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## Abstract

Increased internationalization over the past twenty years has meant that labor has become increasingly mobile, and while employment and earnings effects have been extensively analyzed in host and source nations, the implications for firm and industry performance have been largely ignored. This working 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 United Kingdom (UK). While the UK has traditionally had a substantial inflow of migration, for Spain, the phenomenon is much more recent. The working paper first 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: 1) growth accounting methodology and 2) 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 labor.

## Key words

Migration, productivity, industries.

## Resumen

Los últimos veinte años se han caracterizado por el incremento de la movilidad del factor trabajo entre países. Los efectos sobre el empleo y los salarios en los países de origen y destino de los flujos migratorios han sido ampliamente analizados, pero las implicaciones en la empresa o rama de actividad han sido menos estudiadas. Este documento de trabajo aborda el impacto de la inmigración en la productividad a nivel sectorial en los países receptores. Para ello consideramos dos países europeos con experiencias muy distintas en este ámbito, España y el Reino Unido. El Reino Unido ha sido tradicionalmente receptor de una inmigración sustancial, mientras que en España el fenómeno es muy reciente. El análisis contempla, en primer lugar, el papel jugado por la inmigración en la evolución de la renta per cápita, poniendo énfasis en la importancia de los aspectos demográficos. A continuación se analiza el efecto en la productividad mediante dos procedimientos: 1) la metodología de la contabilidad del crecimiento, y 2) la estimación de las funciones de producción. Los resultados indican que los efectos de la inmigración han sido muy distintos en cada país. Los trabajadores inmigrantes son más productivos que los nacionales en el Reino Unido, pero en España sucede lo contrario. Esto puede deberse, en parte, a diferencias en las políticas de inmigración, especialmente en lo relativo a la cualificación requerida del inmigrante para permitir su entrada, pero también a la distinta capacidad del país receptor para *absorber* inmigrantes del exterior.

## Palabras clave

Inmigración, productividad, ramas de actividad.

***The Economic Impact of Migration:***
***Productivity Analysis for Spain and the United Kingdom***


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*C O N T E N T S*

# 1. Introduction

In an era of global labor 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 largely focusses on wage and employment effects on native labor. In many of these studies, micro data is 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 and Hunt, 1995; Borjas, 1999; for US studies see, e.g., Card, 1990, 2001 and 2005; Card and DiNardo, 2000; Borjas, 2003, and for evidence on Europe, see Angrist and Kugler, 2003; Dolado and Vázquez, 2007). Similarly, there is work on migrants' instantaneous impact on wage distribution and the complementarity or substitutability of migrants and natives in the total economy (Grossman, 1982; Manacorda, Manning and Wadsworth, 2006; Ottaviano and Giovanni, 2006). Bauer and Kunze (2004) study the issue using firm level analysis and conclude that most firms' workers from the European Union (EU) countries are used to complement domestic high skilled labor, but non-EU migrants are hired because of shortage of appropriate high-skilled labor. In a study of the United Kingdom (UK), Manacorda, Manning and Wadsworth (2006) find that migrants and natives are imperfect substitutes. A similar result is obtained by Carrasco, Jimeno and Ortega (2007) and Amuedo-Dorantes and De la Rica (2008), for the Spanish case. It remains, however, uncertain whether these aggregated findings carry through to sectoral or firm level or to occupational labor 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 of channels, which are largely dependent on the characteristics of the migrants:

- Labor market demographics may change, which will ultimately affect labor 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 labor 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 or influence the adoption of technology (Lewis, 2005).
— Migrants may influence total factor productivity (TFP) growth through their contribution to innovation (Mattoo, Maskus and Chellaraj, 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 exist 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 labor? To what extent can we control for differences in labor composition between migrant and native labor? 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. Using both approaches allows us to consider how far the findings are dependent on the various restrictive assumptions, highlighting the strengths and weaknesses of each methodology. The growth accounting approach enables us to look at the impact by sector more clearly than does the industry panel approach. On the other hand, the econometric approach is less dependent on the assumptions of perfect competition and constant returns to scale and allows exploring the impact of additional regressors and conducting rigorous statistical tests of the findings.

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 working paper is organized as follows: Section 2 briefly outlines the data sources used in this analysis. Section 3 presents an overview of re-

cent 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

OUR main data source is the EU KLEMS database, which 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) [1]. This dataset was augmented with shares of migrant and native labor (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 United Kingdom (UK) and the *Encuesta de Población Activa (EPA)* for Spain.

There are a multitude of problems in measuring the number of migrants, which means that no data source for any country is likely to capture all inward migration. Migrants are not always long-term, indeed increasingly, migration from Eastern Europe is observed as being short-term. Other problems related to capturing the true impact of migration stem substantially from problems measuring illegal entry. Generally this is thought to be a larger problem in Spain than it is in the UK, given its geographical features and location, and, indeed, Spain has in the past held *amnesties* for illegal immigrants. In addition to problems with head counts, there are also problems of comparability of educational standards when classifying migrants on the basis of their skills. It has been observed that migrants often enter the labor force in a lower skilled occupation than they might otherwise consider, in part a feature of any language problems they may have. Our analysis is based on similar datasets in Spain and the UK, of legally registered individuals—it is hoped therefore that any limitations of the data will be relatively consistent across the two countries.

The LFS [2] records detailed characteristics of individuals, including employment and migrant status [3], education and skills, wages and various

1. Further information on the harmonization and construction of these data is available at http://www.euklems.net.

2. The access to the LFS micro data 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.

3. Identified by the *country of origin* variable.

measures of job training, which can be used as individual records or summarized by industry. For the UK, we use the LFS to calculate shares of migrant labor in each industry for 1984-2005. For Spain, the information for the number of migrants, as well as their characteristics, is from the EPA for the period of 1996-2005. These shares are applied to the number of hours per industry from the EU KLEMS database in order to obtain migrant and native labor input. The data on the relative wages of migrants and nationals for Spain are 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.

