Do public funds increase the efficiency of the Italian theatres?

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Abstract

In Italy, as in many other European countries, the performing arts (PA) are publicly subsidised. Italian PA subsidies are ensured by a Parliamentary Law that in 1985 established the Fund for the Performing Arts (FUS). The main aim of this research is to measure the impact of the FUS allocation to technical efficiency of Italian performing arts firms, since firms that receive less or no public funds can be either more or less efficient. In the first case in order to stay in the market, in the second case because public funds guarantee more cash to them. Data are derived from the AIDA dataset carried out by Bureau van Dijk and from the annual relationship of the *Fondo Unico per lo Spettacolo* over the period 2006-2014. The results obtained using different stochastic frontier estimation techniques confirm our hypotheses based on factors (capital assets, labour cost) and firm characteristics (size, age and area). The impact of public funds on the technical efficiency of the theatrical firms is positive, than since theatre efficiency could be increased by around 30%, policy makers could take work on public incentives.

1. Introduction

In the last years there has been an increasing attention to the firms' performance in the cultural sector, by studying both firms productivity and firms technical (in)efficiency in different cultural activities. The determinants of technical efficiency have been studied for theatre (Fazioli and Filippini, 1997; Taalas, 1997; Zieba, 2011; and Zieba and Newman, 2013), museums (Mairesse and Vanden Eeckaut, 2002; Bassi and Funari, 2004), performing arts sector (Castiglione, Infante and Zieba, 2016), and public historical archives (Guccio et al., 2014). The last two works also refer to Italy.

In the last years, a lot of attention is devoted to the subsidisation of the cultural sector in different countries, especially due to the crises of the public finance. In Italy, the subsidisation of the "entertainment sector" is ensured by a Parliamentary Law (n.163), approved on the 30 April 1985, that established the Fund for the Performing Arts (Fondo Unico per lo Spettacolo-FUS). The intention of the government was to insure stability and continuity for all cultural activities via the FUS. However, the crises of Italian public finance and the consequent reduction of subsidies have made the use of public resources a central theme, especially in the management of opera houses (Castiglione and Infante, 2017).

Despite the importance and the discussion on the public funds there is a lack in the empirical literature to measure the impact of public funds on the performance of firms operating in the cultural sector. By using a panel of 168 Italian firms over the period 2006-2014, the aim of this work is to fill this lacunae and to empirical measure the impact of subsides on the efficiency of a set of Italian cultural firms (Lyric-Symphonic Foundation, Theatre of Tradition, Lyrics, Permanent Public Theatres, Permanent Private Theatres, Permanent Innovative Theatres, Theatre Companies) that are subject to publish the balance sheet data.

To reach this aim we apply the stochastic frontier approaches (SFA), in particular those developed by Aigner et al. (1977), Battese and Coelli (1995), and Greene (2005) which in contrast to non-parametric techniques, such as the DEA method, recognise not only the technical inefficiency component (deviations below the optimal output level) but also the fact that random shocks beyond producers' control may affect the production output. Estimation of technical efficiency using SFA allows us not only to appraise technical efficiency scores but also to measure output elasticities and returns to scale of the theatrical sector. As highlighted by Castiglione, Infante and Zieba (2016) performing arts companies in Italy are very heterogeneous with regard to localization, size, quality and institutional setting of the firm. The companies may operate in different regions with various environmental factors and characteristics that are only partially observed. Thus, we apply, similarly to Pieri and Zaninotto (2013), and Castiglione, Infante and Zieba, (2016), the SFA techniques of Greene (2005) that control for the unobserved heterogeneity that is not related to the (in)efficiency but rather to the specific characteristics of the firms.

The remainder of the paper is structured as follows. Section 2 introduces the literature to which this work refers, section 3 describes the economic model setting, whilst section 4 briefly presents the dataset. Section 5 encompasses the methodology and the empirical approach used to evaluate technical efficiency, and section 6 focuses on the results. Some conclusions are presented in Section 7.

2. Literature Review

In the current literature there are some works that focus on technical efficiency in the PA sector. Taalas' (1997) results suggest that, in managing Finnish theatre, inputs are not combined in optimal proportions in light of prevailing market prices, the relative shares of inputs utilisation vary when output expands, and there are scale economies in the production of theatrical performances. While Zieba (2011) demonstrates that theatre efficiency estimates are very sensitive to the unobserved heterogeneity of Austrian and Swiss theatres, Zieba and Newman (2013) confirm that the organisational structure has an important impact on technical efficiency of German public theatres. Mairesse and Vanden Eeckaut (2002) focus on a network of French-speaking regional museums in Belgium. Their results are not univocal. They observe that the same museums can react in very different ways, being efficient in one model and not in another. Two other studies focus on specific Spanish cultural organizations. Fernandez-Blanco and Rodriguez-Alvarez (2015) measure the allocative efficiency of the *Fundación Princesa de Asturias*, a Spanish non-governmental organization devoted to promoting cultural, scientific and humanistic values of universal heritage. Their results indicate that, although the *Fundación* is not efficient (the same output could be produced with less inputs), both technical and allocative efficiencies have clearly improved during the analysed period. Marco-Serrano (2006), using data on the *Theatrical Circuit of Valencia*, a Spanish regional theatres network, develops the concept of managerial efficiency and applies a non-parametric Data Envelopment Analysis (DEA) method. The author finds decreasing trends for the managerial efficiency, caused by the progressive incorporation of new municipal theatres into the network, due to either the existence of a saturation point or because these incorporations drastically affect the structure of the cultural production frontier.

For what concerns Italy, in the cultural sector, the attention has been limited to few works and devoted to local institutions (theatre and museum) and to public historical archives (Guccio et al. 2014). Fazioli and Filippini (1997), using data on 28 Italian theatres, localized in the Emilia Romagna region, demonstrate the presence of economies of scale and scope. Their results provide evidence to the effects that theatre shows which are already prepared should be more frequently given in different locations. Bassi and Funari (2004) focus on a set of municipal museums localized in three Italian cities: Bologna, Florence and Venice. Their results show that four out of the fifteen museums have a DEA index equal to one and therefore can be considered as relatively efficient. Within the cultural institution, Guccio et al. (2014) analyse the public archives as a primary source for historical research exhibiting quite interesting features from an economic point of view. To address such an issue the authors use a nonparametric approach to measure the efficiency in the production of archival services, and find that there are wide margins for improving Italian public historical archives average efficiency.

