# The Economic Impact of Migration – Productivity Analysis for Spain and the UK[1]

Mari Kangasniemi*, Matilde Mas[§], Catherine Robinson* and Lorenzo Serrano[§]

*National Institute of Economic and Social Research, UK[2]

[§]IVIE and University of Valencia, Spain

PRELIMINARY: PLEASE DO NOT CITE OR QUOTE WITHOUT PERMISSION

**ABSTRACT**

As a consequence of increased internationalization in markets over the past 20 years, the movement of labour has also become more prevalent over time. The purpose of this paper is to explore the direct economic consequences of immigration on host nations' productivity performance at a sectoral level. Here 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 starts providing 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 with two approaches: *i)* growth accounting methodology and *ii)* econometric estimation of a production function, in which both methodologies feature migrant labour as a separate labour input. 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.

[1] This research has been funded by the European Commission, Research Directorate General as part of the 6th Framework Programme, Priority 8, *"Policy Support and Anticipating Scientific and Technological Needs"*. We are grateful to the EUKLEMS consortium for helpful comments on our initial findings, presented at the EU KLEMS Conference, Brussels, 15-17th March, 2007. M. Mas and L. Serrano acknowledge the support of the Spanish Minister of Education/FEDER grant SEJ2005-02776

[2] We would also like to thank Peter Loveridge and Juan Carlos Robledo for their research assistance.

## 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. Much of the analysis in the economic literature that considers migration has largely concerned the 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 (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). Many of these and similar studies use regional level data. 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). These studies take into account the demand and supply effects at an aggregate level. In one study of the UK Manacorda et al. 2006 conclude 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 results carry through to sectoral or firm level or occupational labour markets. The effects of migration at the industry level are largely unexplored in the economics literature, as indeed is its impact on performance indicators, such as productivity.

Migration could have a significant impact on economic growth through a number routes:

- It may affect labour market demographics, which will ultimately affect labour participation, activity and employment rates
- Migrants may be more productive than natives since they represent a selected group, especially in the presence of selective immigration policy
- the availability of low skilled migrant labour may contribute to expansion of activities with low value added and productivity, which will 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 2006) or increased knowledge spillovers (Moen 2003)

Given these possible channels through which migration may influence productivity, we wish to explore whether the 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 bots a growth accounting and an econometric approach using a specially constructed industry panel data.

We have chosen to consider the UK and Spain 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 data come 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). This information has been augmented by shares of migrant and native labour (including information on the characteristics of migrant workers) in different industries. The migrant 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)*[3] 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.

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

## 2 Migration in Spain and the UK

Whilst the UK has a long established tradition of immigration, migration to Spain 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 experienced in the Spanish economy. Figure 1 illustrates the strong upturn of immigration in Spain compared to the almost stable profile of 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 dramatically: 10.1% in UK compared to 13.1% in Spain.

[3] 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.

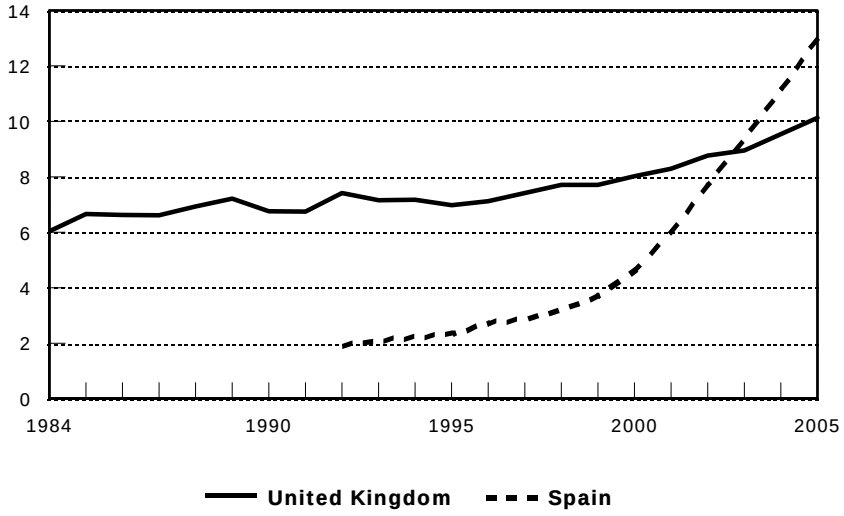


Figure 1 Percentage of migrants in total employment. UK vs. Spain.
Migrants classified according to their country of origin. Source: EPA (INE) and LFS (ONS)

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 |
| **Spain** | | | | | | |
| 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 |
| **United Kingdom** | | | | | | |
| 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).

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[4] 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[5]. 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.

[4] Working age population is defined as 16 years and over.
[5] A second source has been increased participation of women in the labour market

