PRODUCTIVITY IN ELECTRICITY GENERATION: THE ROLE OF FIRM OWNERSHIP AND REGIONAL INSTITUTIONAL QUALITY

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Productivity in electricity generation: The role of firm ownership and regional institutional quality

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This version: : 3/05/2012

Abstract:

The electricity generation sector is considered the most competitive segment of the industry and has undergone significant reforms in the recent years. Liberalization, market opening and privatizations have characterized, with country-specific variations, the European electricity supply market. This paper examines the links between possible outcomes of these reforms, in particular firm ownership, and total factor productivity, while also controlling for regional characteristics. Results of the estimation of quantile regressions show that foreign ownership is associated with higher total factor productivity (TFP) levels, while public ownership exhibits a different behavior in different quantiles. Regional institutional quality is positively related to TFP. Results are robust to alternative TFP measures.

Keywords: productivity, electricity supply, foreign ownership, public ownership, density, regional institutions

JEL codes: L25, L94, F23, L32, R12

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1. Introduction and motivation

The European electricity market has been characterized, in the past twenty years, by a unique cross-country process of reform aimed at achieving a competitive and liberalized internal market. The 1996 EU Directive (Directive 96/92/EC) was the starting point, followed by the 2003 Directive (Directive 03/54/EC), which contained concrete provisions of market design, providing the basis for unbundling of transmission and distribution systems, established independent regulatory agencies and fostered free entry in the generation segment of the industry. The 2009 Directive (Directive 09/72/EC) includes further specific requirements to the creation of an internal electricity market in the EU. Historically, the current reform paradigm dates back to the British energy reform which started in 1989 with the Electricity Act, and is characterized by privatization, unbundling and liberalization (Del Bo and Florio, 2012). The underlying idea guiding this reform process is that, on the one hand, public ownership is less efficient than private ownership, and, on the other, that market opening and free liberalization will bring new players in the industry, thus leading to greater competition and deliver production and allocative efficiency.

[1] The following research grant: Dote Ricercatori: FSE, Regione Lombardia is gratefully acknowledged.

The current situation in Europe with respect to progress of the reform process shows however quite an heterogeneous picture. By analyzing the evolution, between 1980 and 2007, of the ETCR indicator (OECD regulatory dataset; Conway and Nicoletti, 2006) which aggregates data on privatization, unbundling and liberalization, it is clear that, while the path towards liberalization is generalized, the ownership structure is still quite varied. In fact, while only in few countries[2] does the electricity sector appear to be not fully liberalized, several European countries still have a high presence of fully or partially public firms active in the industry.[3] This indicator thus suggests that the reform process may entail the coexistence of liberalized markets with the direct involvement of public bodies in the electricity sector (Haney and Pollitt, 2010).

A natural research question is thus related to the correlation between the reform process in the electricity sector and firm-level performance as measured by total factor productivity (TFP) and can be formalized as follows:

RQ1: Has the general reform process at the EU level in electricity generation had an impact on firm-level productivity?

Institutional quality and elements of governance are also being increasingly considered as important determinants of firms' behavior and performance (Dal Bo' and Rossi, 2007; Commander & Svejnar, 2011) and the local environment in which firms operate has also been taken into account (Yeung, 2000; Marrocu et al., 2012). The presence of a well-functioning public administration, rule of law and low levels of corruption at the national and regional level should be beneficial to firms' activities and entail a positive relationship with TFP, as will the size of the local market. These considerations thus lead to the second research question:

RQ2: Are firms influenced by regional factors, most notably institutional quality?

The aim of this paper is to analyze the relationship between public and foreign ownership, as a result of the reform process, and regional factors, in particular density and institutional quality, with firm-level TFP in the electricity generation sector, on a sample of EU firms from 20 countries in 173 regions between 2002 and 2009. The cross-country perspective allows moving beyond single-country studies and provides a broader analysis of TFP determinants, while focusing on a homogeneous sector entails more precise TFP measures and a more focused analysis. In order to account for potentially varying implications depending on the level of TFP, a quantile regression approach is considered, which unveils interesting non-linearities in the investigated relationships.

In the next Section, a brief overview of related literature is presented, while the dataset is described in detail in Section 3. Section 4 presents the empirical model in two steps. In the first step, TFP is estimated with different methodologies, and is then used in the second step as the dependent variable. In Section 5, the link between ownership and regional variables with TFP is presented and discussed, while Section 6 summarizes and concludes.

[2] Belgium, Poland and the Slovak Republic.

[3] See Del Bo and Florio, 2012.

2. Related Literature

The literature on the efficiency of the generation segment of the electricity industry has mainly been framed in firm-level or sectoral level single-country studies. Empirical analyses of firm-level productivity determinants in the electricity generation sector have highlighted the importance of a set of technical, such as economies of scale and generating technologies, and organizational factors, most notably related to the ownership structure. Broader sectoral studies have also examined the role of regional and institutional factors along with sector-specific characteristics, and have assessed the extent and impact of regulatory reforms and liberalization.

Starting from firm-level studies of productivity, Lam and Shiu (2004), examining TFP growth of thermoelectric Chinese generating companies between 1995 and 2000, find that fuel efficiency and capacity utilization rates affect technical efficiency of power generation. Shrivastava et al. (2011) examine instead the efficiency of coal fired power plants in India and the results point to the existence of significant economies of scale in the sector. Public ownership is also found to be associated with lower productivity in the sample considered, suggesting an efficiency advantage argument for private ownership. Akkemik (2009) examines the cost-efficiency of the Turkish electricity generation sector, highlighting the importance of economies of scale and quality of regulation. Abbott (2005) presents a review of the literature on productivity in the electricity industry and stresses the role of economies of scale, of the regulatory framework and the private vs. public ownership structure.

Focusing on a cross-section of 182 steam-electric generating US firms in 1986, Koh et al. (1996) frame the private vs. public comparison in a scale argument, and find that public firms are more efficient at low output levels, while Kwoka (2005) attributes the differences between private and public electricity firms to quality differences, with a sample of 147 US electric utilities in 1989. Public firms are found to have an efficiency advantage in producing goods and services whose quality is difficult to ascertain a-priori, with lower costs in the electricity distribution sector, as compared to lower costs in generation achieved by private entities. A similar finding related to the advantage of private firms in the generation sector can be found in the cross-country analysis in Pollitt (1995) while Hausman and Neufeld (1991) document the opposite result for US generating firms. From this brief review of the literature on the impact of public ownership on productivity and efficiency in the electricity sector, the evidence does not seem to be conclusive and warrants more detailed analysis, especially moving beyond single-country studies.

Concentrating instead on foreign ownership, results are pointing towards a productivity advantage of foreign firms and their affiliates with respect to domestic firms. Blackman and Wu (1999) analyze the impact of foreign direct investment on the efficiency of China's power sector, finding a significant positive effect. Interestingly, the impact of foreign ownership on productivity in the electricity generation sector appears to be a somewhat neglected topic in the literature and this paper aims at providing evidence for the EU on this issue.

