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The effects of KIBS outsourcing on Aragon firms' efficiency

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ABSTRACT

The use of Knowledge Intensive Business Services (KIBS) has become an essential element for competitiveness in modern economies. New competitive advantages often relate to capacity of innovation, the correct use of information and communication technologies, product design or market analysis, among others. The activities related to these new advantages require a great specialization in order to obtain high levels of efficiency. This is the main reason that explains the general tendency to contract externally KIBS. Nevertheless, externalisation is not necessarily a guarantee of efficiency. This paper focuses on Aragon, with a relatively under-developed supply of KIBS, and explores the effect of the use and external provision of these services on regional firms' efficiency. We use a database of tertiary and secondary firms and apply a non-parametric approach, the DEA technique, to this analysis. Results show that the mere use of KIBS has no clear effect on efficiency, but such a clear effect can be observed when some types of these activities are externally consumed.

Palabras clave: Outsourcing, Knowledge Intensive Business Services (KIBS) and Efficiency.

Efectos de la externalización de servicios a empresas intensivos en conocimiento sobre la eficiencia de las empresas en Aragón

RESUMEN

El uso de servicios a empresas intensivos en conocimiento (KIBS) se ha convertido en un elemento esencial para la competitividad en las economías desarrolladas. Las ventajas competitivas a menudo se relacionan con la capacidad de innovación, el uso adecuado de las tecnologías de la información y la comunicación, el diseño de productos o el análisis de mercados. Las actividades que generan estas ventajas requieren una gran especialización para conseguir un nivel elevado de eficiencia. Esta es la razón principal que explica la tendencia general a externalizar la contratación de KIBS. Sin embargo, la externalización, no siempre es una garantía de eficiencia. Este trabajo se centra en Aragón y analiza el efecto del uso y la provisión externa de KIBS sobre la eficiencia de las empresas regionales. Para ello se utiliza una base de datos de empresas de industria y servicios de la región, caracterizada por una poco desarrollada oferta de KIBS. A partir del uso de un enfoque no parámetrico, la técnica DEA, los resultados muestran que el simple uso de KIBS no tiene un efecto claro sobre la eficiencia, pero sí lo tiene cuando algunas actividades concretas se consumen externamente.

Keywords: Externalización, servicios a empresas intensivos en conocimiento y eficiencia.

Clasificación JEL: L24, L84.

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1. INTRODUCTION

The use of Knowledge Intensive Business Services (normally known by their acronym KIBS) has become an essential element for competitiveness in modern economies. Traditional competitive advantages based on prices, lower labour costs or the abundance of natural resources are being replaced by new advantages such as capacity of innovation, the correct use of information and communication technologies, product design or market analysis, among others. The activities related to these new advantages require a great specialization in order to obtain high levels of efficiency. This is the main reason that explains the general trend to contract externally certain services such as computing, communications, human resources, engineering, consulting or management among others.

Nevertheless, externalization is not necessarily a guarantee of efficiency in all cases. For example, these activities tend to concentrate around certain areas following a clear central place location pattern and some research shows that high efficiency scores only work for those firms located in central nodes of development where economies of scope and scale really operate. Consequently, client firms' efficiency may be influenced by the regional competitiveness and efficiency attained by the KIBS suppliers (this could even affect their decision to use or not, and to outsource or not, this kind of services). Other factors, such as the type of service, the degree of externalisation or the way in which the externalisation is established could affect the final efficiency, too.

The main objective of this paper is to explore the real incidence of KIBS externalisation decisions on the global efficiency of client firms. Data collected include firms of different sectors and sizes in the region of Aragon and will be used to explore the real efficiency incidence of the use and the external provision of this type of services. We focus our analysis on this region, as it is an interesting case for the proposed objectives. It is not particularly specialized in the KIBS sector. In 2004, Aragon was home to 2.9% of the total number of national firms, 3.3% of the industrial firms and 2.8% of the tertiary firms, but only 2.6% of firms exclusively devoted to the provision of business services. Pardos and Gómez-Loscos (2003) confirm its clear under-specialization in business services, both in terms of value added and employment, against the rest of the Spanish regions in the nineties[1]. Nevertheless, the weight of these services in the economy is growing rapidly. This process increases the potential growth of the regional economy, where in spite of the growing importance of the tertiary sector, the industrial sector

[1] Spain is an example of business services polarization, and it is hard to find a region that can keep a proportion between its national weight in general economic activity or employment and the same variable referred to business services. In 1996, 46% of jobs in business and real estate services belonged to only two regions (from a total of 17), Madrid with 25% and Catalonia with 21%. When the analysis refers to the most advanced services, the polarization is even more pronounced, with percentages of 30 and 24%, respectively (Rubiera, 2005).

still maintains a relevant weight[2]. However, in last decades, a significant part of the productivity in advanced countries has been due to enlargement of labour division between industry and services. Industrial firms have outsourced some of the services activities that in the past where produced inside the organization, as a way of reducing costs. On the other side, a large number of services firms have appeared, and with a high efficiency gained through specialization, they sell their products in the form of KIBS. So, it is in the KIBS sector and in the conjunction of industry and services where we can find the core of the capacity of innovation and growth for a regional economy with the aforementioned characteristics.