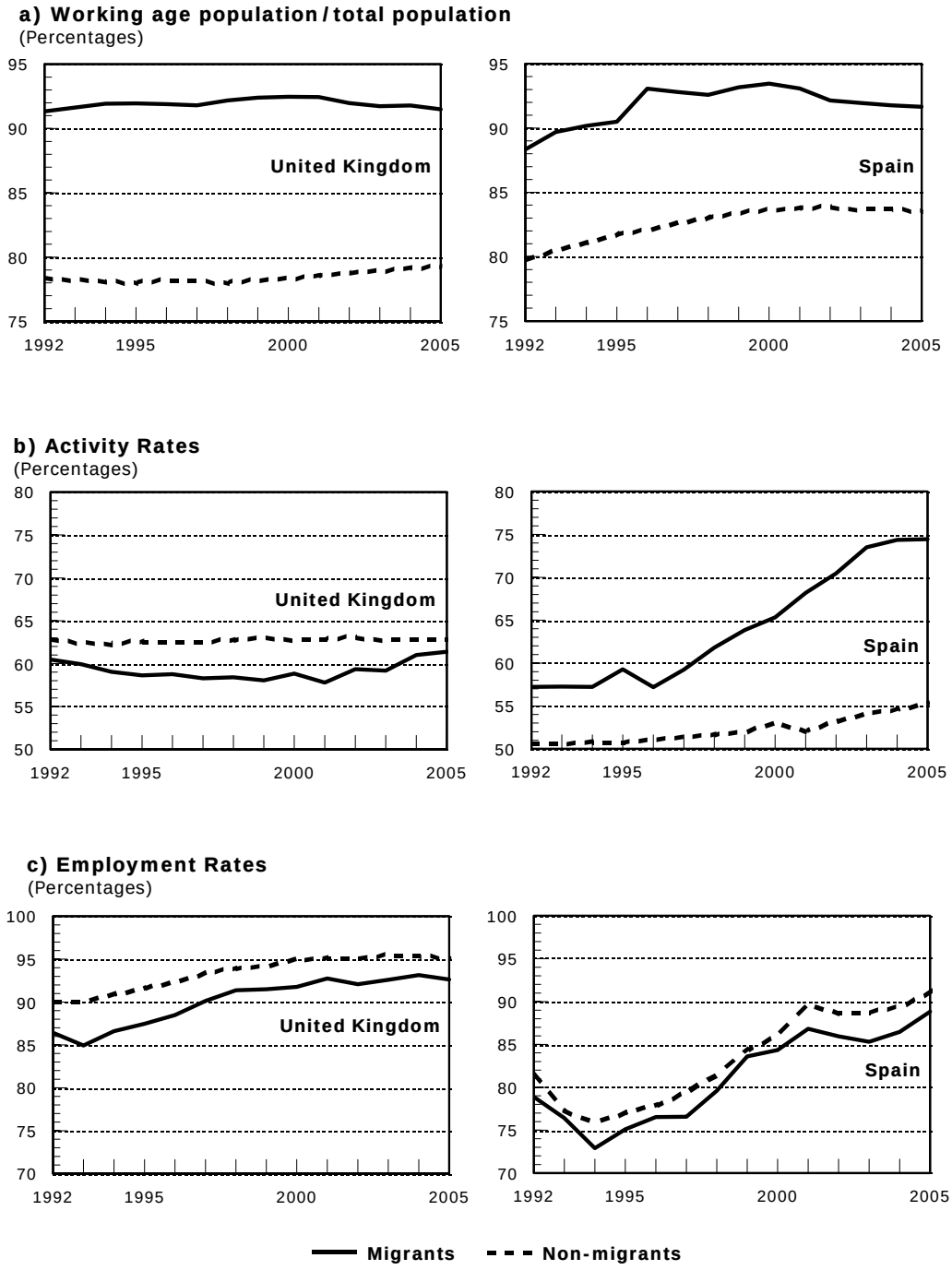


Figure 2. Migrants and non-migrants. UK vs. Spain.

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

Changes in labour market demographics have had consequences on 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]:

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

Equation [1] is, in fact, an identity, where Y stands for Value Added 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. This graph provides a decomposition of *actual* per capita income in three demographic variables and labour productivity. It can be seen that Spanish per capita income growth has been fuelled by demographic changes, especially 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, in Spain – a relative newcomer in terms of migration flows- demographic variables have an important role in economic growth, while in the UK, productivity growth is the driving force.

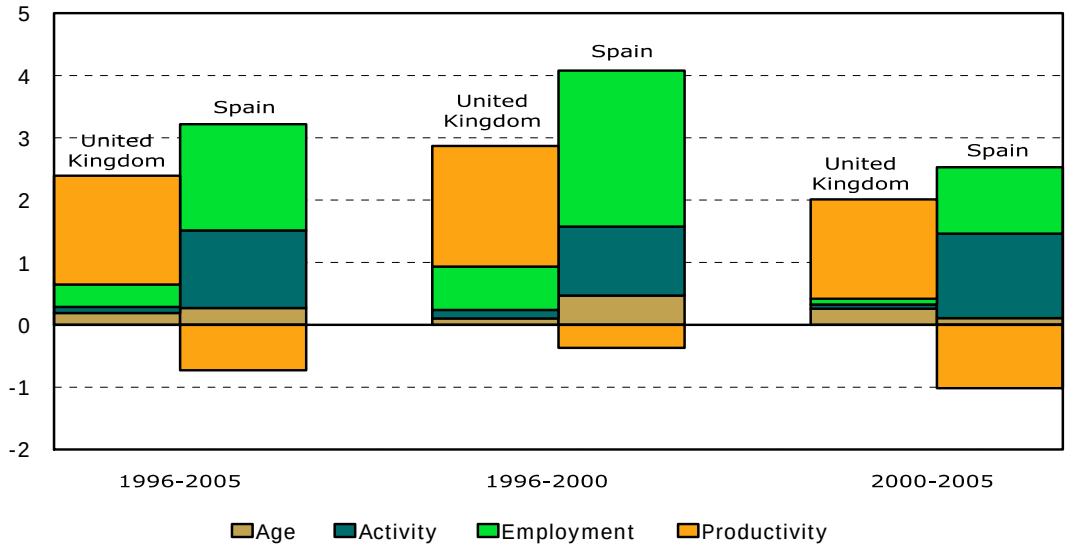


Figure 3 Contributions to per capita value added growth (percentages). Source: EUKLEMS database, March 2008, http://www.euklems.net, EPA (INE) and LFS (ONS) and own calculations.

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[6]. The information for the *actual* economy was presented in figure 3, above. The *virtual* alternative is constructed by substituting, in equation [1], all the demographic variables with those corresponding to the non-migrants group in each country, thus we assume that the demographic characteristics of native workers apply to migrant labour in each country. Notice that by doing so we are computing the impact on GDP per capita growth of the different behaviour in the labour market, *assuming that labour productivity remains unchanged.* Relaxing this assumption will be discussed in the next sections.