These findings on public and foreign ownership are related to the broader literature exploring the links between productivity and ownership, mainly in manufacturing sectors. In particular see Megginson et al. (2004) and Cabeza-García and Gómez-Ansón (2011) for the link between

privatization and productivity and Harris and Robinson (2002 and 2003) and Griffith et al. (2002), to name a few, for the foreign ownership efficiency advantage literature.

Jamasb and Pollitt (2005), for the EU, and Kwoka (2008) for the US offer a comprehensive review of the impacts on the industry structure, on firms' productivity and the effects on consumer prices of the reforms process of the electricity industry.

The consideration of regional aspects in shaping firm-level behavior and production and cost efficiency has gained space in the economic literature. Ciccone and Hall (1996) focus on density and show that there is a positive relations between employment density and productivity, a result that has been reinforced by Andersson and Loof (2011) which use disaggregated firm-level data and confirm the association between regional density and firm productivity. In the Swedish electricity sector, Hjalmarsson and Veiderpass (1992) show that density leads to productivity growth, a result that has been confirmed by several studies, with a focus mainly on the electricity distribution sector in selected countries (Pérez-Reyes and Tovar, 2010 for Perù and Goto and Sueyoshi, 2009for Japan).

Institutional quality plays an important role for growth of countries (Knack and Keefer, 1995; Mauro, 1995; Glaeser et al,. 2004; Acemoglu and Robinson, 2010) and firms' productivity and efficiency (Dollar et al., 2005 in developing countries and Scarpetta et al., 2002 for OECD countries). With respect to the latter issue, a firm's performance and productivity is influenced by the environment in which it operates, which can be identified as the institutional, regulatory and governance framework. De Rosa et al. (2010) tackle this issue empirically, and provide compelling evidence of the negative effect corruption has on firm-level productivity. Borghi et al. (2011) examine the interplay between the institutional setting and public ownership on productivity in the context of local monopolies in the electricity distribution sector. Their results point towards the paramount importance of institutional quality in influencing firm-level productivity, and mitigating the negative correlation associated with public ownership.

This paper aims at combining and extending the literature on ownership (both public and foreign) on firm-level productivity, with the insights from studies on the role of regional and institutional factors. The explicit focus on generation, which is characterized as being the potentially most competitive segment of the electricity sector, and the cross-country perspective, over 8 years in the EU, will add to the understanding of the correlation between internal ownership arrangements and external institutional factors on firm-level productivity.

3. Data and descriptive statistics

The analysis focuses on firms declaring as their primary activity the generation of electricity (3511) according to the NACE Rev.2 classification.

Firm-level data used to compute total factor productivity and other firm-specific determinants is taken from the Amadeus database (Bureau Van Dijk). This database collects and reports yearly balance-sheet data provided to national statistical offices by European private and public companies. The variables considered in the empirical analysis are operating revenue, the number of

employees, total assets and tangible fixed assets, material costs, the average wage and the amount of shareholder funds. Ownership information is also extracted from the Amadeus database. Focusing on the ultimate owner (defined as the independent shareholder of a firm with the highest direct percentage of ownership) and using information on its country of origin and on its public or private nature, firms are classified in our analysis in four classes, namely: private domestic, private foreign, public domestic and public foreign. Balance-sheet data is available yearly between 2002 and 2009, while ownership data refers to the latest year of available data for each firm. Entries with obvious keypunch errors are corrected, while firms without ownership information are dropped from the sample. Finally, firms are geo-referenced at the NUTS2 (Nomenclature of territorial units for statistics) level, allowing matching with regional variables of interest, namely density (Eurostat) and institutional quality (Charron et al., *forthcoming*).

Data on regional institutional quality is the result of a survey of roughly 34,000 respondents in Europe in December of 2009, where respondents in 172 NUTS 1 and NUTS 2 regions within 18 of the 27 countries were asked 16 questions on quality of government (QoG) in their region. The aggregate regional index is the result of the aggregation of the individual questions pertaining to the three main concepts of "quality", "impartiality" and "corruption". The basis for the construction of this indicator is the combined WGI (World Government Indicator) index (with equal weighting) that aggregates information on "control of corruption", "government effectiveness", "rule of law" and "voice and accountability" (Kaufmann et al, 2009). The resulting index used in the empirical analysis uses both regional and country information and is constructed as follows:

eq. 1 $$EQI_{rc} = WGI_{c} + \left(Rqog_{rc} - CRqog_{c}\right)$$

where subscript *r* refers to regions and *c* to countries, *WGI* is the World Bank's national average for each country, *Rqog* is each region's score from the regional survey and *CRqog* is the country average (weighted by regional population) of all regions within the country from the regional survey. *EQI* is standardized with mean 0 and standard deviation of 1.

The resulting dataset is an unbalanced firm-level panel of 1268 firms, in 20 European countries and 173 NUTS2 regions (see Table A1 for a complete list of regions and countries in the sample), between 2002 and 2009.

The following table presents some descriptive statistics for the year 2008 (the single year with the highest number of firms available) and the whole panel and distinguishing between ownership types.

For a total of 4005 observations (corresponding to 662 firms in 2008), 42% are private domestically owned (44% in 2008), 14% (17% in 2008) are private foreign-owned, 35% (32% in 2008) are domestic state-owned while the remaining 8% (7% in 2008) are foreign-owned public firms. A very small number of foreign firms (16) are from non-EU countries, while the remaining are from EU countries. Overall, foreign firms represent the 23% of the sample (24% in 2008), while public, or state-owned firms correspond to the 43% of the sample (39% in 2008).

From Table 1 it is clear that public firms are on average bigger than private firms, in terms of employees, total fixed assets and operating revenue. The pattern is not so clear for foreign private firms, which appear to have fewer employees and operating revenues than their domestic private counterparts. Comparing formally, by means of t-tests, differences between foreign and domestic firms, on one hand, and public and private firms on the other, confirms the general picture provided by simple descriptive statistics. When considering foreign versus domestic, statistically significant results are found only for operating revenues, which are on average higher for foreign-owned firms. On the contrary, public firms are found to have statistically significant higher operating revenues, more employees and total fixed assets than private firms.

[TABLE 1 ABOUT HERE]

Table 1: Descriptive statistics

4. Empirical Strategy

The empirical investigation aimed at analyzing the relationship between ownership, as the outcome of the reform process of the electricity sector in the EU, and regional variables, with a focus on institutional quality, with firm-level productivity, is carried out in two steps. First, firm-level total factor productivity (TFP) is estimated, then the association between the firm-level and regional level determinants and productivity is considered with quantile regression analyses.

