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"FDI and Ownership in Czech Firms: Pre- and Post-crisis Efficiency"

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FDI and Ownership in Czech Firms: Pre- and Post-crisis Efficiency

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Abstract:

We analyze how efficiency of firms in the Czech Republic is affected by their size, age, competition, capital structure, ownership types, and global financial crisis. We employ the stochastic frontier approach, use a large and detailed dataset, and cover time span 2001-2012. We show that larger firms cannot be associated with better efficiency in general. Effect of their age has only negligible impact. Impact of the capital structure is shown to be strong in large and more leveraged firms. Higher competition is not contributive to efficiency neither on individual nor aggregate levels. While effects of firm characteristics are small, the effects of ownership are economically substantial. We show that majority owners are most contributive with respect to firm's efficiency when compared to other categories we analyze. Minority owners with legally grounded power are able to impose significant efficiency improvement. The effect of the foreign ownership is strongest when foreign owners control firms with less than majority of voting power. Minority owners sharing the control do not seem to contribute to efficiency. The impact of crisis is not balanced but can be regarded as negative in general. The firms' characteristics change only a little. In contrast, worsening impact of the crisis is evidenced for controlling ownership categories. Minority owners exhibit a limited disciplining effect to improve efficiency after the crisis.

Keywords: efficiency; ownership structure; firms; panel data; stochastic frontier; Europe
JEL Classification: C33, D24, G32, L60, L80, M21

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1. Introduction, motivation and relevant literature

Social and economic reforms of the 1990s in Central and Eastern Europe (CEE) helped to the CEE countries in creating competitive market economies and more efficient enterprises by firm restructuring, privatization, and supporting institutional reforms (Aussenegg and Jelic, 2007). In this respect, ownership structures have become a key determinant of corporate performance in CEE countries (Estrin et al., 2009). Following their transition from the command to market system and quite soon after their successful integration into the European Union (EU) the CEE countries had to face another challenge in form of the global financial crisis (GFC; crisis). Privatized, restructured, and newly established firms had all to cope with a dramatic change in the economic environment. How did the firms performed during the period of ending transition, ongoing European integration and merciless crisis? In this paper we strive to provide some answers. We target one of the CEE countries and analyze the corporate performance of the Czech firms in terms of their efficiency and how this efficiency has been determined by various firms' characteristics, ownership structures, presence of the FDI and how it was affected by the GFC.

What determines firm efficiency is a central question in economics and finance. The seminal literature suggests that primary determinants of firm efficiency are capital structure and ownership (Jensen and Meckling, 1976; Jensen, 1986), while other firm, market, and cultural characteristics play a role as well (Leibenstein, 1966; Diaz and Sanchez, 2008). However, the existing empirical literature on the link between capital structure, ownership structure, and firm performance and/or efficiency is fragmented (Shyu, 2013; Arocena and Oliveros, 2012; Cabeza-García and Gómez-Ansón, 2011; Margaritis and Psillaki, 2010; Weill, 2008; Barth et al., 2005; Dilling-Hansen et al., 2003; Palia and Lichtenberg, 1999); only recently more comprehensive findings became available (Hanousek et al., 2015). Further, the related literature almost uniformly suggests that foreign ownership improves firm performance in a better way than domestic ownership. In many instances empirical evidence supports this argument in CEE countries. The positive spillover effects of foreign ownership in the form of Foreign Direct Investment (FDI) on firm performance in the CEE is shown by Hanousek et al. (2011) and further reported at microeconomic level by Djankov and Hoekman (2000) and Hanousek et al. (2012) for Czech firms and, for example, by Javorcik (2004) for Lithuanian firms.

However, the literature remains largely silent on the effects of particular ownership structures on firm efficiency in the Czech Republic and the CEE. Further, much of the work targeting the early stage of the transformation frequently uses small and often

unrepresentative samples of firms, often combines data from different accounting systems, and has access to limited data on firm ownership and treats ownership as a relatively simple categorical concept (e.g., private versus state, state versus foreign, domestic private outsider versus domestic private insider), and they are often unable to distinguish the exact extent of ownership by individual owners or even relatively homogeneous groups of owners.[1] These shortcomings prevent many studies from providing accurate evidence on the effects of various ownership categories on technical efficiency, as well as corporate performance. The exception is a study by Hanousek et al. (2012) that employs a variety firms' characteristics and ownership categories to analyze performance of the Czech firms but does not address the challenge of the recent GFC.