3. Economic model

The main aim of this work is to measure the impact of public subsidies on Italian theatres technical efficiency (TE) using a stochastic production frontier approach, by estimating a translog production function. In order to estimate TE for the Italian theatres, the stochastic production frontier model firstly proposed by Aigner et al. (1977) is used. Expressing output and inputs in natural log values, the translog stochastic production frontier can be written as:

$$\ln(Y_{it}) = \alpha + \beta_K \ln K_{it} + \beta_L \ln L_{it} + 0.5\left[\beta_{KK}(\ln K_{it})^2 + \beta_{LL}(\ln L_{it})^2\right] + \beta_{KL} \ln K_{it} \ln L_{it} + d_t + v_{it} - u_{it} \qquad \text{Eq. (1)}$$

where Y_{it} is the real output (total revenues) of the i^{th} theatrical firm in year t ($i=1,2,\ldots,N$ and $t=1,2,\ldots T$), K_{it} and L_{it} are the capital (total assets) and labour (number of employees) inputs used in the artistic production. d_t is the dummy variable for each year that might cause the shift in the production function, v_{it} is the statistical noise term with zero mean and constant variance, and $u_{it} \geq 0$ is a non-negative one-sided inefficiency term which follows a half-normal distribution so that $u_{it} \sim N^+\left(0,\sigma_u^2\right)$. The parameters of the model in Eq. (1) are estimated by maximum likelihood (LM) and the inefficiency term is computed using the technique of Jondrow et al. (1982). Moreover, given the logarithmic functional form in Eq. (1), the technical efficiency index (TE) for firm i in year t, is predicted as:

$$TE_{it}=exp(-u_{it}) \qquad \text{Eq. (2)}$$

and it is bounded by zero and one. A score of one means full technical efficiency, whilst a score less than one means that the firm is inefficient for the given technology, and it could increase its output level without increasing the level of inputs.

A further aim of this work is to verify the impact of public subsidies on TE of performing arts companies controlling for firm' size, age, wage and firm's location, which in the Italian performing arts sector may be considered as factors affecting firm performance:

$$u_{it}=f(Subsidies_{it},Size_{it},Age_{it},Wage_{it},Area_{i}) \qquad \text{Eq. (3)}$$

where $Subsidies_{it}$ indicates the amount of public funds received by the firm, $Size_{it}$ is firm's size: *micro* if the firm has 0-9 employees, small if the firm has 10-49 employees, middle sized if the firm has 50-249 employees, and large if it has more than 250 employees; Age_{it} is the age of the firm in years, $Wage_{it}$ is the log of the unit cost of labour incurred by the firm and is a proxy for quality and competences; and $Area_{i}$, indicates the dummy variables for the four Italian macro territorial areas (*North_West*, *North_East*, *Centre*, and *South and Islands*).

All inputs and output are divided by their means before including them in logs in the translog production frontier in Eq. (1). Consequently, the expected sign for the first order β-coefficients is positive as they denote the output elasticities with respect to each of the inputs, evaluated at the means of the data. For the δ-parameters (in the inefficiency equation) the economic theory is taken into account.

Public subsidies were introduced in the performing arts sectors after the seminal paper of Baumol and Bowen (1965) on the cost disease afflicting this sector. Many governments introduced a law to sustain the performing arts. However, since the introduction of these subsidies, economists had different point of view on the overall influence of public subsidy on technical efficiency performing arts firms. Public funding may be correlated, for example, with higher expenditures on more talented artists that would turn in increasing quality and hence in the output of the firm. On the other side, the standard argument could also apply that public funding might have an adverse effect on the incentives of the theatre management and the employees to be efficient (see Bishop and Brand, 2003).

In the economic literature, firm performance is also depending on firm size that may affect its efficiency. However, this relationship is not well acquainted since empirical evidence suggests mixed results with regard to the link between efficiency and firm size in either direction. Diaz and Sanchez (2008) assert that whilst a positive effect may be expected due to the economies of scale, the firm size may be negatively linked to efficiency if large firms experience management and supervision problems. On the other side, Jha et al. (1998) find that large firm size is associated with higher technical as well as allocative efficiency. These mixed results may be influenced by technology and sector characteristics. However, since we are analysing a sector where the technological progress is scarce and the Italian performing arts sector is largely composed of small and medium theatres, we expect that the efficiency of theatrical sector is positively influenced by small and medium size.

We also test whether older firms are more efficient than younger ones. According to Castiglione (2012) a positive relationship between age and TE can be expected due to 'learning by doing' which occurs through production experience. Over time, firms become more efficient as a result of a growing stock of experience in the production process. However, other economists argue that when an innovation is introduced, older firms may have to delay adoption as it may be too costly to substitute old methods, thus implying that efficiency may decrease with age. At the Italian level, Castiglione and Infante (2014) find a positive effect of age on firm efficiency for the manufacturing sector.

A company is efficient if it has also quality and competences that can be recognized through the *Wage* variable in the inefficiency equation. Labour is the factor that prevails in the performing arts production processes and may positively influence company efficiency. In our model we take also into account the characteristics of the Italian cultural sector. According to Castiglione and Infante (2016), the theatre market is characterised by important differences across the Italian regions, both from demand (i.e. numbers of tickets sold) and supply (i.e. number of theatres and performances) factors.

4 Data

To estimate the (in)efficiency of the Italian theatre, we use an unbalanced panel of 168 Italian firms for the period of 2006–2014. The data were collected from two sources: the *Analisi Informatizzata delle Aziende* - Computerized Analysis of Firms (AIDA), and from the Ministero dei Beni delle Attività Culturali e del Turismo (MiBACT) (2014).

The AIDA database is carried out by Bureau van Dijk and contains detailed accounts following the scheme of the 4th Directive EEL, indicators and trade description of Italian companies, divided by economic sector and geographical area. Other information includes year of incorporation, ownership and number of employees. After matching the data from the AIDA and MiBACT we obtained a 168 theatres, for a total of 1512 observations, belonging to the following categories: Lyric-Symphonic Foundation, Theatre of Tradition, Lyrics, Permanent Public Theatres, Permanent Private Theatres, Permanent Innovative Theatres, Theatre Companies.

Information on output, inputs and other firm-level characteristics are from the AIDA dataset. The number of performing arts firms with non-missing values for output and inputs and non-zero turnover, amounted to 148 firms, which forms an unbalanced panel data with 723 observations. Output (*Y*) is measured by the amount of revenues from sales and services at the end of the year; labour input (*L*) is measured as the total number of employees at the end of the year; and capital stock (*K*) in a given year is proxied by the nominal value of total fixed assets which includes both tangible and intangible assets. Both output and capital stock were deflated using Consumer Price Index (CPI) published by ISTAT (2015).

Data on the public subsides are taken from the annual relationship on the Fund for the Performing Arts (FUS) for the years 2006-2014. We have choosen from this relationship the firms that are subject to present the balance sheet data, and hence are present also in the AIDA database.

According to the MiBACT Annual Report (2014) the FUS (at 1985 constant values) has decreased continuously from an initial allocation of €357,480,000 at its start in 1985 to a recent all time low of €162,510,000 in 2014, representing an overall decrease of 55% since the fund was created (Figure 1). In 2014, the FUS allocation was divided in varying proportions between the different performing arts and cinema activities. Given the centuries-old Italian tradition of "bel canto", the Opera Foundations received 45.6% of the 2014 FUS budget, followed by cinema (20.7%), music (14%), dance (2.6%) and circus (1.3%). Theatre and drama activities received 15.7% of the total annual allocation. The FUS contributions to theatres and companies are allocated according to quantitative (mainly production and running costs) and qualitative (mainly multiannual activity, artistic direction, innovation) criteria. To receive a contribution from the FUS, an Italian performing arts company must present a final report on the work performed, independent of box office revenues and spectator numbers (Figure 2).