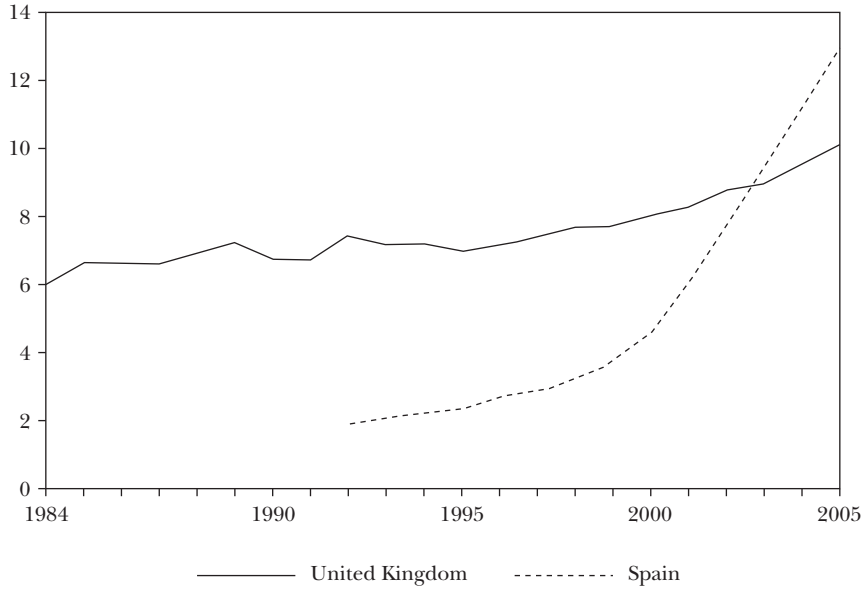
# 3. Migration in Spain and the United Kingdom

WHILE the United Kingdom (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 enormous changes, both politically and economically. Traditionally what little migration there was into Spain came largely from Northern Europe, particularly from Britain. However since the late nineties, the number of migrants from developing nations has increased dramatically.

While 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), Eastern European migration has risen partly due to the expansion of the European Union (EU) in May 2004, well documented in the media. Longer term trends in both emigration and immigration are 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 labor market" (Salt and Millar, 2006: 342). 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. Graph 3.1 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.

**GRAPH 3.1: Migrants in total employment. UK versus Spain**
(percentages)




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

Such a marked increase has affected population and employment growth (table 3.1) and, consequently, per capita income and productivity. Of the total population growth in Spain during the 1996-2005 period (1.2% p.a.), migrants contributed 1 percentage point, but in terms of employment growth their contribution was even higher (1.7 percentage points of the 4.5% employment growth can be attributed to migrants), although their share is smaller. 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, 1996-2005). Despite the modesty of employment and population growth in the UK, it should be noted that the contribution of migrant labor was larger than that of natives.

In both countries, the demographics of the labor market have also been altered by immigration. Changes in three key variables are shown in graph 3.2. Panel *a)* shows the proportion of working age in the total population of migrants (and nonmigrants). In both countries, the ratio of working-age population to total population [4] is higher for migrants than for natives.

4. Working-age population is defined as 16 years and older.

**TABLE 3.1: Contributions to population and employment growth migrants and nonmigrants**

| | 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 |
| Nonmigrants | 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 |
| Nonmigrants | –0.03 | 0.06 | –0.10 | 0.51 | 0.89 | 0.21 |