Hence, we ground this paper in comprehensive perspective and offer the following contributions. We use an exceptionally sizable dataset of the Czech firms in both manufacturing and service sectors during the period from 2001 to 2012. Our approach employs a stochastic production frontier model and shows many details of how key firm characteristics plus specific ownership structures affect firm efficiency. We further analyze development of firm efficiency before the recent global financial crisis (2001-2008) and later on (2009-2012).

We analyze links between ownership structure, firms' characteristics and firm performance primarily from the agency theory perspective. E.g., in case of the ownership the theory predicts a conflict of interest between owners and managers. Owners are interested in firm performance and strive to maximize profits, whereas managers are tempted to pursue selfish strategies—low effort level, high compensation, empire building—to maximize their own utility, resulting in a lower market value of the firm (Jensen and Meckling, 1976). As agency conflicts could be mitigated by monitoring, the presence of large shareholders is positively correlated with firm performance because larger owners have stronger incentives to monitor and influence managers to protect their investments (Shleifer and Vishny, 1986). At the same time, large shareholders might use their control rights to maximize their own utility rather than the firm's value at the expense of minority shareholders. In the case of less concentrated ownership, conflict between shareholders and managers could also result in conflicts among shareholders.

The composition of our dataset follows strict requirements for data quality in terms of the coverage (number of firms) and details on the ownership structures. Further, by dividing

[1] See, for example, early studies of Brada and King (1994), Brada et al. (1994) and Konings and Repkin (1998).

our sample into subsamples we detect and analyze the impact of the economic crisis after 2008 onwards. In addition, our dataset enables us to trace the true development of ownership structure over time in unprecedented detail. In each firm in the sample, we are able to detect 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.

The firms under research constitute the bulk of the economic activity in the Czech Republic which makes our analysis stronger because the potential bias due to focusing on specific sectors is negligible. However, at the same time we are 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 affect firm efficiency.

In the paper we want to evaluate the efficiency effect of the FDI via foreign ownership, as well as the effects of various degrees of ownership concentration. We employ the stochastic production possibility frontier approach introduced by Aigner et al. (1977) and Meeusen and van den Broeck (1977) to analyze the effect of ownership by using a model for panel data and time-varying technical efficiency from Khumbhakar (1990) and Battese and Coelli (1995). The methodology is well established in the empirical literature. We adjust our methodology in such a way that all parameters of the production function account for the specific two-digit (NACE) industries in which firms operate. Effects at a high level of detail are derived from this set-up. Within our methodology we also address potential problem of unobserved (fixed) firm heterogeneity, including the endogeneity of firm ownership with respect to its efficiency.

The paper is structured as follows. The methodology is described in section 2. In section 3 we introduce our data, specific development of Czech firms, describe firm and market characteristics and ownership categories, and formulate our hypotheses. In section 4 we present our empirical results and conclude in section 5.

2. Modeling approach

We analyze the drivers of a firm's efficiency in two steps by employing stochastic frontier analysis (SFA). First, we derive firm's efficiency from the stochastic production possibility frontier. Second, 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, and degree of competition) and ownership structure. Thus, our model consists of two specifications (i) describing the efficiency frontier with the help of production function and (ii) modeling the determinants of efficiency.

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.[2] The estimation itself is performed using the maximum likelihood one-stage procedure originally designed by Battese and Coelli (1995). Similarly as in Weill (2008), we obtain efficient estimates that are free of potential correlation among variables.

2.1 Firm efficiency

To perform the SFA we first formulate production function.[3] The general production function $y_t = f(x_t;\ \beta)$ relates 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. If a firm employs all inputs efficiently (TE_i = 1), it achieves an optimal output while TE_i smaller than one indicates a degree of inefficiency. 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 $u_{it} \geq 0$. Further, 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 $lny_{it} = \beta_0 + \sum_{j=1}^{k} \beta_{jit}\, lnx_{it} + v_{it} - u_{it}$. In this general specification v_{it} is a pure noise component and a two-sided normally distributed variable, while u_{it} is the nonnegative

[2] We employ the fixed effects estimation approach because alternative use of the instrumental variables (IV) 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).

