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A non parametric analysis of the relative performance and efficiency patterns of service industries in the advanced countries

Andrés Maroto-Sánchez

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A NON PARAMETRIC ANALYSIS OF THE RELATIVE PERFORMANCE AND EFFICIENCY PATTERNS OF SERVICE INDUSTRIES IN THE ADVANCED COUNTRIES

RESUMEN

Los servicios hoy en día juegan un papel determinante en el crecimiento a largo plazo de la productividad y el nivel de vida de las economías avanzadas debido a su peso cuantitativo. Igualmente, tienen un impacto directo en la evolución agregada de la economía a través de sus efectos sobre la eficiencia del país y la frontera tecnológica. Uniendo estas dos ideas el objetivo de este WP es doble. Por un lado, analizar la evolución de la productividad relativa en el sector servicios, tanto agregada como desagregadamente. Por el otro, explorar algunas posibles causas relacionadas con la eficiencia – estática y dinámica – dentro del sector. Para ello, usaremos técnicas no paramétricas – en concreto, índices de Malmquist (para el cálculo de la PMF) y técnicas DEA para el análisis de la eficiencia – aplicados a los datos macroeconómicos ofrecidos por la base EUKLEMS para una muestra de países OCDE.

Los principales resultados de este trabajo parecen refutar, al menos parcialmente, la hipótesis convencional de la baja productividad y eficiencia. Por el contrario, existe una clara dualidad y heterogeneidad dentro del mismo. Adicionalmente, los resultados obtenidos a través de técnicas no paramétricas pueden abrir futuras opciones para el análisis y la medición de la productividad y la eficiencia en los servicios.

Palabras clave: Sector servicios, Eficiencia, Productividad, Malmquist, DEA

ABSTRACT

The service sector plays a key role determining long-term productivity growth rates and living standards due to the increasing share of services both in production and employment within developed economies. Secondly, it can impact the whole economy through its capacity to affect a country's efficiency and technological frontier. Linking these two ideas, the aim of this paper is twofold. On one side, to analyse the behaviour of productivity in the service sector, both in aggregate and disaggregate terms, and also to explore some explaining factors related to its efficiency in shaping this sector. In doing so, we apply non-parametric approaches – concretely, Malmquist indices and frontier DEA techniques – for macroeconomic data provided by the EU KLEMS database for a set of OECD countries.

The main results of the paper seem to outline a partial refutation of the traditional hypothesis of low productivity. There is a huge heterogeneity and dualism within the tertiary sector in the advanced economies. Finally, the results based on non-parametric approaches might complement those obtained by using traditional parametric estimations, widening the future options to measure and analyse the productivity and efficiency patterns in service industries.

Key words: Services, Efficiency, Productivity, Malmquist, DEA

AUTOR

ANDRÉS MAROTO SÁNCHEZ Senior Lecturer in the Department of Economic Analysis: Economic Theory, Universidad Autónoma de Madrid. Associate Researcher of The Institute for Economic and Social Analysis (IAES), University of Alcalá, Madrid.

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1. INTRODUCTION

In the developed countries, the service sector has evolved continually over the recent four decades, modifying the structure of employment and the composition of production, until accounting for about two thirds of their productive net. The advanced economies are also service economies both in quantitative and strategic terms (OECD, 2005a,b). The service sector can impact the whole economy in advanced economies through two channels. Firstly, it plays a key role in determining long-term productivity growth rates and living standards due to its previously mentioned increasing weight. Traditional services, such as transport, logistics and wholesale trade, are the links between the different production blocks of the economy; hence, an increase in the productivity of these sectors will improve productivity in the production of final goods as well (European Commission, 2009). Secondly, it can impact the whole economy through its capacity to affect a country's efficiency and technological frontier. Some services such as telecommunications, software and engineering services can strengthen the innovative capacity of the whole economy, improving a country's long-term growth potential (OECD, 2001; Gallego and Maroto, 2013; Europe Innova, 2011) while potential inefficiencies within some other service activities would spill over the whole economy.

Under this umbrella, one of the most outstanding debates around the service sector in recent years, especially in European economies, has been the one on productivity and efficiency. Theoretical reasoning is based on the conventional theories related to the unproductive nature of the service sector that appeared at the end of the 1960s with the well-known 'cost disease' introduced by Baumol (1967). This injurious myth about the productivity of services has led many economists to affirm that the tertiarization processes in advanced countries restrain the productivity growth of their overall economies, worsening their long-term growths and the life standard of their populations. This assumption is, as has been introduced before, controversial, although certain legitimacy cannot be denied. It is certain that labour productivity in the service sector at a whole grows at lower rates than it does in other economic sectors. However, two objections or limitations counter this assessment. Firstly, we can speak about vital problems in measuring productivity within services and the estimation of some attributes that characterise service provision. Secondly, the majority of empirical studies in the past decade1 have concluded that some service industries have contributed to the productivity growth of Western countries from the mid-1990s. This evidence, which clearly resists the conventional thesis about the unproductive nature of services, has leaded the

[1] See, among others, Bosworth and Triplett (2007) and Triplett and Bosworth (2004) for the United States; Crespi *et al*. (2006) for the United Kingdom; McLachlan *et al*. (2002) for Australia; or O'Mahony and Van Ark (2003) and Maroto and Rubalcaba (2008) for the European Union.

academic community to look for new theoretical approaches and inputs on the relationships between productivity and services2. These new waves, kinder with respect to the tertiary sector, consider issues as diverse as the inherent quality of the services (Navarro and Hernandez, 2011), their innovation and knowledge (Baumol, 2002; Gallouj and Savona, 2008), or the indirect and positive effects that some service activities induce in the productivity growth of other economic industries through the externalisation or outsourcing processes (Kox, 2006). The conclusion of this conceptual, theoretical and empirical argumentation has been a change, or at least a clarification, of the conventional hypotheses. Thus, the current vision is more positive for the service sector, at least concerning some countries and some sectors of activity (Rutkauskas and Paulavicien, 2005).

Methodologically speaking, one of the more extended fields of analysis on efficiency is that related to the use of non-parametric techniques3. Within these techniques, efficiency estimations using Data Envelopment Analysis (DEA) and productivity indices, such as the Malmquist we apply in this paper, are some of the most extended areas both in economic analysis and in business or engineering4. Nevertheless, these tools have generally been developed in microeconomic studies and their applications to macroeconomic data, with the only exception of Färe et al. (1994) are rare, especially in the case of services.