Our results of this exercise are presented in Figure 4 where Panel a) shows the contributions to GDP growth of the three demographic variables 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 –*via* demographic variables- particularly compared with the UK, which has a long established tradition of migration. Our results show that if the whole

[6] This approach is a modified version of the statistical model developed by Stockman (1988), Costello (1993) and Marimon and Zilibotti (1998).

of the Spanish population had the same structure –in terms of working age ratio, activity and employment rates- as non-migrants (that is to say, if there were not migrants at all) per capita income growth would have been 0.4 percentage points lower in period 1996-2005, and 0.6 percentage points lower in 2000-2005, largely as a result of higher migrants activity rates. In the case of UK, this assumption would have had only very minor changes, 0.05 percentage points 1996-2005 and 0.07 percentage points in 2000-2005.

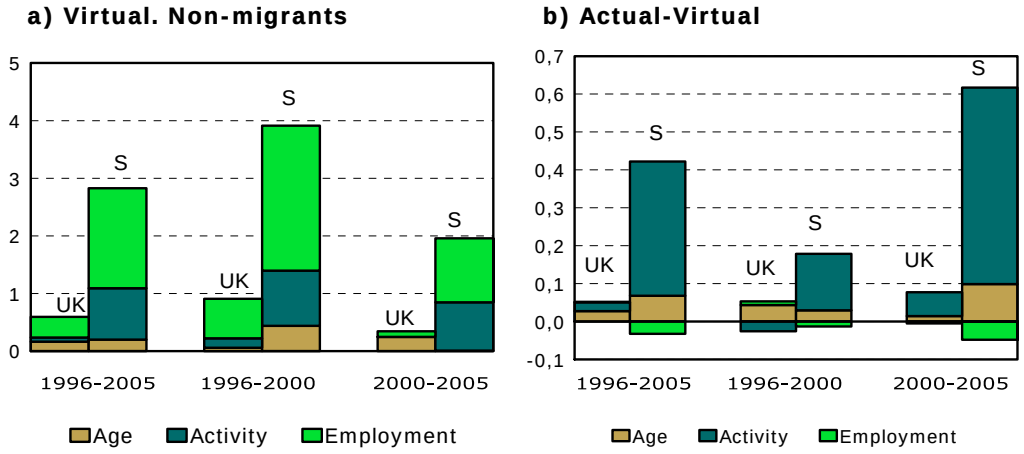


Figure 4. Contributions to per capital value added growth, actual and virtual scenario. Source: EUKLEMS database, March 2008, http://www.euklems.net, EPA (INE) and LFS (ONS) and own calculations.

The next two sections are devoted to analyzing the role played by migration in productivity growth.

## 3 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).

Applying the growth accounting methodology, 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:

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

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 can also obtain the contribution to output growth from the changes in the labour mix (labour quality contribution) from:

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

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:

$$\frac{W_t + W_{t-1}}{2}\left[\ln H_t - \ln H_{t-1}\right] - \frac{W_t + W_{t-1}}{2}\left[\ln H^*_t - \ln H^*_{t-1}\right] \qquad [4]$$

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:

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

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

The complete 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[7]. The GVA growth and the contributions of total labour, ICT capital, Non-ICT Capital and TFP are directly obtainable from EUKLEMS.

| | 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 |
| **Migrants** | | | | | | | | |
| 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

[7] 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)* where the wages data comes from.

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 break the whole period down into subperiods. Still both quantity and quality effects are almost negligible for the period 1987-1996. However, the total contribution for 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 contributions is the quantity effect. 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.

Taken as a whole, we see that the growth contribution of migrants in the UK is quite modest and only begins to be significant from the mid-90s onwards, particularly during the last five years when its size is comparable to the TFP growth.

The case for Spain differs considerably, largely a result of virtually no immigration from abroad to speak of until the late 1990s. In fact, Spain was the origin of a significant migration towards other countries during the 1950s and the 1960s. Therefore the impact of migrants should be 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.

Looking at 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 sheer increase of migrant labour in Spain. This is 0.28% (1996-2000)

and grows to an impressive 1.07% over the 2000-2005 period. For the whole period we estimate an average of 0.72%.

This quantity effect is dampened by low 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. For the whole period 1996-2005 one sixth of the GVA growth in Spain is due to the migrants' contribution and for the 2000-2005 this contribution has increased to account for roughly one third of total growth.

There are naturally 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 eight industrial groups: Agriculture; Manufacturing; Construction; Trade; Hotels and restaurants; Finance, insurance, real state and business services; Transport and communication; and Community, social and personal services.

| | **GVA** | **Migrants** | | |
|---|---|---|---|---|
| **UK 1996-2005** | | **Quantity** | **Quality** | **Total** |
| 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 |
| **UK 2000-2005** | | | | |
| 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 |

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

| SPAIN 1996-2005 | GVA | Migrants | | |
|---|---|---|---|---|
| | | Quantity | Quality | Total |
| 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 |
| **SPAIN 2000-2005** | | | | |
| 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.

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. Hotels and restaurants is, as in the UK, 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. The rest of the industries lie somewhere in between. We notice 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, conversely the quality effect is bigger than in the UK and 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% such as in Construction and Hotels and restaurants, whereas the lowest contribution (Finance) is 0.38%. The increases are very 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.

As explained in a previous section by using equations [3] and [5] we can estimate also the migrants' total contribution to labour productivity growth. The assumption is that migration does not have an effect on TFP growth or on capital accumulation. The results from this approach are shown in Table 4 for the total contribution of migrants to labour productivity after adding the quantity and the quality effects of migrants.

| | 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 |
| **Migrants** | | | | | | | | |
| 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 the 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 the subperiod 2000-2005 the size of the contribution are similar although slightly higher. The negative sign is due to the fact that the positive quality effect is dominated by the quantity effect (i.e. the dampening of the capital deepening).

| | Labour Productivity | Migrants | | |
|---|---|---|---|---|
| **UK 1996-2005** | | **Quantity** | **Quality** | **Total** |
| 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 |
| **UK 2000-2005** | | | | |
| 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 |
| **SPAIN 1996-2005** | | | | |
| 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 |
| **SPAIN 2000-2005** | | | | |
| 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 a poorer performance (Agriculture, Construction and Hotels and restaurants) are characterized by the most negative contributions from migrant workers. Share of migrant labour and productivity seem to be closely 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.

