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MEASURING ALLOCATIVE EFFICIENCY IN CULTURAL ECONOMICS: THE CASE OF FUNDACIÓN PRINCESA DE ASTURIAS

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Measuring allocative efficiency in cultural economics: The case of Fundación Princesa de Asturias*

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ABSTRACT

Literature on Cultural Economics gives us some examples about how to measure technical efficiency. But there is a lack in the case of allocative efficiency analysis. Our aim is to fill this gap incorporating a methodology that analyzes both technical and allocative efficiency. We use the Shepard's distance function, particularly suitable when we face non-profit firms or institutions that are not interested in cost minimization. As an empirical application, we analyze the efficiency of *Fundación Princesa de Asturias* (*PAF*), a Spanish non-governmental organization devoted to promote cultural, scientific and humanistic values of universal heritage, during the period 1988-2012. Our findings suggest that *PAF* could have use 7% less inputs to achieve the same level of outputs. On the other hand, there is no allocative efficiency. *Other expenditures* input has been over-utilized related both to *labor* and *current assets* inputs, and *labor* has been over-utilized related to *current assets*. Moreover, our results indicate that both technical and allocative efficiency have clearly improved during the analyzed period. In summary, our empirical application shows how distance function methodology can be successfully implemented to measure allocative efficiency in cultural firms and institutions.

Keywords: technical and allocative efficiency, stochastic frontier analysis, input distance function, non-profit institutions

JEL classification: L82 – D24 – Z10

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1. INTRODUCTION

The aim of this paper is to measure technical and allocative efficiency in the performance of *Fundación Princesa de Asturias (Princess of Asturias Foundation*, *PAF*), a Spanish non-governmental organization devoted to promote cultural, scientific and humanistic values of universal heritage and, at the same time, to promote and spread the image of Asturias, a Spanish region, all around the world. The paper tries to contribute to literature on efficiency in cultural firms and institutions in different ways. First of all, it measures allocative efficiency, a field that had not been incorporated to Cultural Economics yet. Second, to achieve this goal, this paper applies a stochastic frontier approach estimating an input distance function. This methodology, that it is especially adequate in the case of firms and institutions that not are market-oriented and where the minimizing cost principle can be under question, has been incorporated to measure technical efficiency, but not allocative inefficiency, to the best of our acknowledgement. And third, both in cases of parametric and non-parametric procedures, estimating a frontier function implies to deal with the information coming to a set of firms or institutions involved in the same kind of activity. However, *PAF* is a unique institution and it cannot be compared with any other institution, at least in Spain. This fact adds another challenge to our paper.

In sum, this paper incorporates to Cultural Economics a methodology that analyzes both technical and allocative efficiency by means of a stochastic production frontier model and presents an empirical example developed in the field of non-profit cultural institutions. Moreover, in contrast to OLS, in a stochastic production frontier context the heteroskedasticity problem is potentially more severe, since it can cause biased estimations (Kumbhakar and Lovell 2000). Because of this, we model heteroskedasticity in both error terms of the frontier.

The paper is organized as follows. Section 2 reviews efficiency and productivity literature in Cultural Economics briefly. Section 3 describes *Princess of Asturias Foundation* (*PAF*), the non-profit non-governmental organization subject of our efficiency analysis. Section 4 contents the key theoretical features of the input distance function approach and Section 5 provides the empirical procedure. Section 6 discusses our main results and Section 7 concludes.

2. EFFICIENCY AND PRODUCTIVITY IN CULTURAL ECONOMICS LITERATURE

Efficiency and productivity analysis is a well-established and fertile field of research in Economics. However, it is not so frequent in Cultural Economics. We can track the first attempts to incorporate productivity analysis to cultural firms and organizations in Throsby (1977), who estimated a Cobb Douglas production function for Australian performing arts institutions, or Gapinsky (1980, 1984) and Zieba and Newman (2011) who estimated transcendental production functions applied to performing arts firms in US and United Kingdom and Germany, respectively. Estimating cost functions is an alternative approach that has also been explored by different authors on different areas of culture: Globerman and Book (1974) and Lange et al. (1984) for US symphonic orchestras; Paulus (1993) for French museums; Fazioli and Filippini (1997) for Italian theaters; or Taalas (1997) for Finnish theatres, both using a flexible translog cost function

These first approaches do not consider production and/or cost functions as frontiers and, then, they do not evaluate efficiency in terms of distance from this optimal frontier, as it is commonly considered in efficiency and productivity literature from Farrell (1957) onwards. However, as Kumbhakar and Lovell (2000) pointed out, the information obtained from the estimation of production and/or cost frontiers is more accurate than that derived from research based on average functions, given that the former includes the possibility of not achieving the objective of maximizing output or minimizing costs, respectively. Hence, if there exists a difference between the potential and the observed frontier and it is not taken into account, the estimation of parameters describing technology will be biased.

The frontier can be defined in terms of a production, cost or benefit function, but also through a distance function, the approach we have selected, and can be deterministic or stochastic. The first possibility implies that, when a firm is not on the frontier, it is exclusively due to an inefficient behavior captured by a random disturbance (u). In presence of a stochastic frontier any deviation can be a combination of inefficiency and the presence of certain exogenous effects, like weather or the institutional environment that the firm cannot control. Then, we face a composed error term (v-u) where u measures inefficiency and v incorporates those non controllable shocks.

