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Corporate Efficiency in Europe

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Abstract

Using a stochastic frontier model and a comprehensive dataset, we study factors that affect corporate efficiency in Europe. We find that (i) larger firms are less efficient than smaller firms, (ii) greater leverage contributes to corporate efficiency, and (iii) high competition is less conductive to efficiency than moderate or low competition. In terms of ownership, we find that (iv) efficiency increases when a majority owner must deal with minority shareholders and that (v) domestic majority owners improve efficiency more than foreign majority owners when no minority shareholders are present, but (vi) the opposite is true when minority shareholders hold a substantial fraction of the firm's equity. In the analysis, we distinguish between a pre-crisis period (2001–2008) and a post-crisis period (2009–2011), and find that our results are sensitive to the period of observation.

JEL-Classification: C33, D24, G32, L60, L80, M21

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1. Introduction

What determines corporate efficiency is a central question in economics and finance. Corporate (technical or production) efficiency can be defined as the ability of a firm to produce the most output with a given amount of inputs. Several factors can reduce the ability of a firm to operate at the best (most efficient) technical level. First, as firms grow larger, they may lose focus and become more complacent and prone to agency problems (Monsen and Downs, 1965; Leibenstein, 1966; Mueller, 1972; Jensen and Meckling, 1976; Dhawan, 2001; Campa and Kedia, 2002; Villalonga, 2004). Lack of competition may also make firms become more complacent (Aghion et al., 1999; Raith, 2003; Bloom and Van Reenen, 2007). In finance, the free-cash flow hypothesis similarly suggests that leverage promotes efficiency because the servicing of debt puts constraints on managerial discretion (Jensen, 1986). Ownership concentration and foreign ownership are also generally believed to be conducive to more efficient operation (Aitken and Harrison, 1999; Blomström et al., 2001; Gugler, 2001; Sánchez-Ballesta and García-Meca, 2007; Temouri et al., 2008). Yet, to date, empirical research on the determinants of corporate efficiency and performance is fragmented (Shyu, 2013; Arocena and Oliveros, 2012; Cabeza-García and Gómez-Ansón, 2011; Margaritis and Psillaki, 2010; Weill, 2008; Barth et al., 2003; Dilling-Hansen et al., 2003; Palia and Lichtenberg, 1999). The extant literature typically analyzes the effects of firm size, competition, capital structure, and ownership characteristics in isolation, despite the fact that these factors may be closely intertwined. Moreover, the literature tends to focus on specific industries or countries, raising concerns about generalizability.

In this paper, we take a more integrated approach. We analyze the effects of size, competition, capital structure, and ownership characteristics in a large and comprehensive dataset covering more than 3 million firm/year observations. The analysis covers both firms operating in "old" European Union (EU) countries and in "new" EU countries,[1] as well as manufacturing and services firms. Methodologically, we employ a stochastic production frontier model.

[1] Specifically, we use firm-level data from the following countries. Old EU: Austria, Belgium, Denmark, Finland, France, Germany, Italy, the Netherlands, Portugal, Spain, Sweden, and the United Kingdom. New EU: Bulgaria, the Czech Republic, Estonia, Hungary, Latvia, Poland, Romania, Slovenia, Slovakia.

Our results indicate that several factors contribute to corporate efficiency in Europe. We find that larger firms are less efficient than smaller firms, and that leverage contributes to corporate efficiency. Furthermore, moderate competition in the product market is associated with greater efficiency in old EU countries. In new EU countries both moderate and low competition are associated with greater efficiency.

As expected, we find a positive association between ownership concentration and efficiency. Interestingly, the effect of foreign ownership appears to be contingent on whether control is divided. When minority shareholders hold a substantial fraction of the firm's equity, foreign majority ownership is conducive to efficiency. However, if there are no minority shareholders, domestic majority owners are superior. Overall, our results demonstrate that capital structure and ownership characteristics, as well as a number of other factors, matter for corporate efficiency in European countries.

The paper makes a number of important contributions to the literature. We focus on the technical efficiency of firms, instead of accounting ratios. Technical efficiency is estimated using the stochastic production possibility frontier approach (SFA) introduced by Aigner et al. (1977) and Meeusen and van den Broeck (1977) and further developed by Battese and Coelli (1988, 1992) and Kumbhakar and Lovell (2000). More precisely, we use a time-invariant technical efficiency model for panel data adjusted to account for the specific two-digit (NACE) industries in which firms operate.[2] This approach also addresses the potential problem of unobserved (fixed) firm heterogeneity, including the endogeneity of firm ownership with respect to its efficiency. Furthermore, by using several short panels (with maximum four years), we overcome the shortcomings of time-invariant firm-level inefficiency, while benefitting from easier identification and smaller bias (Green, 2005 and Cornwell and Schmidt, 2008, among others).

Our results highlight the potential for efficiency associated with firm growth. As firms grow larger and expand their scale of operations, they become more complacent or prone to agency problems (Campa and Kedia, 2002; Graham et al., 2002; Mansi and Reeb, 2002; Villalonga, 2004). Managers with cash in hand may grant themselves

[2] Chirinko at al. (2010) show that a production function accounting for interactions with industrial dummies is flexible and with their sample of 1,860 firms, even the OLS estimates are consistent.

higher salaries or invest in "pet projects". The situation may be aggravated by higher bureaucracy, higher communication costs and a greater resistance to change than in smaller firms. As our dataset provides a wide coverage of small and medium firms, we can analyze the effect of firm size on firm efficiency with greater reliability than in previous studies.

We also highlight the role of capital and ownership structures in affecting corporate efficiency. Capital structure and concentrated ownership can both exert a disciplining effect on managers, albeit for different reasons. Higher leverage helps discipline managers by reducing the amount of cash at their disposal and by increasing the cost of misbehavior (Jensen, 1986). Higher ownership concentration, on the other hand, motivates owners to closely monitor managers, so that their actions comply with firm goals. Different degrees of concentration can potentially have different implications for firm efficiency. For each firm in the sample, we are able to determine ownership concentration, its domestic or foreign origin, and the degree to which owners control the firm. Following legal standards, we distinguish several ownership categories that provide owners with different degrees of control, including potential coalitions of owners. In particular, we distinguish between majority ownership, monitored majority ownership, majority ownership plus blocking minority, controlling blocking minority and combined controlling minority ownership. The available information on ownership structures allows us to document its effects on firm efficiency to an extent not found in earlier studies.

On the temporal dimension, we distinguish between a pre-crisis period (2001–2008) and a post-crisis period (2009–2011). Two results stand out. First, we find that the magnitude of coefficients is often smaller in absolute value in the post-crisis period than in the pre-crisis period. This is not unexpected. During a severe downturn, many of the most inefficient firms may drop out of the sample. Thus, firms may on average be closer to the efficiency frontier in the later part of the sample. More surprising is the fact that the sign of many coefficients change after the crisis. In some cases, the results are easy to rationalize. For instance, consistent with the free cash flow hypothesis, before the crisis we find that leverage is associated with greater efficiency. However, after the crisis, leverage is associated with lower efficiency. The latter result may be due to the

fact that, after the crisis, highly leveraged firms may find it difficult to refinance their operations. While interesting, we view these temporal patterns with caution and focus mostly on the pre-crisis period when business conditions were arguably more “normal”. A full investigation of the implications of the 2008 financial crisis on efficiency is left for future research.

Finally, we believe the fact that the firms in our dataset constitute the bulk of the economic activity in the EU countries makes our analysis stronger because the potential bias due to focusing on specific sectors is negligible. At the same time we are also able to distinguish two-digit industrial sectors in which the firms operate and aggregate our results across the two key sectors: manufacturing and services. Further, in our analysis we include additional firm and market characteristics (size, leverage, market concentration) and, hence, we are able to provide substantially richer results in terms of how these characteristics potentially effect firm efficiency.

The paper is structured as follows. In section 2 we review the literature on the links relevant to firm performance and efficiency. The methodology is described in section 3. In section 4 we introduce our data, describe firm and market characteristics and ownership categories, and formulate our hypotheses. In section 5 we present our empirical results and conclude in section 6.

2. Firm performance, ownership, and capital structure: A selective literature review

From the empirical point of view, firm performance can be measured in a number of ways. Traditionally, financial ratios (e.g. return on equity, return on assets) have been the predominant choice. Empirical studies employing this type of measure to assess the effect of majority ownership on firm performance have produced mixed and inconclusive results. For example, Thomsen and Pedersen (2000) and Claessens et al. (2002) report a positive relationship between ownership concentration and shareholder value as well as firm performance. However, scholars have also argued in favor of a non-linear relationship between firm performance and ownership. A U-shaped link has been found between managerial ownership and firm value (Morck et al., 1988; McConnell and Servaes, 1990) as well as between government ownership and firm performance (Tian and Estrin, 2008). In contrast, Demsetz and Lehn (1985), Holderness and Sheehan (1988), and Demsetz and Villalonga (2001) find no statistical relationship between ownership structure and firm performance. Finally, Thomsen, Pedersen, and Kvist (2006) determine a negative association between blocking ownership and firm performance for the largest firms in Continental Europe.