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

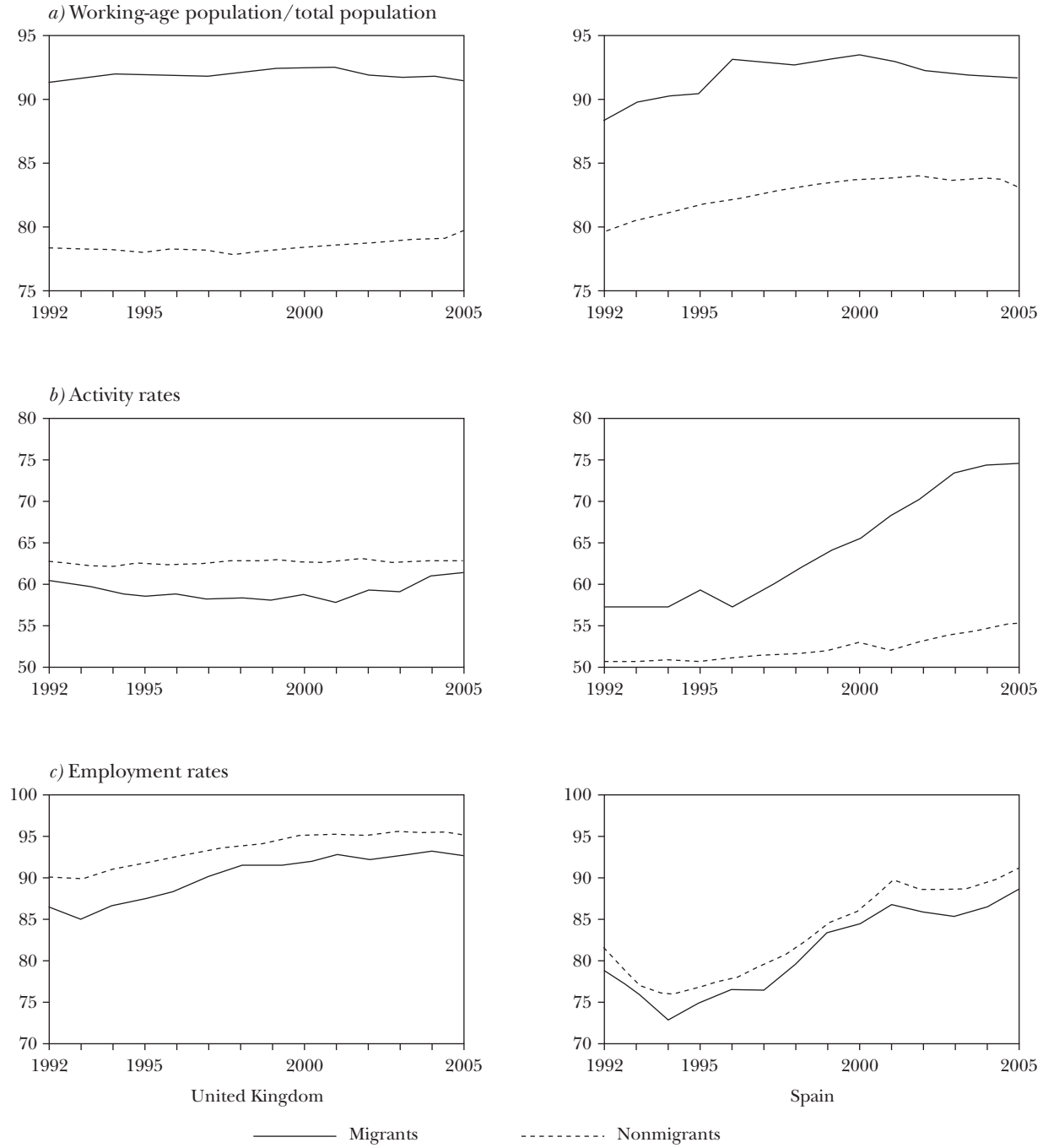
This is especially true for the UK, where the difference between migrants and nonmigrants is more than ten p.p. higher.

The influence of immigration on 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]. In the most recent years, the difference between migrants and nonmigrants in this variable is 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 nonmigrants. Finally panel *c)* shows that 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 was accompanied by a more than noticeable drop in the unemployment rate not observed in the UK.

These changes to labor market demographics alone are likely to have affected per capita income and labor productivity. Here we provide some insight as to its impact on per capita income, while the next two sections concentrate on changes in labor productivity as a result of migrant labor using two complementary methodologies.

5. A second source is the increased participation of women in the labor market.

**GRAPH 3.2: Migrants and nonmigrants. UK versus Spain**
(percentages)



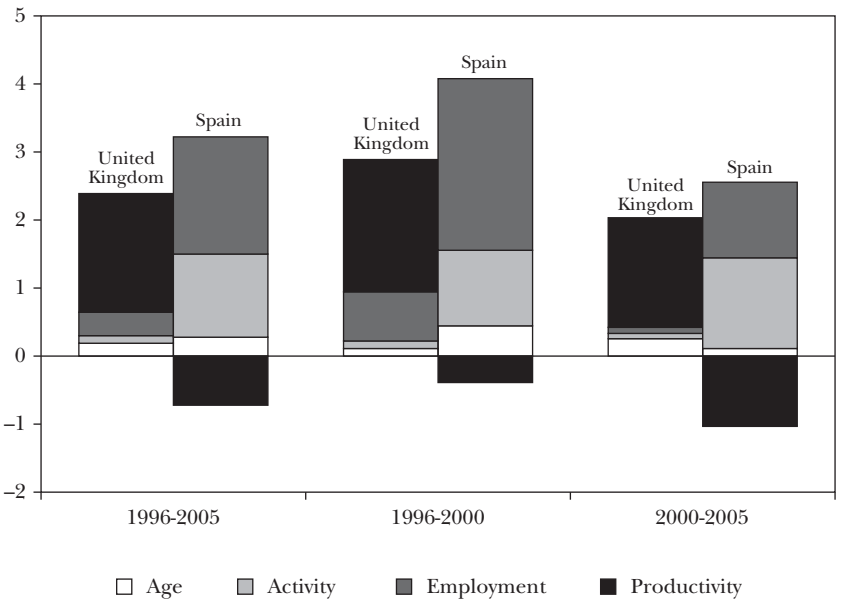

*Note:* Migrants classified according to their country of origin.
*Source:* EPA (INE) and LFS (ONS).

The demographic impact of migrants on per capita income may be analysed by considering firstly the gross value added (GVA) per capita decomposed into its four components (3.1):

$$\underbrace{\frac{Y}{N}}_{GDPpc} = \underbrace{\underbrace{\frac{WAP}{N}}_{age} \cdot \underbrace{\frac{AP}{WAP}}_{activity} \cdot \underbrace{\frac{L}{AP}}_{employment}}_{demography} \cdot \underbrace{\frac{Y}{L}}_{productivity} \cdot \qquad (3.1)$$

Equation (3.1) 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 graph 3.3. The graph shows a decomposition of *actual* per capita income in three demographic variables (age, activity and employment) and labor productivity. Spanish per capita income growth is 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 labor productivity is negative. Conversely UK per capita income growth is barely affected by demographic changes, where we see an increase in the employment rate being the only significant

**GRAPH 3.3: Contributions to per capita value added growth**
(percentages)




*Source:* EU KLEMS database, March 2008, http://www.euklems.net, EPA (INE) and LFS (ONS) and own calculations.

influence. The main source of UK per capita income growth is labor productivity. Thus the demographic forces have the most important role in per capita income growth in Spain [6], while in the UK productivity growth is the driving force.