4.1. Empirical model: Productivity measures and determinants

As an indicator of firm performance, TFP summarizes output differences that are not explained by differences in the inputs used in the production process, and is usually estimated as a residual.

TFP is estimated from a Cobb-Douglas production function of the following form:

eq. 2 $y_{it} = \beta_0 + \beta_1 k_{it} + \beta_2 l_{it} + \beta_3 m_{it} + e_{it}$

where lower-case letters are natural logarithms, subscript *i* refers to firms and *t* to years.

Output *y* is measured by operating revenues, the capital input *k* is proxied by tangible fixed assets, labour *l* by employees and material costs *m* are measuring the use of intermediate inputs.

We also use a more flexible production function, relaxing the assumption of unitary elasticity of substitution, and estimate a translog model (Berndt, Christensen, 1973), of the following form:

eq. 3 $y_{it} = \beta_0 + \beta_k k_{it} + \beta_l l_{it} + \beta_m m_{it} + \beta_{ll} l_{it}^2 + \beta_{lk} l_{it} k_{it} + \beta_{lm} l_{it} m_{it} + \\ + \beta_{kk} k_{it}^2 + \beta_{km} k_{it} m_{it} + \beta_{mm} m_{it}^2 + e_{it}$

After estimating the production function with fixed effects with the two production functions, our measures of TFP are obtained as the residual of the regression. These measures are then used in the second step estimations which highlight the importance of ownership, firm-level determinants and regional characteristics.

As a consistency check, TFP is also measured by means of stochastic frontier analysis (SFA). SFA (Kumbhakar and Lovell, 2000) assume that firms (or the units of observation) will produce below some deterministic production frontier which is affected by external random shocks. Thus, randomness may be in the production process and in the possibility that firms are technically inefficient. Stochastic frontier methods provide an estimate, with Maximum likelihood estimations, of the mean level and variance of average inefficiency, while relying on parametric assumptions on the distribution of the random terms. The estimated production function is of the form in equation 3. Results for the SFA methodology are presented in section 5.1.

The following table shows correlation among the three TFP measures adopted.

[TABLE 2 ABOUT HERE]

Table 2: Correlation between different TFP measures

First we consider both the nature and nationality of the ultimate owner and compare private domestic firms (our base category) to foreign-owned private firms, public domestic firms and public foreign firms:

eq. 4 $$TFP_{it} = \beta_0 + \beta_1 private\_foreign + \beta_2 public\_domestic + \beta_3 public\_foreign + e_{it}$$

We then add the relevant firm-level controls that might help in explaining differences in productivity levels and focus on the size of firms (measured by total assets), the size and composition of the work force (indirectly captured by the firm's average wage, with higher wages paid indicating potentially more qualified work force) and the firm's solvency ratio (measured by the ratio of direct shareholder funds to total assets):

eq. 5 $$TFP_{it} = \beta_0 + \beta_1 private\_foreign + \beta_2 public\_domestic + \beta_3 public\_foreign + \beta_4 total\_assets + \beta_5 wage\_bill + \beta_6 solvency + e_{it}$$

Finally, the regional dimension is added and the relation of firms' TFP with the density of economic activities (proxied by regional population density) and the regional institutional setting (regional quality of government aggregate index) is analysed. Firm productivity should be affected by density as this may entail higher degrees of market competition, the presence of localized knowledge spillovers and higher wages. A good institutional setting will instead provide a well-functioning environment, with good protection of property rights, rule of law and low corruption, which will positively impact of firms' economic performance.

eq. 6
$$TFP_{it} = \beta_0 + \beta_1 private\_foreign + \beta_2 public\_domestic + \beta_3 public\_foreign + \beta_4 total\_assets + \beta_5 wage\_bill + \beta_6 solvency + \beta_7 density + \beta_7 QoG + e_{it}$$

The choice of the quantile regression approach as the estimation procedure is suggested by the properties of the distribution of firm-level productivity and allows a better understanding of the interrelation of our variables of interest beyond the simple average relationship provided by ordinary least square (OLS) regressions.

TFP (expressed in logs) is not distributed as a standard normal, exhibiting values of kurtosis and skewness of 8.81 and -0.51, respectively, for the Cobb-Douglas specification, and 16.61 and -1.36 for the translog measure. The SFA TFP has values of 6.96 and 1.94 for kurtosis and skewness. These figures suggest that the behavior of productivity varies over its distribution, and the correlation with other variables of interest may exhibit a nonlinear behavior that will not be adequately captured by an OLS estimation, but which may vary across quantiles. The next sub-section will introduce quantile regression methods to better gauge the relationship between firm-level productivity and a set of relevant determinants.

The following table provides an initial description of the relationship between ownership status and productivity. An initial inspection highlights that foreign ownership appears to be associated with higher productivity using all TFP measures, and the same appears to be true for public (compared to private) firms. The group which exhibits the highest productivity levels is that of public foreign firms, while the lowest values are found in domestic private firms[4].

[TABLE 3 ABOUT HERE]

Table 3: Total Factor Productivity and ownership

4.2. Quantile regressions

Quantile regressions methods (Koenker and Hallock, 2001) allow estimation of conditional quantile functions, where the quantiles of the conditional distribution of the dependent variable of interest is a function of observed regressors. Quantile regressions provide information about the relationship between the dependent variable, *y*, and a set of regressors, $\boldsymbol{x}$, at different points in the conditional distribution of *y*. Quantile regressions present several advantages with respect to OLS regressions, which summarize the average relationship between *y* and regressors, $\boldsymbol{x}$, through the conditional mean function $E(y|\boldsymbol{x})$. Quantile regressions may help overcome the problem of sensitivity of OLS to outliers, as the median (or least absolute-deviations) regression is more robust to outliers; they provide a more complete characterization of the data, especially in the presence of non-normalities by examining the impact of regressors on the full distribution, or selected quantiles, of the dependent variable; do not require the existence of the conditional mean for consistency and are invariant to monotonic transformations (Cameron and Trivedi, 2005).

Formally, the q^{th} quantile estimator β_q is obtained through linear programming by minimizing over the following objective function:

$$Q(\beta_q) = \sum_{a:y_i \geq x_i'\beta}^{N} q\left|y_i - x_i'\beta_q\right| + \sum_{a:y_i < x_i'\beta}^{N} (1-q)\left|y_i - x_i'\beta_q\right|, \text{ where } 0<q<1.$$

This objective function is such that there are asymmetric penalties for over-prediction and for under-prediction, depending on the quantile under consideration. The estimator that solves the minimization problem is asymptotically normal under general conditions. Estimates of the variance-

[4] These impressions are validated by formal statistical t-tests comparing private and public firms, on one hand, and foreign and domestic ones on the other. Results available upon request.

covariance matrix are obtained using the paired bootstrap method (Cameron and Trivedi, 2009; Hahn, 1995), which provides a mean of performing statistical inference (i.e. computing standard errors) by generating multiple sampled by resampling from the available sample.