To estimate frontier functions, there are two general approaches, parametric and non-parametric. Nonparametric methods rather than impose a particular functional form allow the observed data from different firms to define the frontier using an envelope function and starting from some plausible assumptions about production technology. Among the nonparametric techniques, Data Envelopment Analysis (DEA) is the most frequently used also in Cultural Economics. In the area of performing arts, Marco-Serrano (2006) estimated technical efficiency and cost efficiency in the case of Spanish and German theatres, respectively using DEA. But this approach is also frequent in many other fields in Cultural Economics like cultural heritage (e. g. Guccio et al. 2014), libraries (e. g. De Witte and Geys 2011) or museums (e. g. Del Barrio et al. 2009; or Mairesse and Van den Eeckaut 2002 who used Free Disposal Hull technique)[1].

The estimation of parametric stochastic frontiers is a more recent and less frequent technique in cultural economics. This approach implies defining a specific functional form for the frontier but its great advantage, coming from its composed error term, is that allows us to distinguish if a firm is not on the frontier due to inefficiency or the presence of random shocks beyond the agent’s managing possibilities. In 2003, Bishop and Brand opened this alternative estimating a stochastic frontier production function in

[1] For a more detailed overview, see Fernández-Blanco et al. (2013).

the case of British museums. Zieba (2011) estimated a stochastic production frontier applied to a sample of Austrian and Swiss non-profit theaters. Finally, Last and Wetzel (2010 and 2011) introduced a methodological novelty analyzing efficiency, productivity and cost disease in German public theaters through an input distance function.

After this brief review, we have noted that efficiency analysis is present in Cultural Economics both in terms of parametrical and non-parametric methodologies. However, allocative inefficiency has not been explored yet. Our paper contributes to fill this gap using the input distance function approach, a methodology that is particularly suitable for institutions far from minimizing cost behavior.

3. THE PRINCESS OF ASTURIAS FOUNDATION, A NON-PROFIT NON-GOVERMENTAL ORGANIZATION

The *Princess of Asturias Foundation* (*PAF*) is a Spanish non-profit private institution, created in 1980, whose essential aims are to contribute to extolling and promoting those scientific, cultural and humanistic values that form part of the universal heritage of humanity and consolidate the existing links between the Principality of Asturias and the title traditionally held by the heirs to the Crown of Spain.

Along its 35 years of life, the Foundation has used different instruments to achieve these goals. The most powerful and relevant are the Prince (Princess since 2014) of Asturias Awards, yearly conferred and "aimed at rewarding the scientific, technical, cultural, social and humanistic work performed by individuals, institutions, or groups of individuals or institutions in any part of the world, especially in the Ibero-American community of nations" (Princess of Asturias Foundation 2014). These Awards comprise eight categories: the Arts, Literature, Social Sciences, Communication and Humanities, Technical and Scientific Research, International Cooperation, Concord and Sports.

These Awards have concentrated the efforts of *PAF*, attracting more than 60% of its resources in the last years. The Awards have reached 34 editions and have gone growing in terms of number, from six to eight awards, and complexity involving a greater number of international institutions and personalities as participants and awarded.

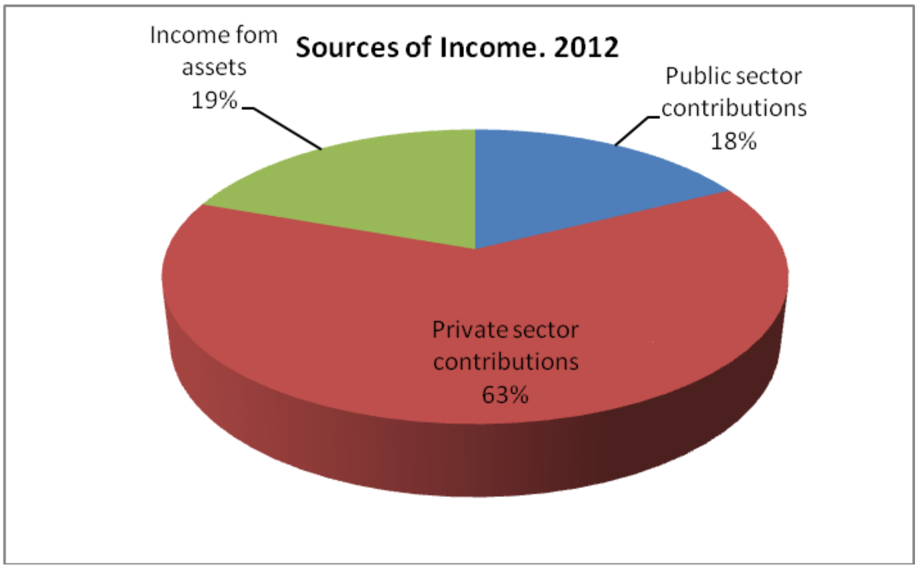
But *PAF* participates also in other aims. It contributes to the promotion of musical activities in Asturias, both in terms of musical concerts and events than developing music education programs[2]. Finally, *PAF* has developed many other activities oriented to develop the cultural environment and abilities in Asturias (scholarships, promotion of rural areas, and arrangement with several institutions like National Geographic or The Moscow Virtuosi Orchestra).

[2] Since 1985, *PAF* manages three choirs and an International Music School, launched in 1990, that offers summer courses, master classes, conferences and seminars. And, from 1992 onwards, *PAF* has scheduled more than four hundred concerts in different towns and villages of the Region.

To summarize all these activities, *PAF* is satisfying some of the standard roles attributed to a nonprofit organization (Moulton and Eckerd 2011), in particular service provision, individual expression and specialization, social capital and community building, and citizen engagement.

The financial figures can help us to draw a better image of PFA. In 2012 its income summed €5.72 million, as the result of a continuous decreasing path beginning in 2008, a 42% decreasing rate during this period. As we can see in Figure 1, 63% of this income comes from private donors and 19% from own assets. This composition is the outcome of a process of increasing relevance of private and own assets income and a serious decrease of public grants, which have been reduced by around 75% in the last five years.