To achieve our goal, a brief review of the literature about KIBS and efficiency is made in Section 2. In Section 3 we discuss our choice of method, namely an application of DEA followed by regression analysis to explore the particular role of KIBS for efficiency scores. The contents of our database are explained in section 4. Next, Section 5 presents the main results of our empirical analysis. The conclusions drawn from these results are summarised in the final section.

2. KIBS OUTSOURCING AND FIRMS EFFICIENCY: THE "UNFINISHED BUSINESS"

Knowledge intensive business services constitute one of the characteristics of the rise of the knowledge-based economy (Muller and Zenker, 2001), and are one of the most dynamic components of the services sector in most industrialized countries (Strambach, 2001). In the late 1990s, there were significant research efforts directed to this particular type of services. As a result, a better understanding of the way in which these activities contribute to economic development and growth is now possible.

A wide part of literature focused on the analysis of the role of KIBS on companies' competitiveness, innovation, organization or quality. See, among many other examples, the revisions of Fixler and Siegel (1999), Mas (1992) or Martinelli (1991) about the effect of these activities on the general competitiveness of firms or territories as a whole. Tomlinson (1997) presents evidence on the positive impact of KIBS activities on the organization of manufacturing companies. As Bryson and Monnoyer (2002), Gallouj (2002), Muller and Zenker (2001) or Hertg (2000), among others, pointed out, business services, especially those that are intensive in knowledge or technology, also make a crucial contribution to the acquisition of knowledge and generation of innovation. In a similar way, Lindahl (1994) found that KIBS encourage the quality improvement of the firms.

Albeit all the quoted works and many others have confirmed the relevance of KIBS in the context of contemporary knowledge-based economies, this sector requires a great specialization in order to obtain high levels of efficiency. This is

[2] In 2004, 67.2% of Aragonese GDP was in the tertiary sector and 21.2% in the industrial sector (INE).

the main reason that explains the general trend to contract the KIBS externally. In fact, there are several factors, closely related to firms' competitiveness, that confirm the increasing demand for these kinds of business services. Martini and Varietti (1989), Freeman and Soete (1987) or Guile and Quinn (1998) show the increasing role of knowledge-intensive workers in the economies, finding that the new information and communication technologies imply continuous adaptations. Moreover, markets internationalization means greater service needs to face higher legal and organization complexity as Aharoni (1993) or Daniels (1993) point out[3].

Several recent works focus on some branch of KIBS. In particular, Barrar *et al.* (2002) compare the efficiency of producing accounting services internally or consuming them externally, using the DEA approach. The paper finds that, through comparative advantages, outsourcing involves a more efficient solution for the management of very small accounting firms than internal provision. A review of the papers related with IT/IS outsourcing efficiency can be consulted in Mahnke et al (2005).

But external consumption is not always a guarantee of efficiency. In Rubiera *et al.* (2005) a measure of the efficiency of KIBS in a particular Spanish region with a low development in KIBS activities was carried out, obtaining very low efficiency levels in KIBS production. In line with this, Love and Roper (2001) and Martinez and Rubiera (2006) found evidence of greater competitiveness in advanced business services located in areas with high concentration of this kind of firms. As a consequence, the efficiency levels of KIBS could be conditioned by the location. The strong concentration of KIBS suppliers around certain areas following a central place location pattern might cause that high efficiency scores only appear clearly for those firms located in central nodes of development where economies of scope and scale really operate.

To contrast this hypothesis more evidence from different points of view is needed. The number of contributions about KIBS efficiency or KIBS externalisation efficiency effects is still very low. The reason for this lack of analyses can surely be explained by the usual problems when measuring production and productivity in services in general, which is especially clear in KIBS activities. The heterogeneity and non-standardization of services offered, the difficulty to approximate the real value of the internal productions in order to weigh it against external buying, the differences among clients' situations and demands, along with other factors, cause this "unfinished business" situation in the measure of KIBS efficiency contributions.

[3] See Pardos et al. (2007) for a general revision of the recent KIBS externalisation processes.

3. METHODOLOGY

A first stage of our proposal is to assess the efficiency level of the firms that contract a significant part of their KIBS demand externally. In order to measure this, a flexible approach, which takes into consideration the heterogeneity of the firms, is required. Thus, a non-parametric formulation must be used. Among the different non-parametric approaches the Data Envelopment Analysis (DEA) formulation has been chosen, using a specification that does not require knowing the type of returns-to-scale of the sector (BCC approach). In a second stage, once we have obtained the efficiency score from the DEA analysis, and with the information obtained from our survey on the quantity and type of KIBS that each firm contracts externally, an evaluation of the role of the use and externalization of these activities on the efficiency scores is estimated.

3.1. First stage: DEA approach to efficiency

The measurement of efficiency in the business world is based on the comparison of the performance of the firm with respect to an optimum. The ideal situation would be to measure the efficiency of the firm by comparing its performance with what it should do to maximize its returns. This, however, is not possible, since we do not have perfect knowledge of the world in which each firm operates and we do not have precise knowledge of the technology or restrictions that may affect the attainment of maximum returns (Álvarez, 2001). Thus, the best that can be done is to compare what the firm does with what other similar firms do. Farrell (1957) is the precursor in studies based on this idea. By means of algebraic calculations, this author empirically determines an efficient frontier, defined by the performance of the best firms observed.