In the empirical exercise, estimations are run at the 0.1, 0.25. 0.50, 0.75 and 0.90 quantiles and standard errors are obtained by 100 bootstrap replications. All regressions include country and year dummy variables and are obtained for observations from 2002 to 2009. Similar conclusions can be drawn by focusing on one year cross-sectional regressions. [5]

5. Results and discussion

5.1. Baseline estimates

Table 3 presents results of the estimation of equation (4.), which models the relationship between TFP and ownership structure. Firms whose ultimate owners are foreign private entities are, across all quantiles and with both TFP measures, associated with higher levels of productivity than domestic private firms, the base category in this regression analysis. Similar conclusions can be reached by looking at public foreign-owned firms, with even higher estimated coefficients. Looking instead at domestic public ultimate ownership, results vary across quantiles. Domestic state-owned or state-controlled firms are characterized by higher TFP levels, with respect to their private domestic counterparts, in the first three quantiles (first two when using the translog measure) considered. Only in the 0.90 quantile does the relationship become significantly negative.

[TABLE 4 ABOUT HERE]

Table 4: The role of ownership

In order to gain a better understanding of the relevant TFP determinants in the European electricity generation sector in the EU in recent years, we add firm-level controls, as in equation (5.) and verify whether the conclusions related to the ownership structure vary or not. Interestingly, some results are remarkably stable, while other findings need to be qualified. Foreign ownership, both for private and public firms, is still unambiguously associated with higher productivity levels across the whole TFP distribution, irrespective of which measure (Cobb-Douglas or translog) is used. However, it is now clear that this relationship is actually stronger in the higher quantiles. Foreign ownership thus seems to be particularly relevant with respect to productivity for the most productive firms in the sample. Domestic public ownership, on the contrary, is now associated with lower productivity levels, except in the bottom quantile (statistically significant only in the translog specification) where higher TFP levels are found with respect to domestic private firms. Controlling for firm-specific characteristics, such as size, the size and composition of the workforce and financial structure thus is relevant and helps explain variations in TFP levels.

Considering firm-level controls, larger firms, as measured by total assets, are more productive, irrespective of their ownership structure. The estimated coefficient is also increasing with quantiles, indicating that this characteristic is more relevant at the right tail of the TFP distribution. The same can be said with respect to the average wage, which reflects both the number and possibly the skill

[5] Results available upon request.

level of the employees and is associated with higher TFP levels. In this case, however, the coefficient is higher in the bottom quantiles and monotonically decreasing. Solvency appears to be mildly related to lower productivity, albeit with a small and frequently not statistically significant coefficient.

[TABLE 5 ABOUT HERE]

Table 5: Firm-level determinants

Finally, the regional dimension is added, with the inclusion of density and the aggregate index of quality of government , as in equation (6.). The additional variables, while overall improving the explained variation in the data, do not alter the conclusions regarding the role of ownership or other firm-level controls as in the previous discussion. Regional population density, as expected, is positively associated with TFP values with an increasing associated coefficient in the different quantiles, albeit rather small. It thus appears that more productive firms are able to reap greater benefits from operating in a dense and active marketplace, while lower productivity firms are relatively lacking the capacity to benefit from higher density. Regional institutional quality, as captured by the aggregate index of QoG, exhibits a positive relationship with firm-level productivity (with the exception of the first quantile with the translog TFP measure) which is increasing across quantiles. A good local institutional setting, controlling for other firm-level and regional determinants is thus a positive influencing factor for firm-level TFP in the electricity generation sector for the most productive firms. Efficient firms are thus better equipped to take advantage of regional institutional quality with respect to less productive firms, possibly due to internal characteristics and qualities that allow external positive conditions to influence firm-level economic behavior.

[TABLE 6 ABOUT HERE]

Table 6: Regional variables

A graphical representation of the estimated coefficients associated with ownership and regional variables at different quantiles is presented in Figure 1.[6] OLS estimates (indicated by horizontal lines) and confidence intervals for quantile and least squares coefficients are also included. The left panel shows results for the Cobb-Douglas specification, while the translog specification is in the right panel. From the top, the variables considered are: private foreign, public foreign, public domestic, regional institutional quality and density. The only difference between the two models is related to the behavior of the private foreign dummy, which appears to be more precisely modeled in the Cobb-Douglas specification, since confidence intervals widen at the extreme upper quantile for this variables in the translog specification. A first glance confirms that OLS results could over or understate the relationship between the variables of interest and productivity at the different quantiles, thus not providing a complete picture. With reference to the left panel (Cobb-Douglas approach), the positive association between private foreign ownership and TFP is increasing in quantiles, as is public foreign ownership. On the other hand, as already commented, the initially positive association with domestic public ownership decreases and eventually becomes negative from the lower to the upper quantiles. Interestingly, the estimated coefficient on regional

[6] The plotted coefficients are the result of the estimation of equation (6.).

institutional quality is increasing up to the 0.90 quantile, and so is the estimated density coefficient, indicating the importance of the regional dimension.

[FIGURE 1 ABOUT HERE]

Figure 1: Coefficients over quantiles of firm ownership and regional variables

5.2. Stochastic Frontier Analysis

As a consistency check, estimates of the first step firm-level TFP are obtained by means of SFA, which assumes that the stochastic production frontier for a given industry (in this case electricity generation) is expressed in terms of inputs, a random error component and a time varying technical inefficiency component which describes deviations below the optimal output level (Aigner et al., 1988; Meeusen and van den Broeck, 1977; Kumbhakar, 1990; Battese and Coelli, 1992). Stochastic frontier models assume that firms do not fully utilize existing technology due to a set of institutional and organizational factors which lead to inefficiencies in production processes and this is modeled by introducing a negative error term in the production function, which brings production below its efficiency level.

The initial relationship between ownership and TFP (Table 7) mimics the results presented in Table 4, with positive estimated coefficients associated with foreign ownership (both private and state-owned) and an initially positive value for public domestic ownership in the first two quantiles examined, which then becomes negative and statistically significant.

[TABLE 7 ABOUT HERE]

Table 7: SFA and ownership

Adding firm-level controls does not alter our main conclusions substantially, once again indicating a positive association between TFP and foreign ownership and with public domestic ownership only in the 0.10 and 0.25 quantiles. Size (as measured by total assets), the quality of the labor force (as indicated by the average wage level) both exhibit positive and significant coefficients, decreasing across quantiles. Solvency is negatively related to performance only in the upper quantiles.

[TABLE 8 ABOUT HERE]

Table 8: SFA and firm-level determinants

Finally, the regional dimension adds to our understanding of the determinants of firm-level productivity in the European electricity supply sector for the middle and upper quantiles of the distribution. Both density and institutional quality are not statistically significant at the two bottom quantiles, suggesting that lower productivity firms do not benefit from external positive factors due to intrinsic inefficiencies. On the contrary, these regional determinants are relevant for more productive firms, with an increasing coefficient, across quantiles, for density. The most productive firms in the sample are thus better equipped to further increase their efficiency levels in favorable regional markets and environments.