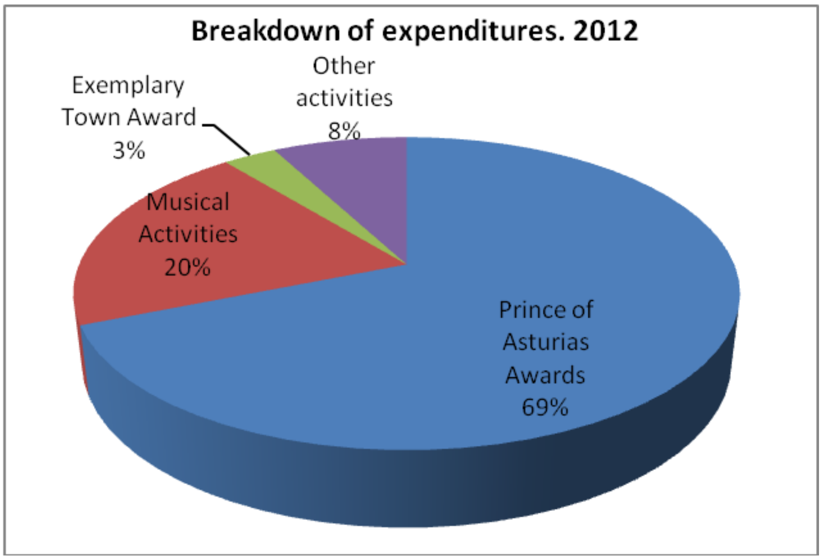
Figure 1



Source: Princess of Asturias Foundation

The total cost of activities carried out by *PAF* summed 5.49 million euros in 2012, with a 24% decrease since 2008. Princess of Asturias Awards concentrates 69% of total cost and its dominance has been increasing during the last years. Musical activities represent 20% of costs, a percentage that is more or less stable in the last years. Finally, any other activity is more or less testimonial in the last years in terms of costs (Figure 2). To summarize, as a result of the recent financial crisis, *PAF* has concentrated its efforts in its Awards.

Figure 2



Source: Princess of Asturias Foundation

4. MEASURING TECHNICAL AND ALLOCATIVE EFFICIENCY: THE INPUT DISTANCE FUNCTION APPROACH

The aim of our paper is to analyze efficiency in *PAF* performance, paying special attention to allocative efficiency, that is, to test if *PAF* is using inputs in optimal proportions, given their respective market prices, the production technology and the desired level of output, or, if this is not the case, what inputs are being relatively under or over-utilized. We use an input distance function in order to analyze the allocative efficiency of *PAF* that has some advantages in contrast to the more popular production function and cost function. First, it is especially suitable in presence of multi-output production. Second, it does not imply cost minimization. And third, it allows obtaining a measure of allocative inefficiency directly and independently of the degree of technical inefficiency.

Independently of estimating a distance function, as in our case, or cost or production functions or even using a non-parametric approach like Data Envelopment Analysis (DEA), measuring efficiency implies to construct an optimal frontier function and calculate how distant our institution (or firm) is from it. Usually, this frontier function is constructed using the information coming from a set of institutions or firms involved in the same kind of activities. However, as we have pointed out above, *PAF* is a unique institution, so we cannot define this set or similar institutions. In this case, the solution is to use the institution own history as source of information[3]. To do this, we have collected all relevant *PAF* economic information during the period 1988-2012, which

[3] This procedure has been successfully implemented in the case of Spanish National Railways (Baños-Pino et al. 2002).

allows us to identify the most successful years of activity as well as detect possible areas for change and improvement.

a) The input distance function

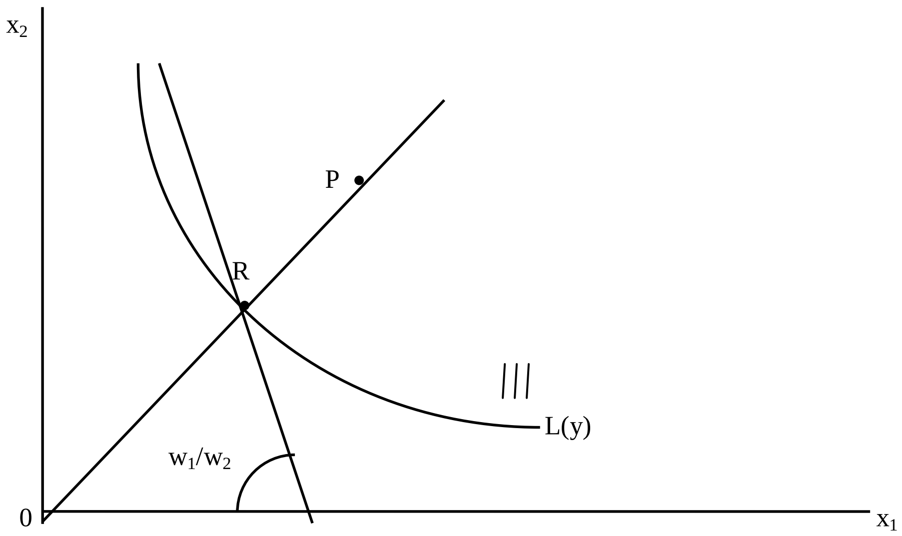
An input distance function is the maximum possible reduction in the inputs vector to achieve a given output level. Formally, given any two vectors *x* and *y*, the Shephard (1953, 1970) input distance function is defined as follows:

$$D_I(y, x) = \max\{\delta > 0: x/\delta \in L(y)\} \quad (1)$$

where y ($y_1 \ldots y_m$) is the vector of outputs, x ($x_1 \ldots x_m$) is the vector of inputs and $L(y) = (x \in R_n^+: x \text{ can produce } y \in R_m^+)$ is the input requirement set. Graphically, and considering a firm that produces a single output (y) with two inputs (x_1 and x_2), the ratio 0R/0P is the Farrell (1957) input-orientated measure of technical efficiency (TE_I) for the point P (Figure 3). It means the maximum proportional reduction that can be achieved in the utilized inputs that allows production of the same quantity of output. Formally,

$$TE_I(y, x) = \min\{\lambda: \lambda x \in L(y)\} \quad (2)$$

Figure 3



The maximum value of this index is one, which would mean that the firm is operating on the isoquant and thus technically efficient. A value lower than one (as can be seen in Figure 3), informs us about the degree of technical efficiency achieved by the firm.

From reciprocal of this index, we obtain the definition of the input distance function, that is, 0P/0R represents the largest scalar (δ) by which all factors can be divided proportionally and continue producing the same output level. Evidently, $x \in L(Y)$, if and only if $D_I(y, x) \geq 1$. If $D_I = 1$, it means that production is technically efficient. A value higher than one informs us about the degree of efficiency achieved.

Since the input distance function is dual of the cost function[4], and following Shepard (1970), we can relate prices and quantities of the inputs by the following dual equations:

Shephard's Lemma: $$x_i^s(y,w) = \frac{\partial C(y,w)}{\partial w_i} \quad (3)$$

Dual of Shephard's Lemma: $$w_i^s(y,x) = \frac{\partial D_I(y,x)}{\partial x_i} \quad (4)$$

where:

$x_i^s(y,w)$ denotes the least-cost input given (y, w)

$w_i^s(y,x) = \frac{w_i^s}{C(y,w^s)}$ is the cost minimizing price given (y, x).

Hence, we interpret w_i^s as the shadow price for x_i. According to Färe and Grosskopf (1990), we can write:

$$\frac{\partial D_I(y, x)}{\partial x_i} = \frac{w_i^s}{C(y,w^s)} \quad (5)$$

That is, the derivative of the input distance function with respect to an input is the normalized shadow price. From this equation, with any two given inputs i, j = 1, 2,…, n, the shadow price ratio is obtained:

$$\frac{\frac{\partial D_I(y, x)}{\partial x_i}}{\frac{\partial D_I(y, x)}{\partial x_j}} = \frac{w_i^s}{w_j^s} \quad (6)$$

Now, if the cost-minimization assumption is satisfied, this shadow price ratio should be the same as the input market price ratio. However, if inputs are not selected in the appropriate proportion, that is to say, if allocative inefficiency occurs, the aforementioned price ratios will differ. To study the quantity and direction of such a deviation, a relationship between the shadow prices (obtained through the distance

[4] The input distance function also satisfies the following properties: is decreasing in outputs, increasing in inputs, homogenous of degree one and concave in inputs.

function) and the input market prices is introduced by means of a multiplicative price correction k_i (Färe and Grosskopf 1990):

$$w_i^s = k_i w_i$$

Dividing this expression by that corresponding to input j we obtain:

$$\frac{w_i^s}{w_j^s} = k_{ij} \frac{w_i}{w_j} \qquad (7)$$

where $k_{ij} = k_i/k_j$

Now, we can calculate the degree to which the shadow prices differ from the market prices. And the direction of such inefficiency can be identified as follows:

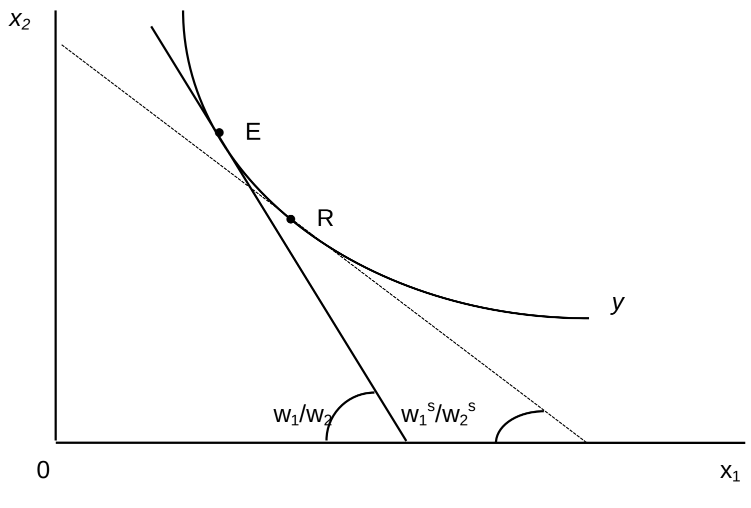
(a) If $k_{ij} = 1$, there is allocative efficiency.

(b) If $k_{ij} > 1$, the factor *i* is being under-utilized relative to the *j* factor.

(c) If $k_{ij} < 1$, the factor *i* is being over-utilized relative to the *j* factor.

Figure 4 contributes to a better understanding of this technique. If we suppose a level of output y and a slope of the isocost, w_1/w_2, point E represents an input combination that is technical and allocative efficient, whereas point R is technical but not allocative efficient. Our procedure defines an isocost (the tangency line of the isoquant in R) whose slope is w_1^s/w_2^s defined as the shadow prices ratio. In this way, comparing both slopes w_1/w_2 and w_1^s/w_2^s we can get a measure of allocative inefficiency.