For this reason, the main contribution of this WP is to fulfil this caveat analysing the productivity and efficiency of services industries, both in aggregate and subsectorial terms, in a sample of OECD countries. The implementation of DEA and Malmquist techniques to macroeconomic data is also another element of innovation from the methodological point of view. The core research hypothesis is that the service sector is not unproductive per se, but a clear duality appears within it, where some dynamic branches coexist with others that, because of their labour-intensive nature and organisation, can hardly secure high productivity growth. After this brief introduction, we describe the methodological framework and data sources used in the following empirical sections. The empirical sections analyse the efficiency and productivity of services in a sample of 17 OECD countries during 1995-2007, both at an aggregate (section 3) and disaggregate (section 4) level. Finally, we conclude with some important remarks.

[2] See Maroto (2012) for a comprehensive review of these relationships between services and productivity.

[3] See, among others, Färe et al. (1985), Cooper et al. (2000), Seiford (1996), Forsund and Sarafoglou (1999) or Sarafoglou (1998) for a detailed review of these techniques.

[4] See, among others, Fried et al. (1993), Charnes et al. (1995), Färe et al. (1998), Kumbhakar and Lovell (2000) or Coelli et al. (1998, 2005) for a review of these methodological approaches.

2. METHODOLOGY AND DATA

The dataset used in this paper has been extracted from the source provided by the **EU KLEMS** project[5]. This source provides estimations on economic growth, productivity, labour force and capital accumulation at the sectorial level for the Member States of the European Union and other economic reference areas such as Australia, Japan or the United States from the 1970s onwards. We have chosen this statistical dataset due to its international homogeneity and comparability and its significant industrial disaggregation and extensive time span.

In particular, the variables used for calculating efficiency and productivity changes were gross value added (in constant prices) for the output, and total employment (in terms of full-time equivalent employees) and gross capital stock (in constant prices) for the labour and capital inputs respectively. At the lowest level of aggregation, the activities classification includes 11 branches corresponding to service industries: distribution (European NACE Rev. 1 G), hotels and restaurants (H), transport (60-63), communications (64), finance (J), business services (71-74), public administration (L), education (M), health (N) and other services (O). Among the countries provided by EU KLEMS, 16 countries were finally included in the study due to availability for every year and variable of the research: Australia, Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Italy, Japan, the Netherlands, Slovenia, Spain, Sweden, the United Kingdom and the United States. Finally, the used time span ranges from 1995 to 2007. The reasoning for this selection of variables and sample is threefold: availability and homogeneity of cross-country time series; need of data on capital input; and, lastly, tertiary focus which delimits the aim of this paper.

After the description of the methodological framework, the paper analyses the efficiency and productivity changes in the sample mentioned before. We calculate the production efficiency and the productivity development for national economies globally considered, the clustering of activities included within the service sector comparing to the manufacturing sector, and finally, of each of the 11 service industries included in EU KLEMS series. There are different methods on measuring efficiency which can be classified in two major groups: productivity indexes and frontier models. At the same time, frontier models can be parametric (deterministic) and non-parametric,

[5] The EU KLEMS Growth and Productivity Accounts are the result of an international research project, financed by the European Commission, to analyse the productivity in the European Union at sectorial level. Data and main results are available at http://www.euklems.net. For a brief methodological description and a summary of the main results, see Timmer et al. (2007).

depending on whether a specific form of the production function frontier is used. We will use the last sort of model in this paper. Specifically, we use the analytical method for efficiency analysis of **Data Envelopment Analysis** (DEA) because it is a flexible method, not restrictive in reference to technology and easy to implement in multiproduct contexts, additionally due to their extensive use in the recent specialised literature[6].

From the numerous formulations of DEA models, we have chosen the one introduced by Banker, Charnes and Cooper (BCC) in 1984 that assumes variable returns to scale (VRS). One of the advantages of this choice is that it allows the use of different measuring units for the considered input and output variables without any restriction. Following BCC formulation, the technical efficiency is estimated solving the following optimising problem (1):

$$\max \theta \quad \text{s.a.} \quad \begin{aligned} &\sum_{j=1}^{N} v_j \lambda_j^{'} \geq \theta^{-1} v_i \\ &\sum_{j=1}^{N} l_j \lambda_j^{'} \leq l_i ; \sum_{j=1}^{N} k_j \lambda_j^{'} \leq k_i \\ &\sum_{j=1}^{N} l_j \lambda_j^{'} \leq l_i ; \sum_{j=1}^{N} k_j \lambda_j^{'} \leq k_i \\ &\lambda_j^{'} \geq 0,\ j = 1, \ldots, N \end{aligned} \qquad (1)$$

where θ represents the maximum potential growth in the output, being stable the output vector of each analysed country *i* (right-hand side of the formulation); v_j is the output vector; l_j and k_j are the labour and capital inputs vectors used by the rest of the decision countries *j* (left-hand side of the formulation) which are relatively compared to the unit *i*; and λ_j is a vector of describing the percentages of each decision country used to construct the virtual benchmarking optimal frontier. DEA model configuration in our case is quite unpretentious. We will use only one variable for output (value added) and two variables for inputs (employment and stock of capital). Each observation is strictly positive and the number of observations remains invariable in every year.

Using the DEA formulation described before and the estimates of efficiency scores calculated,, the next stage of the paper is to estimate productivity growth indices. In doing so, we have chosen the geometrical[7] mean of two output-oriented[8] **Malmquist** indices. This

[6] Although the DEA technique is widely used in the microeconomic studies, where decision-making units are equivalent to companies or even industrial plants, in this case the originality of our approach is its implementation for macroeconomic units, particularly the production units included in the model referred to branches of activity, groups of them or even whole economies.

[7] The choice of the reference time periods in which the growth is estimated could be arbitrary. For this reason, an obvious key is using the geometrical mean of both previous indices (Caves et al., 1982a,b)

primary productivity index was introduced by Caves, Christensen and Diewert (CCD) in 1982, following the seminal work of Malmquist (1953), who constructed quantitative indices from the ratios of distance functions[9] related to a previously defined underlying (but not observable) technology frontier S^t. The CCD Malmquist index formulation (2) will be as follows:

$$M_O\left\{\left(l^{t+1},k^{t+1},v^{t+1}\right),\left(l^t,k^t,v^t\right)\right\}=\left[\left(\frac{D_O^t\left(l^{t+1},k^{t+1},v^{t+1}\right)}{D_O^t\left(l^t,k^t,v^t\right)}\right)\left(\frac{D_O^{t+1}\left(l^{t+1},k^{t+1},v^{t+1}\right)}{D_O^{t+1}\left(l^t,k^t,v^t\right)}\right)\right]^{1/2} \quad (2)$$