[3] 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). The advantage of the SFA over the non-parametric approach of data envelopment analysis is that the SFA allows for hypothesis testing (see Fried at al., 1993).

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 we estimate a time-invariant technical inefficiency model separately in a series of short panels and the time dimension is then brought in by merging the results from the short panels. This approach enables easier estimation and any potential bias is actually fairy moderate; for more details see Green (2005) and Hanousek at al. (2015). Therefore, we opt for estimating the model via a series of three short panels (2001–2004, 2005–2008, and 2009–2012).

The actual form of the production function we employ is the mainstream Cobb-Douglas function with two-digit NACE sectors. Thea Cobb-Douglas function represents less restrictive production function than other options, it is robust (Chirinko et al., 2010), and has been shown empirically to fit the Czech data (Hájková and Hurník, 2007) as well as those from other CEE or CIS countries (e.g., Brown et al., 2006 and Brada et al., 1994). 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:

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

In specification (1) $\ln y_{it}$ is the natural log of the value of the production of firm i at time t, measured as firm operational revenues (sales). Then $\ln c_{it}$ is the natural log of the capital of each firm measured as working capital, and $\ln l_{it}$ is the natural log of the firm's labor, measured as the number of employees.[4] A common intercept for all firms is denoted by β_0.

Further, it has been shown that ownership structures in firms 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: ID_{ijt} represents a vector of dummy variables to associate each firm with the specific industry sector j it operates in. By the construction of the model we interact

[4] Working capital is the optimal proxy for capital in our efficiency analysis despite the fact that the money tied up in working capital is costly since it earns zero rate of return (Kim et al., 1998). However, managing working capital efficiently stimulates growth opportunities and enables avoiding costly interruptions to firms' 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. Thus, 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. During estimation we employed different measures of capital as well as staff costs. Our results were not materially different. All alternative results are readily available upon request.

dummy variables for each of the 45 two-digit NACE industries with both inputs (capital and labor) to control for industry-specific effects. We also include in specification (1) yearly time dummies (ϕ_t) that control for time-specific effects (country-wide economic development and business cycles) that are equal for all firms but vary over time. Finally, the random error is denoted as v_{it} and $u_{it} \geq 0$ represents inefficiency - producer effects are required to be nonnegative because they represent the degree of inefficiency.[5]

3.2 Drivers of firm efficiency

In the second step we follow the estimation approach outlined in Hanousek et al (2015) and model firm efficiency (u_i) as a function of (i) a set of key market and firm characteristics used widely in the literature and (ii) detailed firm ownership structure. Formally, the model for each period (pre-crisis and post-crisis) is specified as follows:

$$u_{it} = \alpha_i + \beta_1 Size_i + \beta_2 Age_i + \beta_3 Debt_i + \beta_4 DebtLInfo_i + \sum_{c=1}^{C} \delta_c HHI_c + \sum_{j=1}^{J} \gamma_j OWN_{it}^{j} + \sum_{k=1}^{K} \xi_t I(industry = k) + v_{it} \quad (2)$$

for all i = 1,…, N *(firm index)*; t = 1,…, T *(time index)*; c = 1,…, C *(market competion categories)*; j = 1,…, J *(ownership categories)*; and k = 1,…, K *(double digit industry categories)*. Let us note that model (2) is estimated separately for the periods (2001-2008) and (2009-2012) to take into account the potential effect of the economic crisis.

In the above specification (2) we account for number of factors potentially affecting corporate performance. *Size* of the firm is measured as (log of) total assets and captures the effect of firm size on inefficiency based on the hypothesis larger firms lose momentum to improve their efficiency (e.g., Diaz and Sanchez, 2008). *Age* is defined as the number of years from a firm's incorporation and measures the effect of a firm's age on efficiency under a prior that younger firms might be eager to compete via higher efficiency or be less efficient due to not being established yet.[6] *Debt* (leverage) defined as Total Debt/Total Assets (in percent) captures the effect of the capital structure as 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). On the other hand, according to the pecking order hypothesis, projects are financed according to

[5] See Hanousek et al (2015) for technical details.

[6] The *Age* variable might also capture the effect of survival bias. However, since firms leave as well as enter the data set based on factors under the control of the data collecting agency (Amadeus), we consider this possibility negligible.

a pre-committed schedule (Meyers, 1977). As in our data set we also have firms for which we have limited information on their leverage we include a special dummy *DebtLInfo* in order not to lose track of these chiefly small firms.