Figure 4



5. EMPIRICAL PROCEDURE

a) An input distance function proposal

To compute technical and allocative efficiency, once we imposed the homogeneity of degree one in inputs[5] and considering a logarithmic Cobb-Douglas technology, the input distance function to be estimated is

$$-LnX_{1t} = \beta_0 + \sum_{1}^{3} \beta_i Ln\left(\frac{X_{it}}{X_{1t}}\right) + \sum_{1}^{3} \alpha_i LnY_{it} + \chi_D Aniv + \phi_t Time + v_t - u_t \qquad (8)$$

where X is the input vector; Y is the output vector; *Anniv* controls for years when *PAF* held its anniversaries; *Time* is a temporal trend; $u_t \approx N^{+}(0, \sigma_u^2)$ reflects technical inefficiency and $v_t \approx N(0, \sigma_v^2)$ is an error term.

On the other hand, ignoring heteroskedasticity in the composed error term will lead to biased estimations. In particular, not allowing for heteroskedasticity in the random error u causes bias both in the estimates of the parameters describing the structure of production frontier and in the estimates of technical inefficiency. On the other hand, ignoring heteroskedasticity in the inefficiency error term v causes bias in estimates of technical inefficiency (*u* term) (Kumbhakar and Lovell 2000). Because of this, in equation (8) we allow for heteroskedasticity in either error terms (*u* and *v*). Then, we assume that the random error component (*v*) is heteroskedastic with its variance depending on a linear combination of variables (*h*):

$$v \approx iid\ N\left(0, \sigma_v^2\right), \sigma_v^2 = f(h, \phi) \qquad (9)$$

where ϕ is a set of parameters to be estimated.

Also, we model the variance of u as a linear function of a set of covariates *z* that can influence the distance to the frontier, with δ being the set of parameters to be estimated. Increases in the variance represent increases in the distance to the frontier and vice versa (Caudill et al. 1995).

$$u \approx iid\ N^{+}\left(0, \sigma_u^2\right), \sigma_u^2 = g(z, \delta) \qquad (10)$$

Concretely, we are interested to know how the presences of special years in the history of *PAF* and time have impacted on the variance of error terms. Because of this, we model both *h* and *z* as a function of *Anniv* and *Time*. This procedure allows us to analyze the evolution of technical efficiency along the whole time period considered, also taking into account special events such as anniversaries. After estimating equations

[5]Homogeneity of degree one in inputs is a property of the input distance function (see for example Coelli and Perelman 2000). Also, note that in the right-hand side of Equation (8) inputs appear as covariates in a ratio form. Hence, they will be independent of the random error term (see Coelli and Perelman 2000 or Kumbhakar 2011 for details). That is, by imposing the homogeneity of degree one in inputs, we are able to obtain consistent estimates, despite recognizing the possible endogenetiy of the input variables.

(8-10), we can calculate technical efficiency indexes according to the following expression:

$$TE = \exp(-u) \qquad (11)$$

Where, given that $u \geq 0$, the values of the TE indexes range between zero and one. If TE = 1, *PAF* is technical efficient and the closer TE to one, the lesser the technical inefficiency. Moreover, and according to Färe and Primont (1995), the following expression allows us to calculate the scale elasticity:

$$\varepsilon_{\lambda} = \frac{-1}{\sum \frac{\partial \mathrm{D_i}}{\partial \mathrm{y}} \mathrm{y}} \qquad (12)$$

Where $\frac{\partial D_i}{\partial y}$ is the first order coefficient of the distance function respect to outputs vector. If the scale elasticity is higher (lower) than one, we face increasing (decreasing) returns of scale; obviously, if it is equal one, we face constant returns of scale.

b) The data

Our aim is to analyze efficiency in *PAF* along the period 1988-2012. To do so, we have collected all the available information in terms of inputs applied and outputs produced. It is true that we have only twenty five years and it could be considered a short time series. Nevertheless, we should also consider that we have the complete dataset that documented the history of *PAF*.

It is clear that PFA is a non-market oriented institution. This fact influences seriously how to measure and evaluate its behavior. In this sense, our first challenge is to identify the output. As in any other cases, we could think in monetary or physical measures, which have advantages and difficulties. As far as physical measures are concerned, the numbers of visitants or attendees are frequently considered as good measures of output (Stiglitz et al. 2009). Nevertheless, in the case of *PAF*, we face at least two obstacles. On the one hand, the main activities of *PAF* are not oriented to be delivered as a show. It is true that there is an official ceremony of Princess of Asturias Awards but, for institutional reasons, it is not open to public in general. Attendants are members of local, regional and national administrations, people representing firms and institutions sponsoring *PAF* and the civil society in general. There are other activities related to these Awards but many of them, like public parades, sports demonstrations, open conferences, etc., can be hardly measured through the number of participants. This applies also to most of the other activities organized by *PAF*. And, finally, some of them are developed in villages and small towns with the goal of approximating cultural events to these areas and, hence, the number of attendants is not really a good measure of such activities: in many cases a little number of attendants is really a big social success. In order to tackle these issues, we propose to employ monetary measures which are homogeneous and then facilitate comparisons. This alternative implies to consider that we are not in presence of X inefficiency (Leibenstein 1966) that means that all people working in *PAF* is fully committed to the objectives of the institution and apply their optimal effort to achieve the *PAF* aims. It may be a reasonable assumption if we consider the history and nature of the PAF which, as mentioned above, is a non-profit institution whose essential aims are to contribute to promoting scientific, cultural and humanistic values.