The use of financial ratios to measure performance has important drawbacks, though. Most importantly, financial ratios can easily be manipulated for tax or other reasons particularly in countries where the rule of law is weak and among private medium and small enterprises, which constitute the bulk of our sample (Demsetz, 1996; Schulze et al, 2001; Durand and Vargas, 2003). For instance, family owners may be more willing to take their earnings in the form of capital gains rather than salaries, thus potentially explaining the greater liquidity and profitability of European family-owned firms (Belenzon, Patacconi, and Zarutskie, 2014). Technical efficiency, on the other hand, because it simply measures a firm's ability to produce the maximum output from a given set of inputs, may be harder or less important to manipulate, although its estimation may be fraught with technical difficulties, too.

Relatively few empirical studies use technical efficiency instead of accounting measures. According to Dilling-Hansen, Madsen, and Smith (2003), ownership

concentration does not translate into higher efficiency. In contrast, Nanka-Bruce (2006) and Amornkitvikai and Harvie (2011) report positive relations between ownership concentration and efficiency. Moreover, ownership type is also found to be important. For example, state-owned firms are reported to be inefficient compared to private-owned firms (Nanka-Bruce, 2006; Roy and Yvrande-Billon, 2007; Cabeza-García and Gómez-Ansón, 2011; Arocena and Oliveros, 2012). Also, foreign ownership is associated with higher efficiency as demonstrated by Fukuyama et al. (1999); Goldar, Renganathan, and Banga (2003); Bottasso and Sembenelli (2004); and Hanousek et al. (2012). Finally, Durand and Vargas (2003) find owner-controlled firms to be more efficient than manager-controlled firms.

The other stream of literature focuses on the link between firm performance and capital structure (see Myers, 1977; Jensen, 1986; Stulz, 1990; Margaritis and Psillaki, 2007; and Weill, 2008; among others). Capital structure is hypothesized to have an effect on firm performance because debt is often used as an alternative or supplementary tool to managerial ownership. On the one hand, higher debt has a disciplining effect on managers through the reduction of the free cash flow at their disposal and the increase of the probability of default (Jensen, 1986). The positive relationship between firm capital structure and its performance measured by technical efficiency have been reported by Sena (2006), Mok et al. (2007), Margaritis and Psillaki (2007), and Weill (2008). On the other hand, higher debt leads to a conflict of interest between shareholders and debtholders, suggesting negative relations between debt and performance (Jensen and Meckling, 1976; Myers, 1977; Harris and Raviv, 1991). Therefore, higher leverage is associated with lower firm efficiency (Weill, 2008; Seelanatha, 2010).

Researchers have become interested in the links between capital structure, ownership structure and firm performance only recently, though. For example, Brailsford et al. (2002), Short et al. (2002), and King and Santor (2008) report a positive effect of concentrated ownership on capital structure and firm performance, while Duc Nam and Thi Phuong Vy (2013) report a negative impact of foreign ownership on firm performance and a positive impact on capital structure. Anderson and Reeb (2003) find no significant effect. Managerial ownership is found to be

marginal, or even negative if large shareholders are not present (Short et al., 2002; Wahba, 2013). The link between firm technical efficiency, capital structure and ownership structure has been even less investigated, though a positive association was found by Margaritis and Psillaki (2010).

Overall, the existing empirical literature on the link between capital structure, ownership structure and firm performance and/or efficiency is scarce. Scholars use small and unrepresentative samples of firms and focus on a particular industry or one country at most. It is not clear whether the ownership concentration effect on firm technical efficiency and its capital structure depends on the country, the period studied, or other factors. In this paper we aim to overcome most of the shortcomings present in earlier studies by providing systematic evidence of the effect of ownership and capital structure on firm technical efficiency for a large sample of firms from EU economies over the period 2001 to 2011.

3. Modeling strategy

What drives a firm's efficiency? We will analyze this question in two steps by employing stochastic frontier analysis (SFA). First, we describe how a firm's efficiency is derived from the stochastic production possibility frontier in section 3.1. In the second step, we relate the technical efficiency of a firm—defined as the distance from the efficiency frontier—to a number of factors that are shown in the literature to affect it: firm specific characteristics (size, capital structure, degree of competition) and ownership structure (section 3.2). Hence, the estimated model consists of two equations: a specification describing the efficiency frontier and a specification modeling the determinants of efficiency. However, the estimation itself is performed within a one-stage procedure.

We perform the estimation on a series of short panels with fixed effects that enables easy identification, requires the least restrictive assumptions, alleviates the potential problem of unobserved (fixed) firm heterogeneity, lowers potential estimation bias, and accounts for the endogeneity of firm ownership structures with respect to its efficiency.[3] The model is estimated using the maximum likelihood one-stage procedure originally designed by Battese and Coelli (1995). We obtain estimates of the efficiency frontier parameters as well as estimates of efficiency determinants. Our estimation is performed in a similar manner as Weill (2008) and the procedure delivers efficient estimates that are free of potential correlation among variables. Finally, estimation is performed separately for firms operating in manufacturing and services, and for two groups: old and new EU countries. This set-up provides four sets of key results plus additional evidence as a robustness check.

[3] The use of the fixed effects estimation approach is motivated by two assumptions. First, we can make the assumption that unobservable effects of the ownership structures are typically correlated with the explanatory variables and error term in the model and do not change over time. In this case the bias arising from unobserved heterogeneity can be removed by estimating the fixed effects model. The fixed effects model contains an individual specific constant that captures all time-invariant (observed as well as unobserved) characteristics. The second assumption concerns the situation in which unobservable ownership effects vary over time. In this case one might use instrumental variables (IV) to account for the selection/endogeneity problem that would be present under specific conditions, for example in case of firm privatization. This is not our case, though. Moreover, the success of the IV estimation depends heavily on finding adequate instrumental variables that satisfy the exogeneity condition. However, suitable IVs are usually difficult to obtain, especially in the case of empirical studies with extremely large data-sets, which is our case. Fixed effect estimation as well as IVs have also been identified as an appropriate approach to account for the endogeneity of ownership structures by Estrin et al. (2009). Hence, fixed effects estimation is employed as the most suitable and useful solution.

3.1 Firm efficiency

The SFA framework has its roots in the stochastic production frontier models introduced simultaneously by Aigner et al. (1977) and Meeusen and van den Broeck (1977), and further adapted for panel data by Schmidt and Sickles (1984), Khumbhakar (1990), Battese and Coelli (1995), and Greene (2005).[4] The methodology helps to explain firm-level differences in efficiency as a function of the number of explanatory variables, and this makes it superior to estimating the average efficiency relative to the "best practice".

Technical efficiency under single-output production is modeled within a stochastic production possibility frontier. We opt for this parametric approach for one key reason: SFA allows for hypothesis testing, unlike the non-parametric approach of data envelopment analysis (see Fried at al., 1993). Since our analysis is framed by multiple hypothesis testing, SFA represents a natural choice.[5] Further, given that our production function has a very flexible functional form with parameters varying across double digit industries, and the number of observations exceeds several million, our parametric specification does not represent a major restriction with respect to the functional form.

The methodology of the stochastic frontier begins with the production function $y_t = f(x_t; \beta)$ relating inputs (x) to the resulting output (y), which is produced efficiently. However, as the production involves some degree of inefficiency, the production function is modified to $y_t = f(x_t; \beta) \cdot TE_i$. The firm's technical efficiency TE_i represents the non-negative ratio of observed output to the maximum feasible output and lies within the interval (0,1] as the firm's output is assumed to be positive. A firm

[4] For a detailed survey see Kumbhakar and Lovell (2000).

[5] Other options to measure the effects of a particular variable on a firm's efficiency are the differences-in-differences approach or matching. By using a differences-in-differences approach we could analyze for example the firm's efficiency before and after a change in its ownership structure. However, it is not clear when such a change materializes into an effect. Other changes are even harder to account for. Further, the advantage of the matching procedure is associated with the control for one-dimensional "treatment", which can be for example majority ownership by a domestic owner. However, choosing one control group poses a dilemma whether it is the right choiceL why should other possible control groups (dispersed ownership, minority controlled, foreign majority controlled, etc.) be less suitable choices?

employs all inputs efficiently and achieves an optimal output if $TE_i = 1$ while TE_i smaller than one indicates a degree of inefficiency in firm's production. Further, two assumptions are made. First, efficiency is assumed to be a stochastic variable with a distribution common to all firms and can be written as $TE_i = \exp\{-u_{it}\}$, since if $0 < TE_i \leq 1$, then $u_{it} \geq 0$. Second, a firm's output is also assumed to be subject to various random shocks (from machinery breakdown to bad weather) that are denoted as $\exp(v_{it})$. The production function is then written as $y_t = f(x_t;\beta) \cdot exp(-u_{it}) \cdot exp(v_{it})$. After taking the natural log of both sides we obtain

$$lny_{it} = \beta_0 + \sum_{j=1}^{k} \beta_{jit}\, lnx_{it} + v_{it} - u_{it}. \qquad (1)$$

In this general specification v_{it} is a pure noise component and a two-sided normally distributed variable, while u_{it} is the nonnegative technical inefficiency component showing the distance from the efficiency frontier. Both terms form a compound error term with an a priori unknown distribution.