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[7]. The information for the *actual* economy is presented in graph 3.3. The *virtual* alternative is constructed by assuming that all the demographic characteristics of those in the nonmigrant group in each country apply to migrant labor in each country. With this information we can compute the impact on GDP per capita growth of the different behavior in the labor market, *assuming that labor productivity remains unchanged.*

In graph 3.4, panel *a)* shows the contributions to GDP growth from 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 its impact on the demography of the workforce compared with the UK, which has a long established tradition of migration. Our results show that if the whole of the Spanish population had had the same structure in terms of working age ratio, activity and employment rates (that is to say, if the increased labor market participation had exhibited exactly the same characteristics as the existing native population), per capita income growth would have been 0.4 percentage points lower in 1996-2005, and 0.6 percentage points lower in 2000-2005 [8], 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.

Thus our findings suggest, other things being equal, that migrant labor (because of its higher activity rates) increased per capita income in Spain noticeably, but this is barely true for the UK. They assume that productivity of migrant labor exactly matches that of native workers. There are a number of reasons why we would not expect this to be the case. There

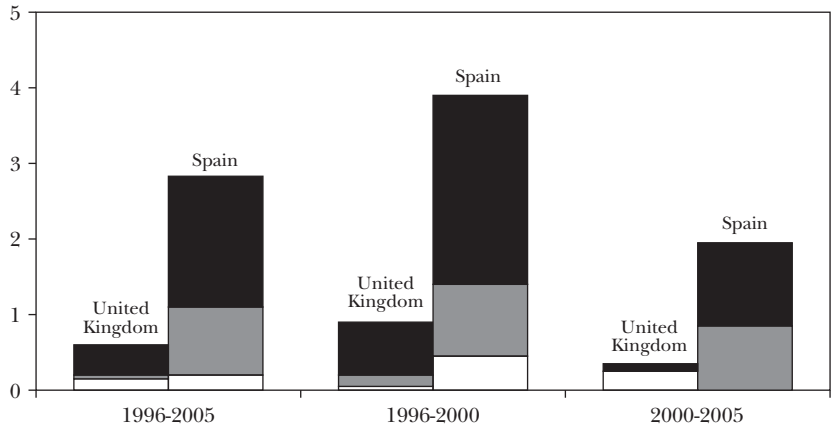
6. A similar result is obtained by Conde-Ruiz, García and Navarro (2008) using a similar accounting decomposition but aggregating our *age* and *activity* variables in one called *demographic factor*. Amuedo-Dorantes and De la Rica (2008) follow the immigration surplus approach concluding that at the national level, the immigration surplus amounts to approximately 0.02% of GDP.

7. This approach is a modified version of the statistical model developed by Stockman (1988), Costello (1993) and Marimon and Zilibotti (1998) and departs from the approach followed by Dolado and Vázquez (2007) chapter 1 and Conde-Ruiz, García and Navarro (2008).

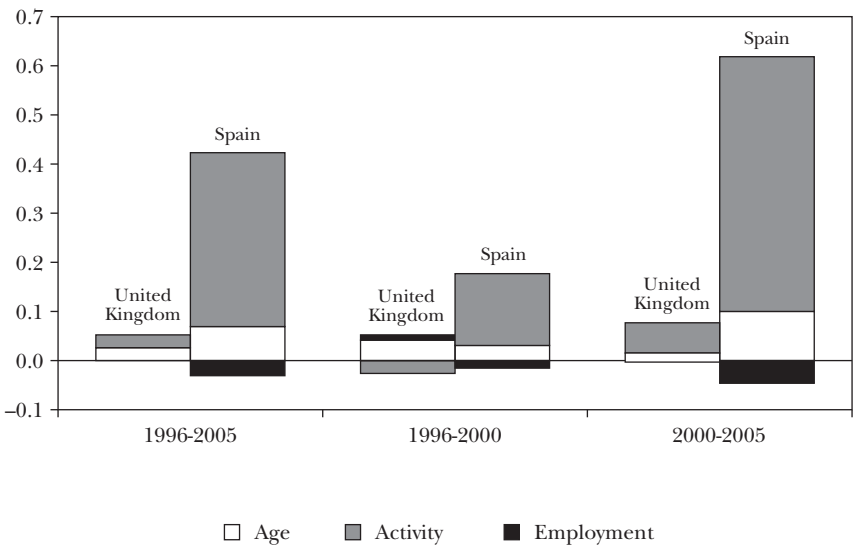
8. According to the estimates by Conde-Ruiz, García and Navarro (2008), the impact of migrants demographic factors on per capita income growth would have been 0,4 percentage points in 2000-2006.

**GRAPH 3.4: Contributions to per capita value added growth, actual and virtual scenarios**
(percentages)

*a)* Virtual. Nonmigrants




*b)* Actual-Virtual




*Source:* EU KLEMS database, March 2008, http://www.euklems.net, EPA (INE) and LFS (ONS) and own calculations.

are likely to be language and cultural differences and different standards in education and training experiences compared with those of native workers. Such factors are likely to affect how migrant workers interact with other factors of production, such as technology and other less tangible inputs, such as organizational systems, R & D, etc. In addition, from the perspective of host governments, selective entry policies should also be designed to maximize the benefit from additional foreign workers.

