that, in Spain, the use of migrant labour is clearly linked with lower productivity, confirming the growth accounting outcome. In the UK, however, it is often positively but not statistically significantly linked with the share of migrants. It is not however, possible to infer to what extent the negative relationship in Spain indicates causality. Using GMM estimation method for a dynamic specification of the production function did not change the essential result and this estimation method does not seem well suited for these data.

The Translog production function provides a more flexible way to estimate the relationship between inputs and output, not constraining the elasticity of substitution between inputs to be one or to be equal in all units of observation. However, in some specifications some of the output elasticities are negative for most observations which is unrealistic. Thus, the more flexible functional form does not completely solve the problem of estimating production functions consistently.



The elasticity of substitution between migrant and native labour has a median close to zero in both countries. The preferred estimates suggest that in the majority of industries, migrant and native labour are complements in both countries although the absolute values of the elasticity are small. Intuitively in the case of the UK this may be result of selective migration policies. For Spain it probably reflects the fact that migrants are not competing for the same type of jobs/sectors than nationals but, instead, they are mostly being hired in sectors by which there is not national's supply of labour.

Our results provide evidence that immigrant labour input is used by different industries in these countries and to some extent this is linked to productivity differences. The growth accounting findings show how this varies significantly by industrial sector. In the econometric estimation, better methods to control for endogeneity have to be used to explore whether for example changes in productivity lead to increased use of migrant labour.

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## APPENDIX

Percentile	UK				Spain			
	OLS Service level	OLS Hrs& stock	FE service level	FE hrs& stock	OLS Service level	OLS Hrs& stock	FE service level	FE hrs& stock
	<b>Output elasticity of migrant labour</b>							
1%	-0.37552	-0.56139	-0.06557	-0.14316	-0.08316	-0.20080	-0.01505	-0.02099
5%	-0.28089	-0.39532	0.00496	-0.12966	0.05196	-0.16971	-0.00177	0.00669
10%	-0.16344	-0.25395	0.02716	-0.11062	0.09588	-0.15655	0.00556	0.01245
25%	0.05944	-0.02557	0.05875	-0.04885	0.13050	-0.13340	0.01760	0.01755
<b>50%</b>	<b>0.14457</b>	<b>0.09817</b>	<b>0.09126</b>	<b>-0.03410</b>	<b>0.16071</b>	<b>-0.10805</b>	<b>0.02862</b>	<b>0.02200</b>
75%	0.23400	0.23443	0.12291	-0.01602	0.20014	-0.08959	0.03636	0.02636
90%	0.37454	0.37735	0.15786	0.00462	0.23858	-0.06104	0.04655	0.03004
95%	0.45272	0.51183	0.17473	0.01545	0.24641	-0.00875	0.05404	0.03216
99%	0.69746	0.83500	0.19455	0.03744	0.25894	0.08253	0.06686	0.03518
	<b>Output elasticity of capital</b>							
1%	0.07178	0.04010	-0.69722	0.32737	-0.26989	-0.15716	0.28882	-0.09929
5%	0.08897	0.10473	-0.55053	0.41059	-0.06953	-0.09345	0.42074	-0.06924
10%	0.18335	0.13528	-0.48759	0.48155	0.17038	-0.00601	0.46602	-0.03751
25%	0.28210	0.19325	-0.41396	0.59103	0.31997	0.13459	0.48508	0.02593
<b>50%</b>	<b>0.35930</b>	<b>0.34436</b>	<b>-0.36266</b>	<b>0.69083</b>	<b>0.52810</b>	<b>0.34183</b>	<b>0.50072</b>	<b>0.14148</b>
75%	0.45530	0.44975	-0.30278	0.82344	0.83625	0.54680	0.51463	0.24621
90%	0.53620	0.57552	-0.16455	0.98588	1.04186	0.72274	0.52886	0.50861
95%	0.65289	0.64488	-0.03974	1.18384	1.14417	0.95931	0.53651	0.65829
99%	0.82603	0.87365	0.03525	1.49494	1.27962	1.32244	0.54719	1.05266
	<b>Output elasticity of native labour</b>							
1%	-0.37971	-0.48709	0.32750	-0.32928	-0.15754	-0.42147	-0.14608	-0.07644
5%	-0.22462	-0.27496	0.35248	-0.25059	-0.03681	-0.10706	-0.13253	0.35600
10%	-0.07380	-0.12797	0.37939	-0.21203	0.06065	0.27483	-0.12755	0.45660
25%	0.27046	0.27436	0.48179	-0.12643	0.11686	0.57085	-0.11180	0.66026
<b>50%</b>	<b>0.37537</b>	<b>0.43889</b>	<b>0.59054</b>	<b>0.06169</b>	<b>0.14372</b>	<b>0.69086</b>	<b>-0.09262</b>	<b>0.73706</b>
75%	0.49744	0.59829	0.72477	0.17300	0.17073	0.83119	-0.07434	0.80158
90%	0.79455	0.83289	0.82387	0.37180	0.18800	0.88267	-0.05678	0.91913
95%	0.95383	1.09815	0.87789	0.49989	0.20451	0.90550	-0.04477	0.96465
99%	1.01791	1.24627	0.93672	0.67733	0.23254	0.94158	0.07536	1.00182