The next stage is breaking down the former Malmquist index into different explaining components. Following the pioneer papers by Färe, Grosskopf, Lindgren and Ross (1989, 1992), almost all the alternative versions of decompositions[10] have been versed around different assumptions on the underlying reference technology. Among those decompositions, we will use the one (3) followed by Färe, Grosskopf, Norris and Zang (1994):

$$M_O\left\{\left(l^{t+1},k^{t+1},v^{t+1}\right),\left(l^t,k^t,v^t\right)\right\}=\frac{D_O^{t+1}\left(l^{t+1},k^{t+1},v^{t+1}\right)}{D_O^t\left(l^t,k^t,v^t\right)}\times\left[\left(\frac{D_O^t\left(l^{t+1},k^{t+1},v^{t+1}\right)}{D_O^{t+1}\left(l^{t+1},k^{t+1},v^{t+1}\right)}\right)\left(\frac{D_O^t\left(l^t,k^t,v^t\right)}{D_O^{t+1}\left(l^t,k^t,v^t\right)}\right)\right]^{1/2} \quad (3)$$

which breaks down the productivity change into two components. The first term (the ratio outside the brackets) can be identified as the '***efficiency change'***, whereas the second one (between brackets) might be denominated the '***technical or technological change'***. Generally speaking, improvements in the efficiency score are associated with convergence patterns, whereas improvements in the technical change are related to innovations. Finally, the efficiency change could be broken down into two complementary factors: one related to '***pure efficiency change***' and the other related to the returns of scale ('***scale change'***).

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[8] In input-oriented models, the reference units (which build the frontier) are chosen among those reaching the same output that the evaluating unit. On the contrary, in output-oriented models, the reference units are chosen among those using the same volumes of inputs as the evaluating unit. Output orientation has been chosen because the aim of the paper is to reach the likely maximum value added with given input resources. In most cases, the choice of input or output orientation in DEA models will only play a minor role (Coelli and Perelman, 1996).

[9] The definition for these distance functions will be the one introduced by Färe et al. in 1998:

$$D_O^t\left(l^t,k^t;v^t\right)=\inf\left\{\theta:\left(l^t,k^t;v^t/\theta\right)\in S^t\right\}=\left[\sup\left\{\theta:\left(l^t,k^t;\theta v^t\right)\in S^t\right\}\right]^{-1}$$

In particular, $D_O^t(l^t,k^t;v^t)\le 1$ only if $(l^t,k^t;v^t)\in S^t$. Additionally, it is equal to 1 only if the technology frontier is reached. Using Farrell's (1957) concepts, this occurs when production is technically efficient.

[10] See Balk (2001), Lovell (2003) or Grosskopf (2003) for detailed reviews of all of these likely decompositions for the Malmquist index.

3. Aggregate Results: Does Productivity in Services Behave Differently than it does in Manufacturing?

In the previous section, we described a non-parametric methodology to analyse efficiency and productivity changes by using Malmquist indices and their components. In this section, we apply it to the services sector and compare the results with those found in manufacturing[11] and the whole economy. **Table 1** displays the results on the efficiency using our DEA output-oriented model for the services sector. Efficiency scores in 1995 and 2007 are presented, and also the ranking of the countries. Average results for manufacturing and the whole economy also are shown.

Table 1

Efficiency in the services sector, 1995 vs 2007

1995			2007		
	Efficiency score	Ranking		Efficiency score	Ranking
Australia	0.637	9	Australia	0.630	10
Austria	0.557	12	Austria	0.635	10
Belgium	0.717	6	Belgium	1.000	1
Czech Republic	0.477	16	Czech Republic	0.431	16
Denmark	1.000	1	Denmark	0.883	5
Finland	0.556	12	Finland	0.587	13
France	0.814	4	France	0.719	7
Germany	1.000	1	Germany	1.000	1
Hungary	0.521	15	Hungary	0.470	15
Italy	0.645	8	Italy	0.767	6
Japan	0.526	14	Japan	0.541	14
Netherlands	0.766	5	Netherlands	0.931	4
Slovenia	0.416	17	Slovenia	0.426	16
Spain	0.614	11	Spain	0.690	8
Sweden	0.657	7	Sweden	0.661	9
United Kingdom	0.616	10	United Kingdom	0.621	12
United States	1.000	1	United States	1.000	1
Sample average	0.678		Sample average	0.705	
Manufacturing	0.755		Manufacturing	0.795	
Total economy	0.624		Total economy	0.642	

b Between brackets, the standard deviation of the sample

Source: Based on EUKLEMS (Rel. November 2009)

[11] Manufacturing content includes all economic activities within 15–37 NACE codes, whereas service content includes activities within 50–95 NACE. Therefore, primary activities (01–05), mining (10–14), energy (40–41) and construction (45) will not be analysed.

Average efficiency was around 68 per cent in 1995. On other side, in 2007, it was significantly higher, up to 70 per cent, so the efficiency of services in the sample OECD countries has slightly improved since the latter half of the 1990s onwards. In comparison to the manufacturing sector, the efficiency within services is significantly lower in both years and the differences between both economic sectors have widened during the last years. In 1995, the production efficiency in manufacturing was around 75 per cent (7 points higher than in services), while it was nearer to 80 per cent in 2007 (around 10 points higher than in services). Finally, the efficiency of the whole economy was around 5 points below lower than in services, although that distance has almost remained stable, so the gap between services and the total economy in 2007 was practically the same.

It can also be observed in the previous **Table 1** that three countries were located on the theoretical optimal frontier at the beginning of the analysed period: United States, Germany and Denmark. Finally, in 2007 there were also three countries with no inefficiencies in their overall tertiary sector: United States, Germany and Belgium. Thus, the United States and Germany have been located on the benchmarking frontier during the whole period under investigation, although Denmark and Belgium have behaved efficiently during some of this time. The rest of the countries present, to some extent, certain inefficiencies in services. Czech Republic (with an efficiency score of 0.43), Hungary (0.47), Japan (0.54), Finland (0.59), the United Kingdom (0.62), Australia and Austria (0.63), Sweden (0.66) and Spain (0.69) had the least efficient service sectors in 2007. All of them present scores below the sample average. On the contrary, countries such as the Netherlands (0.93), Denmark (0.88), Italy (0.77) and France (0.72) show scores above the average in their service sectors. If the changes are analysed, we observe that only a few countries have experienced a convergence process related to those benchmarking countries. They are Austria, Finland, Italy, the Netherlands, Spain, and especially Belgium, which even reaches the frontier in 2007. All of them display higher efficiency scores at the end of the reference period than in the mid-90s. The opposite (divergence) trend has been experienced in the rest of countries, particularly in the Eastern countries and Denmark. Finally, the rest of countries display no differences. This is the case with Sweden and the United Kingdom and the benchmarking countries (Germany and the United States).