# 4. Growth Accounting Estimation of 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. The total factor productivity (TFP) is considered to be what is left unexplained, but cost shares or output elasticities are determined flexibly based on the data rather than constraining them 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 (labor quantity contribution) as:

$$\frac{W_t + W_{t-1}}{2} [\ln H_t - \ln H_{t-1}], \tag{4.1}$$

where $W_t$ is the labor 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 labor mix (labor quality contribution) from:

$$\frac{W_t + W_{t-1}}{2} \sum_i \left( \frac{w_{it} + w_{it-1}}{2} \right) \left[ \ln \frac{H_{it}}{H_t} - \ln \frac{H_{it-1}}{H_{t-1}} \right], \tag{4.2}$$

where $\omega_{it}$ is the share of type-$i$ workers in total labor 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 labor and the quality of labor. This last contribution can be obtained from equation (4.2) by considering two types of labor: migrant and nonmigrant. 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:

$$\frac{W_t + W_{t-1}}{2} [\ln H_t - \ln H_{t-1}] - \frac{W_t + W_{t-1}}{2} [\ln H^*_t - \ln H^*_{t-1}]. \qquad (4.3)$$

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 labor productivity growth. The first component of that contribution would be a quantity effect: the negative effect of migrant labor through diminishing the capital-labor ratio:

$$-\left[\left(1 - \frac{W_t + W_{t-1}}{2}\right) [\ln H_t - \ln H_{t-1}] - \left(1 - \frac{W_t + W_{t-1}}{2}\right) [\ln H^*_t - \ln H^*_{t-1}]\right]. \qquad (4.4)$$

The second is simply the quality effect from the standard growth accounting equation specified in (4.2).

Full growth accounting results, distinguishing migrant labor from native labor, obtained for the total economy in the UK and Spain are shown in table 4.1 for different periods [9]. The GVA growth and the contributions of total labor, ICT capital, Non-ICT Capital and TFP are directly obtainable from EU KLEMS.

We see that the contribution of migrant labor to economic growth is quite modest in the UK for the whole 1987-2005 period. 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 labor in the 1980s. Furthermore

9. In this section the Spanish data for migrants refers to nationality, instead of country of origin as in the previous section. The reason is that nationality is the criteria used by the *Encuesta de Estructura Salarial* (Structure Wage Survey) the source of the wage data.

**TABLE 4.1: Total economy. GVA growth accounting**
(annual percentage)

| | United Kingdom | | | | | Spain | | |
|---|---|---|---|---|---|---|---|---|
| | 1987-1996 | 1996-2000 | 2000-2005 | 1987-2005 | 1996-2005 | 1996-2000 | 2000-2005 | 1996-2005 |
| **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 EU KLEMS** | 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 |

*Source:* EU KLEMS database, March 2008, http://www.euklems.net, EPA (INE), ESS (INE) and LFS (ONS) and own calculations.

the quality effect is even smaller and very close to zero. This is unsurprising since the shares of migrants and nonmigrants 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 1987-2005 period 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 1987-1996 period. 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 2000-2005 period. For the 1996-2005 period, 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 labor 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 1996-2000 period; 0.33% for the 2000-2005 period; and 0.26% for the whole 1996-2005 period. 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 labor, 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 60s. 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 4.1 we see that the estimated contribution of migrants was 0.60% on average over the 1996-2005 period. 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 labor in Spain. This is 0.28% (1996-2000) and grows to 1.07% over the period 2000-2005. 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 labor 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 1996-2005 period, one sixth of the GVA growth in Spain is due to migrant contributions, and for the 2000-2005 period this contribution increases to roughly one third of total growth.

A feature of migrant labor is that it tends to be concentrated in certain industries, and an advantage of the growth accounting methodology is that it enables sectoral impacts to be explored easily. 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 4.2 shows growth rates in GVA and migrant contributions 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) for the 1996-2005 period and 2000-2005 subperiod. The table gives us some indication of where migrant labor matters the most.

In the UK, in absolute terms, for the whole 1996-2005 period, the migrant total contribution is especially noteworthy in hotels and restaurants, accounting for 0.73% out of the total 3.26 percent of GVA growth. In transport and communications it accounts for 0.51%, which is the next largest contribution—well above the 0.29% estimated for the total economy. On the other hand, construction (0.14%) and agriculture (0.17%) show the lowest absolute contributions to growth from migrant labor. This is perhaps surprising, given the perceived importance of migrant labor particularly in construction; however, this is because of relatively low levels of overall growth in these sectors. The remaining industries (manufacturing; trade; and community, social and personal services) experienced contributions to

**TABLE 4.2: GVA growth accounting across industries**
(annual percentage)

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

*Source:* EU KLEMS database, March 2008, http://www.euklems.net, EPA (INE), ESS (INE) and LFS (ONS) and own calculations.

growth from migrant labor very similar to the total economy. In all industries, the contributions are mainly driven by the quantity effect because the labor quality effect is always very small, being usually 0.02% or 0.03% (although a bit higher in hotels and restaurants [0.08%] and transport and communication [0.06%]).

It is interesting to note that even in the industries where the migrant contribution is high, it represents around one fifth of total growth (hotels and restaurants) and around 10% (transport and communications). When compared to their relative contribution to GVA growth, however, the contribution made by migrants in the case of manufacturing in particular is substantial. The quantity effect alone raises GVA growth by 0.23%, going some way to offset any potential decline in GVA stemming from other sources. Without this contribution, growth in manufacturing would be declining.

Focussing only on the most recent period (2000-2005), our estimates show an even higher contribution from migrants although the overall picture is very similar to the full period. Sectors that are important are hotels and restaurants (1%) and transport (0.53%) which 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 still driven by the quantity effect.