[TABLE 9 ABOUT HERE]

Table 9: SFA and regional variables

By plotting the estimated coefficients from quantile regressions for the ownership and regional variables, along with confidence intervals and OLS estimates, several interesting results emerge. By using a translog production function, estimated with MLE and allowing for technical inefficiency (SFA), a clearer picture of the potential misspecification of simple OLS estimate as compared to Figure 1 emerges.

In the bottom (upper) quantiles, foreign ownership runs the risk of being over (under) estimated with OLS, while the contrary is true for public domestic ownership. Both regional variables instead display coefficients which are below the OLS estimate (up to the 0.75 quantile) and are increasing along the TFP distribution.

[FIGURE 2 ABOUT HERE]

Figure 2: SFA and coefficients over quantiles of firm ownership and regional variables

6. Conclusions

The reform process of the European electricity generation sector appears to have been effective in promoting market opening and foreign entry, and in allowing private firms to operate in a context of mixed market structure with public entities. The presence of a significant number of foreign-owned firms is an indication of an ongoing process of market liberalization, while the coexistence of both private and public firms in this segment of the electricity market suggests a more complex path in the privatization process. The unambiguously positive association between productivity and foreign ownership is in line with a vast literature in international economics and can be explained by two non-mutually exclusive considerations. On the one hand, foreign ownership might entail exposure to different, and potentially more successful, business models and practices, thus leading once domestic owned firms to become more productive. On the other hand, it could well be the case that foreign firms might enter a foreign market (or enhance their production possibilities) by acquiring the most productive domestic firms. Both explanations can be backed by the empirical analysis, which in general is supportive of the view that the liberalization process in the EU is progressing, and significant steps towards an internal electricity market are being made.

The association between public ownership and productivity, instead, varies across quantiles and goes from positive, in the lower TFP quantiles, to negative in the right tails of the distribution. This result, coupled with the fact that public ownership still represents a relevant ownership structure for electricity generating companies in the EU sample, suggests that the link between private or public ownership with TFP is not straightforward. The negative sign in the higher quantiles could be explained by an intrinsic productivity disadvantage of public firms or, in parallel to the discussion of foreign ownership, as the result of having privatized the most efficient public firms, in order to maximize the revenues of privatization for public finances.

Finally, the positive and statistically significant coefficient associate to regional quality of government highlights the importance of intangible and institutional factors for firm-level

performance and the relevance of other regional factors points to the role of the local market environment in shaping individual firms' responses and behavior. This result is statistically significant only for the most productive firms in the sample, suggesting that already efficient firms are more able to enjoy the advantages of a well-developed local market and high quality of institutions environment, while less productive firms are hampered in their ability to reap the benefits of external conditions due to intrinsic inefficiency internal factors.

Taken together these results can be read as suggesting the co-existence of different institutional arrangements, both internal and external to the firm, that are related to performance and production efficiency with different implications across quantiles of the TFP distribution. A more precise evaluation of the desirability of different ownership structures, however, should move beyond simple firm-level measures and encompass a broader view, by examining the impact on measures of social welfare.

References

Acemoglu, D. and J. Robinson, 2010, "The Role of Institutions in Growth and Development", *Review of Economics and Institutions*, 1(2): 1-33.

Aigner, D., Lovell, C. and P. Schmidt, 1977, "Formulation and Estimation of Stochastic Frontier Production Function Models", *Journal of Econometrics*, 6(1): 21-37.

Andersson, M. and H. Lööf, 2011, "Agglomeration and productivity: evidence from firm-level data", *The Annals of Regional Science*, 46(3): 601-620.

Battese, G. and Coelli, T. (1995). "A Model for Technical Inefficiency Effects in a Stochastic Frontier Function for Panel Data", *Empirical Economics*, 20, 325-332.

Blackman, A. and X.Wu, 1999, "Foreign direct investment in china's power sector: trends, benefits and barriers", *Energy Policy*, 27(12): 695-711.

Borghi, E., Del Bo, C. and M. Florio, 2011, "Institutional quality and productivity: implications for public firms in the electricity sector", *paper presented at the Xth Milan European Economy Workshop*, Università degli Studi di Milano, 8-9 June 2011.

Cabeza-García, L. and S. Gómez-Ansón, 2011, "Post-privatisation ownership concentration: Determinants and influence on firm efficiency", *Journal of Comparative Economics*, 39(3):, 412-430.

Cameron, A.C. and P. K. Trivedi, 2005, *Microeconometrics: Methods and Applications*, Cambridge University Press, New York

Cameron, A.C. and P.K. Trivedi, 2009, *Microeconometrics using Stata*¸ Stata Press, College Station, Texas

Charron, N., Lapuente V. and L. Dykstra, *forthcoming*, "Regional Governance Matters: A Study on Regional Variation in Quality of Government within the EU", *Regional Studies*

Ciccone, A. and R. Hall, 1996. "Productivity and the Density of Economic Activity", *American Economic Review*, 86(1): 54-70.

Commander, S. and J. Svejnar, 2011, “Business environment, exports, ownership, and firm performance”, *Review of Economics and Statistics* 93(1): 309-337.

Conway, P. and G. Nicoletti, 2006, “Product market regulation in non-manufacturing sectors in OECD countries: measurement and highlights”, *OECD Economics Department Working Paper*.

Dal Bo, E. and M. Rossi, 2007, “Corruption and inefficiency: Theory and evidence from electric utilities”, *Journal of Public Economics*, 91(5-6): 939-962.

De Rosa D., Gooroochurn, N. and H. Görg, 2010, “Corruption and Productivity: Firm-level Evidence from the BEEPS Survey”, *Policy Research Working Paper* 5348, The World Bank.

Del Bo, C. and M. Florio, 2012, “Electricity Investment: An Evaluation of the New British Energy Policy”, paper presented at the 7th Conference on Energy Economics and Technology Infrastructure for the Energy Transformation, Dresden, April 27th 2012

Dollar, D., Hallward-Driemeier, M. and T. Mengistae, 2005, “Investment Climate and Firm Performance in Developing Economies”, *Economic Development and Cultural Change*, 54(1): 1-31.

Glaeser, E., La Porta, R., Lopez-de-Silanes, F. and A. Shleifer, 2004, “Do Institutions Cause Growth?” *Journal of Economic Growth*, 9(3): 271-303.

Goto,M. and T. Sueyoshi, 2009, “Productivity growth and deregulation of Japanese electricity distribution”, *Energy Policy*, 37(8): 3130-3138.

Griffith, R., Redding, S. and H. Simpson, 2004, “Foreign Ownership and Productivity: New Evidence from the Service Sector and the R&D Lab”, *Oxford Review of Economic Policy*, 20(3): 440-456.