## 4 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 most common form, Cobb Douglas production function. Its log linear form allows for straightforward estimation, defined as:

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

where the coefficients reflect output elasticities of inputs. 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 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 clearly endogenous[8] and that productivity shocks are persistent and inputs may be dependent on the past or current shocks.

In our case there are no obvious "external" instruments for migrant labour input to resolve potential endogeneity. General Method of Moments (GMM) methodology that

[8] For plant level analysis various solutions have been suggested, see for example Olley and Pakes 1996, Levinsohn and Petrin 1996, for an overview see Griliches and Mairesse 1995.

uses a 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.[9]

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). Especially in the case of the UK 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).[10]

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

[9] For both estimations we use Roodman's (2006) xtabond2 procedure in Stata.
[10] 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.

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

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

We are particularly interested in 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 most common measure, the Allen (partial) elasticity of substitution (AES). AES measures the percentage change in the demand for a factors relative to change in the price of the other input given that other factors adjust to their optimal levels.

Unlike in the case of Cobb-Douglas production function, the AES is not constrained to be one in the Translog production function neither does it constrain the elasticity of substitution to be the same for all units. The elasticity of substitution can be calculated as a function of the parameters of the production function. We use industry level 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. Because of the involved formula of the AES[11], it is also difficult to obtain the standard deviation thereof. Thus we will 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.

[11] The exact formula of the AES and its components is presented in e.g. Heyer, Pelgrin and Sylvain 2004.

The composition of migrant labour is likely to be different from that of the native workforce and will develop differently. Thus, we calculate a separate labour composition indices for each group and use them to adjust the labour input for the Translog estimation. Changes in labour composition are calculated at industry level as in equation [3] but instead of migrants and non-migrants, 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 the seven industry level 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, shares by education groups were all that was available and the labour composition index is based on these, rather that 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 these have been applied to the whole period. Information on the levels of labour and capital services were also available[12] 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 to migrant and non-migrant services by using the 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.

[12] Estimates based on EUKLEMS source data.

*Econometric findings*

We first estimated Cobb-Douglas specification presented above[13] by using standard regression methods. Different combinations of measures of input and output were 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)[14]

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 with logarithm of migrant share as an additional regressor for the UK and Spain are presented in table 6.

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.

[13] 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.

[14] Cross industry differences are not meaningful, and produce effectively the same estimates as labour and capital service levels. Capital and labour service indices are also available for non-market industries

| Variable | UK OLS | UK Fixed effects | UK First differences | Spain OLS | Spain Fixed effects | Spain First differences |
|---|---|---|---|---|---|---|
| ln(capital services) | 0.428*** | 0.571*** | 0.328*** | 0.365*** | 0.333*** | 0.531*** |
| | (0.057) | (0.025) | (0.040) | (0.091) | (0.10) | (0.12) |
| ln(labour services) | 0.473*** | -0.00520 | 0.157*** | 0.576*** | 0.333*** | 0.106 |
| | (0.061) | (0.031) | (0.039) | (0.085) | (0.12) | (0.11) |
| ln(migrant share) | 0.0782 | 0.0354 | -0.00401 | -0.0911*** | -0.0113*** | -0.00200 |
| | (0.13) | (0.022) | (0.0093) | (0.029) | (0.0033) | (0.0024) |
| Constant | -1.376** | 0.374** | 0.0164* | -1.960*** | 0.0514 | 0.00580 |
| | (0.60) | (0.18) | (0.0085) | (0.61) | (0.61) | (0.0097) |
| Obs | 572 | 572 | 546 | 156 | 156 | 130 |
| R-squared | 0.92 | 0.76 | 0.32 | 0.92 | 0.53 | 0.26 |

| Variable | UK OLS | UK Fixed effects | UK First differences | Spain OLS | Spain Fixed effects | Spain First differences |
|---|---|---|---|---|---|---|
| ln(capital stock) | 0.402*** | 0.662*** | 0.461*** | 0.413*** | 0.272*** | 0.394*** |
| | (0.039) | (0.029) | (0.052) | (0.054) | (0.077) | (0.11) |
| ln(total hours) | 0.483*** | 0.0534** | 0.135*** | 0.488*** | 0.366*** | 0.275*** |
| | (0.053) | (0.027) | (0.037) | (0.065) | (0.074) | (0.085) |
| ln(migrant share) | 0.0848 | -0.0128 | -0.00900 | -0.0538 | -0.0107*** | -0.131 |
| | (0.16) | (0.021) | (0.18) | (0.033) | (0.0029) | (0.18) |
| Constant | -2.246*** | -2.112*** | 0.0276*** | -2.705*** | -0.308 | 0.00960 |
| | (0.76) | (0.26) | (0.0077) | (0.81) | (0.64) | (0.0086) |
| Obs | 660 | 660 | 630 | 180 | 180 | 150 |
| R-squared | 0.90 | 0.74 | 0.28 | 0.88 | 0.60 | 0.28 |

| Variable | UK Fixed effects | UK First differences | Spain Fixed effects | Spain First differences |
|---|---|---|---|---|
| ln(index of capital services) | 0.513*** | 0.291*** | 0.368*** | 0.494*** |
| | (0.024) | (0.038) | (0.077) | (0.11) |
| ln(index of labour services) | 0.0436 | 0.158*** | 0.247*** | 0.128 |
| | (0.028) | (0.036) | (0.079) | (0.086) |
| ln(migrant share) | 0.0360 | 0.0382 | -0.0106*** | -0.130 |
| | (0.022) | (0.19) | (0.0030) | (0.19) |
| Constant | 2.121*** | 0.0209*** | 1.757*** | 0.00539 |
| | (0.13) | (0.0080) | (0.36) | (0.0088) |
| Obs | 660 | 630 | 180 | 150 |
| R-squared | 0.72 | 0.26 | 0.58 | 0.25 |

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

Table 6. Estimates of Cobb Douglas production function

Our findings suggest that for the UK, migrant labour is generally associated with higher productivity especially 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 adequate to capture the contribution of migrant share if there indeed is any.