Table 1 includes definitions of all variables and sources of data, whilst Tables 2 provides the sample summary statistics of the variables used in the analysis. According to Table 2, there is a considerable variation in output and inputs about their means. The efficiency determinants which are continuous variables and affect the variability and hence the mean of the inefficiency are also presented in Table 2. The average *Age* of the firm is about 21 years with zero being the minimum age. The *size_1* variable indicates that the very small theatres with less than 10 employees account for 20% of the observations in our sample, whilst the small firms (10-49 employees, *size_2*) account for more than half of the observations in our sample (65%), followed by the middle-sized firms (*Size_3* which is 50 to 249 employees) and by only 6% of companies, finally large companies, with more than 250 employees, account for 9.4%. Finally, the area in which the theatre companies are located as the population are roughly equally distributed among the four large different regions in Italy.

5. Estimation method

To estimate the technical efficiency of the Italian theatres, we apply the stochastic production frontier panel data model of Greene (2004, 2005) which is an extension of the original stochastic frontier approach (SFA) proposed by Aigner et al. (1977). Greene proposes a 'true' random effects (TRE) approach that integrates into original SFA model presented in earlier section, the firm-specific random component that is not related to the (in)efficiency but to the unobserved heterogeneity of the firms. Assuming the log-linear form of the translog production function specified in Eq. (1), the TRE stochastic production frontier model can be written as:

$$\ln y_{it} = w_i + d_t + f(x_{it};\beta) + v_{it} - u_{it} \qquad \text{Eq. (4)}$$

where $\ln y_{it}$ is the log of observed output (revenue) for firm *i* in year *t*, and x_{it} is the vector of inputs (in logs); β is a *J x 1* vector of the corresponding production function parameters, including the constant that is common to all firms. As regards the model parameters, v_{it} is the statistical noise term with zero mean and constant variance, $u_{it} \sim N^+(0, \sigma_u^2)$ is a non-negative stochastic term representing inefficiency of firm *i* in year *t*; and $w_i \sim N^+(0, \sigma_\alpha^2)$ represents a time-invariant, firm-specific random intercept which captures the unobserved heterogeneity, and d_t are the time-fixed effects. Both v_{it} and u_{it} can be expressed as a two-part composite error that is: $\varepsilon_{it} = v_{it} - u_{it}$ which is not normally distributed.

For the TRE model the inefficiency term, u_{it}, is computed as the simulated conditional expectation of inefficiency which is $E[-u_{it} \mid w_i+\varepsilon_{it}]$ whereas w_i is integrated out of u_{it} using simulations presented in Greene (2005, p. 290). The variance parameters for this half-normal model are given by: $\lambda^2 = \sigma_u^2 / \sigma_v^2$ and $\lambda^2 = \sigma_u^2 / \sigma_v^2 \geq 0$. If $\lambda = 0$ then there are no technical inefficiency effects and all deviations from the production frontier are due to noise. The term u_{it} is the log-difference between the maximum output ($\ln y_{it} = w_i + d_t + f(x_{it};\beta) + v_{it}$) and the actual observed output ($\ln y_{it}$). Hence, the technical inefficiency equals the percentage by which the actual output could be increased without increasing the inputs of production. Consequently, the technical efficiency index (TE_{it}) for firm *i* in year *t*, as presented in Eq. (3) in earlier section, is obtained as the ratio of the observed output over the maximum technical output obtainable for a firm, defined by the production frontier.

Due to the inclusion of unobserved heterogeneity term, w_i, the TRE model presented in Eq. (4) has important advantages as it differentiates between unobserved time-varying efficiency and the exogenous heterogeneity of firms through random effects (Farsi et al. 2006). First, in contrast to the original model of Aigner et al. (1977), it controls for any omitted variable biases. The omission of firm heterogeneity may lead to biased estimates of the parameters describing the production frontier and also to an overstatement of technical inefficiency, u_{it}, and an understatement of technical efficiency, TE_{it}. The inefficiency of firms is also time-varying which is an appropriate assumption given the fact it is a dynamic phenomenon (Farsi et al., 2006). Thus, in contrast to the time-invariant efficiency panel data models (e.g. Pit and Lee 1981), using the TRE specification to estimate the SFA model, we also avoid heterogeneity biases in the estimates of technical (in)efficiency. This holds especially for our analysis as the number of time periods in the panel is large, and thus, it is difficult to assume a persistent level of inefficiency.

The aim of this research is not only to estimate the TE scores but also to examine how the observed level of subsidies and other PA firm characteristics variables affect the firm's technical efficiency. The efficiency determinants are interpreted in this paper as observed managerial or regional factors which can be taken into account by incorporating them either in the estimated distribution of inefficiency or directly in the production function. According to Greene (2004) there is no clearly defined rule which indicates how these factors should enter the model. Thus, we extend the TRE and TREM models, presented above to allow for heteroscedasticity in the one-sided technical inefficiency error component. Following Caudill et al. (1995), Hadri (1999), Wang (2002), Hadri et al. (2003), and Greene (2007) we include the efficiency determinants Z_k as heteroscedastic variables in the inefficiency function, directly parameterising the variance of the inefficiency:

$$\sigma^2_{u_{it}} = \exp(\partial' Z_{it}) \quad \text{Eq. (5)}$$

where Z_{it} is a vector of variables defined earlier in Eq. (2), including a constant, that influences the inefficiency of performing arts firm i in year t and δ is a vector of unknown parameters to be estimated. An important advantage of the specification given by Eq. (5) is that it facilitates the estimation of the inefficiency effects simultaneously, as a single-stage procedure, together with the parameters of the stochastic production frontier. This procedure has an advantage over the alternative two-stage methods where the first stage involves estimation of a conventional frontier model with environmental variables omitted, and the second stage involves regressing these predicted technical efficiencies on the environmental variables. This procedure arouses the inconsistency in the assumptions about the distribution of the inefficiency since the estimates of u_{it} will be biased by the omission of Z_k-variables in the first step regression. Unlike the classic linear model in which heteroscedasticity affects only the efficiency of the estimators and not their consistency, ignoring the observed heteroscedasticity in u_{it} may lead to biased estimates of both TE and the production function parameters (Kumbhakar and Lovell 2000; Kumbhakar et al. 2014).