In order to account for changes in technical inefficiency over time, researchers have primarily two main options available. First, time-varying inefficiency is usually introduced directly into the model (1) as $u_{it} = exp\big(-\eta(t - T_i)\big)u_i$, where T_i is the last period in the panel of i firms. In this notation, coefficient *eta* (η) enables us to distinguish whether the efficiency increases or decreases over time. However, this decay-type model of time-varying inefficiency relies on a set of relatively strong assumptions, including a truncated normal distribution and additional conditions needed for a joint identification of u_{it}, v_{it}, and η. There have been proposed several modifications, including so-called "true fixed effect" models (for an overview and extensive discussion see Green, 2008). However, given the size of the data, the suggested procedures cannot be run even on subsamples by country and selected sectors.

Therefore, we opt for the second possibility: estimating a time-invariant technical inefficiency model (1) separately in a series of short panels. The time dimension is then brought in by merging the results from the short panels. The use of short panels has the advantage of a feasible assumption of constant inefficiency. Further, the small time dimension enables easier estimation and any potential bias of the estimated

parameters in a fixed-effect stochastic frontier model resulting from a small number of periods is actually fairy moderate as demonstrated by Green (2005). Therefore, we opt for estimating the model via a series of three short panels (2001–2004, 2005–2008, and 2009–2011).

When modeling production we follow the mainstream of the literature and in the specification below we interact the parameters of the Cobb-Douglas function with two-digit NACE sectors to employ a flexible form that accounts for sector specifics.[6] Formally, our model of the efficiency frontier of I firms (i = 1,…,I) in J two-digit NACE sectors (j=1,…,J) over T time periods (t = 1,…,T) is specified as follows:

$$lny_{it} = \sum_{j=1,\dots,J}\left[\beta_{0j} + \beta_{1j} lnc_{it} + \beta_{2j} lnl_{it}\right] \cdot ID_{itj} + \phi_t + v_{it} - u_{it}. \qquad (2)$$

In specification (2) individual corporate performance y_{it} is expressed as the natural log of the value added of firm i at time t; firm turnover is used as an alternative measure. Following the practice in the literature (Margaritis and Psillaki, 2010; Arocena and Oliveros, 2012), ln c_{it} is the natural log of the capital of each firm i measured as total fixed assets plus working capital (measured as the difference between short-term tangible assets and short-term liabilities).[7] As an alternative and robustness check we also use total fixed assets. ln l_{it} is the natural log of the firm's labor, measured as the number of employees. A firm's capital can be understood as a proxy for the machinery used in production as input while the number of employees directly measures labor input.

[6] The Cobb-Douglas function represents a less restrictive production function and has been shown empirically to fit a number of the studies cited in section 2 as well as the recent contribution of Chirinko et al. (2010), who support its robust behavior. Specifically, they show that fixing the production function within a double digit industry provides needed flexibility and assures the consistency of the underlying OLS estimation.

[7] Total fixed assets plus working capital is the relevant measure in our efficiency analysis for the following reasons. First, the money tied up in working capital is costly since it earns zero rate of return (Kim et al., 1998). Second, managing working capital efficiently, however, stimulates growth opportunities and enables a firm to avoid costly interruptions to their day-to-day operations (Ross et al., 2005). Hence, working capital is kept invested constantly with the purpose to secure the constant production of the firm, which is directly linked to its efficiency.

Further, ID_{ijt} represents a vector of dummy variables to associate each firm with its specific industry sector j. It has been shown that ownership structures are often industry-specific (Thomsen and Pedersen, 1998). Therefore, we employ industry-sector dummies to capture the specific effects of various sectors so that these effects do not interfere with the ownership effects. By the construction of specification (2), we consider the full set of interactions of double-digit NACE industry codes (45 industries in total) with the constant term and both inputs (capital and labor) to control for industry-specific effects. This set-up results in a flexible functional form: since the parameters of the production function vary across 45 industries, the flexible functional form has 135 "beta" parameters (3x45).

In addition, we also include in specification (2) yearly time dummies (ϕ_t) to control for time-specific effects (country-wide economic development and business cycles) that are equal for all firms but vary over time. Since the estimation is done over a short panel (of maximum four years), adding a set of annual dummies allows us to capture the majority of industry-specific price variation. The random error is denoted as v_{it}, similarly as in (1), and $u_{it} \geq 0$ represents inefficiency. Producer effects are required to be nonnegative because they represent the degree of inefficiency.[8]

Finally, specification (2) is estimated country-by-country due to the extremely large data set and also because of potentially different efficiency levels in different countries. Country-wise estimation is preferred to including country dummies as it is a flexible form of country interaction with all parameters involved.

[8] The inefficiency component of the model (u_{it}) cannot be directly observed. However, it can be identified by using classical assumptions: $v_{it} \sim iid\ N(0, \sigma_v^2)$ and $u_i \sim iid\ N^+(0, \sigma_u^2)$. Then, the minimum squared error predictor of the technical efficiency of the ith firm is $E(\exp\{-u_{it}\}|\varepsilon_i) = E(\exp\{\beta(t) \cdot u_i\}|\varepsilon_i) = \frac{1-\Phi[\sigma_i^* - (\mu_i^*/\sigma_i^*)]}{1-\Phi(-\mu_i^*/\sigma_i^*)} \cdot exp\left\{-\mu_i^* + \frac{1}{2}\sigma_i^{*2}\right\}$, where $\varepsilon_{it} = v_{it} - u_{it}$, $\mu_i^* = \frac{\mu\sigma_v^2 - T\varepsilon_i\sigma^2}{\sigma_v^2 + T\sigma^2}$, and $\sigma_i^{*2} = \frac{\sigma_v^2\sigma^2}{\sigma_v^2 + T\sigma^2}$,.

Since u is identified by the minimum squared error predictor, v is the remaining difference ($\varepsilon - u$). Further details are provided in Battese and Coelli (1992), Kumbhakar and Lovell (2000), or Greene (2008).

3.2 Factors affecting firm efficiency

In the second step we model how firm efficiency (u_i) is determined by a set of key market and firm characteristics used widely in the literature, plus detailed firm ownership structure, a factor that has been identified in numerous relevant studies cited in section 2 as a key determinant of firm performance. Formally, the model for each year (period *t*) is specified as follows:

$$u_{it} = \alpha_i + \beta_1 Size_i + \beta_2 Debt_i + \sum_{c=1}^{C} \delta_c HHI_c^L + \delta_G HHI^G + \mu\, I\,[year > 2008]$$
$$+ \sum_{j=1}^{J} \gamma_j OWN_{it}^j * I\,[year \leq 2008] + \sum_{j=1}^{J} \lambda_j OWN_{it}^j * I\,[year > 2008] +$$
$$+ \sum_{t=1}^{T} \xi_t I\,(year = t) + \nu_{it} \qquad (3)$$

for all i = 1,…, *N (firm index)*; t = 1,…, *T (time index)*; c = 1,…, *C (market concentration categories)*; and j = 1,…, *J (ownership categories)*. The variables in (3) are defined as follows.

First, we account for the *Size* of the firm, measured as log (total assets). Size captures the effect of firm size on inefficiency. It is often hypothesized that larger firms lose momentum to improve their efficiency (e.g., Diaz and Sanchez, 2008).[9]

Second, we account for the effect of the capital structure of a firm on efficiency by including *Debt* (leverage) defined as Total Debt/Total Assets (in percent). Firms may finance a project by their own resources or by loans and thus become more indebted. Based on free-cash-flow theory (Jensen, 1986), projects financed by loans must meet the market interest rate and hence, they are likely to be more profitable than projects financed by internal funds (free cash flow). Firms using chiefly loans become more leveraged and should engage in profitable projects. This should positively affect the firms' efficiency. On the other hand, according to the pecking order hypothesis, projects are financed according to a pre-committed schedule (Meyers, 1977).[10]

[9] In one version of our specification we also included the *Age* of the firm, defined as the number of years from a firm's incorporation, that would capture the effect of a firm's age on efficiency. The economic effect of *Age* was found negligible and therefore we opted for a parsimonious specification without this variable.