For Spain the coefficients of migrant share in OLS, FE and FD specifications are negative (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 which implies that also 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 7[15]. The number of instruments in the UK was very large compared to the number of units which weakens the credibility of estimates (we tried limiting the number of lags used but the estimates were not significantly different) and the instruments did not pass the Sargan test for validity of instruments. The coefficients for labour input are much smaller than in the standard estimations and the coefficients for migrant share did not reveal patterns significantly different from the standard estimations. The large size of the autoregressive coefficient suggests that the data indeed is highly persistent and may have a unit root.

| | UK | | Spain | |
|---|---|---|---|---|
| **Variable** | **Capital and labour services** | **Capital stock and hours** | **Capital and labour services** | **Capital stock and hours** |
| AR coefficient | 0.997*** | 0.998*** | 1.017*** | 1.032*** |
| | (0.002) | (0.002) | 0.007 | 0.006 |
| Capital | 0.366*** | 0.480*** | 0.535* | 0.339*** |
| | (0.041) | (0.049) | 0.280 | 0.101 |
| Labour | 0.125*** | 0.106*** | -0.041 | 0.156* |
| | (0.033) | 0.032 | 0.124 | 0.086 |
| Migrant share | 0.003 | 0.005 | -0.006* | -0.005 |
| | (0.008) | 0.008 | 0.003 | 0.003 |
| Observations | 546 | 600 | 130 | 150 |
| Sargan test p value | 0.000 | 0.000 | 0.001 | 0.000 |

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

Table 7. System GMM estimates of Cobb Douglas production function.

[15] 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.

As for the UK data the GMM estimates for the Spanish data show significant persistence of the data. The capital coefficient is somewhat realistic but the coefficient of labour input are very small in these estimates. The coefficient of migrant share is negative as in the OLS estimations but only significant at 10% level in the service estimation and not significant in hours and stock specification. The instruments, however, 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 improvement to the standard methods.

In the UK 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. Nor is there significant evidence that changes in productivity are related to contemporanous changes in the use of migrant labour. If migrants are hired as a response to productivity shocks this does not appear to occur simultaneously. In Spain on the other hand there is a fairly clear negative link between the use of migrant labour and productivity. This also occurs within industries which seems to imply that a decline in productivity is associated with increasing share of migrant workers.

As pointed out above, the Cobb Douglas specification is limiting in the sense that elasticity of substitution is constrained to one. We estimate a Translog specification (full results in the appendix) and test the hypothesis that the Cobb Douglas specification is correct by testing a hypothesis that all interaction terms are zero. In all specifications this hypothesis is rejected which means that Cobb Douglas is not an adequate description of the relationship between inputs and output.[16]

The coefficients themselves in the Translog specification are not as easily interpreted as in the Cobb Douglas specification. We, however, calculated output elasticities for each input which are presented in the appendix, and elasticities of substitution between migrant and native labour from the existing sample and examine the distribution. We also correlate the elasticities with migrant share (tables 8 and 9).

[16] We calculated GMM estimates also for Translog specification but because test results were unsatisfactory in the same way as in the Cobb Douglas case we will not report them here. These results are available on request.

| | 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 | -3.830 | -5.479 | -8.774 | -0.433 |
| 5% | -0.029 | -0.011 | -0.045 | -0.003 | 0.001 | -0.056 | -0.353 | -0.203 |
| 10% | -0.014 | -0.006 | -0.020 | 0.000 | 0.001 | 0.000 | -0.157 | -0.062 |
| 25% | -0.005 | -0.002 | -0.006 | 0.002 | 0.002 | 0.001 | -0.061 | -0.037 |
| **50%** | -0.002 | 0.000 | -0.002 | 0.004 | 0.009 | 0.002 | -0.016 | -0.008 |
| 75% | 0.000 | 0.000 | 0.000 | 0.009 | 0.020 | 0.006 | -0.001 | -0.002 |
| 90% | 0.007 | 0.004 | 0.000 | 0.019 | 0.038 | 0.010 | 0.000 | -0.001 |
| 95% | 0.038 | 0.013 | 0.000 | 0.066 | 0.071 | 0.041 | 0.001 | -0.001 |
| 99% | 0.165 | 0.092 | 0.370 | 0.125 | 1.873 | 1.015 | 0.002 | 1.935 |

Table 8. Distribution of elasticities of substitution of migrant and native labour

| | **Estimation method** | **Elasticity of substitution migrant/native** | **Output elasticity of migrant labour input** |
|---|---|---|---|
| **UK** | 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* |
| **Spain** | OLS Capital and labour services | 0.1882* | -0.4282* |
| | OLS Capital stock and hours | 0.1854* | -0.3433* |
| | FE Capital and labour services | 0.1761* | 0.3814* |
| | FE Capital stock and hours | -0.1041 | 0.5104* |

Table 9 Correlations between elasticities and migrant share * significant at 95% level

The median output elasticity from the UK data for migrant labour input is positive (except for FE specification of capital stock and unadjusted hours) but there are also implausible negative values in the lowest percentiles, which suggests that coefficient estimates in the stock FE specification are incorrect.

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 in the many of the UK data points but there is clearly a large amount of variation between industries and time periods. Complementarity of 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 be hired instead of native workers.

In Spain data the median output elasticity for migrant labour input is negative for the OLS coefficients. Therefore the endogeneity problem seems to carry over to translog specification when industry specific effects are not controlled for. When we estimate the fixed effects, however, the output elasticities are by and large positive. In this case, the fixed effects estimation seems to provide more realistic coefficient estimates for Spain.