In any case, there is something we have to take into account when offering and empirical measure of output: *PAF* produces a multiple output and we have to introduce some weights in order to achieve an accurate evaluation of how its resources have been used. Because of this, we have considered three activities or outputs *Prince of Asturias Awards* (PPA), *Musical Activities* (AM) and *Other Activi*ties (OAC). How to measure these outputs is really a great challenge due to their own nature. As we have pointed out above, we cannot use the usual measures like number of visitors or attendants, total revenues, number of events or performances. In this situation, and as a first approach to a more accurate measure, we propose to measure those outputs using the amount of budget expenditure compromised to each one of those three activities every year of our time period.

We have considered three inputs: *labor* (L), *current assets* (K) and *other expenditures* (OG). *Labor* is the number of employees[6]. *Current assets* have been measured through depreciation expenses excluding building depreciation. *Other expenditures* incorporates those expenditures not included into current assets depreciation or labor expenses, particularly expenditures in outsourced activities. Table 1 displays the main descriptive statistics.

Table1
Descriptive statistics 1988-2012

Variable	#Observ.	Mean	Stand. Dev.	Min	Max
PPA	25	2669304	831647	1408987	4121670
AM	25	558314	397863	238714	1801443
OAC	25	1287957	1225457	206287	5200049
L	22	18	8	9	34
K	25	123174	103945	29789	403681
OG	25	3747926	1061626	2085990	6241177
TIME	25	13	7	1	25

[6] We have not distinguished between temporary and permanent personnel or different professional categories. Since we have no labor data for the first three years of our period, the final number of observations implied in our estimations is 22.

6. EMPIRICAL RESULTS

a) Technical efficiency

Equations (8) - (10) have been estimated using maximum likelihood procedure. Table 2 displays the estimated parameters of the input distance function.

Table 2
Input distance function estimated

Variable	Coefficient	t-statistic
INPUTS		
Ln(L)	.3193	4.68***
Ln (K)	.5553	4.35***
Ln (OG)	.1248	2.12***
OUTPUTS		
Ln(PPA)	-.5599	-7.67***
Ln(AM)	-.2303	-5.87***
Ln(OAC)	-.2169	-28.31***
Time	-.0170	-1.36
Aniv	.0130	1.29
Constant	.1444	4.89

Number of observations = 22. *** Statistically significant at 1%; ** statistically significant at 5%; * statistically significant at 10%.

The input and output variables are in the form of deviations with respect to their means. Then, the first-order coefficients of the distance function can be interpreted as elasticities at the sample mean. All these first order coefficients are statistically significant, and with the expected sign; hence, the estimated input distance function, at the sample means, fulfils the regularity conditions: it is non-decreasing in inputs and decreasing in outputs.

The impact of the variables trend (*Time*) and special events (*Anniv*) is not significant at the frontier. However, these variables explain heteroskedasticity in the error term. Concretely, results obtained from the analysis of heteroskedasticity in the random error term v (Equation 9) are presented in Table 3. *Time* increases heterokesdasticity in the v residual. This may be explained by the fact that the activity of *PAF* in the first years can be affected by more variability and as time went by, the activity became more centered on its tree main outputs.

Table 3
Heteroskedasticity of the random error term v

Variable	Coefficient	t-statistic
Time	-2.1059	-1.82*
Anniv	-12.8525	-0.02
Constant	-20.3324	-1.92*

Number of observations = 22. *** Statistically significant at 1%; ** statistically significant at 5%;
* statistically significant at 10%.

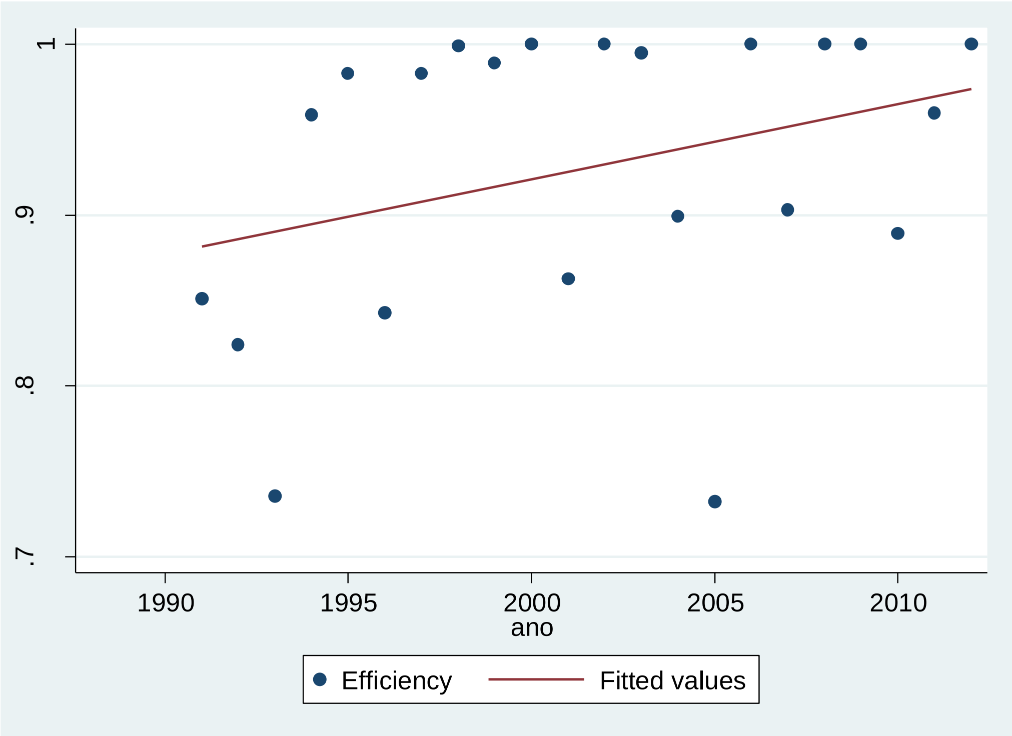
To explain the variance of the *u* error term, (Equation 10) we have included the same set of variables as in the case of the *v* error term. Table 4 displays the estimated coefficients. Let us recall that increases in the variance of *u* represent increases in the distance to the frontier (and vice versa). The *Anniv* dummy variable coefficient is positive and statistically significant, which means that PAF has required more resources to deal with special activities and events in those special years. Finally, the negative and statistically significant coefficient of *Time* means that PAF has improved its efficiency along the period considered (time reduces the distance to the frontier). In sum, we conclude that PAF has experienced a "learning by doing" effect. This conclusion is reinforced with Figure 5 that displays the positive evolution of technical efficiency along the period.