[10] The relevant literature identifies the firm leverage to be sector/industry-specific and the firm leverage is taken as exogenously given. For example, Frank and Goyal (2009) emphasize the importance of the industry median leverage in determining firm-specific leverage; we admit that the endogeneity issue could exist in

Third, we account for the degree of competition that is defined by market concentration in the industry in which firms operate. Based on the *x*-inefficiency theory (Leibenstein, 1966), low competition provides a protective environment leading to higher corporate inefficiency. This inverse relationship means that a less concentrated industry, which provides more competition, should lead to increased efficiency (Nickell, 1997; Dilling-Hansen et al., 2003). Several studies have also demonstrated that an increase in market concentration above a certain threshold tends to negatively affect firm efficiency (Caves and Barton, 1990; Green and Mayes, 1991; and Caves et al., 1992). Hence, we include a market characteristic—the Herfindahl-Hirschman Index (HHI) of industry concentration—as a proxy for the degree of competition.[11] Many industries compete on a global scale, whereas others have only local markets. Given EU single-market characteristics, we considered HHI^L computed for the local competition and HHI^G characterizing the "global", i.e., single market concentration. HHI^G is calculated only for manufacturing industries as technology is much easier to transfer than services. Further, we account for the regulatory perspective of the different (local) levels of industry concentration. Instead of using a continuous variable, in the case of HHI^L we employ the scale used by the U.S. Department of Justice and the Federal Trade Commission (2010) for assessing industry concentration levels. On this scale industries are considered non-concentrated if HHI^L is less than 1500, moderately concentrated if HHI^L lies between 1500 and 2500, and highly concentrated if HHI^L is greater than 2500; the most recent thresholds are used. If a firm belongs to a moderately concentrated (moderate competition) or highly concentrated (low competition) industry, in each case the HHI^L variable in (3) takes a value of one and zero otherwise. The effect of a low concentrated industry (high competition) is captured by a constant term.

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general, though. Nevertheless, according to MacKey and Phillips (2005), industry fixed effects account for 13% of the variation in financial structure, firm fixed effects explain 54% and the remaining 33% is within-firm variation. Therefore, by accounting for industry-specific and firm-specific effects we are substantially narrowing the latitude for potential unobserved heterogeneity and endogeneity. From our data we identify that the pattern of the NACE industry-specific level of leverage is present in our sample. Hence, we use the debt/leverage variable as exogenous. Further, any potential endogeneity would be captured by the fixed effects estimation that we describe in connection to the potential ownership-structure endogeneity in section 3.

[11] Formally, the HHI for sector *j* is defined as the sum of the squares of a firm's market share in sector *j*, i.e. $HHI_j = \sum_{i=1}^{N_j} \left(S_i / \sum_{k=1}^{N_j} S_k \cdot I\,[Firm\ k \in Sector\ j] \right)^2 \cdot I\,[Firm\ i \in Sector\ j]$, where S_i denotes turnover (sales) of firm *i* in sector *j* and N_j is the number of firms in sector *j*.

Fourth, we account for a possible shift in the mean of technical efficiency (parameter μ) caused by different economic conditions from 2009 on. Our data provide a sign of a structural break and although the effect of the global economic crisis is not our primary topic, we allow for a different (post-crisis) mean from 2009 onwards.

Fifth, we account for the effects of diverse ownership structures over time. The ownership structure (OWN_{it}^{j}) is defined in year *t* for each firm *i* to account for a specific ownership category *j* (domestic, foreign, and unknown domicile owners). The coefficients γ_j and λ_j in (3) then capture the "transitory" effects of ownership; e.g. the effect of ownership in firms where an ownership structure underwent change. Further, since the crisis is potentially disruptive to firm operation we account for the pre-crisis and post-crisis periods by interacting ownership structures with pre-crisis and post-crisis dummies. To account for unobserved firm-level heterogeneity, the model is estimated by using fixed effects that are captured by coefficient α_i.

In our sample there also exist many firms where no change in ownership occurred during the whole period under research and for those firms we cannot identify the coefficients γ_j and λ_j in (3). In order to estimate the "permanent" effect of the ownership, i.e., the effect of ownership in firms with no change of ownership structure, we have to regress the estimated fixed effect ($\hat{\alpha}_i$) on ownership categories of firms with no change in ownership. Formally, we estimate the following model:

$$\hat{\alpha}_i = \sum_{j=1}^{J} \gamma_j^* OWN_{it}^{j} * I[year \leq 2008] + \sum_{j=1}^{J} \lambda_j^* OWN_{it}^{j} * I[year > 2008] \\ \sum_{k=1}^{K} \eta_k I(country = k) + \tau_i \qquad (4)$$

for all *i* = 1,…, *N (firm index)*; *t* = 1,…, *T (time index)*; *j* = 1,…, *J (ownership categories)*; and *k* = 1,…, *K (country dummies)*.

To summarize, coefficients γ_j and λ_j associated with the ownership effect estimated via panel fixed-effects specification (3) represent transitory (or changes in) ownership effects, while coefficients γ_j^* and λ_j^* from (4) represent the permanent effect of unchanged ownership. The employed variables of the ownership structure also distinguish the extent of ownership concentration along with the extent of control over a

firm. The ownership categories require a more detailed explanation, and therefore we elaborate more on the ownership categories in section 4.3.

In order to control for country and time specifics we include the relevant dummies. While time dummies usually control for different effects of the business cycle, country fixed effects would account for various measures of country-specific variation, such as financial development and the legal environment (see for example Francis et al., 2013).

The estimation results of (in)efficiency regressions (3) should be interpreted as follows. Larger coefficients associated with specific ownership categories mean that under a particular ownership type, a firm moves further from the efficiency frontier. Hence, a larger positive coefficient means that under that specific type of ownership the firm is less efficient. On the contrary, a smaller coefficient value illustrates the fact that a firm is closing the gap to the efficiency frontier. For example, in the case of the two coefficients $\gamma_1 > \gamma_2$, the ownership type associated with the coefficient γ_2 has a smaller distance from the efficiency frontier and, hence, contributes to firm efficiency more than the ownership type associated with the coefficient γ_1. A similar interpretation applies to firm characteristics, as well.

4. Data, variables, and hypotheses

4.1 Data

We employ firm-level unbalanced panel data for the period 2001–2011 from the Amadeus database covering 22 countries of the European Union. As these are multiproduct firms we are unable to obtain exact information about the quantities (input, output) connected with the production process of each product of a firm. For this reason we follow the standard approach in the literature and employ financial variables from firms' balance sheets (see Coelli et al., 2005 for an overview). We further combine the balance-sheet data with ownership data obtained from Amadeus. Let us note that each edition of the Amadeus database covers only the current ownership structure. Therefore, we use several editions of the Amadeus database to reconstruct end-of-the-year ownership structures for the period under research. Altogether we work with unique firm-level matched panel data of 3,375,595 firm/year observations for the period from 2001 to 2011.

In order to capture the difference between EU members as well as the differences across sectors, we divide the sample into two sub-samples of old and new EU countries. Due to the fact that we do not have adequate data for firms from all EU countries, our division between old and new EU members does not correspond to the official one, but rather reflects data availability. Hence, the old EU group in the scope of our analysis includes Austria, Belgium, Denmark, Finland, France, Germany, Italy, the Netherlands, Portugal, Spain, Sweden, and the United Kingdom. Further, from the data availability perspective, the new EU group is defined as Bulgaria, the Czech Republic, Estonia, Hungary, Latvia, Poland, Romania, Slovenia, and Slovakia. Both groups are further divided into firms operating in the manufacturing and services sectors. Since we are able to precisely distinguish each firm's domicile, geographical separation is not an issue.

4.2 Sample

Basic descriptive statistics of the firm-level balance-sheet data associated with equations (2) and (3) are summarized in Table 1 (manufacturing) and Table 2 (services). The value added and turnover of firms operating in the old EU countries is on average higher than the value added of the new EU firms in both manufacturing and service sectors. The old EU firms in the manufacturing sector employ less capital and less labor when compared to the new EU manufacturing firms. The situation in service sectors is the opposite. The overall comparison of new and old EU firms covered by the data shows that the new EU segment of the dataset is smaller in terms of number of observations, however, it mostly contains larger and more influential firms. Understandably, the oldest and largest firms are found in the old EU group. Firms seem to be slightly more leveraged in the manufacturing sector, with the old EU firms having average leverage ratios almost double what the new EU members have.