It should also be noted that other studies (e.g. Wang 2002; Diaz and Sanches 2008) include the inefficiency factors in line with Battese and Coelli's (1995) method, that is directly in the mean of the inefficiency function where u_{it} is assumed to be independently distributed as truncations at zero of the $N(-Z_{it}\delta, \sigma_u^2)$ distribution. However, this approach becomes highly unstable in practice within the true-random effects model framework, and it is not applied for our data due to its complexity and issues with the convergence (see e.g. Pieri and Zaninotto 2013). In contrast, we treat the efficiency determinants as heteroscedastic variables of the inefficiency term as explained above. As noticed by Greene (2007), allowing variance of inefficiency to vary over individuals and/or time induces not only the heteroscedasticity but also the variation in the mean of u_{it}. To the best of our knowledge, this is the first study for the performing arts sector that incorporates the heteroscedasticity in u_{it} directly within the TRE model framework.

The TRE model provides unbiased estimates of the production functions parameters under the assumption of no correlation between firm-specific random components (w_i) and the explanatory variables (inputs). Thus, in line with Farsi et al. (2005), Pieri and Zaninotto (2013), we account for this possible correlation. We apply adjustment by Mundlak (1978) which is the last modification for the earlier specified TRE model and TRE model with heteroscedasticity. We call this model TREM specification and it involves inserting the within-group means of inputs in the production frontier model which is given in an auxiliary regression of the form:

$$w_i = \lambda' \cdot \overline{X_i} + \eta_i \qquad \text{Eq. (6)}$$

where $\overline{X_i} = (1/T_i)\sum_{t=1}^{T} X_{it}$ are firm specific means, T_i is the number of time periods for firm i, λ' is the corresponding vector of coefficients to be estimated, and $\eta_i \sim N(0, \sigma_\eta^2)$. Eq. (6) divides the firm-specific stochastic term into two components: the first explains the relationship between the exogenous variables and the firm-specific effect (with the auxiliary coefficients λ_i) and the second component, η_i, is orthogonal to the explanatory variables. In this way we control for any correlation between the exogenous variables and the heterogeneity component eliminating any bias.

6. Empirical Results

The parameter estimates of the translog production function and the efficiency determinants for Italian theatre companies are displayed in Table 3 for the true-random effects (TRE) model and in Table 4 for the true random-effects model with Mundlak adjustment (TREM).[1] Column (1) of both Tables 3 and 4 presents the model without including heteroscedastic variables in the

[1] All models were estimated using LIMDEP version 3.0 (Greene 2007).

variance of u_{it}, whereas columns (2), (3), and (4) extend the basic models using the subsidies and other characteristics of the firms which are examined as potential efficiency determinants.

6.1. Translog production function estimates

The Hausman test rejects in all cases the hypothesis of no correlation between the inputs and the firm-specific characteristics (w_i) which suggests that the true-random effects specification with the Mundlak's adjustment (TREM) gives unbiased production function coefficients and so it is the most appropriate model. Nevertheless, the magnitudes of the production function parameters are very similar across the two specifications in Tables 3 and 4, and hence both models are presented.

As all inputs and output variables are normalised at their sample mean prior to the estimation of the translog production function, the presented first-order coefficients (β_1 and β_2) are directly interpreted as output elasticities with respect to labour and capital, respectively. The estimated output elasticities are positive and significant at the 1% level with the exception of the output elasticity of labour in columns (1) and (2) of both tables where they are not statistically different from zero. The total share of the statistically significant translog production function coefficients is also reasonable. Consequently, the estimates provide large enough well-behaved regions of the approximated underlying production technology. Moreover, the output elasticity of capital is much higher than that of labour, suggesting that the largest contribution to the production in the theatrical sector in Italy is due to capital input. This result can be explained by the fact that the output per man-hour cannot be easily raised in the performing arts sector and the productivity improvements may arise from increases in capital rather than in labour, such as capacity of venues, organisation, directing, rehearsing, scenes and costumes.

Furthermore, the total elasticity of scale, or total output elasticity, which is defined as a local measure of returns to scale, ranges between 0.60 and 0.66 for the TRE model (Table 3) and between 0.85 and 0.89 for the TREM model (Table 4). Based on the more appropriate TREM model that controls for the correlation of firm-specific effects with production function coefficients, we can conclude that the returns to scale are greater than 0.80 but smaller than 1. Thus, at the sample mean, the decreasing returns to scale (DRS) are prevalent in the Italian performing arts sector, indicating that increasing all inputs by 1% would increase output by less than 1%. The evidence of decreasing returns to scale in the Italian performing arts sector was also found in Castiglione, Infante and Zieba (2016) for performing arts sector in Italy albeit using a different and a smaller data set. Similar result was also found in the previous studies on theatres such as Zieba and Newman (2013) for German theatres, and Zieba (2011) for Austrian and Swiss theatres, and Gapinski (1980; 1984) for the performing arts firms in the UK and the US.

Tables 3 and 4 display also the year dummy variables, d_t, with year 2006 being the reference category. They represent the time effects in production function that are constant for all firms but change over time. Hence, they can be interpreted as technological change and they are statistically significant and negative in particular for the years 2009 to 2014. This finding is also reinforced when, we substitute the time dummies with the simple time trend and the trend squared (not presented in the Table but available upon request), following Coelli et al. (2005). The time trend is always significantly smaller than zero and the time squared is positive and significant as expected. These results confirm our hypothesis that technological progress is not present for the theatrical Italian sector during the examined time period. These results even further imply that the technological change is negative confirming the presence of Baumol's disease in this sector.

6.2. Technical efficiency estimates

Summary statistics of the estimated average technical efficiency scores, the log-likelihoods and the variance parameters for the compound error are also presented in Tables 3 and 4. Similar TE estimates are found across all columns suggesting that they are robust to the particular type of econometric specification. The mean TE score for the TRE and TREM models varies between 0.70 and 0.74. Moreover, the λ-parameters are significantly greater than zero indicating that there are inefficiency effects in the Italian performing arts sectors.

The results imply that the Italian performing arts firms could increase output by around 30% to 36% on average without increasing the inputs levels. These results are very similar to those obtained by Castiglione, Infante and Zieba (2016) who found the average TE scores of 0.68 for the Italian performing arts firms, albeit for different and smaller sample, and also for the different time period. Moreover, even if the theatrical firm sample tested in the present study is different from those used in other studies conducted for other countries, here we want cautiously compare the efficiency scores obtained in our research with the other efficiency studies. The average TE scores for Italian performing arts are lower than those found by Zieba (2011) for Austrian theatres (0.87) but similar for Swiss theatres (0.73). The TE scores are also much lower than those found by Last and Wetzel (2010) for German public theatres for the period 1991-2005 (which ranged between 0.967 and 0.964), and are also lower than those found by Zieba and Newman (2013) for German public theatres over the period 1972-2004 (which were about 0.85 on average). The TE scores found for Italian performing arts sector are higher than those found by Marco-Serrano (2006) for Spanish theatres which range between 0.24 and 0.54.