Table 11. Distribution of output elasticities

	UK			Spain		
	OLS	Fixed effects	First differences	OLS	Fixed effects	First differences
ln(capital services)	1.398*** (0.46)	-0.218 (0.59)	-0.416 (0.43)	3.524*** (0.77)	0.591 (0.54)	0.468 (0.46)
ln(migrant labour services)	-2.073*** (0.36)	-0.376 (0.32)	0.0716 (0.081)	-0.0171 (0.25)	-0.0688* (0.034)	-0.0157* (0.0089)
ln(native labour services)	3.139*** (0.37)	2.121*** (0.53)	0.659** (0.31)	0.551 (0.46)	0.0273 (0.038)	0.0175* (0.0088)
ln(migrant labour services)*ln(migrant labour services)	-0.216*** (0.045)	-0.0320 (0.029)	0.0153** (0.0068)	0.00411 (0.0068)	0.00483** (0.0020)	0.000292 (0.00039)
ln(native labour services)*ln(migrant labour services)	0.528*** (0.096)	0.0830 (0.071)	-0.0399** (0.016)	0.0332 (0.021)	-0.0126** (0.0053)	-0.000940 (0.0010)
ln(capital services)*ln(migrant labour services)	0.0572 (0.051)	0.00815 (0.029)	0.00990 (0.0071)	-0.00598 (0.021)	0.0210*** (0.0058)	0.00258** (0.0012)
ln(capital services)*ln(native labour services)	-0.227*** (0.063)	-0.168*** (0.041)	-0.141*** (0.031)	-0.0397 (0.044)	-0.0173*** (0.0060)	-0.00321** (0.0014)
ln(native labour services)*ln(native labour services)	-0.223*** (0.062)	-0.0690 (0.042)	0.0678*** (0.018)	-0.0122 (0.0089)	0.00651*** (0.0023)	0.000397 (0.00048)
ln(capital services)*ln(capital services)	0.0100 (0.026)	0.107*** (0.033)	0.0957*** (0.034)	-0.169*** (0.053)	-0.00248 (0.029)	0.00488 (0.023)
Constant	-9.827*** (2.18)	-2.779 (3.28)	0.0196* (0.011)	-13.64*** (3.02)	0.444 (2.46)	0.0149** (0.0067)
Observations	572	572	546	260	260	234
R-squared	0.96	0.85	0.39	0.88	0.75	0.27
Number of NR		26			26	

Robust standard errors in parentheses

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

Table 12 Results of estimation of Translog production function (year dummies suppressed)

	UK			Spain		
	OLS	Fixed effects	First differences	OLS	Fixed effects	First differences
ln(capital stock)	2.029*** (0.46)	-0.581 (0.86)	-0.599 (0.68)	2.717*** (0.52)	-0.417 (0.52)	-0.140 (0.50)
ln(migrant hours)	-2.855*** (0.62)	-0.0547 (0.51)	0.0499 (0.094)	-0.466*** (0.17)	-0.00152 (0.017)	0.00486 (0.0061)
ln(native hours)	4.045*** (0.65)	2.260** (0.87)	0.753 (0.45)	2.123*** (0.52)	2.380*** (0.52)	1.899*** (0.63)
ln(migrant hours)*ln(migrant hours)	-0.292*** (0.079)	0.00199 (0.044)	0.00977 (0.0087)	-0.0127** (0.0054)	0.00113 (0.00092)	0.000368 (0.00032)
ln(native hours)*ln(migrant hours)	0.692*** (0.16)	0.0334 (0.11)	-0.0279 (0.020)	0.0395* (0.022)	0.00329 (0.0039)	0.000150 (0.00062)
ln(capital stock)*ln(migrant hours)	0.0614 (0.051)	-0.0226 (0.027)	0.00646 (0.0053)	0.0166 (0.013)	-0.000313 (0.0023)	-0.000323 (0.00028)
ln(capital stock)*ln(native hours)	-0.217*** (0.060)	-0.100** (0.040)	-0.0998*** (0.029)	-0.253*** (0.027)	-0.202*** (0.043)	-0.119*** (0.035)
ln(native hours)*ln(native hours)	-0.314*** (0.084)	-0.0969 (0.074)	0.0394* (0.021)	0.0788* (0.041)	0.0296 (0.037)	-0.0239 (0.034)
ln(capital stock)*ln(capital stock)	-0.0225 (0.014)	0.103** (0.047)	0.0852** (0.037)	-0.0394 (0.023)	0.0922** (0.036)	0.0629** (0.029)
Constant	-16.62*** (2.88)	-3.509 (4.45)	0.0283** (0.011)	-18.93*** (2.91)	-3.830* (2.10)	0.0150** (0.0058)
Observations	660	660	630	300	300	270
R-squared	0.95	0.80	0.33	0.94	0.84	0.37
Number of NR		30			30	

Robust standard errors in parentheses

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

Table 12 (continued) Results of estimation of Translog production function