Hahn, J., 1995, “Bootstrapping Quantile Regression Estimators”, *Econometric Theory*,11(1): 105-121

Haney, B. and M.G. Pollitt, 2010, “New Models of Public Ownership in Energy”, *Cambridge Working Paper in Economics 1055*

Harris, R. and C. Robinson, 2003, “Foreign Ownership and Productivity in the United Kingdom Estimates for U.K. Manufacturing Using the ARD”, *Review of Industrial Organization*, 22(£): 207-223.

Hausman, W. and J.L.Neufeld, 1991. “Property Rights versus Public Spirit: Ownership and Efficiency of U.S. Electric Utilities Prior to Rate-of-Return Regulation”, *The Review of Economics and Statistics*, 73(3): 414-23.

Hjalmarsson, L. and A. Veiderpass, 1992, “Productivity in Swedish Electricity Retail Distribution”, *Scandinavian Journal of Economics*, 94(0): S193-205.

Jamasb. T. and M. Pollitt, 2005, “Electricity Market Reform in the European Union: Review of Progress toward Liberalization & Integration”, *The Energy Journal*, 26(Special I): 11-42.

Kaufmann, D., Kraay A. and M. Mastruzzi, 2009, “Governance Matters VIII: Aggregate and Individual Governance Indicators for 1996-2008”, *World Bank Policy Research Working Paper No. 4978*. Washington, D.C.

Knack, S. and P. Keefer, 1995, “Institutions and Economic Performance: Cross-Country Tests Using Alternative Institutional Measures”, *Economics and Politics* 7(3): 207-227.

Koenker, R. and K. Hallock, 2001, “Quantile Regression”, Journal of Economic Perspectives, 15(4): 143-156

Koh, D.S, Berg, S. and W Kenny, 1996, “A comparison of costs in privately owned and publicly owned electric utilities: the role of scale”, *Land Economics*, 72 (1): 56–65

Kumbhakar, S. C. and C. A. Lovell, 2000, *Stochastic Frontier Analysis*, Cambridge University Press, New York

Kumbhakar, S., 1990, “Production Frontiers, Panel Data, and Time-Varying Technical Inefficiency”, *Journal of Econometrics*, 46: 201-212.

Kwoka, J, 2008, “Restructuring the U.S. Electric Power Sector: A Review of Recent Studies”, *Review of Industrial* Organization, 32(2): 165-196.

Kwoka, J.E., 2002, “ Vertical economies in electric power: evidence on integration and its alternatives”, *International Journal of Industrial Organisation*, 20(5): pp. 653–671.

Marrocu, E., Paci, R. and M. Pontis, 2012, “Intangible capital and firms’ productivity”, *Industrial and corporate change*, 21(2): 377-402.

Mauro, P., 1995, “Corruption and Growth”, *Quarterly Journal of Economics* 110: 681-712.

Meeusen, W. and J. van den Broeck, 1977, “Efficiency Estimation from Cobb-Douglas Production Functions with Composed Error”, *International Economic Review*, 18(2): 435-444.

Megginson, W. , Nash, R. C. , Netter, J. , and A. Poulsen, 2004,. “The Choice of Private Versus Publc Capital Markets: Evidence from Privatizations”, *The Journal of Finance*, , 2835-2870.

Pérez-Reyes, R. And B. Tovar, 2010, “Explaining the inefficiency of electrical distribution companies: Peruvian firms”, *Energy Economics*, 32(5): 1175-1181.

Pollitt, M.G. (1995) *Ownership and performance in electric utilities: the international evidence on privatization and efficiency.* Oxford: Oxford Institute for Energy Studies.

Yeung, H., 2000, “Organizing ‘the firm’ in industrial geography I: networks, institutions and regional development”, *Progress in Human Geography* 24(2): 301–315.

Appendix

[TABLE A1 HERE]

Table A1: List of countries and regions in the sample

Figures and Tables

Sample		Private Domestic		Private Foreign		Public Domestic		Public Foreign	
2008	*Panel*	*2008*	*Panel*	*2008*	*Panel*	*2008*	*Panel*	*2008*	*Panel*
n° 662	n° 4005	n° 294	n° 1685	n° 111	n° 588	n° 211	n° 1415	n° 46	n° 317
Employees		261	287	272	341	651	834	614	701
Total Fixed Assets		112,114	143,211	117,551	135,127	371,308	474,472	438,688	466,810
Operating Revenue		214,306	215,713	196,803	203,741	529,094	421,576	1,558,443	1,166,876

Table 1: Descriptive statistics

	TFP CD	TFP Trans	TFP Front
TFP CD	1		
TFP Trans	0.8676	1	
TFP Front	0.7156	0.7282	1

Notes: Pearson correlation coefficients, all statistically significant at the 1% level. CD=Cobb Douglas; Trans=Translog and Front=Frontier.

Table 2: Correlation between different TFP measures

	Private Domestic		Private Foreign		Public Domestic		Public Foreign	
	Mean	Std Deviation	Mean	Std Deviation	Mean	Std Deviation	Mean	Std Deviation
TFP CD	4.08	1.03	4.43	1.03	4.36	0.613	5.15	0.957
TFP Translog	4.01	0.89	4.25	0.86	4.22	0.45	4.61	0.65
TFP Frontier	0.24	0.19	0.29	0.19	0.23	0.12	0.38	0.23

Notes: CD=Cobb Douglas; Trans=Translog and Front=Frontier.

Table 3: Total Factor Productivity and ownership

	Dep. Var. TFP (CD)					Dep. Var. TFP (Translog)				
	Quantiles					Quantiles				
Ownership	0.1	0.25	0.5	0.75	0.9	0.1	0.25	0.5	0.75	0.9
Private										
Foreign	0.33***	0.35***	0.40***	0.51***	0.31***	0.26***	0.25**	0.22***	0.16***	0.09
	0.06	*0.04*	*0.06*	*0.07*	*0.09*	*0.05*	*0.03*	*0.03*	*0.04*	*0.06*
Public										
Domestic	0.25***	0.122***	0.07**	-0.033	-0.22***	0.21***	0.11***	0.03	0.00	-0.17***
	0.06	*0.04*	*0.03*	*0.04*	*0.07*	*0.04*	*0.03*	*0.02*	*0.02*	*0.04*
Public										
Foreign	1.02***	1.17***	1.15***	0.99***	1.15***	0.69***	0.63***	0.56***	0.50***	0.42***
	0.1	*0.06*	*0.04*	*0.09*	*0.11*	*0.04*	*0.03*	*0.04*	*0.05*	*0.08*
Constant	4.13***	4.55***	4.72***	4.85***	5.91***	4.04***	4.35***	4.49***	4.62***	5.83***
	0.15	*0.12*	*0.04*	*0.17*	*0.4*	*0.12*	*0.08*	*0.03*	*0.18*	*0.38*
N° Obs	4005	4005	4005	4005	4005	4005	4005	4005	4005	4005
Pseudo R^2	0.2489	0.2055	0.1574	0.1380	0.1373	0.2482	0.1938	0.1273	0.1103	0.1478

Notes: Base category is Private Domestic. Country and year dummies included in all regressions. CD refers to Cobb Douglas. Standard errors in italics, based on 100 bootstrap replications. *** Significant at the 1% level, ** significant at the 5% level and * significant at the 10% level.