Our analysis of efficiency will focus on technical efficiency, which consists in obtaining the maximum production given a specific combination of resources or employing the strictly necessary resources to obtain a particular level of production. Starting out from a set of homogeneous observations to be evaluated, the technical efficiency of each firm will be estimated by its approximation to the efficient production frontier. The empirical calculation of the frontier may be made by means of parametric or non-parametric approximations. The main advantage of the latter is the fact that it is not necessary to assume a concrete functional form of the frontier, giving greater flexibility to the analysis.

The most habitual non-parametric technique is the Data Envelopment Analysis approach (henceforth DEA). This method, originally put forward by Charnes, Cooper and Rhodes in 1978, is characterized by its standardization, as well as by allowing the possibility of considering multiple inputs and outputs. DEA does not impose specific functional forms between inputs and outputs, and it provides better information about the sources and magnitude of inefficiencies of a particular unit.

Thus, DEA has been suggested as a potential general management tool (Epstein and Henderson, 1989).

With this non-parametric approach a set of n Decision Making Units (DMU_j, $j = 1, 2, 3,\ldots, n$) is analyzed. Each DMU uses m inputs, $X_j = (x_{1j},...,x_{mj})$, to obtain l outputs, $Y_j = (y_{1j},...,y_{lj})$. The efficient frontier may be calculated by maximizing the output given a level of inputs (output orientation), or by minimizing the input given a level of outputs (input orientation). We propose to use an output orientation, where the maximum possible increment for a specific unit, named with the sub-index 0 (E_0), is determined for each DMU_0, given the level of inputs. In mathematical terms:

$$\begin{aligned} &Y_j = (y_{1j},...,y_{lj}) \\ &E_0(DMU_0) = \text{Max } (\phi/(X_0, \phi Y_0) \in T\} \end{aligned} \tag{1}$$

φ being the maximum possible increase in the outputs vector maintaining the inputs vector unchanged; X_0 is the inputs vector of the specific unit 0; Y_0 is the outputs vector of that specific unit and T represents the empirical set of production possibilities. Hence, the rate of efficiency of the DMU_0 will be calculated as:

$$DMU_0 = \frac{\text{Distance from the origin to the frontier}}{\text{Distance from the origin to the } DMU_0} \tag{2}$$

There exist a variety of models within DEA method for obtaining the set of production possibilities. The basic mathematical programming models of DEA are the CCR model (Charnes, Cooper and Rhodes, 1978) and the BCC model (Banker, Charnes and Cooper, 1984). These models are based on the postulates of convexity and free availability of inputs and outputs[4]. What distinguishes the CCR model from the BCC model is that the former considers constant returns-to-scale while the latter considers variable returns-to-scale. We have opted to use the BCC model, given that we do not know the type of returns-to-scale in the firms using KIBS. Besides, variable returns-to-scale postulated by this model allow a more flexible production frontier than that obtained by the CCR model. Moreover, the BCC model establishes comparisons between firms by exclusively measuring inefficiencies due to management, because it establishes comparisons with respect to units that operate on a similar scale, and may be adapted to the individual behaviour of each firm.

[4] The former means that whenever two inputs (outputs) attain a given amount of output (input), any linear combination among them can do it as well. The latter implies that each firm can produce less (the same) output with the same (a higher) level of inputs.

Assuming the existence of variable returns to scale (BCC model; Banker, Charnes and Cooper, 1984), the maximization problem to solve for each one of the considered units of analysis may be formulated in the following way:

$$\begin{aligned} \text{Max} \quad & \phi + \varepsilon\,(1S_r^+ + 1S_i^-) \\ \text{s.t.} \quad & X_0 - S_i^- = \sum_{j=1}^{n} \lambda_j X_j; \quad i = 1,2,\ldots,m \\ & \phi Y_0 + S_r^+ = \sum_{j=1}^{n} \lambda_j Y_j; \quad r = 1,2,\ldots,l \\ & \sum_{j=1}^{n} \lambda_j = 1 \\ & \lambda_j \geq 0, \quad j = 1,2,\ldots,n \end{aligned} \tag{3}$$

where: ϕ is the efficiency coefficient, and $(\phi - 1) * 100$ is the percentage in which the outputs may increase given the level of inputs of each evaluated unit. Thus, when $\phi = 1$, $S_i^- = 0$ and $S_r^+ = 0$ the evaluated unit will be situated on the efficient frontier. Then a specific unit will be efficient when $\phi = 1$, and the slack were $S_i^- = 0$ and $S_r^+ = 0$. Thus we can say that the units are weakly efficient if some slack is different of cero, $S_i^- \neq 0$ or $S_r^+ \neq 0$. Then, S_i^- and S_r^+ are the values between the inputs and outputs can vary being the unit still efficient. λ is the vector of weights pertaining to observations.

With the application of this procedure to the firms' data in our sample, a determination of their efficiency scores can be obtained. The second stage of the analysis will be to check the relationship between these scores and the service consumption behaviour of those firms.