Table 1: Descriptive statistics (Manufacturing sector)

Group	Variable	Mean	Std. Dev.	Min	Max	Obs
Old EU Members	Value Added	1.94	14.43	1.44E-06	7148.75	1,230,649
	Turnover	4.45	27.57	1.18E-06	13109.46	1,230,649
	Tangible Fixed Assets	0.71	4.73	1.00E-06	346.40	1,230,649
	Capital	0.25	1.66	1.27E-06	768.70	1,299,872
	Number of Employees	22.23	144.72	1	61000	1,230,649
	Size	13.30	1.99	0.46	19.11	1,279,630
	Leverage	0.17	0.25	0.00	1.56	1,029,930
New EU Members	Value Added	1.09	52.50	6.35E-06	13240.26	105,099
	Turnover	2.40	13.28	2.99E-07	2943.01	236,585
	Tangible Fixed Assets	4.80	33.14	1.00E-06	2820.65	248,117
	Capital	0.40	10.89	2.99E-07	3796.04	250,575
	Number of Employees	24.64	119.55	0	30714	249,731
	Size	12.02	2.34	2.99	18.83	250,067
	Leverage	0.10	0.19	0.00	2.63	133,116

Table 2: Descriptive statistics (Service sector)

Group	Variable	Mean	Std. Dev.	Min	Max	Obs
Old EU Members	Value Added	1.95	49.66	1.34E-06	18080.89	1,894,239
	Turnover	2.33	110.14	1.18E-06	62759.36	1,894,239
	Tangible Fixed Assets	0.25	2.42	1.00E-06	369.69	2,690,008
	Capital	0.18	32.57	0.00	58390.61	3,232,410
	Number of Employees	11.53	91.40	1	41311	1,894,239
	Size	11.92	2.32	0.46	19.11	3,117,137
	Leverage	0.13	0.25	0.00	1.56	1,894,239
New EU Members	Value Added	0.39	2.54	3.59E-06	392.94	265,672
	Turnover	0.64	6.09	9.00E-08	1843.81	405,085
	Tangible Fixed Assets	0.97	13.27	1.00E-06	3170.77	434,364
	Capital	0.10	1.98	9.13E-08	694.05	445,833
	Number of Employees	8.92	82.21	1	27273	442,083
	Size	10.71	2.14	2.99	18.82	443,449
	Leverage	0.06	0.17	0	2.35	265,672

Note: Value added, turnover, tangible fixed assets and capital are in mil. USD. Capital is defined as the sum of tangible fixed assets and working capital. Size is a natural logarithm of total assets and leverage is total liabilities over total assets. Old EU: Austria, Belgium, Denmark, Finland, France, Germany, Italy, Netherlands, Portugal, Spain, Sweden, UK. New EU: Bulgaria, Czech Republic, Estonia, Hungary, Latvia, Poland, Romania, Slovenia, Slovak Republic.

4.3 Ownership categories

Based on the derived efficiency we examine the impact of the ownership structure on estimated efficiency. Ownership type and concentration has been recognized as an important determinant of firm performance in developed economies (Temouri et al., 2008; Hill and Snell, 1989) as well as emerging European economies (Estrin et al., 2009). We define the ownership variables with respect to country-specific legal rules as argued in Gugler (2003), using dummy variables for specific ownership categories rather than percentages of their share holdings. The specific ownership categories that are associated with a legally grounded extent of control differ in the countries in our sample. Hence, the use of dummy variables is more appropriate as it maintains the various extents of control level across countries. This approach is especially important when we analyze the effects of composite ownership categories and potential coalitions (details are provided below).

Holders of different concentration thresholds have different opportunities to influence corporate governance. Majority ownership represents the highest degree of concentrated ownership, while minority ownership can be viewed as a form of moderately dispersed ownership. Hence, we define several specific ownership categories to distinguish the diminishing extent of control these categories provide. Rather than using exact percentage stakes, we opt for dummy variables that differentiate various ownership categories and allow us to provide more comprehensive results. All ownership categories are exclusively defined and they are also distinguished by domestic and foreign ownership, as well as those without a known domicile. The categories of foreign ownership defined below are based on stakes above 10% and are considered to represent FDI ownership (more details are provided in section 4.3). Further, the data do not involve problems related to pyramid structures.

Our ownership categories are listed below with a greater ability to control (majority) first; each subsequent ownership category has less ability to control. *Majority ownership* is a dummy variable that is coded 1 when an owner holds more than a 50% stake in a firm and the rest of the stakes represent only dispersed ownership; it is coded 0 otherwise. Majority ownership grants the owner the right to staff management and the supervisory board, to alter and transfer firms' assets, and to make crucial strategic decisions at general shareholder meetings. Through management and the supervisory board, majority ownership also facilitates more direct executive control of the company. This category provides the majority owner with effective control over the company.

Further, we construct composite ownership categories that reflect the reality of ownership control among firms. *Monitored majority ownership* is a dummy variable that is coded 1 when a majority owner (holding more than a 50% stake in a firm) is confronted with a minority owner that holds a stake that is greater than the country-specific legal minority percentage threshold (see below); it is coded 0 otherwise. The legal minority percentage threshold is usually not very large, but legal minority owners are potentially important because the law entitles them to call general shareholder meetings and obstruct decisions by delaying implementation through lengthy court proceedings. In our sample, the legal minority thresholds are as follows: 20% (Belgium

and Italy), 10% (Czech Republic, Denmark, Estonia, France, Latvia, the Netherlands, Poland, Portugal, Romania, Sweden, and the United Kingdom), 5% (Austria, Bulgaria, Germany, Hungary, Slovakia, Slovenia, and Spain).

Majority ownership plus blocking minority is a dummy variable that is coded 1 when there is a majority owner (holding more than a 50% stake in a firm) confronted with a minority owner that holds a stake higher than the legally required blocking minority threshold; it is coded 0 otherwise. The blocking minority threshold differs from country to country. In our sample, blocking minority thresholds are as follows: 33.3% (France and Italy), 33% (the Czech Republic, Portugal, Romania, Slovakia, and Sweden), 25% (Austria, Belgium, Bulgaria, Denmark, Estonia, Germany, Hungary, Latvia, the Netherlands, Poland, Spain, and the United Kingdom). This ownership category reflects the situation in firms where the majority owner is confronted with a strong minority owner that might pursue its own interests. A blocking minority enables a strong minority owner to contest the decisions of a majority owner. For all three majority-type categories above, we are also able to distinguish domestic and foreign owners and to apply this distinction throughout the estimation.

Two minority categories complete our ownership structures. *Controlling blocking minority ownership* is a category representing a blocking minority owner whose stake is higher than the sum of the stakes of all the remaining known (identified) owners. In this case it is coded 1 and zero otherwise. This category represents a weak form of control, since even a blocking minority owner can exercise control over highly dispersed owners.

Combined controlling minority ownership is a category that is coded 1 when there are two minority owners whose combined stake exceeds the sum of all the remaining stakes held by the rest of the identified owners; it is coded 0 otherwise. These two owners cannot individually control the firm. They also cannot effectively act against each other as individually they do not have enough voting power. However, they may coordinate their steps or form a coalition and control the company via the combined voting rights that give them a majority.

Finally, a constant captures the highly dispersed or unknown ownership of a firm. In this case the firm either exhibits highly dispersed ownership or does not report its ownership. As we are unable to make reasonable inferences in terms of the ownership captured by a constant, we do not report the coefficients for the sake of conserving space.

4.4 Testable hypotheses

We formulate three hypotheses in order to test how the firm characteristics, extent of control embodied in the ownership concentration, and domestic versus foreign ownership affect the efficiency of the firm. The formulation of our hypotheses is deeply rooted in the literature: on top of the arguments voiced in sections 1 and 2, we elaborate on specific ownership categories and their links with efficiency.

First, as detailed earlier, large firms might be less efficient than smaller ones (Diaz and Sanchez, 2008), more leveraged (indebted) firms might be more efficient than those using internal funds (Jensen, 1986), and firms operating in a highly concentrated industry with a low-competition environment might suffer from higher inefficiency. Hence, various firm characteristics related to capital structure, market environment, etc. are often linked to firm efficiency and lead to the formulation of our first hypothesis. Due to the differences in impact, we formulate the hypothesis in a general way thus:

Hypothesis 1. H_0: Firm characteristics do not effect a firm's efficiency.

Given the fragmented empirical work and partly missing theoretical basis we do not present a full set of alternative hypotheses here. One can obviously expect that larger and older firms are likely to be less efficient compared to smaller and younger ones, respectively. Similarly, based on the literature on capital structure, one can expect that firms with higher leverage would be more efficient, as managers will be forced to service a higher debt.