Table 4
Heteroskedasticity of the random error term u: Determinants of inefficiency

Variable	Coefficient	t-statistic
Time	-.1305	-1.76*
Anniv	2.1513	2.00**
Constant	-4.5223	-8.59***

Number of observations = 22. *** Statistically significant at 1%; ** statistically significant at 5%;
* statistically significant at 10%.

Figure 5
Technical efficiency evolution



From this estimated input distance function, and using Equation (11), we calculate the correspondent technical efficiency indexes (TE). On average, the value of the TE index is around 0.93. Table 5 displays a summary of the results obtained.

Table 5
Technical efficiency (TE) indexes (Summary)

Variable	#Obs.	Mean	Stand. Dev.	Min	Max
Technical Efficiency	22	.9276	.0807	.7320	1

Finally, elasticity of scale is 0.993, also statistically significant. Although it is closer to one, this value indicates that, on the sample mean, the *PAF* presents small decreasing returns of scale[7].

b) Allocative efficiency

As we have discussed above, the distance function technology allows us to compute allocative inefficiency. To do this, and from the estimated input distance coefficients, we can calculate the k_{ij} coefficients, defined through equations (6) and (7) and displayed in Table 6. We can see three different coefficients: $K_{L,K}$ means the relative allocation

[7] The test of constant returns of scale, that is the sum of the three output estimated coefficients equals one, implies a value $\chi^2(1)$=2340. Then, the hypothesis of constant returns of scale can be rejected at a 1% significance level.

between *labor* (L) and *current ass*ets (K); $K_{L,OG}$ represents the relative allocation between *labor* (L) and *other expenditure*s (OG); and $K_{K,OG}$ incorporates the relative allocation between *current assets* (K) and *other expenditures*(OG).

Table 6
Estimated allocative efficiency

K_{ij} Coefficient	**Mean**
$K_{L,K}$	0,26
$K_{L,O}$	2,11
$K_{O,K}$	0,12

$K_{L,K}$ is below one that means that *labo*r is being over-utilized with respect to *current assets*. $K_{L,O}$ is above one so, now, *other expenditures* input is being over-utilized with respect to *labor*. Finally, since $K_{O,K}$ is also below one, *other expenditures* input is over-utilized with respect to *current assets*. In sum, *other expenditures* input has always been used over its optimal level. Hence, any improvement in allocative efficiency implies to reduce its relative participation. On the other hand, *current assets* input has always been under-utilized, so this input should increase its relative presence related to the other inputs, although this policy needs time surely.

The k_{ij} coefficients in Table 6 represent the average value corresponding to the analyzed period. This information can be complemented with their time evolution (Figures 6, 7 and 8). In all the cases, we see that allocative efficiency coefficients have moved towards efficiency, especially in the last years of the period. After a more or less stable stage during the first years, *current assets* input (K) has improves continuously with respect to *labor* (L) and *other expenditures* (OG), although it is far from the efficient allocation. Finally, *labor* (L) has improved seriously its position related to *other expenditures* (OG) and, at the end of the period, $K_{L,O}$ has decreases around five times and is closer to the optimum level. This result reinforces the idea that *PAF* has made special efforts to adequate inputs to the appropriate level according to its cost saving focus given the output level. Obviously, the best results are obtained on those cases where inputs are easier to manage.