Elasticities of substitution for Spain have medians small in absolute value with higher absolute values at both ends of the distribution as with the UK. For the fixed effects results, which seemed more realistic in the light of output elasticities, the elasticities of substitution are by and large negative with some highly negative values at the lower end of the distribution. Thus it seems that in Spain also migrant and native labour are complements in production in most industries. This conclusion 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 is 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 positively correlated with migrant share for the preferred estimates (OLS for the UK, fixed effects for Spain). This is a realistic as industries which benefit most from using migrant labour are most likely to use them extensively. The correlation of the elasticity of substitution with the migrant share is positive for all estimates except the fixed effects estimation for unadjusted hours and capital stock (for Spain this correlation is not significant). 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 in both countries.

## 5 Conclusions

We have analysed the impact of migrant labour input on productivity in the UK and Spain by using growth accounting and econometric methods. 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 in the 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 significant changes in the most recent period. 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 has played a major role in the economic performance of Spain. It has fostered GVA growth during the last years (contributing to the Spanish growth miracle) but, at the same time, it explains a great part of the poor evolution of labour productivity during those years. 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 from an economic growth point of view.

We have estimated Cobb-Douglas production function by using migrant share as an additional regressor. The results indicate that in Spain the use of migrant labour is clearly linked with lower productivity, whereas in the UK it is 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 of estimating the relationship between inputs and output which does not constrain the elasticity of substitution between inputs to be one or to be equal in all units of observation. In levels specifications the Spanish data reveals a negative output elasticity of migrants which is counterintuitive and probably due to low productivity levels in industries that use migrants extensively, so more flexible functional form does not solve the endogeneity problem for levels estimation.

The elasticity of substitution between migrant and native labour has a median close to zero in both countries. The preferred estimates suggest that in 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. However, better estimation methods that control for endogeneity would have to be used to explore whether for example changes in productivity lead to increased use of migrant labour.

**References**


Angrist, Joshua & Kugler, Adriana, 2003. "Protective or Counter-Productive? Labor Market Institutions and the Effect of Immigrations on EU Natives", Economic Journal, 113, pp. F302-F331.

Blackorby, Charles and R. Robert Russell, 1989. "Will the Real Elasticity of Substitution Please Stand Up? (A Comparison of the Allen/Uzawa and Morishima Elasticities)." The American Economic Review, Vol. 79, No. 4 (Sep., 1989), pp. 882-888.

Blundell, Richard & Bond, Stephen R, 2000. "GMM Estimation with Persistent Panel Data: An Application to Production Functions." Econometric Reviews. 2000; 19(3): 321-40.

Borjas, George, 1999. "The Economic Analysis of Immigration," in Handbook of Labor Economics, Volume 3A, edited by Orley Ashenfelter and David Card, North-Holland, 1999, pp. 1697-1760.

Borjas, George, 2003. "The Labour Demand Cure IS Downwards Sloping: Re-examining the Impact of Immigration on the Labour Market," Quarterly Journal of Economics, Vol 188, pp. 1335-1374.

Card, David, 1990. "The Impact of the Mariel Boatlift on the Miami Labor Market." Industrial and Labor Relations Review, 43(2), pp. 245-57.

Card, David, 2001. "Immigrant Inflows, Native Outflows, and the Local Labor Market Impacts of Higher Immigration." Journal of Labor Economics, 19(1), pp. 22-64.

Card, David & DiNardo, John, 2000. "Do Immigrant Inflows Lead to Native Outflows?", American Economic Review, 90(2), pp. 360-67.

Card, David, 2005. "Is the New Immigration Really So Bad?" Economic Journal, Vol 115, pp. F300-F323.

Carrasco, R., Jimeno, J.F. and C. Ortega, 2007: El efecto de la inmigración sobre las condiciones de los trabajadores autóctonos en el mercado de trabajo. Evidencia para España in Dolado, J.J. and P. Vázquez, eds.

Christensen, Laurits R, Jorgenson, Dale W & Lau, Lawrence J, 1973. "Transcendental Logarithmic Production Frontiers", Review of Economics and Statistics, 55(1), pp. 28-45.

Costello, D., 1993, "A cross-country, cross-industry comparison of productivity growth. *Journal of Political Economy* 101 (2), 207-222

Dolado, J.J. and P. Vázquez, eds., 2007, Ensayos sobre los efectos económicos de la inmigración en España, Fundación de Estudios de Economía Aplicada, FEDEA, Madrid.

Friedberg, Rachel M & Hunt, Jennifer, 1995. "The Impact of Immigrants on Host Country Wages, Employment and Growth," Journal of Economic Perspectives, American Economic Association, vol. 9(2), pages 23-44, Spring.

Griliches Zvi & Jacques Mairesse, 1995. "Production Functions: The Search for Identification," NBER Working Papers 5067, National Bureau of Economic Research, Inc.

Grossman, Jean Baldwin, 1982. "The Substitutability of Natives and Immigrants in Production." Review of Economics and Statistics. 64(4), pp. 596-603.

Hamermesh, Daniel S & Grant, James, 1979. "Econometric studies of labor-labor substitution and their implications for policy." Journal of Human Resources, XIV(4), pp. 518–542.

Heyer Eric & Florian Pelgrin & Arnaud Sylvain, 2004. "Translog ou Cobb-Douglas? Le rôle des durées d'utilisation des facteurs," Working Papers 04-19, Bank of Canada.

Hitt Lorin M. and Eli M. Snir "The Role of Information Technology in Modern Production: Complement or Substitute to Other Inputs," *Mimeo*

Jorgenson, Dale W, Gollop, Frank M & Fraumeni, Barbara M, 1987. "Productivity and U.S. economic growth" Harvard Economic Studies, vol. 159, Cambridge, Mass.: Harvard University Press, 1987; 567.

Levinsohn James and Amil Petrin, "Estimating Production Functions Using Inputs to Control for Unobservables," April 2003, pp. 317-342. *Review of Economic Studies* .

Manacorda, M, Manning, Alan & Wadsworth, Jonathan, 2006. "The Impact of Immigration on the Structure of Male Wages: Theory and Evidence from Britain" Centre for Economic Performance Discussion Papers 754.