Second, the literature examining the agency problem arising from the separation of ownership and control often argues that managers might follow goals other than those the owners would prefer. Because of this, a concentrated ownership structure might lead to higher firm efficiency, since it results in a superior monitoring of managers (Shleifer

and Vishny, 1997; Hill and Snell, 1989). On the other hand, concentrated ownership also has its costs. Large owners may engage in self-dealing, which can reduce efficiency. The findings of agency theory also indicate that control is a very good mechanism to assure that managers work to help owners. In other words, minority ownership should not improve a firm's efficiency as control is very likely to be missing in such an ownership structure. On the other hand, even a minority owner, or a pair of minority owners with a sufficiently high stake could be able to control a firm; for example, La Porta et al. (1999) employ 20% as a threshold for control of a company. Further, empirical works show that majority owners can alter their behavior when a strong minority owner is present in the firm, for example in the case of dividend payments (Gugler, 2003). Legal minority owners might not represent an excessive threat to a majority owner's control but they can exert an important monitoring influence. Blocking minority owners might affect a firm's efficiency via the implicitly influential decisions of the majority owner. On the other hand, blocking minority owners may quarrel with the majority owners and oppose decisions instead of monitoring, which may decrease firm efficiency. Finally, the majority and strong minority owners represent coalitions of so-called block owners, who own a major number of shares (>5%) and as a result are able to have a noteworthy disciplinary impact (Dilling-Hansen et al., 2003). Finally, the importance of the (high) ownership concentration with respect to a firm's efficiency is solidly documented by Estrin et al. (2009) for new members of the EU. Based on the above arguments we formulate a baseline hypothesis:

Hypothesis 2. H_0: Ownership concentration and the extent of control has no effect on firm efficiency.

The null hypothesis is formulated in a general way so that it allows testing of various degrees of ownership concentration to capture, for example, the diminishing extent of control. Again, we do not present specific alternative hypotheses, although we believe that most of the existing literature would expect that a higher ownership concentration and the extent of control it provides would contribute to a firm's efficiency.

Third, in the trade literature it has been argued that foreign owners have better access to technology and therefore multinational firms established through FDI and owned by foreign owners should be more efficient (Temouri et al., 2008; Blomström et al., 2001). The existence of a technological gap between foreign and domestic owners has become a stylized fact in the applied trade literature. Specifically in the European context, Mathur et al. (2004) show that foreign-owned firms involved in multinational operations do better in financial performance than purely domestic units. Similarly, Estrin et al. (2009) show that efficiency in foreign-owned (privatized) firms in new EU member countries is higher than in domestically owned firms. From this perspective, the distinction between domestic and foreign ownership represents an important implication with respect to FDI. From our data we are able to distinguish specific ownership stakes of 10% and up. A firm is considered a subject of direct investment if "the direct investor owns at least 10% of the voting power" (OECD 2008; p. 17) in the firm. In this case, the foreign domicile of the direct investor constitutes the origin of the FDI. Hence, based on our data, majority and minority control categories provide information about FDI ownership and we can analyze its impact on a firm's efficiency. Based on the evidence related to FDI ownership, we formulate the third hypothesis:

Hypothesis 3. H_0*: Foreign ownership (through FDI) does not improve a firm's efficiency.*

In our sample the new EU countries are those that underwent a transition from a command economy to a market economy. The literature on transition economies in general expects that foreign ownership leads to higher efficiency. Still, in the context of multinationals, a foreign-owned firm may potentially realize profit but the overall efficiency of such a multinational might be assessed in the country where the foreign owner is domiciled.

Finally, despite the fact that the effect of the global crisis is not our primary topic, we estimate efficiency separately for pre-crisis and crisis periods, since a crisis can be disruptive to a firm's operation. Our prior assumption is that during the crisis, a firm's efficiency might suffer due to difficult conditions. Hence, the effect of a firm's characteristics and ownership categories may change over time. In general, it is

expected that a period of financial distress would push less efficient firms to become more efficient in order to survive. More efficient firms, on other hand, could lose their "advantage" due to a lack of pressure to improve. However, we admit that testing for crisis effects deserves a deeper investigation both in terms of theory and testing because of issues such as firms not knowing when a crisis will occur and the industry specific impacts of recession. Since the discussion of the recession period deserves a separate paper, we do not formulate a separate hypothesis and offer a preliminary assessment via inferences made based on separate set of coefficients; more detailed assessment of the issue is left for further research.

5. Empirical results

In Tables 3–6 we present our key results for how firm efficiency is determined by firm characteristics, market concentration, and ownership. The Tables contain results for old and new EU manufacturing firms (Tables 3–4) and old and new EU firms operating in services (Table 5–6). The explanatory variables (i.e., firm characteristics, market competition, and ownership control categories) are listed in the left column. The next two columns contain coefficients related to explanatory variables during the pre-crisis (2001–2008) and the crisis (2009–2011) periods. We draw our inferences primarily from coefficients associated with the pre-crisis period as it reflects a more standard operating environment. The crisis period coefficients offer complementary findings but, as we believe, they reflect rather unstable, non-standard business conditions and deteriorating financial conditions (Angelopoulou et al., 2014).

Coefficients associated with the distance from the efficiency frontier for a specific variable and specific period should be interpreted in the following manner. A fully efficient firm would have a distance from the efficiency frontier equal to zero. Hence, a positive value of a statistically significant coefficient associated with a variable indicates that this variable moves a firm away from the efficiency frontier. For example, a positive coefficient associated with a particular type of ownership category indicates that the specific ownership category is associated with a lower contribution to firm efficiency; the larger the coefficient, the greater distance and inefficiency it represents. However, even in the case of two positive coefficients, when their values decrease between two periods, we are able to identify an improvement in efficiency. On the other hand, a negative and statistically significant coefficient associated with a specific category indicates that the category helps to move a firm closer to the efficiency frontier: the firm becomes more efficient as the coefficient becomes smaller. To summarize, when comparing the effects of two different ownership categories, we simply look at the value of the associated coefficients: smaller the

coefficient, the greater the contribution to a firm's efficiency and vice versa. A similar interpretation applies to the effects of the firm and market characteristics.[12]

5.1 Effects of firm characteristics and market competition

Results related to the size of the firms consistently differ across both EU regions. In the old EU the larger the firm is, the further it is from the efficiency frontier, as witnessed by the positive coefficients associated with the size variable (Tables 3 and 5); the effect improves slightly during the crisis period when coefficients become negative and indicate improvement in efficiency. In new EU countries, an overall lack of statistical significance precludes making inferences, with the exception of firms operating in services, where the coefficient is negative and rather small during the pre-crisis period (Table 6). Still, based on our findings, we show that larger firms can be associated with less efficiency in general. More importantly, the results associated with the size of a firm are consistent with agency theory, which is a driver of the results.[13]

[12] We performed a robustness check in that the second stage regression (3) was re-estimated with efficiency derived in the first stage when firm performance is measured by turnover instead of value added. Since the results are not materially different we do not report detailed results; they are available upon request. Further, since our data set contains a substantial fraction of small firms, we re-estimated our specification with the data covering a control group of large and medium firms (we used the Amadeus classification to define firm size: a firm is considered to be medium-sized if it has operating revenue greater than 1 million Euro, total assets greater than 2 million Euro, or at least 15 employees). A key reason is that we want to verify whether agency is a major driver of behavior for firms independent of their size or whether the size plays a role; our results show that coefficients for main and control group are not materially different. Second, in very small entrepreneurial firms, wages and dividends are often intertwined. This would tend to make the comparison biased towards small firms, because the observed wages partially include returns to capital. However, the results presented in this section are robust to this issue.

[13] The findings are also very similar to those derived separately for large and medium firms (not reported). Hence, we can infer that results are also robust with respect to the size of the firm itself.

Table 3: Efficiency in manufacturing industries: Old EU countries

General characteristics	Pre-crisis (2003–2008)	Crisis (2009–2011)		
Size	0.005***	–0.001***		
(ln(Total assets))	(0.000)	(0.000)		
Leverage	–0.038***	0.015***		
(Debt/Total assets)	(0.001)	(0.001)		
Moderate competition	–0.005***	–0.009***		
	(0.000)	(0.001)		
Low competition	–0.009***	–0.006***		
	(0.001)	(0.001)		
Global competition	–0.000	0.000***		
	(0.000)	(0.000)		
	Transitory effect		Permanent effect	
Ownership categories	Pre-crisis (2003–2008)	Crisis (2009–2011)	Pre-crisis (2003–2008)	Crisis (2009–2011)
Majority (domestic)	–0.020***	0.015***	0.009***	0.003***
	(0.001)	(0.001)	(0.001)	(0.000)
Majority (foreign)	0.019***	–0.009***	0.003***	–0.003***
	(0.001)	(0.000)	(0.001)	(0.001)
Monitored majority	–0.004	–0.004**	–0.009***	–0.008***
(domestic)	(0.003)	(0.002)	(0.003)	(0.002)
Monitored majority	–0.019***	0.015***	–0.019***	–0.002
(foreign)	(0.006)	(0.003)	(0.005)	(0.003)
Majority & blocking	–0.002	0.000	–0.014***	–0.011***
minority (domestic)	(0.003)	(0.002)	(0.004)	(0.002)
Majority & blocking	–0.024***	0.005*	–0.007	0.003
minority (foreign)	(0.009)	(0.003)	(0.006)	(0.005)
Controlling blocking	–0.005***	0.003***	0.003***	–0.001***
minority	(0.001)	(0.000)	(0.000)	(0.001)
Combined controlling	0.004***	–0.003***	0.005***	0.003***
minority	(0.000)	(0.000)	(0.000)	(0.000)
Crisis		0.151***		
		(0.003)		
Country dummies	N/A		YES	
R^2	0.650		0.263	
Number of observations	1,029,273			

Note: The dependent variable is the distance from the efficiency frontier obtained from the first stage where corporate performance (measured as value added) was related to essential inputs: capital (proxied by sum of total fixed assets and working capital) and labor (proxied by number of employees). Coefficients show the effects of each ownership category or firm characteristic to moving a firm towards or away from the efficiency frontier: the smaller the coefficient is, the more each specific factor contributes to firm efficiency. ***, ** and * denote significance at the 1%, 5%, and 10% levels, respectively. Standard errors are shown in parentheses.