Figure 6
K_{lk} coefficient evolution

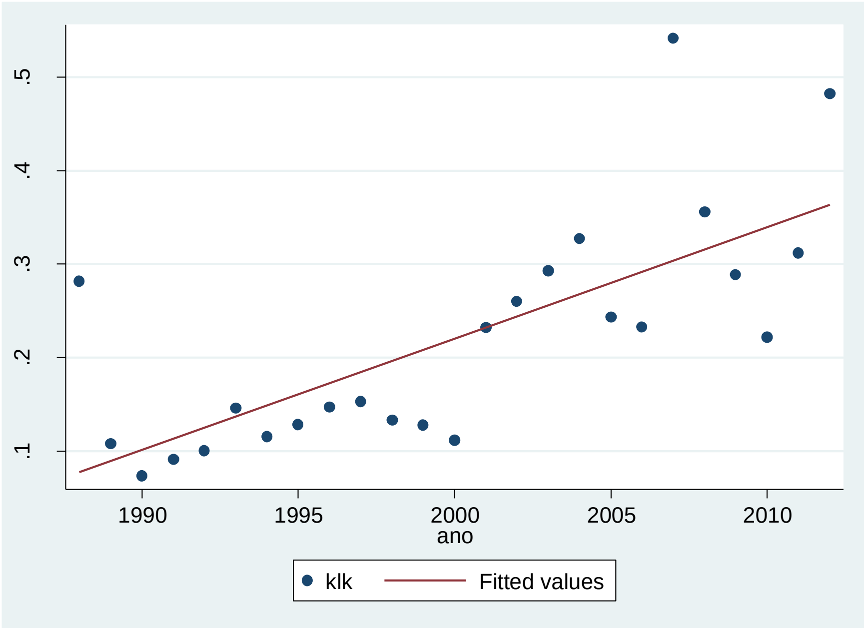


Figure 7
K_{lo} coefficient evolution

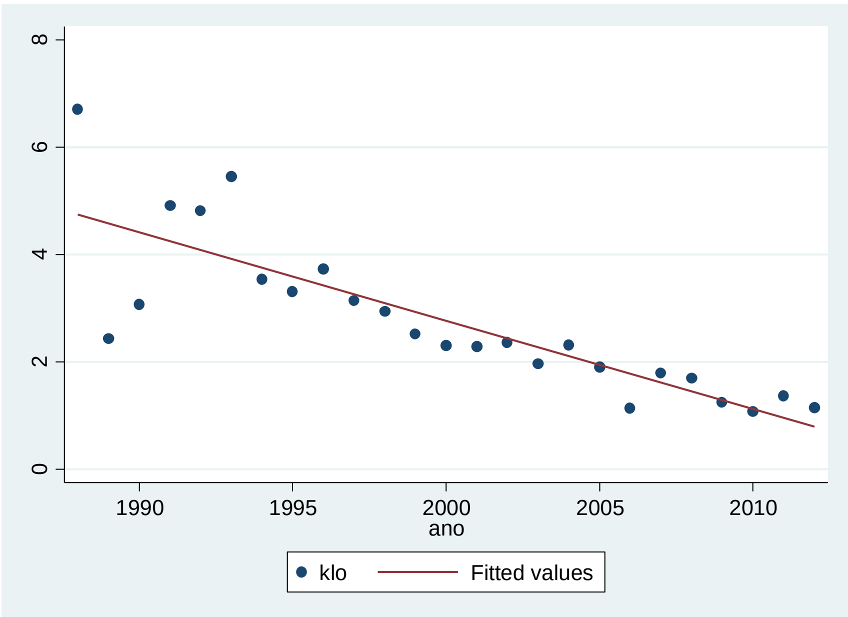
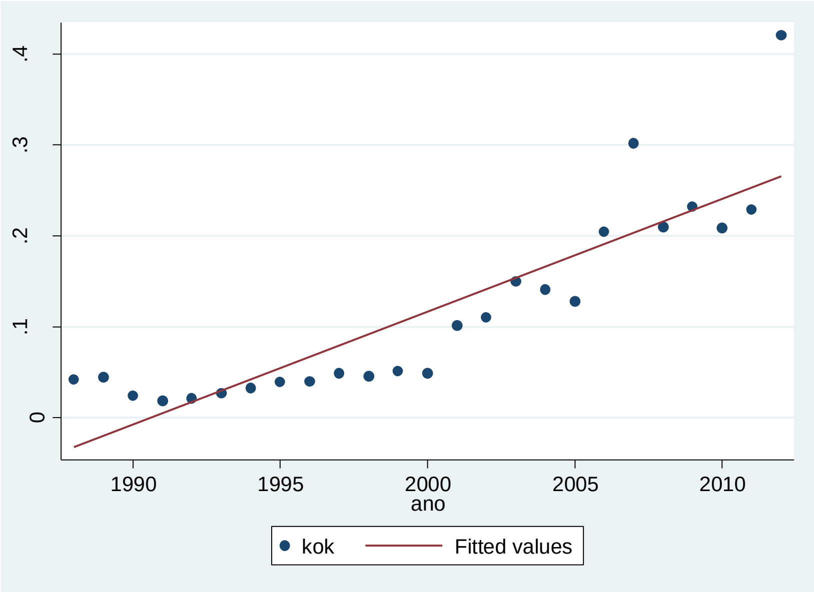


Figure 8
K_{ok} coefficient evolution



7. CONCLUSIONS

Nowadays efficiency and productivity analysis is a relatively common research field in Cultural Economics and it is offering interesting results in different areas like museums or performing arts firms, for instance. Both parametric and non-parametric procedures have been applied to measure technical efficiency successfully. However, there is a lack in terms of allocative efficiency analysis. To fill this gap, our paper proposes a new methodology based on Shepard's distance function that allows measuring both technical and allocative efficiency. This methodology is particularly suitable when we face non-for profit firms or institutions that are not interested in cost minimization. This is just the case of our empirical application that offers an example of how this technique works. We analyze efficiency in the performance of *Princess of Asturias Foundation* (*PAF*) during the period 1988-2012. This is a Spanish non-governmental organization devoted to promote cultural, scientific and humanistic values of universal heritage, especially through the Prince (Princess since 2014) of Asturias Awards that reward scientific, technical, cultural, social and humanistic work in any place of the world.

Using the cumulative history of *PAF* during the period considered, we estimate an input distance function, in a multi-output production framework, that allows achieving different outcomes. First, we compute technical efficient indexes. And second, after obtained the shadow prices of inputs that would satisfy the condition of minimum cost, we use them to calculate the degree of allocative inefficiency of *PAF* and its origin by using a parametric correction of prices (k_{ij}).

Related to technical efficiency, the average technical efficiency index is 0.93 that means that *PAF* could have used 7% less inputs to achieve the same level of outputs. Furthermore, technical efficiency has been improved during the analyzed period.

On the other hand, there is no allocative efficiency. *Other expenditures* input has been over-utilized related both to *labor* and *current assets* inputs, and *labor* has been over-utilized related to *current assets*. However, we have identified a clear improvement in inputs allocation, especially in the last years of the period.

In sum, our paper contributes offering a new procedure, and an empirical application, to facilitate the analysis technical and allocative efficiency in Cultural Economics in general, and in a non-for profit scheme, in particular.

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