We also 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. Hence, less concentrated industry provides more competition and should lead to increased efficiency (Nickell, 1997; Dilling-Hansen et al., 2003). To operationalize the above concept we include the Herfindahl-Hirschman Index (HHI) of industry concentration.[7] From the regulatory perspective of the different (local) levels of industry concentration we employ the HHI based on the scale used by the U.S. Department of Justice and the Federal Trade Commission (2010) for assessing low, moderate and high industry concentration levels.[8] If a firm belongs to an industry with a high competition (low concentration) or low competition (highly concentrated), in each case the HHI variable in (2) takes a value of one and zero otherwise. The effect of moderate competition (moderately concentrated industry) is captured by a constant term. A specific variable captures the proportion of a firm on the sector concentration measured by the HHI – higher proportion means that a firm faces lower competition.

In specification (2) we account for a possible shift in the mean of technical efficiency (parameter μ) caused by the GFC-affected economic conditions from 2009 on. Our data provide a sign of a structural break and since the effect of the GFC is one of our key topics, we allow for a different (post-crisis) mean from 2009 onwards. For this reason we also do not report an overall effect for the whole time span of our data as the coefficients would be meaningless due to the structural break.

Finally, 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). To account for unobserved firm-level heterogeneity, the model is estimated by using fixed effects that are captured by coefficient α_i.

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[7] 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.

[8] On this scale industries are considered non-concentrated if HHI is less than 1500, moderately concentrated if HHI lies between 1500 and 2500, and highly concentrated if HHI is greater than 2500; the most recent thresholds are used.

To summarize, coefficients γ_j associated with the ownership effect estimated via panel fixed-effects specification (2) represent (changes in) ownership effects. 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 4.1. The estimation results of (in)efficiency regressions (2) should be interpreted in terms of coefficients' values: larger coefficients associated with specific ownership categories mean that under a particular ownership type, a firm moves further from the efficiency frontier. More details are provided in Section 5 where we present our results.

4. Data, variables, and hypotheses

4.1 Data and ownership categories

The data-set form the firm-level unbalanced panel data for the period 2001–2012 constructed from several annual updates of the Amadeus database. Overall, we work with unique firm-level panel data where the total number of firm*year observations is 1,021,607. In the period 2001-2008 we have 466,041 firm*year observations, while period 2009-2012 is represented by 555,566 firm*year observations.

Basic descriptive statistics of the above firm-level balance-sheet data used in specifications (1) and (2) are summarized in Table 1. The turnover (sales) of firms exhibits similar standard deviation as that of the inputs, meaning rather constant returns to scale of the Czech firms's production. In all parameter, with the exception of leverage, the increase can be witnessed during post-crisis period. Among the parameters, leverage exhibited a marginal decline, an understandable feature given unfavorable economic conditions associated with the GFC. Marked increase in labor after the crisis should be associated with improving conditions of large firms, while smaller ones experienced some decline in labor force.

Our ownership variables are defined with respect to country-specific legal rules as argued in Gugler (2003). As shown in Hanousek et al. (2007), holders of different concentration thresholds have under Czech law different opportunities to influence corporate governance. Majority ownership represents a high degree of concentrated ownership, while minority ownership can be viewed as a form of moderately dispersed ownership.[9] Based on the above distinction of ownership concentration, we define several specific ownership categories. Rather than using exact percentage stakes, we opt for dummy variables that

[9] Highly dispersed ownership arises when the stake of the largest holder does not reach the legal (10 percent) minority.

differentiate various ownership categories and allow us to provide more comprehensive results. All ownership categories are exclusively defined and they are also distinguished for domestic and foreign owners, 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.

Majority ownership (more than 50% of shares) grants the owner the right to staff management and supervisory boards, alter and transfer firms' assets and make crucial strategic decisions at general shareholder meetings. Through management and supervisory boards, majority ownership also facilitates more direct executive control of the company. *Majority ownership* is a dummy variable coded 1 when an owner holds more than a 50% stake in a firm and it is coded 0 otherwise. Often, control of the company can be pursued with lower ownership stake, though. For example, La Porta et al. (1999) employ 20% as a threshold for control of a company. To account for this possibility, we introduce the dummy variable for the *Controlling non-majority ownership* that is coded 1 when an owner holds a stake in a firm that is lower than 50% but this stake is greater than the sum of all the remaining stakes that can be identified and provides the owner with effective control of the company; it is coded 0 otherwise.