Interestingly, for both TRE and TREM models, which include the efficiency determinants in the variance of u_{it}, the average TE scores range between 73% to 74%. This result shows that despite controlling for the impact of efficiency determinants in the SFA model, the estimated technical efficiency for the Italian theatres is still smaller than 1 but it is slightly higher than the TE scores obtained for the basic homoscedastic model (without efficiency determinants) which range between 69% to 70%.

6.3 Estimates of efficiency determinants (Z_k)

Tables 3 and 4 also report the estimated coefficients of efficiency factors (Z_k) which are included as heteroscedastic variables in the inefficiency function as defined in Eq. (3). As discussed earlier, the efficiency determining variables are examined within the TRE and TREM frameworks. The estimated coefficients of the efficiency determining variables show their direct effect on inefficiency which is the opposite effect on technical efficiency (TE).

The level of public subsidies which is our main variable of interest has a significant but negative effect on inefficiency, indicating a positive effect on technical efficiency. It is significant at 5% level in Table 3 for the TRE model and significant at the 10% level for the TREM specification. However, this result holds only when we exclude the wage rate from estimations in columns (2) and (3) of both tables 3 and 4. In column (4) of both tables, the subsidies are not significant as they may be correlated with the wage rate. The positive effect on subsidies on technical efficiency is line with the findings obtained in Zieba (2011) for the Austrian and Swiss theatres. One explanation for these results might be that the public funding increases the incentives of firm managers to spend more on intangible inputs in order to improve quality which in turn increases the output of the firm. Public funding may be correlated, for example, with higher expenditures on more qualified or more talented staff members or renovation which would in turn increase quality and hence the output of the firm by the given level of inputs. This finding is in contrast to the results obtained by Bishop and Brand (2003) for public museums although a slightly different variable was used in the latter study.

The estimated coefficients of efficiency determinants are very similar for both the TRE and TREM models presented in both tables. The results with regard to the size variable indicate that *size_2*, which denotes 10-49 employees, has always a significant and negative effect on inefficiency (u_{it}). This implies that the small-sized firms are more technically efficient than the micro firms with less than 10 employees, the latter being the reference category (*size_1*). Thus, the small-sized firms could be considered as those with the most-efficient size for the theatre market in Italy, given that medium-sized firms (*size_3*) do not present any statistical difference from *size_1* firms, whilst large firms (*size_4*) present significant higher inefficiency than the reference category (*size_1*) in all specifications. This result demonstrates that the Italian theatre companies could significantly increase their technical efficiency by moving to the small scale represented by firms that operate with 10-49 employees, thereby removing scale inefficiency.

The age_{it} of the firm should have a positive effect on TE and hence a negative effect on inefficiency. Our results confirm this hypothesis as the age of the firm does contributes significantly to changes in inefficiency for the Italian arts companies. For both the TRE and TREM models, the age coefficient is significant and negative, implying that is has a positive effect on technical efficiency.

Moreover, we find that the estimated coefficient of *wage* is always negative and significant indicating that a higher labour unit cost tends to decrease variance and hence the mean of inefficiency (u_{it}) which leads to an increase of TE. This would suggest that the quality and competences as measured by this proxy variable increase efficiency for the performing arts companies. This is an important result, because, despite Baumol's disease theory, demonstrates that when wages are included in the (in)efficiency equation they turn out to be a positive quality-asset that significantly increases performing arts firm efficiency. Moreover, the finding with regard to effect of the wage rate on technical efficiency reinforces the results obtained for the subsidies.

As regards the regional differences, we found that theatres located in the North-West and North-East of Italy, have significantly higher efficiency scores in contrast to the companies located in the South and in the Centre of Italy, the latter being the reference category. According to Figure 3, theatrical firms which are included in our sample and are located in the Central area of the country (where the Lazio region is situated), received the smallest amount of public funds per firm over the examined time period. On the other side, firms located in the North of the country (north-west and north-east region), received the highest amount of public funding. This descriptive statistics reinforces our earlier finding that subsidies have a positive effect on technical efficiency, from which follows that firms located in the Northern part of Italy might increase technical efficiency due to higher public funding availability.

Moreover, the significant and positive effects of subsidies on TE scores coincide with the findings related to the technological progress for Italian theatrical firms. From Figure 4, there was a decrease in the amount of average level of public subsidies per theatrical firm in the more recent years and this also corresponds with the negative and significant time dummy coefficients obtained for the years 2009-2014 in Tables 3 and 4. Hence, one of the reasons for negative technological change and decreasing total factor productivity might be the decreasing level of public funding. Moreover, Figure 5 also highlights the fact that the years with the higher average TE scores for PA firms correspond with higher level of public subsidies (Figure 4).

6.4. ML tests

In order to check the robustness of our result, we also applied generalised likelihood ratio (LR) tests for all SFA techniques used. First, we test the presence of inefficiency term (u_{it}) in the model and the test is based on the log-likelihood values of the OLS (the restricted model which can be obtained by excluding u_{it} from Eq. (1)) and the stochastic frontier models (TRE and TREM models given in Tables 3 and 4). We reject the null hypothesis of no one-sided inefficiency term in all cases, thus confirming that applying the average response function with just the error term, v_{it}, is not adequate to our data. Second, we test the alternative Cobb-Douglas (C-D) production function (the restricted model) against the translog production function (the unrestricted model), and the null hypothesis of $\beta_{ll} = \beta_{kk} = \beta_{lk} = 0$ is always rejected at the 1% level of significance confirming that the flexible translog function fits our data better. However, in order to check the robustness of our results, we estimated all models using the C-D functional form and all the results with regard to the estimated TE did not change.

We also test the restriction that the effects of efficiency determinants are jointly zero (see also Battese and Coelli 1995) and the results are available in Tables 3 and 4. The null hypothesis that the variance of inefficiency is not a function of those factors is rejected at the 1% level of significance. This implies that the SFA models which include the Z_k-variables as explanatory factors provide a better fit to the sample data than the basic SFA specification. As a result, the presented TRE and TREM models with heteroscedastic inefficiency term are an important extension of our analysis as they not only explain possible sources of inefficiency but also incorporate both the observed and unobserved heterogeneity of performing arts companies. Finally, we also tested the restricted TRE model against the unrestricted TREM model and the test results are presented in Table 4. The LR test strongly rejects the null hypothesis that the Mundlak terms are jointly not significant (H_0: $\lambda_1 = \lambda_2 = \lambda_3 = \lambda_4 = \lambda_5 = 0$) in the TREM model.

7. Conclusions

This work greatly contributes to the literature on the determinants of efficiency in the cultural sector. It adds to that strand by investigating the determinants of technical efficiency in the Italian theatrical firms, using their balance sheet data for the period 2006-2014.