It is interesting to note that differences across industries are more perceptible in Spain. Looking at the whole 1996-2005 period we can see industries where the migrant total contribution is 1 percentage point higher than in others. Again, hotels and restaurants are the sector with the highest migrant 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 migrant 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 migrant contribution increases in every industry. As a consequence, we can see migrant contributions over 2% in construction and hotels and restaurants, whereas the lowest contribu-

**TABLE 4.3: Total economy. Labor productivity growth accounting**
(annual percentage)

| | United Kigdom | | | | | Spain | | |
|---|---|---|---|---|---|---|---|---|
| | 1987-1996 | 1996-2000 | 2000-2005 | 1987-2005 | 1996-2005 | 1996-2000 | 2000-2005 | 1996-2005 |
| **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 |

*Source:* EU KLEMS database, March 2008, http://www.euklems.net, EPA (INE), ESS (INE) and LFS (ONS) and own calculations.

tion (finance) is 0.38%. The increases are significant because the migrant contributions within each industry for the 2000-2005 subperiod are some 40-60% higher than for the whole 1995-2005 period.

Using equations (4.2) and (4.4), we can estimate also the migrant total contribution to labor 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 4.3.

For the UK, the impact of migrant workers on labor productivity growth is negative but negligible over the whole 1984-2005 period (–0.07%), although we see some increase in the negative impact in later years, –0.09% for 2000-2005 period. In Spain we find a more sizeable and more negative effect, –0.55% for the whole 1996-2005 period, especially in the last five years. From a contribution of -0.21% for the 1996-2000 period it increases to –0.82% for the 2000-2005 period [10].

The results by industry in table 4.4 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 1996-2005 period 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).

In Spain, the migrant contribution to labor productivity is always negative and quite sizeable: between -0.38% and -1.07% depending on the industry for the whole 1996-2005 period and between –0.43% and –1.54% for

10. According to the estimates of Conde-Ruiz, García and Navarro (2008) using a shift-share methodology, the contribution of migrants on labor productivity growth was –0.51% for the 2000-2006 period.

**TABLE 4.4: Labor productivity growth accounting across industries**
(annual percentage)

| | Labour productivity | Migrants | | Total |
|---|---|---|---|---|
| | | Quantity | Quality | |
| **UK 1996-2005** | | | | |
| 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 |

*Source:* EU KLEMS database, March 2008, http://www.euklems.net, EPA (INE), ESS (INE) and LFS (ONS) and own calculations.

**TABLE 4.5: Total effect of migration on per capita income (1996-2005)**

| Growth rates | | | Percentage points | | |
|---|---|---|---|---|---|
| | **Spain** | **UK** | | **Spain** | **UK** |
| **Per capita GDP growth** | **2.49** | **2,39** | **Per capita GDP growth** | **100** | **100** |
| **Contribution of migrants** | | | **Contribution of migrants** | | |
| 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 |
| **Total** | **–0.16** | **–0.02** | **Total** | **–6.44** | **–0.75** |

*Source:* EU KLEMS database, March 2008, http://www.euklems.net, EPA (INE), ESS (INE) and LFS (ONS) and own calculations.

the 2000-2005 period. The industries with the poorest performance (agriculture, construction, and hotels and restaurants) are characterized by large negative contributions from migrant workers. The share of migrant labor and productivity seem to be closely (inversely) related across Spanish industries, even more so in the last five years. The negative contribution from migrants increases in every industry during the last 2000-2005 period.

Thus using the growth accounting methodology to analyze the contribution that migrant labor 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 labor, e.g., agriculture.

Table 4.5 summarizes the main results obtained from this and the previous section. It highlights both the importance of Spanish migrants' demography on total per capita income growth compared to the UK, and the negative impact of migration on productivity in the two countries.

Given the differences observed between the UK and Spain, it is likely that the positive impact of migration *via* demographic changes will vanish in the near future. In both countries the impact of migration on productivity was negative, although it is much more pronounced in Spain than in the UK. In the case of Spain, the negative impact was the result of the combined quantity and quality effects, whereas in the UK the negative quantity effect was 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:

$$\ln (Y_{it}) = \ln A_{it} + \beta_1 \ln K_{it} + \beta_2 \ln L_{it} + \varepsilon_{it}. \quad (5.1)$$

In the case of constant returns to scale, they 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 labor on the total factor productivity (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 recognized that inputs are endogenous [11], that productivity shocks are per-

11. 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.

sistent, and that inputs may be dependent on past or current shocks. In our case there are no obvious *external* instruments for migrant labor input to resolve potential endogeneity. GMM methodology that 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 labor 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 [12].

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 labor input as separate inputs. This enables us to obtain estimates of the elasticity of substitution between migrant and native labor input [13]. 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) [14].

The Translog production function is defined as (Christensen, Jorgenson and Lau, 1973):

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12. For both estimations, we use Roodman's (2006) xtabond2 procedure in Stata.

13. An alternative method for estimating the elasticity of substitution was developed by Amuedo-Dorantes and De la Rica (2008).

14. 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.

$$\ln (Y) = \beta_0 + \sum_i \beta_i \ln (X_i) + \sum_i \sum_j \beta_{ij} \ln (X_i) \ln (X_j) + \varepsilon, \qquad (5.2)$$

where $Y$ is output, $X_i$ are inputs (in our case capital, native labor and migrant labor) 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 in the use of another input. Similarly, if decline in the price of a factor increases 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 labor is likely to be different from the native workforce and will develop differently. Thus we calculate a separate labor composition index for each group and use it to adjust the labor input for the Translog estimation. Changes in labor composition for the UK are calculated at industry level as in equation (4.2) but the different types of labor include all combinations of gender, three age and three education groups, and the composition changes are calculated separately for migrants and nonmigrants. Sample sizes limit disaggregation, so employment shares are calculated at a seven-industry breakdown, and relative wages are used for calculating wage shares separately for services. Total relative wages are for other industries, and pre-1992 when the LFS did not include a wage

information, wages from 1992 are used. Trends of shares of different gender-age-education groups before 1992 are used to extend the data backwards owing to sample limitations in the pre-1992 LFS.