Following the previously mentioned trend developments, we analyse the productivity changes of the service sector estimating Malmquist indices as well as those components that could explain their development for each country within the sample. Instead of displaying data for each year and country[12], **Table 2** shows a descriptive summary of the average behaviour for each country for the whole time period 1995-2007. Data for manufacturing is displayed too. Annual productivity growth is the average annual growth rate of the Malmquist indices. This growth may

[12] Country and industry detailed results are available from the authors by request.

be decomposed into two effects. On one side, the movement of the optimal frontier, represented in our case by those countries with no inefficiencies at all (*technical change*), and on the other side, the catching-up processes (*efficiency change*). The last effect is approximated by the annual convergence growth of the efficiency indices.

Table 2

Productivity growth in the services sector, 1995-2007

(Annual geometrical growth rate, in %)

	Productivity growth[a]	Convergence	Benchmarking[b]
Australia	3.06	-0.10	3.15
Austria	4.29	1.13	3.15
Belgium	6.05	2.90	3.15
Czech Republic	2.28	-0.87	3.15
Denmark	2.09	-1.06	3.15
Finland	3.62	0.47	3.15
France	2.10	-1.06	3.15
Germany	3.15	0.00	3.15
Hungary	2.26	-0.89	3.15
Italy	4.65	1.50	3.15
Japan	3.40	0.24	3.15
Netherlands	4.84	1.69	3.15
Slovenia	3.35	0.19	3.15
Spain	4.16	1.00	3.15
Sweden	3.20	0.05	3.15
United Kingdom	3.22	0.07	3.15
United States	3.15	0.00	3.15
Sample average	3.46	0.31	3.15
Manufacturing	6.95	1.10	5.85
Total economy	2.80	0.28	2.51

a Productivity growth has been estimated using Malmquist indices, multifactorial productivity growth.

b Benchmarking (technical change) has been estimated as the productivity growth (Malmquist MFP index) of the efficient (benchmarking) countries: US and DE

Source: DEA estimations based on EUKLEMS (Rel. November 2009)

The previous dynamic patterns in efficiency (presented in **Table 1**) may be explained by two effects. First, the growth in relative performance or productivity approximated here using Malmquist MFP indices. Secondly,

this relative performance development might be caused by convergence or divergence movements (convergence growth displayed in the second column in **Table 2**) on one side, or a general positive behaviour of benchmarking countries (technical growth in the third column in **Table 2**) on the other. The last component is approximated using the annual average growth in those efficient countries in our case, the United States and Germany.

The productivity annual average growth in services during the period 1995-2007 has been up to 3.5 per cent. Nevertheless, growth among countries ranges from up to 6 per cent in Belgium to only 2 per cent in Denmark. This heterogeneity of behaviours has been explained by the catching-up patterns observed in countries such as Austria, Finland, Italy, the Netherlands, Spain, and particularly Belgium. On the opposite side, countries such as Australia, Czech Republic, Hungary, and specially France and Denmark, have moved away from the optimal standing since the mid-1990s. In the manufacturing sector, the productivity annual growth has been clearly higher (around 7 per cent) during the whole analysed period. Both manufacturing and services have experienced growth rates above the average of the total economy (2.8 per cent) during this period due to the negative effect of some less dynamic sectors such as construction, agriculture or extraction.

In average terms, this convergence growth, which approximates the catching-up processes relative to improvements in efficiency, has only played a minor role in the productivity growth, both in services and manufacturing. Concretely, it accounted for 9 per cent within services, while the technical growth[13] or the growth experienced by the benchmarking countries has accounted for the rest of the 91 per cent of the annual performance growth in the advanced services. However, the role played by this convergence growth has been more important in specific countries such as Finland (12.9 per cent), Spain (24.1), Austria (26.4), Italy (32.2), the Netherlands (34.8) and, notably Belgium, where the catching-up process has accounted for almost half of the productivity growth since the mid-1990s.

Thus, the main focus of the results analysed in this section is the discrepancies in the productivity evolution between manufacturing and services. This imitates the dichotomising phenomenon between both aggregate economic sectors, which is observed when other indicators such as labour productivity (or other productivity simple ratios) are analysed[14]. These discrepancies between both economic sectors,

13 Firstly, it is important to underline that the decomposition introduced by Färe et al. (1994), used in this paper, presents a significant bias in the technical change component (Zofio, 2007). Technical change scores are commonly overestimated, so results should be driven carefully. Secondly, as explained in the introduction, the aim of the paper is not the theoretical analysis of technology, but the application of a methodological tool for macroeconomic analysis.

14 See, among others, Wölfl, 2003; O'Mahony and Van Ark, 2003; European Commission, 2004; Rubalcaba and Maroto, 2009.

considered as a whole, have traditionally been explained by three realities: the nature of the provision of services (low capital intensity, difficulty to obtain scale economies and lower skills and human capital of the labour force), the organisational structure in services (low concentration and a great number of small firms and autonomous workers) and the peculiarities of some tertiary industries (based on interpersonal relations or the processing of information). These facts limit the gains of productivity in the service sector. Nevertheless, other factors cause a misestimating of the productivity scores in the tertiary sector. Of these factors, the economic literature has underlined four explanatory factors in recent years (Maroto and Rubalcaba, 2008; Maroto, 2012). Firstly, the expansion of the externalisation and inter-sectoral integration processes (Raa and Wolff, 1996; Fixler and Siegel, 1999) and the biases and measurement errors (Wölfl, 2005; Sichel, 1997; Schreyer, 1998, 2001; Pilat et al., 2002; Ahmad et al., 2003) suggest that the productivity gap between manufacturing and services could be overestimated. In contrast, the delay in the technological adoption in many services (Van Ark and Piatkowski, 2004; Stiroh, 2001; Triplett and Bosworth, 2003) and the differences in the competitive pressure between both sectors (McKinsey Global Institute, 1992, 1996, 1998; Roach, 1991) help explain why the evolution of productivity in services is generally less dynamic that that seen in manufacturing activities.

4. INDUSTRIAL RESULTS: THE DUALISM AMONG SERVICE INDUSTRIES

Until this point, we have carried out a non-parametric analysis of the efficiency and productivity of the service sector as a whole for a sample of OECD countries. Nevertheless, this aggregate analysis could hide some crucial aspects and heterogeneous behaviours among the different service sectors, which was the core research hypothesis of this paper. For this reason, it is useful to perform a similar analysis at a much more disaggregated service sector level. Therefore, this presupposes one different analysis for each branch or sector of activity. In each analysis, a frontier is built to compare every country's relative performance with the frontier. Then, instead of presenting the results for each subsector and year, only the average of each industry for the sample will be shown in the paper and some remarks on clearly differentiated subsectors will be introduced.