3.2. Second stage: linear regression model

The objective of the second stage analysis is to capture the effect of different elements on the differences in efficiency that are found in the DEA results. In our case we are interested in establishing whether the use or the external consumption of knowledge business services have an incidence on the efficiency indexes of the firms. We intend to do so by way of three different regressions.

Firstly, a general vision can be obtained comparing directly the efficiency indexes to each firm's expenditure on KIBS. First, the ratio KIBS-SPENDING is calculated through the following expression:

$$\text{KIBS SPENDING} = \left(\frac{\text{External KIBS spending}}{\text{Total facturation}} \right) 100 \tag{4}$$

Then, a first picture of the relationship between spending in KIBS and efficiency indexes can be obtained estimating relation (5), which could be applied to all of the firms or to different sectors.

$$[\text{EFFICIENCY}] = a + b\,[\text{KIBS SPENDING}] + \varepsilon, \quad (5)$$

Secondly, a more detailed approach can be applied by means of linear regressions of the efficiency indexes and the different factors which could a priori affect those indexes, using an expression like the following one:

$$[\text{EFFICIENCY}] = a + b_i\,[\text{VARIABLE}_i] + \varepsilon \quad (6)$$

The independent variables that can be included depend on statistical limitations and on the objective of the study. Their inclusion is supported by the analyses of outsourcing trends in Martínez and Rubiera (2006), Rubiera (2005) and Pardos *et al.* (2007). As we are interested in measuring the influence of KIBS use and KIBS outsourcing, our proposal is to estimate two separate regressions. First, we regress the efficiency indexes (EFFICIENCY) on dummies that take the value 1 when the firm declares to use each type of service (USE_i). Secondly, we regress the efficiency indexes on the percentage of each type of service that is purchased from external (EXT_i). Conclusions on the effect of the use and externalization of KIBS on efficiency can be derived comparing the results of these estimations[5].

4. DATABASE

The empirical application of the approach presented in the previous section is hindered by a considerable lack of adequate sources of statistics; therefore, the authors chose to elaborate their own database, in the form of a survey on the use and outsourcing behaviour of firms inside our region of interest.

The geographical scope of the survey was the region of Aragon. The industrial scope was that of the main sectors demanding advanced services (manufactures, services and construction). In 2005 and for the previous year data, a sample survey was carried out on this population, with a random design stratified by sectors and the size of the firm, within the limits of our framework. That is, we tried to use a low level of aggregation in combination with a satisfactory level of representativeness of the selected groups of firms, given the expected low response for a non-official survey. The size of the firm has been measured in terms of workforce, resulting in three groups: those with less than 10 employees, from 11 to 250 employees and more than 250 employees (as for the latter, we surveyed all the

5 Some researches, see for instance Simar y Willson (2007), notice that the second stage analysis could be not consistent because make a regression over contextual variables. Nevertheless, some recent papers, like Banker and Natajaran (2008) defend this procedure and sustain that the regressions, using ordinary least squares or other approaches, perform well.

available firms in the database). The sample size obtained was 413 valid questionnaires, with a sample error of ±4,82% and a confidence level of 95% with $p = q = 0,5$. The firms that replied appear to reflect quite faithfully the characteristics of the population in the variables that we may monitor from the original information[6]. In order to apply the DEA efficiency analysis explained below, the sample is reduced to 179 companies, including all the firms that gave the needed data and excluding outliers with extreme behaviour[7]. Table 1 summarizes the most important features of our sample that are explained in the following paragraphs.

TABLE 1
Main characteristics of the survey sample.

	Number of firms	% on total	Nr. of employees			Average turnover (th. €)
			Average	Maximum	Minimum	
Services	68	38,0	62	1172	1	9807,7
Industry	73	40,8	124	1823	2	23067,8
Construction	38	21,2	24	110,2	2	3326,4
Total	179	100,0	79	1823	1	13499

Source: Own.

To select the level of disaggregation of KIBS we have tried to follow a theoretical base supported in Pardos *et al.* (2007), Martínez y Rubiera (2006) and Rubiera (2005) and to keep it comparable with other empirical studies in Spain (such as the Annual Service Survey of the National Statistical Institute, Rubalcaba (1999) or Martínez *et al.* (2002)), without deepening further in Correspondence NACE codes. As a result, we differentiate seven kinds of KIBS: computer services, advanced business and management consultancy, human resources, engineering and industrial design, research and development, advertising and environmental consultancy (see Table 2).

As for the KIBS consumption pattern in our sample, the only KIBS used by almost all of the firms in our study are computer services, human resources (over

[6] The main differences consist in an under representation of small firms (around 94% in the region as against 34% in the sample; this is an expected result when depending on databases and surveys) and of service firms (75% in the region, 38% in our sample; again linked to size as most of the smallest firms work in services). We think that the latter does not mean that the bias regarding KIBS consumption will be too great, as in a previous work it has been shown that in Aragon it is split in half between industry and service firms (see Pardos and Gómez-Loscos, 2004).