Table 4: Efficiency in manufacturing industries: New EU countries

General characteristics	Pre-crisis (2003–2008)	Crisis (2009–2011)		
Size	–0.001	–0.002		
(ln(Total assets))	(0.001)	(0.002)		
Leverage	–0.027***	–0.006		
(Debt/Total assets)	(0.008)	(0.007)		
Moderate competition	0.006	–0.012***		
	(0.004)	(0.005)		
Low competition	0.004	–0.014**		
	(0.004)	(0.007)		
Global competition	–0.000	0.000*		
	(0.000)	(0.000)		
	Transitory effect		Permanent effect	
Ownership categories	Pre-crisis (2003–2008)	Crisis (2009–2011)	Pre-crisis (2003–2008)	Crisis (2009–2011)
Majority (domestic)	–0.014**	0.006	0.022***	–0.000
	(0.006)	(0.006)	(0.002)	(0.002)
Majority (foreign)	0.003	–0.016***	0.001	–0.006**
	(0.003)	(0.005)	(0.001)	(0.003)
Monitored majority	0.011	–0.013	0.007	0.025***
(domestic)	(0.017)	(0.012)	(0.008)	(0.006)
Monitored majority	–0.003	0.008	0.014*	0.031***
(foreign)	(0.017)	(0.013)	(0.008)	(0.008)
Majority & blocking	0.001	0.001	–0.009	–0.007
minority (domestic)	(0.026)	(0.015)	(0.011)	(0.009)
Majority & blocking	–0.026	0.004	0.027**	0.021**
minority (foreign)	(0.036)	(0.018)	(0.012)	(0.010)
Controlling blocking	0.002	0.002	0.002	–0.004*
minority	(0.004)	(0.005)	(0.002)	(0.002)
Combined controlling	–0.002	–0.000	0.008***	0.000
minority	(0.003)	(0.003)	(0.001)	(0.002)
Crisis		0.079***		
		(0.023)		
Country dummies	N/A		YES	
R^2	0.253		0.173	
Number of observations	105,099			

Note: The dependent variable is the distance from the efficiency frontier obtained from the first stage where corporate performance (measured as value added) was related to essential inputs: capital (proxied by sum of total fixed assets and working capital) and labor (proxied by number of employees). Coefficients show the effects of each ownership category or firm characteristic to moving a firm towards or away from the efficiency frontier: the smaller the coefficient is, the more each specific factor contributes to firm efficiency. ***, ** and * denote significance at the 1%, 5%, and 10% levels, respectively. Standard errors are shown in parentheses.

Table 5: Efficiency in service industries: Old EU countries

General characteristics	Pre-crisis (2003–2008)	Crisis (2009–2011)		
Size	0.003***	–0.003***		
(ln(Total assets))	(0.000)	(0.000)		
Leverage	–0.020***	0.013***		
(Debt/Total assets)	(0.000)	(0.001)		
Moderate competition	–0.043***	0.008***		
	(0.000)	(0.000)		
Low competition	–0.035***	0.004***		
	(0.000)	(0.000)		
	Transitory effect		Permanent effect	
Ownership categories	Pre-crisis (2003–2008)	Crisis (2009–2011)	Pre-crisis (2003–2008)	Crisis (2009–2011)
Majority (domestic)	–0.011***	0.013***	0.010***	0.003***
	(0.000)	(0.000)	(0.000)	(0.000)
Majority (foreign)	0.022***	–0.011***	0.005***	–0.006***
	(0.001)	(0.000)	(0.000)	(0.000)
Monitored majority	–0.008***	0.005***	–0.007***	–0.003***
(domestic)	(0.002)	(0.001)	(0.001)	(0.001)
Monitored majority	–0.020***	0.019***	–0.016***	–0.002
(foreign)	(0.004)	(0.003)	(0.004)	(0.003)
Majority & blocking	–0.001	0.001	–0.015***	–0.002
minority (domestic)	(0.002)	(0.002)	(0.001)	(0.001)
Majority & blocking	–0.008	0.011***	–0.022***	0.007**
minority (foreign)	(0.007)	(0.003)	(0.005)	(0.003)
Controlling blocking	–0.004***	0.003***	0.004***	–0.001***
minority	(0.000)	(0.000)	(0.000)	(0.000)
Combined controlling	0.005***	–0.004***	0.008***	–0.000
minority	(0.000)	(0.000)	(0.000)	(0.000)
Crisis		0.167***		
		(0.002)		
Country dummies	N/A		YES	
R^2	0.775		0.324	
Number of observations	1,859,838			

Note: The dependent variable is the distance from the efficiency frontier obtained from the first stage where corporate performance (measured as value added) was related to essential inputs: capital (proxied by sum of total fixed assets and working capital) and labor (proxied by number of employees). Coefficients show the effects of each ownership category or firm characteristic to moving a firm towards or away from the efficiency frontier: the smaller the coefficient is, the more each specific factor contributes to firm efficiency. ***, ** and * denote significance at the 1%, 5%, and 10% levels, respectively. Standard errors are shown in parentheses.

Table 6: Efficiency in service industries: New EU countries

General characteristics	Pre-crisis (2003–2008)	Crisis (2009–2011)		
Size	–0.002***	–0.000		
(ln(Total assets))	(0.000)	(0.002)		
Leverage	–0.026***	–0.008		
(Debt/Total assets)	(0.006)	(0.010)		
Moderate competition	0.005	0.010		
	(0.003)	(0.010)		
Low competition	–0.003	0.003		
	(0.004)	(0.008)		
Ownership categories	Transitory effect		Permanent effect	
	Pre-crisis (2003–2008)	Crisis (2009–2011)	Pre-crisis (2003–2008)	Crisis (2009–2011)
Majority (domestic)	–0.007	0.021***	0.030***	–0.009***
	(0.005)	(0.008)	(0.001)	(0.003)
Majority (foreign)	0.003	–0.015**	0.000	0.002
	(0.002)	(0.007)	(0.001)	(0.003)
Monitored majority	0.009	–0.014	–0.019***	0.019***
(domestic)	(0.012)	(0.017)	(0.006)	(0.006)
Monitored majority	–0.014	0.041	0.028***	–0.008
(foreign)	(0.020)	(0.029)	(0.006)	(0.010)
Majority & blocking	0.014	0.004	–0.032***	0.003
minority (domestic)	(0.017)	(0.033)	(0.006)	(0.012)
Majority & blocking	0.012	0.027	0.002	–0.013
minority (foreign)	(0.021)	(0.036)	(0.008)	(0.014)
Controlling blocking	–0.003	0.006	0.006***	–0.005**
minority	(0.002)	(0.007)	(0.001)	(0.003)
Combined controlling	0.001	0.000	0.004***	0.005**
minority	(0.002)	(0.006)	(0.001)	(0.002)
Crisis		0.012		
		(0.025)		
Country dummies	N/A		YES	
R^2	0.094		0.041	
Number of observations	226,265			

Note: The dependent variable is the distance from the efficiency frontier obtained from the first stage where corporate performance (measured as value added) was related to essential inputs: capital (proxied by sum of total fixed assets and working capital) and labor (proxied by number of employees). Coefficients show the effects of each ownership category or firm characteristic to moving a firm towards or away from the efficiency frontier: the smaller the coefficient is, the more each specific factor contributes to firm efficiency. ***, ** and * denote significance at the 1%, 5%, and 10% levels, respectively. Standard errors are shown in parentheses.

Results related to capital structure offer a uniform pattern across firms. Contrary to some earlier studies (Jensen and Meckling, 1976; Myers, 1977) but in line with Jensen (1986) and Dilling-Hansen et al. (2003), we find that during the pre-crisis period more leveraged (indebted) firms are closer to the efficiency frontier (negative coefficients) and hence, they are more efficient. However, the extent of the debt does not help to improve the efficiency of firms during the crisis period, irrespective of whether they are domiciled in old or new EU countries (Table 3–6). The inference drawn from these results is that firms using more loans than their own cash-flows are forced to become more efficient over time, but the hardship of the crisis period affects them negatively.[14] The results support Jensen's 1986 free-cash-flow theory.