Table 3

Efficiency in specific service industries, 1995 vs 2007

(Cross-country analysis by sector)

	1995		2007		Trend
	Efficiency score	Benchmarking countries 1995	Efficiency score	Benchmarking countries 2007	
Distribution	0.463	DK, FI, DE, ND, US	0.433	BE, DE, US	Stagnant
Hotels and restaurants	0.372	AT, US	0.444	AT, DK, US	Convergence
Transports	0.594	ND, US	0.633	ND, US	Dynamic
Communications	0.625	SE, UK, US	0.725	SE, UK, US	Dynamic
Finance	0.685	AU, BE, US	0.667	AU, ND, US	Divergence
Business services	0.474	US	0.537	DE, US	Convergence
Other market services	0.400	FR, US	0.434	DK, FR, DE, US	Convergence
MARKET SERVICES	0.634	DK, ND, US	0.669	DK, DE, ND, US	Dynamic
Public Admin.	0.453	IT, JP, US	0.436	JP, US	Stagnant
Education	0.778	DK, JP, US	0.740	IT, JP, US	Divergence
Health	0.676	DE, JP, US	0.691	JP, US	Dynamic
TOTAL SERVICES	**0.678**	**DK, DE, US**	**0.705**	**BE, DE, US**	**Stable**
TOTAL INDUSTRIES	0.624	BE, US	0.642	BE, US	Stable

NOTE: AT: Austria, DK: Denmark; DE: Germany; FI: Finland; ND: Netherlands; US: United States; UK: United Kingdom; SE: Sweden; FR: France; JP: Japan; IT: Italy; BE: Belgium; AU: Australia

Source: Based on EUKLEMS (Rel. November 2009)

Results for the efficiency estimations are displayed in **Table 3**.The first fact to highlight is the striking heterogeneity observed within the service sector. Efficiency scores have decreased in some services (distribution, finance, public administration and education) since the mid-1990s. In some others, such as the rest of market services and health and social work, we can observe dynamic patterns (leader sectors such as transport or communications, which have widened their differences compared to the rest) and convergence patterns (those industries less efficient at mid-90s, such as tourism, business services and other market services, which have experienced a positive trend onwards) in terms of efficiency during those years.

In 1995, data shows that market services presented a lower efficiency than the aggregate sector (0.63 versus 0.68). This pattern is also displayed in 2007 (0.67 versus 0.70) although the gap between both aggregates is slightly lower (only three percentage points). The most efficient industries in 1995 were financial services and some non-market services such as education and health. All of them show efficiency scores around or above the sector average. Other service industries such as transport and communications also displayed efficiency scores above 60

per cent. This ranking is clearly different at the end of the analysed time span. Although most service industries have improved their efficiency scores, with the exception of education, public administration, distribution and financial services, there are only two subsectors with efficiencies above the one in the aggregate sector (0.70). These are education (0.74) and communications (0.73).

Finally, **Table 3** also displays those benchmarked countries which present no inefficiencies. We may observe that the United States behaves efficiently in all service industries. On the contrary, the European countries show some extent of inefficiencies. Nevertheless, there are some countries, such as Germany, Denmark and the Netherlands, with low inefficiencies in most market service industries. Other countries, such as Austria, Australia, Belgium, Sweden or the United Kingdom, only present no malfunctioning in one sector (respectively, hotels and restaurants, finance, distribution and communications). On the other side, countries such as Italy, and especially Japan, show efficiency among their non-market services.

Additionally, the annual average growth rate of the relative productivity (approximated by the Malmquist index growth) has experienced a wide range of variation among the different sectors, as can be observed in **Table 4**. Again, it is remarkable the heterogeneity that can be observed among tertiary industries. Some services such as communications, financial services, and especially business services, have reached growth rates far above the sector average. On the contrary, the observed pattern in some other services, such as hotels and restaurants, public administration, health, education, and particularly distribution, have not been so positive. The annual average growth rate of the multifactorial productivity for the whole sector, as was introduced in the previous section, was approximately 3.5 per cent. Nevertheless, the range of variation among the different industries was very wide.

Table 4

Productivity growth. Services industries (1995-2007)

(Annual geometrical mean, in %, average of the cross-country analysis by sector)

	Productivity Growth[a]	Convergence (efficiency change)	Benchmarking (technical change)	Type
Market services	3.73	0.41	3.32	
Distribution	0.18	-0.62	0.80	*Backward stagnant*
Communications	4.36	1.66	2.70	*Dynamic*
Transport	2.96	0.96	2.00	*Dynamic*
Hotels and restaurants	1.69	0.49	1.20	*Stagnant*
Finance	3.68	-0.22	3.90	*Backward dynamic*
Business services	9.90	1.10	8.80	*Dynamic*
Other market services	1.87	0.47	1.40	*Stagnant*
Public administration	0.69	-0.51	1.20	*Backward stagnant*
Education	1.63	0.33	1.30	*Stagnant*
Health	1.73	0.41	1.32	*Stagnant*
Total services	**3.46**	**0.31**	**3.15**	
Total industries	2.80	0.16	2.64	

a Productivity growth has been estimated using Malmquist indices, multifactorial productivity growth.

Source: DEA estimations based on EUKLEMS (Rel. November 2009)

The first cluster could be defined as dynamic services. Financial services (3.7 per cent), transport (3.0), communications (4.4), and especially some business services (9.9 per cent), belong to this dynamic group. On the contrary, industries such as other social, personal and communitarian services (1.9), education (1.6), health (1.7), hotels and restaurants (1.7), and especially public administration (0.7) and distribution (0.2), experienced a productivity growth rate clearly below the average. This second cluster of services will be defined as stagnant services, following the nomenclature introduced by Baumol (1967). Within both typologies there additionally are some industries with convergence or divergence patterns (those denominated '*backward*') in terms of efficiency and scale changes.

Relative to the likely explanations of this evolution, **Table 4** shows the effects of the convergence growth and the technical growth on the productivity growth of service industries. It also shows the country average for total industries and the aggregate service sector. In the overall tertiary sector, we previously stated that around 90 per cent of the overall dynamic evolution of malfunctioning was accounted for by the technical growth. Nevertheless, in some specific industries these figures are significantly higher. In public administration, financial

services and distribution, the role of technical growth stands above 100 per cent. This component is significantly related to innovation processes (both technical and organisational), structural factors and institutional issues. The residual growth of productivity has been induced by efficiency and scale changes. However, those efficiency changes are heterogeneous among industries again. In some services such as transport, communications, and particularly business services, the role of the efficiency change or catching-up effect is more predominant.