[7] The characteristics of this new sample are identical to the original one in terms of size and sectoral representativeness (as well as age, juridical nature, degree of belonging to a business group, distribution of capital ownership or geographical destination of sales). The main change is the loss of some biggest firms in the sample; although this affects very few of them, it should be kept in mind when interpreting the results.

80% of firms in the sample) and environmental consultancy (to a lesser extent). On the opposite side, R+D are used by less than 20% of Aragonese firms in our sample (Table 3). However, once they have decided to use this kind of services, an overwhelming majority of firms outsource their provision: from 70% of firms for engineering and industrial design to 95% for computer services. R+D is again the exception, since less than 30% of the firms outsource this kind of service. Moreover, the degree of outsourcing is high as well, in one case it covers half of the use of the service (R+D) but it is greater and increasing for the rest, from two thirds in engineering and advanced consultancy up to 90% in environmental consultancy.

Typically, manufacturing firms use more often KIBS than services or construction firms. The portion of users increases with the size of the firm, among the firms that belong to business groups and among exporter companies. The firms with 100% of regional capital use slightly less advanced services than the rest. We interpret these characteristics as a hint that firms that operate in more competitive environments have already assumed the use of KIBS to their productive process, as a means of remaining competitive.

The relative high level of outsourcing is partially explained by the inability of many firms to self-provide the service. This agrees with the observed outsourcing patterns: bigger companies, with better-trained employees, or branches of multinational firms are more capable of producing KIBS by themselves. However, even if the firms can provide the service with a similar quality than the providers, a 40% of them decide to outsource.

Self-providing firms are those belonging to business groups, companies with more than 250 workers, with more college employees (although in less proportion than in the other firms), usually in a manufacturing sector. They sell their products mainly at the national level (as opposed to both the international and regional levels) and have less capital of regional origin[8].

Summing up, the reduced sample is extremely similar to the total. There is no inverted U for the number of firms that use KIBS, but it does appear for outsourcing ones, and the percentage of outsourced services declines with size. Manufacturing enterprises use KIBS more often than the rest (services appear in the last place) but outsource a smaller portion; construction firms outsource more often once they have decided to use, otherwise no clear pattern appears on the total. Branches and headquarters use KIBS more often than the rest but both outsource clearly a smaller fraction; in addition, branches outsource less often than the total while headquarters do the opposite.

[8] It is observed that big enterprises and those belonging to groups outsource more often than the rest, but proportionally less that their expenditure in the service.

TABLE 2
Classification of knowledge intensive business services (*).

[CS] Computer Services	
(72)	Hardware and Software consultancy and supply
	Data processing and data base activities
	Maintenance and other computer services
[Mcs] Advanced Business And Management Consultancy	
(74.11, 74.12, 74.13, 74.14 and 74.84)	Business organization
	Management control
Accountancy, auditing and legal	Strategic planning
consultancy not considered	Economic and financial consultancy
	Foreign trade consultancy
	Logistics consultancy
	Socio-economic studies
	Urban planning consultancy and locating plants
	Quality management
	Market surveys
[Hr] Human Resources	
(74.5) Temporary recruitment	Personnel recruitment and training
agencies not considered	Safety and occupational health
[Eids] Engineering And Industrial Design	
(74.2, 74.4 and 74.84)	Architecture, engineering and another services
	Technical test and analysis
	Quality control
[R&D] Research & Development	
(73)	R&D consultancy
[Adv] Advertising	
(74.4) Advertising leaflets	Advertising, public relations and communications
not considered	Trade fairs, conferences and exhibitions
	Graphic design
[Es] Environmental Consultancy	
(74.7 and 74.84)	Energy saving and waste treatment
Regular refuse collection	
not considered	Environmental impact assessment/correction

(*) In brackets and italics Correspondence NACE Rev 1 codes.

Source: Own.

5. MAIN RESULTS, A FIRST APPROACH

In Table 3 the results of assessing efficiency by means of a DEA approach with a BCC model are presented[9]. The analysis was applied to three different groups of firms: the total survey (all of the firms); the industrial firms, which include manufacturing and construction firms; and the service activities.

With a non-parametric approach of efficiency, as the DEA analysis, the efficient frontier is adapted to the structure of data in each context. Consequently, comparisons between sectors are not possible. Nevertheless, it can be observed that, in terms of efficiency, the service sector presents better indexes than the industrial and construction firms among the Aragonese firms in the survey (Table 4). In fact, the two branches have very different patterns, which imply that when the total sample is analyzed a lower efficiency index is obtained[10]. A deeper observation of the data suggests that service firms are more heterogeneous in their efficiency behaviour, since very efficient firms co-exist with others that present very low indexes in this matter. Among the manufacturing and construction companies, strong differences can also be observed, but the variance is quite smaller than in the service sector.

TABLE 3
Users and outsourcers in the sample (%).

Percentages	Firms that use the service	Users that outsource the service	Outsourcing firms on total sample	Average of service outsourced
Computer services	96,1	95,3	91,6	83,8
Advanced consultancy	39,1	78,6	30,7	66,2
Human resources	78,8	87,2	68,7	83,9
Engin. and industrial design	40,8	68,5	27,9	68,6
R+D	19,6	28,6	5,6	52,5
Advertising	39,7	77,5	30,7	86,7
Environmental consultancy	56,4	78,2	44,1	88,5

Source: Own.