Table 4: The role of ownership

	Dep. Var. TFP (CD)					Dep. Var. TFP (Translog)				
	Quantiles					Quantiles				
Ownership	0.1	0.25	0.5	0.75	0.9	0.1	0.25	0.5	0.75	0.9
Private										
Foreign	0.09**	0.09***	0.15***	0.30***	0.39***	0.12**	0.09***	0.12***	0.13***	0.16**
	0.03	*0.02*	*0.04*	*0.06*	*0.08*	*0.03*	*0.02*	*0.02*	*0.02*	*0.06*
Public										
Domestic	0.02	-0.03*	-0.07***	-0.15***	-0.30***	0.09***	0.01	-0.02	-0.08***	-0.14***
	0.02	*0.02*	*0.02*	*0.03*	*0.04*	*0.03*	*0.01*	*0.01*	*0.02*	*0.03*
Public										
Foreign	0.30***	0.26***	0.33***	0.63***	0.90***	0.11***	0.13***	0.14***	0.24***	0.36***
	0.05	*0.03*	*0.07*	*0.11*	*0.15*	*0.03*	*0.03*	*0.03*	*0.08*	*0.12*
Firm-level										
Total Assets	0.16***	0.17***	0.15***	0.19***	0.21***	0.11***	0.10***	0.10***	0.11***	0.12***
	0.01	*0.01*	*0.01*	*0.01*	*0.01*	*0.01*	*0.00*	*0.00*	*0.01*	*0.01*
Wage	0.43***	0.40***	0.38***	0.32***	0.23***	0.37***	0.33***	0.30***	0.25***	0.23***
	0.04	*0.03*	*0.03*	*0.04*	*0.05*	*0.03*	*0.02*	*0.03*	*0.04*	*0.04*
Solvency	-0.05	-0.12***	-0.20***	-0.27***	-0.55***	-0.02	-0.04	-0.02***	0.00	-0.04
	0.49	*0.04*	*0.04*	*0.06*	*0.09*	*0.05*	*0.03*	*0.03*	*0.03*	*0.08*
Constant	0.64***	0.88***	0.95***	1.30***	2.10***	1.39***	1.74***	1.87***	2.21***	2.87***
	0.14	*0.08*	*0.11*	*0.23*	*0.4*	*0.14*	*0.08*	*0.11*	*0.27*	*0.26*
N° Obs	3841	3841	3841	3841	3841	3841	3841	3841	3841	3841
Pseudo R^2	0.4685	0.4502	0.4032	0.3603	0.3251	0.437	0.4112	0.346	0.2953	0.2799

Notes: Base category is Private Domestic. Country and year dummies included in all regressions. CD refers to Cobb Douglas. Standard errors in italics, based on 100 bootstrap replications. *** Significant at the 1% level, ** significant at the 5% level and * significant at the 10% level.

Table 5: Firm-level determinants

Dep. Var. TFP (CD)						Dep. Var. TFP (Translog)				
	Quantiles					Quantiles				
Ownership	0.1	0.25	0.5	0.75	0.9	0.1	0.25	0.5	0.75	0.9
Private Foreign	0.95*	0.94***	0.15***	0.24***	0.28***	0.10***	0.12***	0.13***	0.13***	0.14**
	0.04	*0.03*	*0.03*	*0.06*	*0.08*	*0.03*	*0.02*	*0.02*	*0.03*	*0.06*
Public Domestic	0.03	-0.04**	-0.06***	-0.17***	-0.29***	0.04**	0.03**	0.05**	-0.11***	-0.11***
	0.02	*0.02*	*0.02*	*0.03*	*0.03*	*0.02*	*0.01*	*0.01*	*0.02*	*0.03*
Public Foreign	0.29***	0.25***	0.38***	0.53***	0.88***	0.19***	0.13***	0.17***	0.19***	0.47***
	0.5	*0.03*	*0.07*	*0.09*	*0.19*	*0.03*	*0.03*	*0.03*	*0.08*	*0.1*
Firm-level										
Total Assets	0.17***	0.17***	0.18***	0.19***	0.20***	0.10***	0.09***	0.09***	0.10***	0.10***
	0.01	*0.01*	*0.01*	*0.01*	*0.01*	*0.01*	*0.01*	*0.00*	*0.01*	*0.01*
Wage Bill	0.40***	0.37***	0.35***	0.29***	0.23***	0.31***	0.28***	0.26***	0.22***	0.22***
	0.04	*0.03*	*0.04*	*0.05*	*0.05*	*0.02*	*0.03*	*0.02*	*0.04*	*0.06*
Solvency	-0.05	-0.08**	-0.15***	-0.23***	-0.58***	0.00	- 0.06**	- 0.08**	-0.04	- 0.14**
	0.05	*0.04*	*0.04*	*0.06*	*0.08*	*0.04*	*0.03*	*0.03*	*0.04*	*0.07*
Regional-level										
Density	0.02**	0.04***	0.06***	0.10***	0.12***	0.00	0.03***	0.04***	0.04***	0.03
	0.01	*0.01*	*0.01*	*0.02*	*0.02*	*0.02*	*0.01*	*0.01*	*0.01*	*0.02*
Institutions	0.00	0.00	0.10***	0.19***	0.12*	-0.05*	0.02	0.04	0.16***	0.10**
	0.03	*0.02*	*0.04*	*0.06*	*0.07*	*0.03*	*0.02*	*0.03*	*0.04*	*0.04*
Constant	0.61***	0.75***	0.73***	0.81***	1.25***	1.26***	1.43***	1.54***	1.75***	2.28***
	0.017	*0.11*	*0.12*	*0.2*	*0.51*	*0.11*	*0.09*	*0.1*	*0.22*	*0.27*
N° Obs	3710	3710	3710	3710	3710	3710	3710	3710	3710	3710
Pseudo R^2	0.4693	0.4517	0.4041	0.3657	0.3324	0.4535	0.4027	0.3467	0.314	0.2791

Notes: Base category is Private Domestic. Country and year dummies included in all regressions. CD refers to Cobb Douglas. Standard errors in italics, based on 100 bootstrap replications. *** Significant at the 1% level, ** significant at the 5% level and * significant at the 10% level.