These results agree with most waves of academic papers on the relationships between productivity and new services waves. Various factors have played a role in this enthralling dynamism in the transport and communication and some knowledge and innovative business services during recent decades. Firstly, the boom of e-businesses during the 1990s. Secondly, the increasing externalisation and outsourcing of these activities both to consumers and other manufacturing and services enterprises. Another key factor is the deregulation processes experienced in many countries that have increased competition in these sectors (O'Mahony and Oulton, 2000; Nickell, 1996). Nevertheless, some authors (Jorgenson and Stiroh, 2000; Gordon, 2000) have introduced limitations to these conclusions because they find definition and measurement problems in these activities, so its productivity development should be carefully taken into consideration.

5. FINAL REMARKS

The take-off research hypothesis of this paper was that conventional theories on the relationships between services and productivity, still having some validity at an aggregate level, can be questioned at a disaggregate level because of the empirical evidence and new waves of thinking. Services are not unproductive *per se*. Several service industries show efficiency levels and productivity growth rates similar, or even higher, than those experienced in the manufacturing sector. Some service industries, particularly those destined for final consumption and most non-market services, continue showing very low productivity growth rates. However, other branches show different behaviour. These (transport, communications, some business services and financial activities) display high productivity growth rates and levels, even simultaneously creating jobs.

Manpower is, and will continue to be, a necessary factor in the production of services. However, it is evident that technical progress actually plays a more relevant role in some activities. Joined to increasing capitalisation and standardisation processes, it must keep on offering significant productivity gains, at least in several market service industries. By contrast, the key factor behind the inefficiencies and the low productivity in many services is the structure and organisation of

many of these activities. They are characterised by low competition and strong regulation pressures, smaller firm sizes, high intangible costs, a need for a high degree of product differentiation, intensive labour use, average or low skills and human capital, and need of proximity to provide the services.

The results obtained in this paper conclude that the productivity growth during 1995-2007 was higher in the manufacturing sector (which includes those industries related to the '*electronic revolution*'[15]) than it was in the service sector. However, if we disaggregate the heterogeneous tertiary sector, the results in some activities are similar to those experienced within the most dynamic manufacturing industries.

Methodologically speaking, our results obtained through non-parametric techniques, although drawing similar conclusions to the results obtained through more traditional methods with growth accounting, differ noticeably. Therefore, the results displayed in this paper, although valid, should be carefully interpreted. Firstly, this methodology refers to a concrete sample of countries (decision units) within each analysed economic sector. It does not take into account the countries in an isolated way, as traditional approaches do. Then, the chosen sample for the construction of the optimal frontier is vital. By contrast, both methodologies differ as soon as inefficiencies occur, both technical and those related to the allocation of resources. Finally, the decomposition of the productivity growth used in this paper (following the one introduced by Färe et al., 1994) tends to overestimate the technological component. Nevertheless, the deep service disaggregation of our results and the robust country sample of this study remarkably improve those works carried out on the subject with non-parametric techniques. This approach, such as Malmquist indices, may answer the question of whether the factors that play a role in efficiency and productivity differ among countries or economic sectors and can be used as an additional tool to study and delve into these issues, comparing and complementing the results and estimations obtained by using traditional techniques.

15 See, for instance, Bernstein, 1997, or Fagerberg, 2000.

6. REFERENCES

AHMAD, N., LEQUILLER, F., MARIANNA, P., PILAT, D., SCHEREYER, P. AND WÖLFL, A. (2003): 'COMPARING LABOUR PRODUCTIVITY GROWTH IN THE OECD AREA: THE ROLE OF MEASUREMENT', *STI WORKING PAPER SERIES*, 14, OECD, PARIS

BALK, B. (2001): 'SCALE EFFICIENCY AND PRODUCTIVITY CHANGE', *JOURNAL OF PRODUCTIVITY ANALYSIS*, 15, 159–83

BAUMOL, W. (1967): 'MACROECONOMICS OF UNBALANCED GROWTH: THE ANATOMY OF URBAN CRISIS', *THE AMERICAN ECONOMIC REVIEW*, 57(3), 416–426.

- (2002) 'SERVICES AS LEADERS AND THE LEADERS OF THE SERVICES' IN J. GADREY AND F. GALLOUJ (EDS.) PRODUCTIVITY, INNOVATION AND KNOWLEDGE IN SERVICES, PP. 147-163. EDWARD ELGAR, CHELTENHAM, UK

BERNSTEIN, J. (1997): 'INTERINDUSTRY R&D SPILLOVERS FOR ELECTRICAL AND ELECTRONIC PRODUCTS: THE CANADIAN CASE', *ECONOMIC SYSTEMS RESEARCH*, 9, 111–125

BANKER, CHARNES AND COOPER (1984)

BOSWORTH, B., AND TRIPLETT, J. (2007). THE EARLY 21ST CENTURY US PRODUCTIVITY EXPANSION IS STILL IN SERVICES. *INTERNATIONAL PRODUCTIVITY MONITOR*, *14*(SPRING): 3-19.

CAVES, D., CHRISTENSEN, L. AND DIEWERT, E. (1982A): 'MULTILATERAL COMPARISONS OF OUTPUT, INPUT AND PRODUCTIVITY USING SUPERLATIVE INDEX NUMBERS', *ECONOMIC JOURNAL*, 92(365), 73–86

- (1982B): 'THE ECONOMIC THEORY OF INDEX NUMBERS AND THE MEASUREMENT OF INPUT, OUTPUT AND PRODUCTIVITY', *ECONOMETRICA*, 50(6), 1393–1414

COELLI, T. AND PERELMAN, S. (1996): 'A COMPARISON OF PARAMETRIC AND NON-PARAMETRIC DISTANCE FUNCTIONS: WITH APPLICATION TO EUROPEAN RAILWAYS', CREPP DISCUSSION PAPER, LIEGE UNIVERSITY, LIEGE

COELLI, T., RAO, D. AND BATTESE, G. (1998): AN INTRODUCTION TO EFFICIENCY AND PRODUCTIVITY ANALYSIS, KLUWER ACADEMIC PUBLISHERS, BOSTON

COELLI, T., RAO, D., O'DONNELL, C.J. AND BATTESE, G. (2005): AN INTRODUCTION TO EFFICIENCY AND PRODUCTIVITY ANALYSIS, 2ND EDITION, SPRINGER, NEW YORK

COOPER, W., SEIFORD, L. AND TONE, K. (2000): DATA ENVELOPMENT ANALYSIS: A COMPREHENSIVE TEXT WITH MODELS, APPLICATIONS, REFERENCES AND DEA-SOLVER SOFTWARE, KLUWER ACADEMIC PUBLISHERS, LONDON

CRESPI, G., CRISCUOLE, C., HASKEL, J., AND HAWKES, D. (2006). MEASURING AND UNDERSTANDING PRODUCTIVITY IN UK MARKET SERVICES. *OXFORD REVIEW OF ECONOMIC POLICY*, *22*(2), 186–202.