[9] We thank Mª Pilar Quindós for her excellent technical support with the DEA analysis.
10 With regard to this point, see Zhang y Bartels (1998) and Staat (2001).

TABLE 4
First stage analysis: DEA efficiency among Aragonese firms, BCC Model.

	Number of firms	Efficient (%)	Inefficient (%)	Efficiency average (all the firms)	Efficiency average (inefficient firms)
Manufacturing and construction activities	119	10 (8.4)	109 (91.6)	25.9	19.2
Service sector	66	9 (13.6)	57 (86,4)	32.2	21.4
All firms	**185**	**11 (5.9)**	**174 (94.1)**	**22.4**	**17.5**

Source: Own.

The heterogeneity in the service sector efficiency affects clearly the second stage analysis. As can be seen in Table 5 and Figure 2, it is not possible to establish any linear relationship between efficiency scores and relative expenditure in KIBS for the total sample[11]. However, splitting the survey into two groups again, secondary and tertiary activities, makes it clear that the service sector's heterogeneity is the cause of the absence of distinct relationships. Thus, focusing on the analysis of manufacturing and construction firms, there is still a great dispersion of the data but a positive relationship between efficiency and external spending on KIBS can be observed. Although there are some cases of relatively large spending on KIBS which show very low efficiency indexes, as well as other cases of great efficiency indexes with very low spending on KIBS, most of the firms show the expected behaviour: the greater the expenditure on KIBS, the higher is their efficiency.

TABLE 5
Second stage analysis (I): Efficiency scores on ratio of expenditure in KIBS.
[EFFICIENCY] = *a* + *b* [KIBS SPENDING] + ε

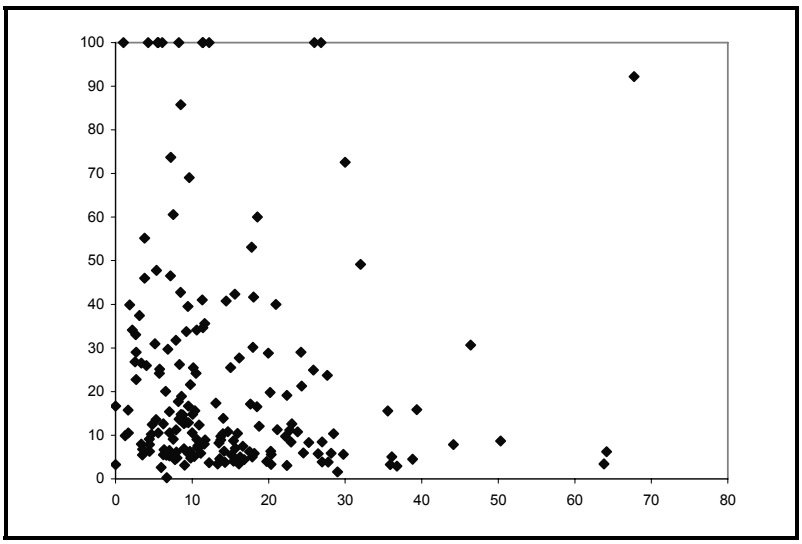
	R^2	*a*		*b*	
		Coefficient	t-Student (p(t) = 0)	Coefficient	t-Student (p(t) = 0)
Manufacturing sector (Industry and construction)	0.082	15.577	2.998 (0.003)	1.158	3.235 (0.002)
Service sector	0.043	41.79	6.626 (0.000)	-0.433	-1.619 (-0.111)
All firms	**0.006**	**25.542**	**8.244 (0.000)**	**-0.173**	**1.044 (0.298)**

Source: Own.

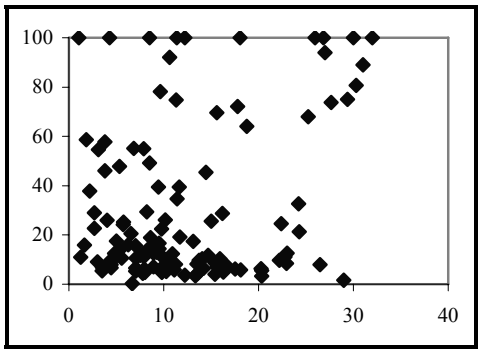
[11] In Table 5 and Figure 2 only the external spending on KIBS is considered. Internal expenditures could not be taken into account in this first approach.

FIGURE 2
Second stage analysis (II): Efficiency scores on ratio of total expenditure on KIBS.

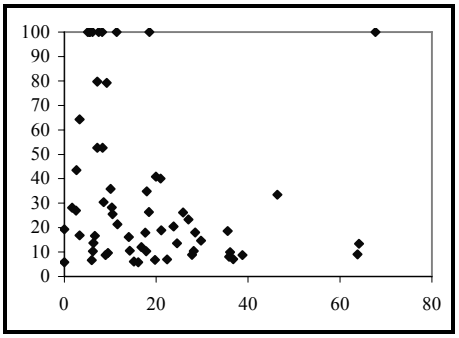
All firms



Manufacturing and construction firms



Service firms



Source: Own.