For Spain, only shares by education groups are available and the labor 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 are only available for 2002 and are applied to the whole period. Information on the levels of labor and capital services was also available [15] in 1997 in 26 market industries. An index of capital services are used to extend the capital service levels to cover the whole period studied. Labor services in 1997 are split into migrant and nonmigrant services by using information on labor composition and shares of hours of migrants and natives (for Spain, shares from 2000 are used). The composition index described above and changes in hours are used to construct a full series of labor services.

We first estimate Cobb-Douglas specification [16] using standard regression methods. Different combinations of measures of input and output are used:

— hours unadjusted for labor composition and capital stock;
— capital and labor services levels (excludes nonmarket services);
— capital and labor service indices (only used in fixed effects and first difference estimations) [17].

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 5.1. 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 labor services (levels or index depending on specification). The coeffi-

15. Estimates based on EU KLEMS source data.

16. We also estimate Cobb-Douglas specification by assuming migrant and native labor as separate inputs. The results imply similar conclusions, and quality adjustment does not seem to have a large impact on the migrant labor output elasticity. These results are available on request.

17. Cross industry differences are not meaningful for indices. Capital and labor service indices are also available for nonmarket industries.

cient on the migrant share variable is small and not statistically significant, and it is negative in first difference estimation for specifications with capital and labor levels. For specification with unadjusted hours and capital stock estimation, fixed effects estimate is also 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 labor is generally associated with higher productivity when levels of productivity and the use of

**TABLE 5.1: Estimates of Cobb-Douglas production function**

| Variable | United Kingdom | | | Spain | | |
|---|---|---|---|---|---|---|
| | OLS | Fixed effects | First differences | OLS | Fixed effects | First differences |
| ln(capital services) | 0.428*** | 0.571*** | 0.328*** | 0.372*** | 0.278* | 0.431*** |
| | (0.057) | (0.13) | (0.092) | (0.097) | (0.15) | (0.077) |
| ln(labor services) | 0.473*** | –0.00520 | 0.157** | 0.544*** | 0.413* | 0.201** |
| | (0.061) | (0.11) | (0.074) | (0.087) | (0.21) | (0.079) |
| ln(migrant share) | 0.0782 | 0.0354 | –0.00401 | –0.0632*** | –0.00295 | –0.00169** |
| | (0.13) | (0.022) | (0.0063) | (0.022) | (0.0022) | (0.00069) |
| Constant | –1.376** | 0.374 | 0.0164 | –1.807*** | –0.0158 | 0.0365*** |
| | (0.60) | (0.82) | (0.010) | (0.60) | (0.88) | (0.0097) |
| *Observations* | *572* | *572* | *546* | *260* | *260* | *234* |
| *R-squared* | *0.92* | *0.76* | *0.32* | *0.91* | *0.73* | *0.30* |
| ln(capital stock) | 0.402*** | 0.662*** | 0.461*** | 0.416*** | 0.268* | 0.343*** |
| | (0.039) | (0.15) | (0.11) | (0.054) | (0.13) | (0.088) |
| ln(total hours) | 0.483*** | 0.0534 | 0.135** | 0.475*** | 0.409** | 0.363*** |
| | (0.053) | (0.086) | (0.062) | (0.062) | (0.16) | (0.13) |
| ln(migrant share) | 0.0848 | –0.0128 | –0.00900 | –0.0428 | –0.00255 | –0.252 |
| | (0.16) | (0.057) | (0.15) | (0.027) | (0.0022) | (0.16) |
| Constant | –2.246*** | –2.112 | 0.0276** | –2.655*** | –0.558 | 0.0185** |
| | (0.76) | (1.33) | (0.012) | (0.79) | (1.05) | (0.0068) |
| *Observations* | *660* | *660* | *630* | *300* | *300* | *270* |
| *R-squared* | *0.90* | *0.74* | *0.28* | *0.88* | *0.78* | *0.33* |

**TABLE 5.1 (cont.): Estimates of Cobb-Douglas production function**

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

*Note:* Robust standard errors in parentheses; *** p < 0.01, ** p < 0.05, * p < 0.1. All estimations include year dummies.
*Source:* EU KLEMS database, March 2008, http://www.euklems.net, EPA (INE), ESS (INE) and LFS (ONS) and own calculations.

migrant labor 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.

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 labor. 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 labor. 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 5.2 [18]. The number of instruments is large com-

18. We also calculate standard GMM estimates, but the coefficients are similarly unrealistic in the sense that the labor input coefficients are very small. Migration coefficients are similar but the AR coefficient is smaller in the Spanish case.

**TABLE 5.2: System GMM estimates of Cobb-Douglas production function**

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

*Note:* Robust standard errors in parentheses; *** p < 0.01, ** p < 0.05, * p < 0.1. All estimations include year dummies.
*Source:* EU KLEMS database, March 2008, http://www.euklems.net, EPA (INE), ESS (INE) and LFS (ONS) and own calculations.

pared 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 labor 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.

As in the case of the UK, GMM estimates for Spain show significant persistence. The capital coefficient is realistic but the coefficients of labor input are small especially for labor 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.