CHARNES, A., COOPER, W., LEWIN, A. AND SEIFORD, L. (EDS.) (1995): *DATA ENVELOPMENT ANALYSIS: THEORY, METHODOLOGY AND APPLICATIONS*, KLUWER ACADEMIC PUBLISHERS, BOSTON

EUROPEAN COMMISSION (2004): *EUROPEAN COMPETITIVENESS REPORT* 2003, EUROPEAN COMMISSION PUBLICATIONS, BRUSSELS

- (2009) PROMOTING THE ROLE OF R&D IN SERVICES, CREST OMC WORKING GROUP, EUROPEAN COMMISSION PUBLICATIONS, BRUSSELS

EUROPE INNOVA (2011) MEETING THE CHALLENGE OF EUROPE 2020. THE TRANSFORMATIVE POWER OF SERVICE INNOVATION, EXPERT PANEL ON SERVICE INNOVATION IN THE EU, EUROPEAN COMMISSION PUBLICATIONS, BRUSSELS

FAGERBERG, J. (2000): 'TECHNOLOGICAL PROGRESS, STRUCTURAL CHANGE AND PRODUCTIVITY GROWTH: A COMPARATIVE STUDY', *STRUCTURAL CHANGE AND ECONOMIC DYNAMICS*, 11, 393–411

FÄRE, R., GROSSKOPF, S. AND LOVELL, C.A.K. (1985): *THE MEASUREMENT OF EFFICIENCY OF PRODUCTION*, KLUWER-NIJHOFF, BOSTON

FÄRE, R., GROSSKOPF, S., LINDGREN, B. AND ROOS, P. (1989): 'PRODUCTIVITY DEVELOPMENTS IN SWEDISH HOSPITALS: A MALMQUIST OUTPUT INDEX APPROACH', *DISCUSSION PAPER* 89-3, SOUTHERN ILLINOIS UNIVERSITY

- (1992): 'PRODUCTIVITY CHANGES IN SWEDISH PHARMACIES 1980–1989. A NON PARAMETRIC MALMQUIST APPROACH', *JOURNAL OF PRODUCTIVITY ANALYSIS*, 3(3), 85–101

FARE, R., GROSSKOPF, S., NORRIS. AND ZHANG, Z. (1994): 'PRODUCTIVITY GROWTH, TECHNICAL PROGRESS AND EFFICIENCY CHANGE IN INDUSTRIALIZED COUNTRIES', *AMERICAN ECONOMIC REVIEW*, 84(1), 66–83

FÄRE, R., GROSSKOPF, S. AND ROOS, P. (1998): MALMQUIST PRODUCTIVITY INDEXES: A SURVEY OF THEORY AND PRACTICE, IN R. FÄRE ET AL. (EDS.) *INDEX NUMBERS ESSAYS IN HONOUR OF STEN MALMQUIST*, KLUWER ACADEMIC PUBLISHERS, BOSTON/DORDRECHT/LONDRES

FARRELL, M.J. (1957): 'THE MEASUREMENT OF PRODUCTIVE EFFICIENCY', *JOURNAL OF THE ROYAL STATISTICAL SOCIETY*, SERIES A, GENERAL, 120(3), 253–82

FIXLER, D. AND SIEGEL, D. (1999): 'OUTSOURCING AND PRODUCTIVITY GROWTH IN SERVICES', *STRUCTURAL CHANGE AND ECONOMIC DYNAMICS*, 10 (1999), 174–194

FORSUND, F. AND SARAFOGLOU, N. (1999): "THE DIFFUSION OF RESEARCH ON PRODUCTIVE EFFICIENCY: THE ECONOMIST'S GUIDE TO DEA EVOLUTION",

DISCUSSION PAPER, D-02/99, DEPARTMENT OF ECONOMICS AND SOCIAL SCIENCES, NHL

FRIED, H., LOVELL, C.A.K. AND SCHMIDT, S. (EDS.) (1993): *THE MEASURING OF PRODUCTIVE EFFICIENCY. TECHNIQUES AND APPLICATIONS*, OXFORD UNIVERSITY PRESS, NEW YORK

GALLEGO, J. AND MAROTO, A. (2013) 'THE SPECIALIZATION IN KIBS ACROSS EUROPE: PERMANENT CO-LOCALIZATION TO DEBATE', *REGIONAL STUDIES* (DOI: DOI:10.1080/00343404.2013.799762)

GALLOUJ, F. AND SAVONA, M. (2008) 'INNOVATION IN SERVICES', *JOURNAL OF EVOLUTIONARY ECONOMICS*, 19(2), 149-72

GORDON, R. (2000): 'DOES THE 'NEW ECONOMY' MEASURE UP TO THE GREAT INVENTIONS OF THE PAST?', *JOURNAL OF ECONOMIC PERSPECTIVES*, 14(4), 49–74

GROSSKOPF, S. (2003): 'SOME REMARKS ON PRODUCTIVITY AND ITS DECOMPOSITIONS', *JOURNAL OF PRODUCTIVITY ANALYSIS*, 20(3), 459–74

JORGENSON, D. AND STIROH, K. (2000). 'RAISING THE SPEED LIMIT: US ECONOMIC GROWTH IN THE INFORMATION AGE', *BROOKINGS PAPERS ON ECONOMIC ACTIVITY*, I, 125-235

KOX, H. (2002) 'THE CONTRIBUTION OF BUSINESS SERVICES TO AGGREGATE PRODUCTIVITY GROWTH', CPB DISCUSSION PAPER, CPB NETHERLANDS BUREAU FOR ECONOMIC POLICY ANALYSIS, THE HAGUE, NETHERLANDS

KUMBHAKAR, S. AND LOVELL, C.A.K. (2000): *STOCHASTIC FRONTIER ANALYSIS*, CAMBRIDGE UNIVERSITY PRESS, CAMBRIDGE

LOVELL, C.A.K. (2003): 'THE DECOMPOSITION OF MALMQUIST PRODUCTIVITY INDEXES', *JOURNAL OF PRODUCTIVITY ANALYSIS*, 20(3), 437–58

MALMQUIST, S. (1953): 'INDEX NUMBERS AND INDIFFERENCE CURVES', *TRABAJOS DE ESTADÍSTICA*, 4(1), 209–42

MAROTO, A. (2012) 'PRODUCTIVITY IN THE SERVICE SECTOR: CONVENTIONAL AND CURRENT EXPLANATIONS', SERVICE INDUSTRIES JOURNAL, 32(5), 719-746

MAROTO, A. AND RUBALCABA, L. (2008) 'SERVICES PRODUCTIVITY REVISITED', *SERVICE INDUSTRIES JOURNAL*, 28(3), 337-353

MCKINSEY GLOBAL INSTITUTE (1992): *SERVICE SECTOR PRODUCTIVITY*, MCKINSEY & CO. INC., WASHINGTON D.C.