To this aim we estimated a translog stochastic production frontier and explored different panel data SFA models. We applied the TRE and TREM models to our data and found that the theatrical firms are very heterogenous. Our results confirm that controlling for both unobserved and observed heterogeneity in the SFA framework is crucial in order to get meaningful and realistic estimates of TE scores. Furthermore, our findings imply that whilst all inputs elasticities turn to be positive, decreasing returns to scale are prevalent in the Italian theatrical sector confirming that the performing arts face potential barriers of output expansion. More importantly, we provide robust estimates of the TE scores for the performing arts companies. These are considerably low and equal around 70%, implying that the performing arts firms could increase their output by around 30% using the same level of inputs. These findings are compatible with other efficiency studies for the performing arts sector (Zieba 2011; Zieba and Newman 2013; Castiglione, Infante and Zieba, 2016). Our results also confirm that technological progress is not present for the theatrical Italian sector during the examined time period and hence they provide support for confirming the presence of Baumol's disease in this sector.

The main contribution of this paper, however, lies in investigating the impact of the public subsidies and other contextual factors on TE scores. We have found that public subsidies increase the efficiency of the Italian firms operating in the theatrical sector. Moreover, our empirical analysis suggests that theatres located in the Northern part of Italy might increase technical efficiency due to higher public funding availability. We have also found that small firms are more technically efficient than the others, confirming that in the Italian performing arts sectors the efficiency can increase incentivating the theatrical companies by moving to the small scale.

Turning to policy implications, our findings imply that policymakers should engage with performance measurement before allocating limited financial resources to the performing arts sector. This is a finding which corroborates results obtained for the performing arts sector in other countries.

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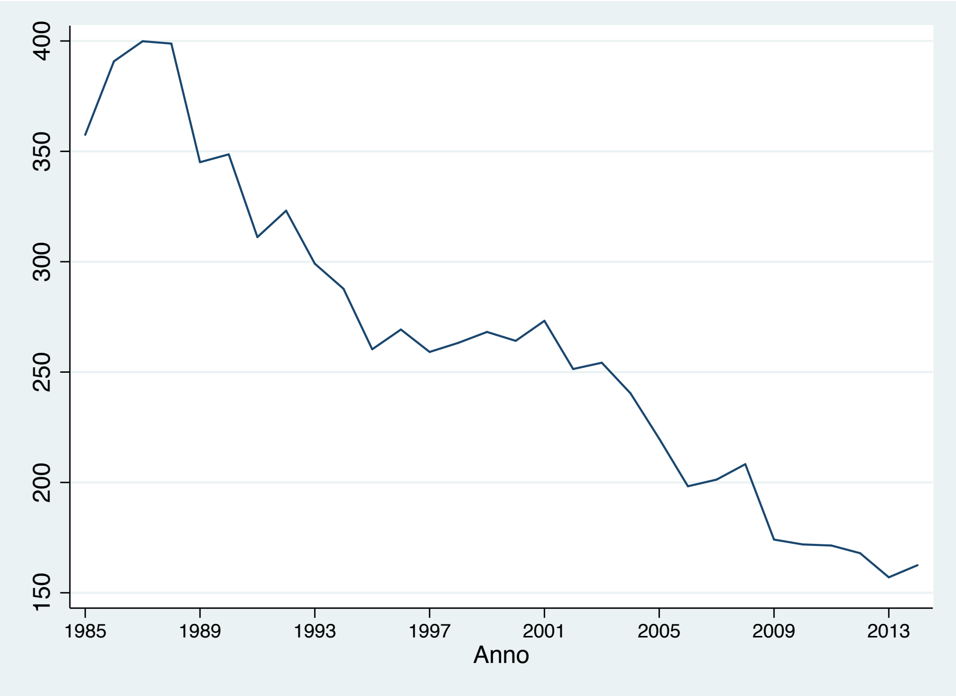
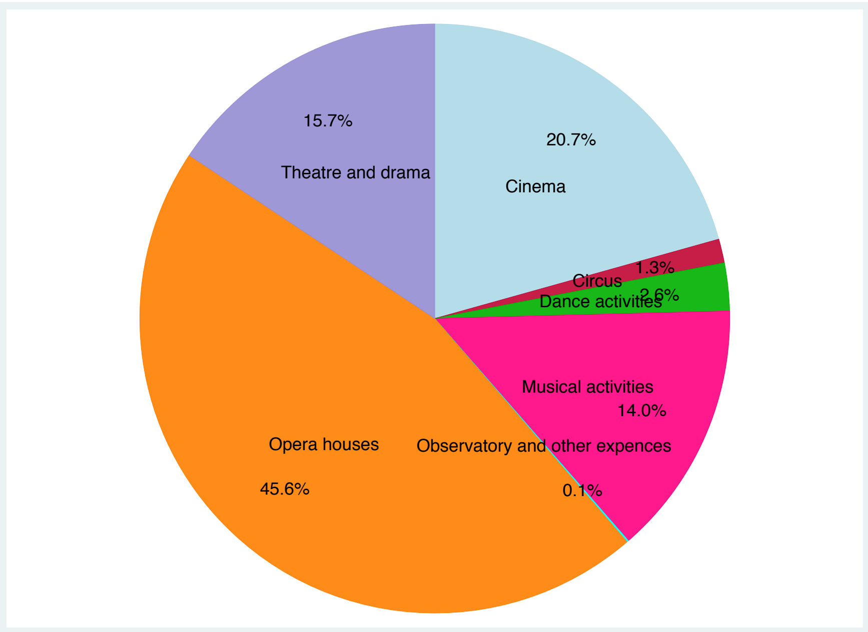
Figure 1: FUS annual allocation, 1985-2014, constant price 1985



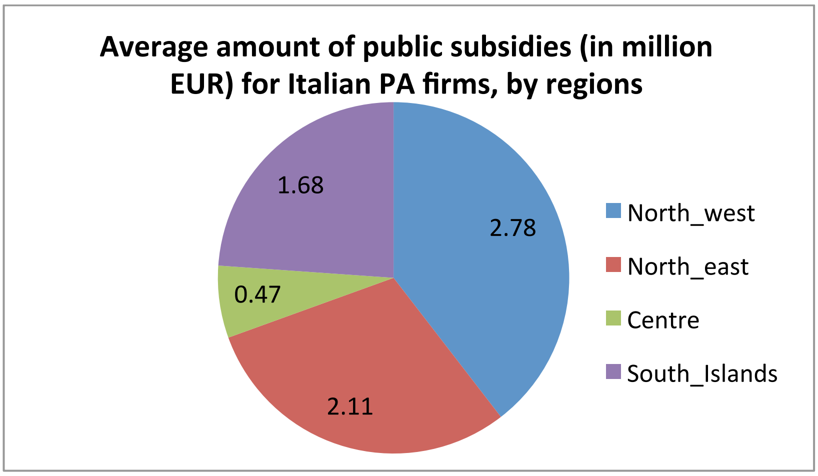
Source: Our elaboration on MiBACT (2014) data