Finally, we present results associated with market concentration, e.g., whether a firm faces moderate or low competition.[15] When interpreting results we have to recall that coefficients associated with degree of competition should be interpreted (as differences) with respect to the third category of high competition that has been left out for reason of identification. Old EU firms operating in an industry that is characterized by moderate competition (moderate concentration) exhibit higher efficiency during the pre-crisis period (Tables 3 and 5) and manufacturing firms do so during both periods (Table 3). The low competition environment induces an improvement in efficiency during the pre-crisis period but less than moderate competition. In new EU manufacturing firms the situation is slightly different as the effect of moderate and low competition is about equally beneficial during the crisis period (Table 4); insignificant coefficients preclude further assessment. Hence, the identified effect in new EU firms should not be overstated because firms operating in a low-competition sector have more space to adjust their prices during a crisis and this translates positively into their profits. On other hand, firms operating under higher competition pressure have their margins quite narrow with little space to adjust, especially during a crisis. Lower margins result in less efficiency in financial terms. Hence, negative coefficients associated with low and moderate competition mean that firms operating in

[14] This is in line with general wisdom that taking cash out of a firm eliminates or highly reduces the freedom of management to adopt dubious projects. The necessity of servicing the debt then puts pressure on a firm to become more efficient.

[15] Given EU single-market characteristics, we included HHI^L computed for the local competition and HHI^G characterizing the "global", i.e., single market concentration. The HHI^G is calculated only for manufacturing industries as technology is much easier to transfer than services.

low- and moderate-competition sectors are more efficient in financial terms than high-competition firms. Finally, coefficients associated with the measure of global competition indicate that both old and new EU manufacturing firms are right on the efficiency frontier but the coefficients are statistically significant only during the crisis period (Tables 3 and 4). In sum, we find sufficient support for the *x*-inefficiency theory of Leibenstein (1966).

5.2 Ownership effects

We assess our results from the perspective of Hypothesis 2 (outlined in section 4.4) on the effect of different ownership categories. We can sum up our findings in that a greater extent of control, or more concentrated ownership, means a stronger contribution towards firm efficiency but this feature is not universally valid for all firms. Our results show that the types of ownership structures where an owner must account for the presence of other owner(s) with a non-marginal extent of control exhibit interesting contributions towards efficiency. Specific cases are presented below.

Our results show that the *majority ownership* category produces the single most consistent effects across firms and industries. This type of control does not overwhelmingly contribute to firm efficiency in EU countries, as the coefficients are chiefly positive during the decisive pre-crisis period. The effect changes into a contributive one during the crisis. This feature is present for both permanent and transitory ownership structures. The exception from the former pattern is represented by a strong contributing effect of transitory domestic majority owners in manufacturing firms (Tables 3 and 4) and old EU services firms (Table 4). The findings indicate that domestic majority owners improve efficiency in EU firms more than foreign ones, but their impact is lower during the crisis period. This exceptional result is in accord with our prior assumption that concentrated ownership structure leads to higher firm efficiency via superior monitoring of managers (Shleifer and Vishny, 1997; Hill and Snell, 1989). However, the rest of our results convey a rather skeptical message about the role of majority owners in a standard business environment.

In firms where a majority owner is confronted with the presence of a *legal minority* owner (or owners), the effects of transitory and permanent *monitored majority* structures (with both domestic and foreign owners) is consistently helpful to efficiency

in old EU firms during the pre-crisis period (Tables 3 and 5). For new EU firms most coefficients are insignificant (Tables 4 and 6). The effect erodes with the crisis, though (the exception is old EU domestic firms in manufacturing where the effect remains (Table 3)). Taken together, the results show that there is evidence of an important positive disciplining effect on firm efficiency when a majority owner must account for the presence of a minority shareholder.

Results for the category of firms where a majority owner must recognize a *blocking minority* shareholder also produce interesting insights. The beneficial aspects of this control arrangement are evidenced by negative coefficients related to the permanent effect of domestic owners in both industries and EU regions (Tables 3–6) but only to old EU firms in service industries in case of foreign owners (Tables 3 and 5). The beneficial permanent effect remains during the crisis for old EU domestic firms. Further, the same pattern of transitory ownership is limited to old EU firms (Table 3). When the size of the coefficients is considered, firms with a foreign majority and a blocking minority exhibit larger inter-temporal differences in coefficients than those with domestic owners.

The results of the category of a blocking minority owner whose stake is higher than the sum of the stakes of all the remaining known (identified) owners (*controlling blocking minority ownership*) provides evidence that even such a dispersed ownership category might exert some influence. Transitory ownership influence is significant only for old EU firms (Tables 3 and 5) and indicates a beneficial effect during the pre-crisis period; the effect erodes with the crisis. In firms where the ownership does not change, the initially (pre-crisis) less contributing permanent effect improves (Tables 3, 5, and 6).

Minority owners whose combined shares provide them with a majority of voting rights—*combined controlling minority ownership*—are a special ownership category in terms of their contribution to firm efficiency. In this category, two minority owners face a situation where neither of them can fully control the company and only coordinated steps in a functional coalition would enable them to jointly control the company. How does this arrangement work for firm efficiency? A combined controlling minority does not seem to work for firms during the pre-crisis period: the relevant positive coefficients

(Tables 3–6) hint that owners do not cooperate effectively irrespective of the EU region or industry. On the contrary, this arrangement seems to be quite beneficial during the crisis. Here, negative coefficients hint at a joint use of power between the two minority shareholders, of either permanent or transitory status, and a contributing effect of this ownership arrangement with respect to firm efficiency, albeit only when there is no other choice.

5.3 Foreign ownership effect

Based on the ownership domicile information, we are also able to summarize the results related to Hypothesis 3 on the effect of foreign ownership through FDI. We discussed the specific influences of owners, including foreign ones, when assessing the effect of the diminishing extent of control on firm efficiency in section 5.2. Now we summarize the specific effect of foreign owners. There are two categories where the contributing effect of foreign owners is clearly visible irrespective of EU region: firms where a majority owner must recognize either legal or a blocking minority shareholders. In the other cases, on average, domestic owners exhibit a more beneficial effect.

The finding might come as no surprise in old EU countries: here foreign owners are present in domestic firms through their FDI, which mostly originates from within the old EU group itself. Further, based on the UNCTAD (2004) report, foreign owners in the old EU group are present to a much smaller degree than in the rest of our sample, since the FDI flows to developed countries were gradually shrinking. On the other hand, firms from the old EU countries were actively acquiring assets in new member states, and their accession in 2004 boosted new FDI from the old EU group, totaling around 67–75% of total FDI in new EU member countries (UNCTAD, 2004). The beneficial effects of foreign owners subjected to legal or blocking minority control in new EU countries may be taken as evidence of corporate governance that gradually improved

over time, without doubt thanks also to the FDI inflow from old EU countries that overwhelmingly dominated FDI in the 12 new EU members (UNCTAD, 2008).[16]

Overall, the contributing effect of foreign owners is primarily limited to majority categories with control by legal and blocking minorities. The result indicates a strong implication with regard to the disciplining effect of the two specific ownership structures involving foreign owners.

Although not reported, all the results are also robust to the alternative measure of performance (sales). Our findings also hold for the subsample of medium and large firms.

[16] Uzagalieva et al. (2012) show that local firms in the new EU markets experience efficiency gains if they supply industries with a higher share of foreign firms or if foreign firms sell to them.

6. Conclusion

In this paper we analyze the effects of size, competition, capital and ownership structure on firm efficiency in a comprehensive dataset using the stochastic frontier approach. One of our important contributions to the literature is a focus on technical efficiency of firms instead of accounting ratios. Private firms have incentive to minimize reported taxable income (Daily and Dollinger 1992; Durand and Vargas, 2003), therefore, accounting measures should be used with caution in studies of privately held companies (Schulze et al, 2001). Given that private firms constitute the vast majority of our sample, focus on technical efficiency — a firm's ability to produce the maximum output from a given set of inputs — represents a considerable advantage as it may be less prone to manipulations by managers.

Our findings highlight that larger firms are characterized by lower efficiency. This result might be driven by higher bureaucracy, higher communication costs and a greater resistance to change in large firms compared to smaller firms. Capital structure and concentrated ownership are also found to be important for firm efficiency as they promote managerial discipline. We pay special attention to firm ownership structure and distinguish between different degrees of control by owners and ownership domicile. As a result, we are able to document the effects of different ownership structures on firm efficiency to an extent not found in previous studies.

In the analysis, we also distinguish between a pre-crisis period (2001–2008) and a post-crisis period (2009–2011). Our results are found to be sensitive to the period of observation. Therefore, we interpret patterns observed for the post-crisis period with caution and base our conclusion mostly on the pre-crisis period. A full investigation the implications of 2008 financial crisis on efficiency is left for future research.

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