In order to identify the relevance of each type of KIBS on efficiency, the approach proposed in expression (6) can be adapted to our case study. In expression (6) the general VARIABLE is specified in the form of different variables. The first five are observable characteristics of the firm which, a priori, could be relevant for efficiency: GROUP, a dummy which informs about the belonging of the firm to a bigger business group; FORCAP, foreign capital percentage over the total capital of the firm; PRIVCAP, percentage of private over the total capital of the firm, QJOB, percentage of qualified workers (with a university degree) and DESFOR, the percentage of foreign over total sales. The

rest are either dummies that inform about the use (in the first approach) or the percentage of external provision of each type of service (in the second one). The meaning of each acronym can be checked with Table 2.

$$\begin{aligned}[\text{EFFICIENCY}] = a + b1[\text{GROUP}] + b2[\text{FORCAP}] + \\ + b3[\text{QJOB}] + b4[\text{PRIVCAP}] + b5[\text{DESFOR}] + b6\ [\text{ICTS}] + \\ + b7[\text{MCS}] + b8\ [\text{HR}] + b9[\text{R\&D}] + b10\ [\text{EIDS}] + \\ + b11[\text{ADV}] + b12[\text{ES}] + e\end{aligned} \tag{8}$$

This expression was applied to all the firms, plus to the two earlier mentioned subgroups, service and industry sectors. As can be easily anticipated from the results in Table 5, only the manufacturing and construction estimations give results that are consistent enough to extract basic conclusions from them. Consequently, only the analysis for this branch is presented in Tables 6 and 7.

In Table 6 the effects of the KIBS use decisions are estimated. The dummy variables take the value 1 when firms declare to use each particular service and the value 0 otherwise (see previous section). The use does not imply external consumption of the KIBS. It could be produced internally or it could be acquired totally or partially in the market.

As can be seen, no great conclusions can be extracted from these results. The global significance of the regression is low. Among the variables that describe the firms' characteristics, only the presence of qualified workers increases efficiency and, among the use of services branches, only the Management and advanced consultancy services are significant (although Advertising and communication and Engineering and industrial design are near the accepted significance levels). With these particular exceptions we can consider that the mere use of KIBS does not imply a significant effect on the efficiency of the firm in our sample.

Table 7 reproduces the estimation of (6) but now we substitute the dummies that represented the use of each service with the ratio of external consumption of each KIBS on its total use by the firm. Thus, we try to measure the effects of opting for the outsourcing of advanced business services instead of providing them inside the user firm. With this change a better regression is obtained, globally significant and with a higher R2, though far from perfect.

Now four independent variables are significant, two of them representing the outsourcing of KIBS[12]. Again, and as expected, the presence of qualified workers

[12] Alternatively, the regression was run using dummy variables that take the value 1 if, at least, a 50 per cent of the service is externally provided and 0 otherwise. In this way, we try to observe whether the lack of significance for most of the services under study is due to the existence of some threshold in the outsourcing level, which could be necessary to reap clear benefits from the external provision. The results are very similar to the ones in Table 7, so that we prefer to maintain the latter, which allows for some interpretation of the estimated coefficients.

increases efficiency, but now the export orientation of the firms is also linked to higher efficiency[13], although both of them are only significant at the 10% level.

Advanced management consultancy services are the ones that have a greater and more significant effect on the efficiency of the firm. This is quite logical, since the aim of these services is to improve the firm's government and to give advice on its strategic decisions. Accordingly, both their use and external consumption make the firm more efficient, precisely in the sense that DEA measures efficiency, through differences in the management of the firm. The other kind of business services which appear clearly significant and with a positive effect on efficiency is Advertising and communication services. The mere internal use of these services had not enough influence on efficiency to make them significant in the previous analysis, but their external consumption has a positive and significant incidence on efficiency. Its positive influence is barely less significant than the one from Advanced management, but with a greater estimated coefficient.

Finally, other knowledge intensive business services do not appear as significant at conventional levels, but are close to reaching them. This is the case of the use and outsourcing of Engineering and industrial design, which is understandable in the context of manufacturing and construction firms, with an estimated coefficient in line with the outsourcing of Advertising and communication, but only significant at the 20% level. Nevertheless, the absence of significance in these and other cases does not imply that these services are unimportant to the firm. Their use and external consumption could also be key factors for efficiency in the long run, or for achieving competitiveness. It must be kept in mind that the results shown in this paper focus strictly on the analysis of efficiency in the short run, leaving other considerations for further investigations.

[13] This begs the question of direction of causality. In the literature on exports and growth, there are arguments both in favour of a stimulus to productivity in the firm from its presence in foreign markets through exports (and its externalities in the rest of the economy) and in favour of increasing the firm's efficiency as a pre-requisite for exports. See a recent example in López (2005).