Marimon, R., and Zilibotti, F., 1998, "`Actual´ versus `virtual´ employment in Europe. Is Spain different?" *European Economic Review* 42, 123-153.

Mattoo, Aaditya, Maskus, Keith E & Chellaraj, Gnanaraj, 2005. "The contribution of skilled immigration and international graduate students to U.S. innovation." The World Bank, Policy Research Working Paper Series: 3588.

Millar, Jane & John Salt , 2006 Foreign labour in the UK: current patterns and trends Labour Market Trends, vol 114, no 10, percentage point 335-355.

Moen, Jarle, 2005. "Is Mobility of Technical Personnel a Source of R&D Spillovers?" Journal of Labor Economics, 23(1), pp. 81-114.

Office for National Statistics. Social and Vital Statistics Division and Northern Ireland Statistics and Research Agency. Central Survey Unit, *Quarterly Labour Force Survey files, 1992-2005* [computer files]. Colchester, Essex: UK Data Archive [distributor].

Office of Population Censuses and Surveys. Social Survey Division, *Annual Labour Force Survey files, 1984-1991* [computer files]. Colchester, Essex: UK Data Archive[distributor].

Olley G. Steven and Ariel Pakes, 1996. "The Dynamics of Productivity in the Telecommunications Equipment Industry" *Econometrica*, Vol. 64, No. 6 (Nov., 1996), pp. 1263-1297.

Ottaviano, Gianmarco I.P. & Peri, Giovanni, 2006. "Rethinking the Effects of Immigration on Wages," NBER Working Papers 12497.

Roodman, David, 2006. "How to Do xtabond2: An Introduction to "Difference" and "System" GMM in Stata," Working Papers 103, Center for Global Development.

Stockman, A., 1988, "Sectoral and national aggregate disturbances to industrial output in seven European countries", *Journal of Monetary Economics* 21, 387-409.

## APPENDIX

| | 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** |
| Percentile | **Output elasticity of migrant labour** | | | | | | | |
| 1% | -0.37552 | -0.56139 | -0.06557 | -0.14316 | -0.18102 | -0.18358 | -0.01471 | -0.04518 |
| 5% | -0.28089 | -0.39532 | 0.00496 | -0.12966 | -0.16308 | -0.16362 | 0.00477 | 0.00951 |
| 10% | -0.16344 | -0.25395 | 0.02716 | -0.11062 | -0.14072 | -0.15883 | 0.00846 | 0.01311 |
| 25% | 0.05944 | -0.02557 | 0.05875 | -0.04885 | -0.11720 | -0.14006 | 0.01230 | 0.01883 |
| **50%** | **0.14457** | **0.09817** | **0.09126** | **-0.03410** | **-0.10044** | **-0.12662** | **0.01733** | **0.02539** |
| 75% | 0.23400 | 0.23443 | 0.12291 | -0.01602 | -0.07908 | -0.11520 | 0.02155 | 0.03229 |
| 90% | 0.37454 | 0.37735 | 0.15786 | 0.00462 | -0.06517 | -0.05652 | 0.02361 | 0.03768 |
| 95% | 0.45272 | 0.51183 | 0.17473 | 0.01545 | -0.05261 | -0.02642 | 0.03136 | 0.04150 |
| 99% | 0.69746 | 0.83500 | 0.19455 | 0.03744 | 0.07562 | 0.01593 | 0.03592 | 0.05538 |
| | **Output elasticity of capital** | | | | | | | |
| 1% | 0.07178 | 0.04010 | -0.69722 | 0.32737 | -0.25432 | -0.24408 | -0.06926 | -0.05126 |
| 5% | 0.08897 | 0.10473 | -0.55053 | 0.41059 | -0.20404 | -0.12849 | -0.06572 | -0.03262 |
| 10% | 0.18335 | 0.13528 | -0.48759 | 0.48155 | -0.16777 | -0.05681 | -0.04012 | 0.00710 |
| 25% | 0.28210 | 0.19325 | -0.41396 | 0.59103 | 0.02469 | 0.10000 | 0.04859 | 0.06293 |
| **50%** | **0.35930** | **0.34436** | **-0.36266** | **0.69083** | **0.33170** | **0.34167** | **0.17868** | **0.15379** |
| 75% | 0.45530 | 0.44975 | -0.30278 | 0.82344 | 0.52019 | 0.57794 | 0.24984 | 0.24364 |
| 90% | 0.53620 | 0.57552 | -0.16455 | 0.98588 | 0.73140 | 0.77351 | 0.33580 | 0.34934 |
| 95% | 0.65289 | 0.64488 | -0.03974 | 1.18384 | 0.97237 | 1.06814 | 0.47187 | 0.43672 |
| 99% | 0.82603 | 0.87365 | 0.03525 | 1.49494 | 1.67772 | 1.46831 | 0.69576 | 0.61918 |
| | **Output elasticity of native labour** | | | | | | | |
| 1% | -0.37971 | -0.48709 | 0.32750 | -0.32928 | -0.40557 | -0.57421 | -0.27520 | -0.01987 |
| 5% | -0.22462 | -0.27496 | 0.35248 | -0.25059 | 0.10770 | 0.07265 | -0.15929 | 0.27505 |
| 10% | -0.07380 | -0.12797 | 0.37939 | -0.21203 | 0.15755 | 0.26963 | -0.11430 | 0.36767 |
| 25% | 0.27046 | 0.27436 | 0.48179 | -0.12643 | 0.63295 | 0.57825 | 0.04806 | 0.54350 |
| **50%** | **0.37537** | **0.43889** | **0.59054** | **0.06169** | **0.73783** | **0.71227** | **0.09221** | **0.62826** |
| 75% | 0.49744 | 0.59829 | 0.72477 | 0.17300 | 0.90407 | 0.81986 | 0.13999 | 0.70620 |
| 90% | 0.79455 | 0.83289 | 0.82387 | 0.37180 | 0.96521 | 0.91831 | 0.20637 | 0.75671 |
| 95% | 0.95383 | 1.09815 | 0.87789 | 0.49989 | 1.02270 | 0.94218 | 0.23043 | 0.77619 |
| 99% | 1.01791 | 1.24627 | 0.93672 | 0.67733 | 1.03165 | 0.99987 | 0.25258 | 0.80279 |