Figure 2: FUS allocation by activities, 2014



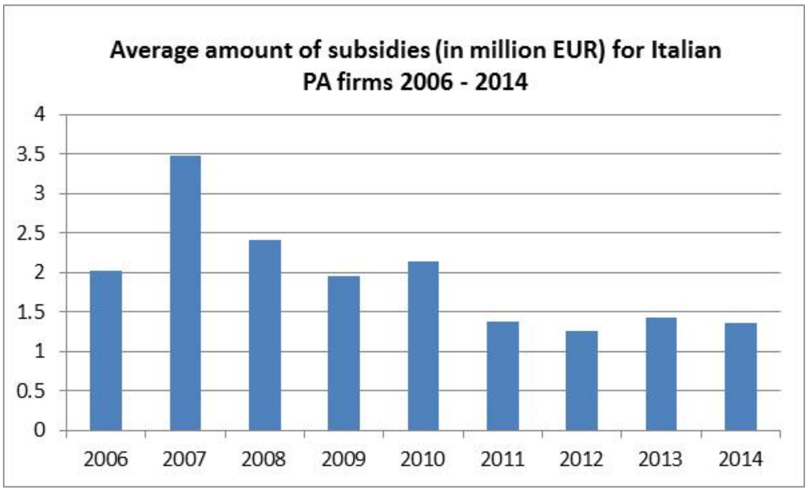
Source: Our elaboration on MiBACT (2014) data

Figure 3: Average estimated TE scores for Italian PA firms over time



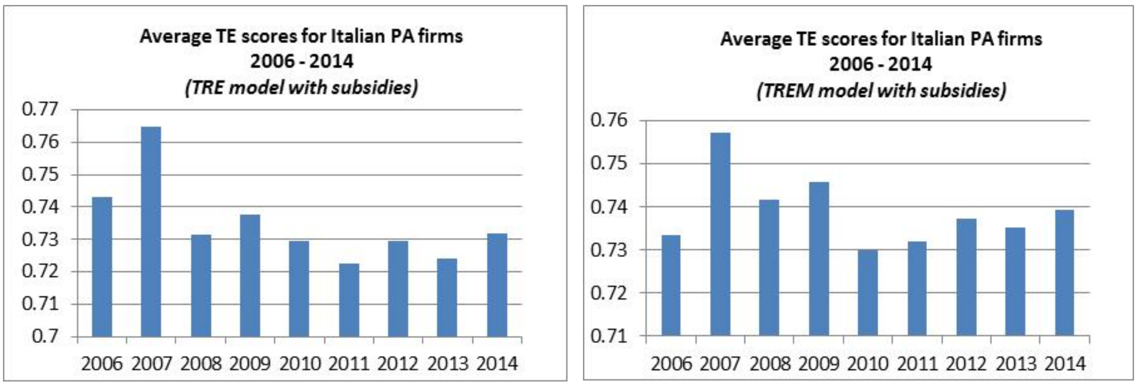
Source: AIDA database 2006-2014

Figure 4: Average public subsidies for the Italian PA firms over time



Source: AIDA database 2006-2014

Figure 5: Average estimated TE scores for Italian PA firms over time



Source: AIDA database 2006-2014

Table 1: Description of variables used

Variables	Description
Output	
Y_{it}	Total revenues of performing arts firm, adjusted for inflation using CPI index.
Inputs	
Capital (C_{it})	Total assets of the performing arts firm. Total assets include tangible and intangible assets. They are adjusted for inflation using CPI index.
Labour (L_{it})	The number of full-time and permanent employees of the performing arts firms.
Contextual variables	
Subsidies	The amount of public funds received by the firms.
Size	Size categories: Size_1 = 0 - 10 employees; Size_2 = 11 - 50 employees; Size_3 => 50 employees (dichotomized in the final analysis).
Age	The age of the firm in years.
Wage	The log of the unit cost of the labour. A proxy measure for quality of personnel in the performing arts firm, and also a proxy for reputation of performing arts firm.
Area	'North_West' = 1 and 0 otherwise, 'North_East' = 1 and 0 otherwise, 'Centre of Italy' (the reference category) = 1 and 0 otherwise (the reference category), 'South_East' = 1 and 0 otherwise.

Table 2. Summary statistics for output, inputs and efficiency determinants

Variable	Description	Mean/% share	SD	Min.	Max.
	Output and input variables				
Y	Output in thousand EUR	1866	5220	9.46	49,638
Capital	Capital stock in thousand EUR	9191	28879	17	222,420
Labour	The number of employees	63	148	1	2006
	Efficiency determinants				
subsidies	The log of subsidies in EUR	12.08	1.87	8.85	17.44
wage	The log of the unit cost of the labour in EUR	5.91	1.61	0.15	10.82
age	Age of the firm in years	20.98	11.8	0.0	66
size_1*	micro firms: 0 - 9 employees*	19.50		-	
size_2	small firms: 10 - 49 employees	64.86		-	
size_3	medium firms: 50 - 249 employees	6.22		-	
size_4	large firms: ≥ 250 employees	9.40		-	
North_West	Dummy = 1 for North-west region	24.61		-	
North_East	Dummy = 1 for North-East region	19.92		-	
Centre*	Dummy = 1 for Central region	30.56		-	
South_Islands	Dummy = 1 for South Islands	24.89		-	

723 observations for 148 firms over the period 2005-2014. *denotes reference category. Where applicable, the standard deviation is presented in parentheses.

Table 3. TRE SFA model estimates

Dependent variable: $\ln Y_{it}$	TRE Model			
	(1)	(2)	(3)	(4)
Translog Production Function Coefficients				
Constant	0.923***	0.834***	0.444***	0.425***
	(0.031)	(0.032)	(0.046)	(0.046)
lnCapital (b_1)	0.649***	0.599***	0.518***	0.506***
	(0.014)	(0.018)	(0.020)	(0.019)
lnLabour (b_2)	0.011	0.003	0.143***	0.157***
	(0.018)	(0.018)	(0.024)	(0.024)
0.5lnCapital^2 (b_{11})	0.058***	0.043***	-0.004	-0.005
	(0.007)	(0.008)	(0.012)	(0.012)
0.5lnLabour^2 (b_{22})	0.038***	0.033**	0.004	0.006
	(0.013)	(0.014)	(0.017)	(0.017)
lnCapital_lnLabour (b_{12})	-0.041***	-0.040***	0.038***	0.040***
	(0.008)	(0.009)	(0.012)	(0.012)
year_ 2007	-0.055	-0.052	-0.016	-0.028
	(0.054)	(0.054)	(0.091)	(0.089)
year _2008	-0.075**	-0.071***	0.009	-0.0004
	(0.036)	(0.036)	(0.058)	(0.059)
year _2009	-0.124***	-0.118***	-0.023	-0.029
	(0.038)	(0.039)	(0.061)	(0.062)
year _2010	-0.229***	-0.222***	-0.132**	-0.138**
	(0.039)	(0.039)	(0.064)	(0.061)
year _2011	-0.341***	-0.331***	-0.222***	-0.223***
	(0.033)	(0.033)	(0.052)	(0.052)
year _2012	-0.341***	-0.332***	-0.263***	-0.256***
	(0.033)	(0.033)	(0.048)	(0.049)
year _2013	-0.398***	-0.385***	-0.299***	-0.303***
	(0.035)	(0.034)	(0.053)	(0.053)
year _2014	-0.380	-0.366***	-0.289***	-0.138**
	(0.033)	(0.035)	(0.050)	(0.061)
Random parameter (w_i)	yes	yes	yes	yes
Within group means	yes	yes	yes	yes
(In)efficiency determinants				
δ_1 (subsidies)	n/a	-0.014**	-0.183***	0.058
		(0.006)	(0.049)	(0.061)
δ_2 (size – small)			-0.567***	-0.529***
			(0.091)	(0.106)
δ_3 (size – medium)			-8.474	-1.614*
			(8.3×10^2)	(0.979)
δ_4 (size – large)			0.545*	0.920***
			(0.315)	(0.348)
δ_5 (age)			-0.015***	-0.017***
			(0.004)	(0.004)
δ_6 (north_west)			-2.618***	-12.07
			(0.995)	(3.0×10^3)
δ_7 (north_east)			-0.662***	-0.543***
			(0.116)	(0.118)
δ_8 (south_islands)			-0.028	-0.017
			(0.096)	(0.097)
δ_9 (wage)			n/a	-0.370***
				(0.071)