- (1996): *CAPITAL PRODUCTIVITY*, MCKINSEY & CO. INC., WASHINGTON D.C.
- (1998): *DRIVING PRODUCTIVITY AND GROWTH IN THE UK ECONOMY*, MCKINSEY & CO. INC., WASHINGTON D.C.

NAVARRO, J.L. AND HERNANDEZ, E. (2011) 'EFFICIENCY AND QUALITY IN HEALTH SERVICES: A CRUCIAL LINK', *SERVICE INDUSTRIES JOURNAL*, 31(3), 385-403

NICKELL, S. (1996): 'COMPETITION AND CORPORATE PERFORMANCE', *JOURNAL OF POLITICAL ECONOMY*, 104, 724–46

OECD (2001) 'DRIVERS OF GROWTH: INFORMATION TECHNOLOGY, INNOVATION AND ENTREPRENEURSHIP', *SCIENCE TECHNOLOGY AND INDUSTRY OUTLOOK*, OECD PUBLICATIONS, PARIS

- (2005A) GROWTH IN SERVICES. FOSTERING EMPLOYMENT, PRODUCTIVITY AND INNOVATION. OECD PUBLICATIONS, PARIS
- (2005B) ENHANCING THE PERFORMANCE OF THE SERVICE SECTOR. OECD PUBLICATION, PARIS

O'MAHONY, M. AND VAN ARK, B. (2003): '*EU PRODUCTIVITY AND COMPETITIVENESS: AN INDUSTRY PERSPECTIVE. CAN EUROPE RESUME THE CATCHING-UP PROCESS?*', ENTERPRISE PUBLICATIONS, EUROPEAN COMMISSION, BRUSSELS

O'MAHONY, M. AND OULTON, N. (2000): "INTERNATIONAL COMPARISONS OF LABOUR PRODUCTIVITY IN TRANSPORT AND COMMUNICATIONS. THE US, THE UK AND GERMANY", *JOURNAL OF PRODUCTIVITY ANALYSIS*, 14, 7-30

PILAT, D., LEE, F. AND VAN ARK, B. (2002): 'PRODUCTION AND USE OF ICT. A SECTORAL PERSPECTIVE ON PRODUCTIVITY GROWTH IN THE OECD AREA', *OECD ECONOMIC STUDIES*, 35 2002/2, OECD, PARIS

RAA, T. AND WOLFF, E. (1996): 'OUTSOURCING OF SERVICES AND THE PRODUCTIVITY RECOVERY IN U.S. MANUFACTURING IN THE 1980S', *CENTER DISCUSSION PAPER,* 9689, TILBURG UNIVERSITY, TILBURG

ROACH, S. (1991): 'SERVICES UNDER SIEGE – THE RESTRUCTURING IMPERATIVE', *HARVARD BUSINESS REVIEW,* SEPTEMBER–OCTOBER, 82–92

RUBALCABA, L. AND MAROTO, A. (2009): 'PRODUCTIVITY IN SERVICES', IN RUBALCABA, L. (ED.) *SERVICES IN EUROPEAN ECONOMY. CHALLENGES AND IMPLICATION FOR ECONOMIC POLICY*, CH. 4, EDWARD ELGAR, LONDON

RUTKAUSKAS, J. AND PAULAVICIEN, E. (2005) 'CONCEPT OF PRODUCTIVITY IN SERVICE SECTOR', *ENGINEERING ECONOMICS*, 3(43), 29-34

SARAFOGLOU, N. (1998): 'THE MOST INFLUENTIAL DEA PUBLICATIONS: A COMMENT ON SEIFORD'", *JOURNAL OF PRODUCTIVITY ANALYSIS*, 9, 279-81

SEIFORD, L. (1996): 'DATA ENVELOPMENT ANALYSIS: THE EVOLUTION OF THE STATE OF THE ART (1978-1995)', *JOURNAL OF PRODUCTIVITY ANALYSIS*, 7, 99-137

SCHREYER, P. (1998): 'INFORMATION AND COMMUNICATION TECHNOLOGY AND THE MEASUREMENT OF REAL OUTPUT, FINAL DEMAND AND PRODUCTIVITY', *STI WORKING PAPERS*, 1998/2, OECD, PARIS

- (2001): 'COMPUTER PRICE INDICES AND INTERNATIONAL GROWTH AND PRODUCTIVITY COMPARISONS', *STATISTICS WORKING PAPERS*, STD/DOC(2001)1, OECD, PARIS

STIROH, K. (2001): *INFORMATION TECHNOLOGY AND THE US PRODUCTIVITY REVIVAL. WHAT DO THE INDUSTRY DATA SAY*, FEDERAL RESERVE BANK OF NEW YORK, NEW YORK

TIMMER, M., O'MAHONY, M. AND VAN ARK, B. (2007): "EU KLEMS GROWTH AND PRODUCTIVITY ACCOUNTS: AN OVERVIEW", *INTERNATIONAL PRODUCTIVITY MONITOR*, 14 (SPRING), 71-85

TRIPLETT, J., AND BOSWORTH, B. (2004). *PRODUCTIVITY IN THE US SERVICES SECTOR: NEW SOURCES OF ECONOMIC GROWTH*. WASHINGTON, DC: BROOKINGS INSTITUTE.

VAN ARK, B. AND PIATKOWSKI, M. (2004): 'PRODUCTIVITY, INNOVATION AND ICT IN OLD AND NEW EUROPE', *RESEARCH MEMORANDUM* GD-69, GGDC, GRONINGEN

WÖLFL, A. (2003): 'PRODUCTIVITY GROWTH IN SERVICE INDUSTRIES. AN ASSESSMENT OF RECENT PATTERNS AND THE ROLE OF MEASUREMENT', *STI WORKING PAPERS* 2003/7, OECD, PARIS

- (2005): 'THE SERVICE ECONOMY IN OECD COUNTRIES', *STI WORKING PAPER* 2005/3, OECD, PARIS

ZOFÍO, J.L. (2007): 'MALMQUIST PRODUCTIVITY INDEX DECOMPOSITIONS. A UNIFYING FRAMEWORK', *APPLIED ECONOMICS*, 39(18), 2371-2387

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Universidad de Alcalá

Plaza de la Victoria, 2. 28802. Alcalá de Henares. Madrid - Telf. (34)918855225
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