TABLE 6
Second stage analysis (III): Effects of KIBS use on the efficiency levels of manufacturing and construction firms.

$$[EFFICIENCY] = a + b_1[GROUP] + b_2[FORCAP] + b_3[QJOB] + b_4[PRIVCAP] + + b_5[DESFOR] + b_6[MCS\text{-}USE] + b_7[HR\text{-}USE] + b_8[R\&D\text{-}USE] + b_9[EIDS\text{-}USE] + + b_{10}[ADV\text{-}USE] + b_{11}[ES\text{-}USE] + \varepsilon$$

Independent variables		Coefficient	t-Student (p(t) = 0)
		–3.296	–0.107 (0.915)
GROUP	Belonging to a business group	*8.358*	0.908 (0.366)
FORCAP	Percentage of UE or other countries capital in the total capital of the firm	–0.002	–0.009 (0.993)
QJOB	Percentage of qualified workers	0.133	1.973 (0.051)
PRIVCAP	Percentage of private capital on the total capital of the firm	0.226	0.795 (0.429)
DESFOR	Percentage of foreign sales of the firm on total sales	0.137	1.204 (0.231)
MCS-USE	Use of management consultancy services	11.109	1.763 (0.081)
HR-USE	Use of human resources services	0.389	0.038 (0.970)
R&D-USE	Use of research, innovation and development services	–0.389	–0.482 (0.631)
EIDS-USE	Use of technical consultancy, engineering and industrial design services	–11.390	–1.380 (0.171)
ADV-USE	Use of advertising and communication services	5.139	1.504 (0.110)
ES-USE	Use of environmental consultancy services	2.884	0.439 (0.661)
R^2		**0.31**	
Durbin-Watson		**1.91**	
F-Snedecor (p(F) = 0)		**1.492 (0.16)**	

(*) Computer services and information and communication technologies were used by all the firms considered. Therefore, this variable was not introduced in this regression.

Source: Own.

TABLE 7
Second stage analysis (IV): Effects of KIBS external consumption on the efficiency of manufacturing and construction firms.

$$[EFFICIENCY] = a + b_1[GROUP] + b_2[FORCAP] + b_3[QJOB] + b_4[PRIVCAP] + + b_5[DESFOR] + b_6[CS\text{-}EXT] + b_7[MCS\text{-}EXT] + b_8[HR\text{-}EXT] + b_9[R\&D\text{-}EXT] + + b_{10}[EIDS\text{-}EXT] + b_{11}[ADV\text{-}EXT] + b_{12}[ES\text{-}EXT] + \varepsilon$$

Independent variables		**Coefficients**	**t-Student (p(t) = 0)**
		7.474	0.196 (0.846)
GROUP	Belonging to a business group	8.997	1.215 (0.227)
FORCAP	Percentage of UE or other countries capital in the total capital of the firm	–0.040	–0.293 (0.770)
QJOB	Percentage of qualified workers	0.106	1.788 (0.077)
PRIVCAP	Percentage of private capital on the total capital of the firm	0.081	0.292 (0.771)
DESFOR	Percentage of foreign sales of the firm on total sales	0.316	1.747 (0.083)
CS-EXT	External provision percentage of computer services and information and communication technologies	0.188	0.990 (0.331)
MCS-EXT	External provision percentage of management consultancy services	0.119	2.248 (0.033)
HR-EXT	External provision percentage of human resources services	0.750	0.425 (0.674)
ADV-EXT	External provision percentage of advertising and communication services	0.233	2.049 (0.046)
R&D-EXT	External provision percentage of research, innovation and development services	0.031	0.108 (0.916)
EIDS-EXT	External provision percentage of technical consultancy, engineering and industrial design services	0.258	1.439 (0.166)
ES-EXT	External provision percentage of environmental consultancy services	0.378	0.066 (0.948)
R^2		**0.51**	
Durbin-Watson		**1.99**	
F-Snedecor (p(F) = 0)		**1.835 (0.07)**	

Source: Own.

6. CONCLUSIONS

Knowledge intensive business services (KIBS) have become an essential element in the context of present-day knowledge-based economies. Since the late 1990s, there have been significant research efforts directed to this particular type of services offering a better understanding of the way in which these activities contribute to economic development and growth. Nevertheless, very few contributions try to measure the effect of KIBS on the efficiency of firms and none analyses the differences between contracting KIBS externally or producing them internally.

This paper explores the effect of the use and external provision of knowledge intensive business services on firms' efficiency in Aragon. A region where these activities have shown an important increase in last years and with characteristics that allow a better use of KIBS outsourcing, that is, a relevant weight of the industrial sector and a growing presence of the tertiary sector. The database of tertiary and secondary firms makes it possible to apply a non-parametric approach, the DEA technique, to this analysis.

Our results show that in this particular case a linear positive relationship between external spending on KIBS and efficiency levels can be found in manufacturing and construction companies. Searching for more details we find that the mere use of KIBS has no clear effects on efficiency among our surveyed firms. Nevertheless, some particular effects can be observed when some types of these activities are externally consumed, namely that management consultancy services enhances efficiency both through its use and outsourcing, while advertising does so only through its external purchase.

Given these preliminary results, we think it is worthwhile to improve the analysis in order to deepen our understanding of these channels. For example, a potential influence not taken into account in our analysis is the role of different types of KIBS providers and/or their location on the amount and quality of KIBS consumption. Other possibility is making a productivity decomposition using the *Malmquist global productivity index*. As a complementary approach to the one presented in this paper, further analyses could consider longer-run effects of KIBS consumption on efficiency and competitiveness.

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