Continued on next page

Table 3. Continued

Dependent variable: $\ln Y_{it}$	TRE Model			
	(1)	(2)	(3)	(4)
	Technical Efficiency Scores (TE_{it})			
Mean	0.694	0.729	0.732	0.734
Standard Deviation	0.168	0.179	0.158	0.159
Minimum	0.275	0.189	0.199	0.197
Maximum	0.961	0.992	0.968	0.969
Returns to scale	0.660	0.602	0.661	0.663
No. Firms (observations)	146 (723)	146 (723)	146 (723)	146 (723)
Log-Likelihood	-416.02	-415.69	-409.35	-392.47
λ – parameter [a]	7.07***	6.54	1.27	1.36
H_0: $\delta_0=\delta_1=\ldots=\delta_k=0$ (no efficiency determinants)[b]	Model under H_0	0.66	13.34	47.1*

The simulations are based on 200 Halton draws. Standard errors are in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%.

[a] The standard error for lambda is reported for the homescedastic model in column (1) only.

[b] An asterisk on the value of the test statistics indicates that it exceeds the 95th percentile for the corresponding χ^2-distribution, and so the null hypothesis is rejected. The critical value comes from Kodde and Palm (1986).

Table 4. TREM SFA model estimates

Dependent variable: lnY_{it}	TREM Model			
	(1)	(2)	(3)	(4)
Translog Production Function Coefficients				
Constant	1.145***	1.154***	0.837***	0.536***
	(0.035)	(0.036)	(0.054)	(0.044)
lnCapital (b_1)	0.799***	0.811***	0.728***	0.694***
	(0.063)	(0.067)	(0.115)	(0.110)
lnLabour (b_2)	0.050	0.050	0.159***	0.200**
	(0.041)	(0.041)	(0.051)	(0.051)
0.5lnCapital^2 (b_{11})	0.148***	0.151***	0.114***	0.104**
	(0.021)	(0.022)	(0.040)	(0.041)
0.5lnLabour^2 (b_{22})	0.045***	0.043*	0.016	0.007
	(0.022)	(0.022)	(0.026)	(0.027)
lnCapital_lnLabour (b_{12})	-0.028***	-0.027	0.043**	0.051**
	(0.016)	(0.017)	(0.022)	(0.024)
year 2007	-0.049	-0.047	-0.011	-0.028
	(0.059)	(0.039)	(0.095)	(0.089)
year 2008	-0.045	-0.042	0.017	-0.0004
	(0.037)	(0.039)	(0.059)	(0.059)
year 2009	-0.103**	-0.098**	-0.021	-0.029
	(0.041)	(0.043)	(0.065)	(0.062)
year 2010	-0.222***	-0.217***	-0.144**	-0.138**
	(0.041)	(0.043)	(0.065)	(0.061)
year 2011	-0.310***	-0.302***	-0.228***	-0.223***
	(0.035)	(0.036)	(0.052)	(0.052)
year 2012	-0.316***	-0.311***	-0.265***	-0.256***
	(0.034)	(0.036)	(0.049)	(0.049)
year 2013	-0.373***	-0.362***	-0.307***	-0.303***
	(0.038)	(0.039)	(0.055)	(0.053)
year 2014	-0.360***	-0.349***	-0.297***	-0.138**
	(0.036)	(0.038)	(0.051)	(0.061)
Random parameter (w_i)	yes	yes	yes	yes
Within group means	yes	yes	yes	yes
(In)efficiency determinants				
δ_1 (subsidies)	n/a	-0.016*	-0.093*	0.108
		(0.009)	(0.054)	(0.066)
δ_2 (size – small)			-0.617***	-0.429***
			(0.100)	(0.118)
δ_3 (size – medium)			-8.650	-0.447
			(8.8x10^2)	(0.334)
δ_4 (size – large)			0.008	1.856***
			(0.354)	(0.392)
δ_5 (age)			-0.019***	-0.007*
			(0.004)	(0.004)
δ_6 (north_west)			-1.800***	-1.219***
			(0.531)	(0.301)
δ_7 (north_east)			-0.503***	-0.581***
			(0.122)	(0.147)
δ_8 (south_islands)			0.007	0.026
			(0.103)	(0.106)
δ_9 (wage)			n/a	-0.621***
				(0.069)

Continued on next page

Table 4. Continued

Dependent variable: $\ln Y_{it}$	TRE Model			
	(1)	(2)	(3)	(4)
	Technical Efficiency Scores (TE_{it})			
Mean	0.698	0.731	0.737	0.742
Standard Deviation	0.168	0.172	0.147	0.146
Minimum	0.226	0.217	0.234	0.228
Maximum	0.957	0.991	0.966	0.968
Returns to scale	0.849	0.861	0.887	0.894
No. Firms (observations)	146 (723)	146 (723)	146 (723)	146 (723)
Log-Likelihood	-396.27	-396.16	-388.16	-374.17
λ – parameter [a]	8.36***	8.32	1.30	1.45
H_0: $\delta_0=\delta_1=\ldots=\delta_k=0$ (no efficiency determinants)[b]	Model under H_0	0.22	16.2*	44.2*
H_0: $\lambda_1=\lambda_2=\lambda_3=\lambda_4=\lambda_5=0$ (No Mundlak terms) [b]	39.5*	39.1*	42.4*	36.6*

The simulations are based on 200 Halton draws. Standard errors are in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%.

[a] The standard error for lambda is reported for the homescedastic model in column (1) only.

[b] An asterisk on the value of the test statistics indicates that it exceeds the 95th percentile for the corresponding χ^2-distribution, and so the null hypothesis is rejected. The critical value comes from Kodde and Palm (1986).