Table 6: Regional variables

Dep. Var. TFP (Frontier)	Quantiles				
Ownership	0.1	0.25	0.5	0.75	0.9
Private Foreign	0.38***	0.25***	0.24***	0.42***	0.25***
	0.07	*0.04*	*0.04*	*0.04*	*0.06*
Public Domestic	0.39***	0.96*	-0.01	- 0.07**	-0.27****
	0.04	*0.03*	*0.02*	*0.03*	*0.06*
Public Foreign	0.38***	0.62***	0.61***	0.65***	0.62***
	0.04	*0.03*	*0.04*	*0.07*	*0.08*
Constant	-2.16***	-1.81***	-1.66***	-1.23***	-0.10***
	0.15	*0.04*	*0.07*	*0.19*	*0.44*
N° Obs	4001	4001	4001	4001	4001
Pseudo R^2	0.2946	0.2291	0.1622	0.1727	0.1861

Notes: Base category is Private Domestic. Country and year dummies included in all regressions. Standard errors in italics, based on 100 bootstrap replications. *** Significant at the 1% level, ** significant at the 5% level and * significant at the 10% level.

Table 7: SFA and ownership

Dep. Var. TFP (Frontier)	Quantiles				
Ownership	0.1	0.25	0.5	0.75	0.9
Private Foreign	0.22***	0.18***	0.20***	0.27***	0.23***
	0.03	*0.03*	*0.03*	*0.03*	*0.06*
Public Domestic	0.17***	0.05**	-0.03	-0.13***	-0.24***
	0.02	*0.03*	*0.02*	*0.02*	*0.04*
Public Foreign	0.18***	0.34***	0.27***	0.45***	0.51***
	0.05	*0.03*	*0.03*	*0.07*	*0.07*
Firm-level					
Total Assets	0.10***	0.06***	0.05***	0.04***	0.03***
	0.01	*0.01*	*0.01*	*0.01*	*0.01*
Wage	0.48***	0.39***	0.37***	0.35***	0.24***
	0.04	*0.03*	*0.03*	*0.04*	*0.05*
Solvency	0	-0.03	-0.04	-0.18***	-0.31***
	0.05	*0.03*	*0.04*	*0.04*	*0.07*
Constant	-4.44***	-3.82***	-3.72***	-3.36***	-2.58***
	0.12	*0.2*	*0.11*	*0.23*	*0.32*
N° Obs	3837	3837	3837	3837	3837
Pseudo R^2	0.4387	0.3535	0.2616	0.26	0.2682

Notes: Base category is Private Domestic. Country and year dummies included in all regressions. Standard errors in italics, based on 100 bootstrap replications. *** Significant at the 1% level, ** significant at the 5% level and * significant at the 10% level.

Table 8: SFA and firm-level determinants

Dep. Var. TFP (Frontier)	Quantiles				
Ownership	0.1	0.25	0.5	0.75	0.9
Private Foreign	0.22***	0.19***	0.23***	0.23***	0.18***
	0.03	*0.04*	*0.02*	*0.03*	*0.07*
Public Domestic	0.17***	0.07***	-0.13	-0.13***	-0.25***
	0.02	*0.03*	*0.02*	*0.03*	*0.04*
Public Foreign	0.17***	0.37***	0.29***	0.38***	0.44***
	0.06	*0.04*	*0.04*	*0.08*	*0.09*
Firm-level					
Total Assets	0.03***	0.04***	0.06***	0.07***	0.10***
	0.01	*0.01*	*0.01*	*0.01*	*0.01*
Wage	0.48***	0.37***	0.35***	0.35***	0.25***
	0.04	*0.04*	*0.03*	*0.05*	*0.05*
Solvency	0	-0.02	-0.02	-0.16***	-0.25***
	0.05	*0.04*	*0.04*	*0.05*	*0.06*
Regional-level					
Density	0	0	0.02**	0.03**	0.04***
	0.01	*0.01*	*0.01*	*0.02*	*0.01*
Institutions	0.02	0.00	0.07**	0.10**	0.06***
	0.04	*0.02*	*0.04*	*0.05*	*0.02*
Constant	-4.44***	-3.82***	-3.72***	-3.36***	-2.58***
	0.12	*0.2*	*0.11*	*0.23*	*0.32*
N° Obs	3710	3710	3710	3710	3710
Pseudo R^2	0.4693	0.4517	0.4041	0.3657	0.3324

Notes: Base category is Private Domestic. Country and year dummies included in all regressions. Standard errors in italics, based on 100 bootstrap replications. *** Significant at the 1% level, ** significant at the 5% level and * significant at the 10% level.

Table 9: SFA and regional variables

Countries	*Regions*											
AUSTRIA	AT12	AT13	AT21	AT22	AT31	AT34						
BELGIUM	BE10	BE21	BE22	BE23	BE24	BE25	BE31	BE32	BE33	BE35		
BULGARIA	BG31	BG32	BG33	BG34	BG41	BG42						
CZECH REPUBLIC	CZ01	CZ02	CZ03	CZ04	CZ05	CZ06	CZ07	CZ08				
ESTONIA	EE00											
FINLAND	FI13	FI18	FI19	FI1A	FI20							
FRANCE	FR10	FR41	FR42	FR61	FR62	FR63	FR71	FR81	FR82			
GERMANY	DE10	DE11	DE12	DE13	DE14	DE21	DE22	DE23	DE25	DE26	DE27	DE41
	DE42	DE50	DE71	DE72	DE73	DE80	DE91	DE92	DE93	DE97	DE98	DEA1
	DEA2	DEA3	DEA4	DEA5	DEB1	DEB3	DEC0	DED	DEE0	DEF0	DEG0	
HUNGARY	HU10	HU21	HU22	HU23	HU31	HU32	HU33					
ITALY	ITC1	ITC2	ITC4	ITD1	ITD2	ITD3	ITD4	ITD5	ITE1	ITE2	ITE3	ITE4
	ITF1	ITF3	ITF4	ITF5	ITF6	ITG1	ITG2					
LUXEMBOURG	LU00											
NETHERLANDS	NL31											
POLAND	PL11	PL12	PL21	PL22	PL31	PL32	PL33	PL34	PL41	PL42	PL43	PL51
	PL52	PL61	PL62	PL63								
PORTUGAL	PT11	PT16	PT17	PT18	PT20	PT30						
SLOVAKIA	SK01	SK03										
SLOVENIA	SI01	SI02										
SPAIN	ES11	ES12	ES13	ES21	ES22	ES23	ES24	ES30	ES41	ES42	ES43	ES51
	ES52	ES53	ES61	ES62	ES63	ES70						
SWEDEN	SE11	SE12	SE21	SE22	SE23	SE32	SE33					

Note: Codes for NUTS2 regions from Eurostat (http://epp.eurostat.ec.europa.eu/portal/page/portal/nuts_nomenclature/introduction).

Table A1: List of countries and regions in the sample