In the UK, the use of migrant labor seems to be weakly related to overall productivity. This may be indicative of migrant labor being rather similar to the native labor. We do not see any significant evidence that changes in productivity are related to contemporaneous changes in the use of migrant labor. If migrants are hired in response to productivity shocks, it does

not appear to occur simultaneously. In Spain, on the other hand, there is a clearly negative association between the use of migrant labor and productivity for levels of labor 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 a 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 [19].

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 labor, from the existing sample, and examine the distribution. We then correlate the elasticities with migrant share (tables 5.3 and 5.4).

The median output elasticity in the UK for migrant labor 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.

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 labor 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 labor rather than replacing them.

19. GMM estimates for Translog specification are unsatisfactory in the same way as in the Cobb-Douglas case. We do not report them here, but these results are available on request.

**TABLE 5.3: Distribution of elasticities of substitution of migrant and native labor**

| | United Kingdom | | | | 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 |
| 50% | –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 |

*Source:* EU KLEMS database, March 2008, http://www.euklems.net, EPA (INE), ESS (INE) and LFS (ONS) and own calculations.

**TABLE 5.4: Correlations between elasticities and migrant share**

| Estimation method | Elasticity of substitution migrant/native | Output elasticity of migrant labor input |
|---|---|---|
| **United Kingdom** | | |
| OLS Capital and labor services | 0.0872* | –0.8036* |
| OLS Capital stock and hours | 0.0977* | –0.8147* |
| FE Capital and labor services | 0.0263 | 0.0077 |
| FE Capital stock and hours | –0.1058* | 0.2161* |
| **Spain** | | |
| OLS Capital and labor services | –0.0358 | 0.4285* |
| OLS Capital stock and hours | 0.1057 | –0.5044* |
| FE Capital and labor services | 0.0182 | 0.1958* |
| FE Capital stock and hours | 0.0050 | 0.4170* |

*Note:* * significant at 95% level.

*Source:* EU KLEMS database, March 2008, http://www.euklems.net, EPA (INE), ESS (INE) and LFS (ONS) and own calculations.

In Spain, the median output elasticity for migrant labor input is negative for the OLS coefficients in unadjusted hours and capital stock specification, and larger than the output elasticity of native labor for OLS service levels specification. In the fixed effects specifications the output elasticities for migrants are realistic, but for labor and capital services the coefficient of native labor 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.

Elasticities of substitution for Spain have medians, small in absolute value, with higher absolute values at both ends of the distribution, which is 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 labor 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 nonmigrants. However they also warn that their finding is most likely overstated by the fact that migrants work in sectors less attractive for nationals. Amuedo-Dorantes and De la Rica (2008) also find imperfect substitutability between migrants and natives in Spain.

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, and OLS capital stock and hours estimates for Spain). This seems counterintuitive as industries which benefit most from using migrant labor 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 labor and capital services for Spain. Thus industries that use migrants to substitute natives tend to have higher levels of migrant labor input. For Spain, however, none of these correlations is statistically significant.

# 6. Conclusions

THE United Kingdom (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 such significant changes in the most recent period analyzed here. These different experiences suggest that, most likely, the links between productivity and the use of migrant labor have different patterns in these countries.

This working paper attempts to explore the extent to which migration affects productivity growth over the 1990s and early 2000s. The growth accounting results show that migration is playing an increasingly important role in the economic performance of Spain. It has fostered gross value added (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 labor 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 labor productivity. Spain and the UK seem to be two stories of migration quite different, both quantitatively and qualitatively, in their impact on productivity growth. Industries in which migrant labor contributes the most to GVA growth include hotels and restaurants and transport and communications. Similar findings hold for labor productivity; however, the impact of migrant labor is generally negative. The UK differs from Spain in that the quality effect of migrants does have a positive influence on labor productivity; however, this is not generally sufficient to offset the negative impact. In Spain, without exception, quality and quantity effects of migrants negatively affects labor productivity.

Estimating a Cobb-Douglas production function, using the migrant share of labor as an additional regressor, shows that, in Spain, the use of migrant labor 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 causal-

ity. Using General Method of Moments (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 a more flexible functional form does not completely solve the problem of estimating production functions consistently.

The elasticity of substitution between migrant and native labor has a median close to zero in both countries. Most estimates suggest that in the majority of industries, migrant and native labor 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 no national supply of labor.

Our results provide evidence that immigrant labor 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 labor.

# Appendix

**TABLE A.1: Distribution of output elasticities**

| Percentile | United Kingdom | | | | 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 |
| **Output elasticity of migrant labor** | | | | | | | | |
| 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 |
| **50%** | **0.14457** | **0.09817** | **0.09126** | **–0.03410** | **0.16071** | **–0.10805** | **0.02862** | **0.02200** |
| 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 |
| **Output elasticity of capital** | | | | | | | | |
| 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 |
| **50%** | **0.35930** | **0.34436** | **–0.36266** | **0.69083** | **0.52810** | **0.34183** | **0.50072** | **0.14148** |
| 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 |
| **Output elasticity of native labor** | | | | | | | | |
| 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 |
| **50%** | **0.37537** | **0.43889** | **0.59054** | **0.06169** | **0.14372** | **0.69086** | **–0.09262** | **0.73706** |
| 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 |

*Source:* EU KLEMS database, March 2008, http://www.euklems.net, EPA (INE), ESS (INE) and LFS (ONS) and own calculations.

**TABLE A.2: Results of estimation of translog production function (year dummies suppressed)**

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

**TABLE A.2 (cont.): Results of estimation of translog production function (year dummies suppressed)**

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

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

*Source:* EU KLEMS database, March 2008, http://www.euklems.net, EPA (INE), ESS (INE) and LFS (ONS) and own calculations.

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