Table 10. Distribution of output elasticities

| | UK | | | Spain | | |
|---|---|---|---|---|---|---|
| | **OLS** | **Fixed effects** | **First differences** | **OLS** | **Fixed effects** | **First differences** |
| ln(capital services) | 1.398*** | -0.218 | -0.416 | 2.588*** | 1.028* | 0.827 |
| | (0.46) | (0.17) | (0.43) | (0.51) | (0.59) | (0.73) |
| ln(migrant labour services) | -2.073*** | -0.376** | 0.0716 | -0.221 | -0.0284 | 0.00996 |
| | (0.36) | (0.19) | (0.081) | (0.13) | (0.040) | (0.015) |
| ln(native labour services) | 3.139*** | 2.121*** | 0.659** | 1.638*** | 0.779 | 0.919 |
| | (0.37) | (0.26) | (0.31) | (0.52) | (0.62) | (0.67) |
| ln(migrant labour services)*ln(migrant labour services) | -0.216*** | -0.0320* | 0.0153** | -0.0128*** | 0.00253 | 0.000945 |
| | (0.045) | (0.019) | (0.0068) | (0.0038) | (0.0020) | (0.0016) |
| ln(native labour services)*ln(migrant labour services) | 0.528*** | 0.0830** | -0.0399** | 0.0591* | -0.00424 | 0.00122 |
| | (0.096) | (0.041) | (0.016) | (0.030) | (0.014) | (0.0097) |
| ln(capital services)*ln(migrant labour services) | 0.0572 | 0.00815 | 0.00990 | -0.0201 | 0.00790 | -0.000865 |
| | (0.051) | (0.020) | (0.0071) | (0.023) | (0.012) | (0.0066) |
| ln(capital services)*ln(native labour services) | -0.227*** | -0.168*** | 0.0678*** | -0.258*** | -0.153** | 0.0163 |
| | (0.063) | (0.019) | (0.018) | (0.077) | (0.073) | (0.091) |
| ln(native labour services)*ln(native labour services) | -0.223*** | -0.0690** | -0.141*** | 0.0880 | 0.0952 | -0.0963 |
| | (0.062) | (0.028) | (0.031) | (0.057) | (0.074) | (0.095) |
| ln(capital services)*ln(capital services) | 0.0100 | 0.107*** | 0.0957*** | -0.0446 | 0.00183 | 0.0119 |
| | (0.026) | (0.0092) | (0.034) | (0.038) | (0.043) | (0.039) |
| Constant | -9.827*** | -2.779*** | 0.0196* | -13.56*** | -4.321 | 0.00241 |
| | (2.18) | (0.91) | (0.011) | (2.19) | (3.05) | (0.0094) |
| Observations | 572 | 572 | 546 | 156 | 156 | 130 |
| R-squared | 0.96 | 0.85 | 0.39 | 0.96 | 0.65 | 0.33 |
| Number of NR | | 26 | | | 26 | |

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 11 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*** | -0.581*** | -0.599 | 3.074*** | 0.831 | 0.627 |
| | (0.46) | (0.22) | (0.68) | (0.68) | (0.62) | (0.79) |
| ln(migrant hours) | -2.855*** | -0.0547 | 0.0499 | -0.449** | -0.0395 | 0.00244 |
| | (0.62) | (0.21) | (0.094) | (0.20) | (0.041) | (0.015) |
| ln(native hours) | 4.045*** | 2.260*** | 0.753 | 2.263*** | 1.061* | 1.218 |
| | (0.65) | (0.28) | (0.45) | (0.50) | (0.60) | (0.83) |
| ln(migrant hours)*ln(migrant hours) | -0.292*** | 0.00199 | 0.00977 | -0.00787 | 0.00256 | 0.00160 |
| | (0.079) | (0.021) | (0.0087) | (0.0054) | (0.0016) | (0.0013) |
| ln(native hours)*ln(migrant hours) | 0.692*** | 0.0334 | -0.0279 | 0.0106 | -0.00359 | -0.00308 |
| | (0.16) | (0.045) | (0.020) | (0.045) | (0.010) | (0.0073) |
| ln(capital stock)*ln(migrant hours) | 0.0614 | -0.0226 | 0.00646 | 0.0300 | 0.00704 | 0.00230 |
| | (0.051) | (0.016) | (0.0053) | (0.036) | (0.0085) | (0.0049) |
| ln(native hours)*ln(native hours) | -0.314*** | -0.0969*** | 0.0394* | 0.106* | 0.0748* | 0.00739 |
| | (0.084) | (0.028) | (0.021) | (0.057) | (0.043) | (0.053) |
| ln(capital stock)*ln(native hours) | -0.217*** | -0.100*** | -0.0998*** | -0.291*** | -0.136*** | -0.0940** |
| | (0.060) | (0.018) | (0.029) | (0.048) | (0.035) | (0.040) |
| ln(capital stock)*ln(capital stock) | -0.0225 | 0.103*** | 0.0852** | -0.0465 | 0.00868 | 0.0181 |
| | (0.014) | (0.011) | (0.037) | (0.028) | (0.035) | (0.042) |
| Constant | -16.62*** | -3.509** | 0.0283** | -21.18*** | -5.537 | 0.00703 |
| | (2.88) | (1.40) | (0.011) | (3.59) | (3.85) | (0.0071) |
| Observations | 660 | 660 | 630 | 180 | 180 | 150 |
| R-squared | 0.95 | 0.80 | 0.33 | 0.94 | 0.69 | 0.33 |
| Number of NR | | 30 | | | 30 | |

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 11 (continued) Results of estimation of Translog production function