Further down the ladder of control is the *Combined controlling minority ownership* – it is the minority category dummy that is coded 1 when there are two owners whose combined stake exceeds 50%; it is coded 0 otherwise. These two owners cannot individually control the firm or act against each other as individually they do not have enough voting power. However, they may or may not coordinate their steps or form a coalition and control the company via the combined voting rights that give them a majority.

Finally we establish two important categories that are grounded in the legal provisions. First, a blocking minority ownership enables a strong minority owner to pursue its own interests and gives it potential to contest decisions of a majority owner. Hence, *Blocking minority* is a dummy variable that is coded 1 when a minority owner holds a stake higher than the threshold of 33% legally required by the Czech law; it is coded 0 otherwise. Second, on the opposite side of the control, there are minority owners with a block of at least 10% of shares that are potentially important because the law entitles the holder of this stake to call general shareholder meetings and obstruct decisions by delaying implementation through lengthy court proceedings - based on this legal provision we label this category as *Legal minority* and a dummy variable is coded 1 when there is a minority owner with a stake higher than 10%; it is coded 0 otherwise. This ownership category reflects the situation in firms

where other owners are confronted with at least one non-marginal owner pursuing its own interest.

Further, all ownership categories above are distinguished based on domestic and foreign owners. In this sense, the distinction between domestic and foreign ownership represents an important implication with respect to FDI. Based on the official definition, if "the direct investor owns at least 10% of the voting power" (OECD 2008; p. 17) in a firm, then the firm is considered a direct investment and the foreign domicile of the direct investor constitutes the FDI. Since from our data we are able to distinguish specific ownership stakes of 10% and up, majority and minority control categories can be distinguished according to the domicile and provide information about FDI ownership.

Finally, a constant captures the dispersed or unknown ownership of a firm. In this case the firm either exhibits highly dispersed ownership or does not report on its ownership.[10]

4.2 Testable hypotheses

Based on our data and our priors we formulate four hypotheses to be assessed. Their formulation is grounded in the literature and the key arguments are show below as well.

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

The hypothesis 1 accounts for that 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.

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

The hypothesis 2 indirectly examines the agency problem arising from the separation of ownership and control. 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, large owners may engage in self-dealing, which can reduce efficiency. Further, 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. Further, legal minority owners might not represent an

[10] In our analysis we do not consider a category of highly dispersed ownership when owners hold stakes smaller than 10% in the firm. First, less-than-10% ownership is not required to be reported by law. Hence, we are not able to completely trace all these stakes. Second, even when we are able to trace less-than-10% stakes, their proportion in our sample is negligible (about 3%).

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 or they may quarrel with the majority owners and oppose decisions instead of monitoring, which may decrease firm efficiency. Finally, owners might form coalitions of the so-called block owners and as a result might be able to exert a noteworthy disciplinary impact (Dilling-Hansen et al., 2003) or in contrast might refuse to cooperate. 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.

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

The hypothesis 3 is related to the trade literature where 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). 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.

Hypothesis 4. H_0: Global financial crisis did not affect a firm's efficiency.

The hypothesis 4 examines the effect of the GFC 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.

5. Empirical results

The key results for how firm efficiency is determined by firm characteristics, competition, ownership types, and financial crisis are presented in Table 2 for all Czech firms. Further, in Table 3, we present results for a subset of large firms defined according to the EU rules as those with 50 or more employees. The results are reported separately for pre-crisis (2001–2008) and post-crisis (2009–2012) periods.

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. 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. To summarize, when comparing the effects of two different ownership categories, we simply observe 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 firm characteristics, as well.

5.1 Effect of firm characteristics and market competition

Our results related to the Hypothesis 1 show that the overall effect of the size of firms is statistically significant but very small. The effect is consistently associated with essentially neutral impact on efficiency as witnessed by small, positive and statistically significant coefficients (Table 2-3). All firms exhibit unchanged effect of the size before and after the crisis (Table 2). On other hand, for large firms the impact is somewhat better during the post-crisis period (Table 3). However, the effect of the firms' size must be regarded as narrow in economic terms since the associated coefficients are quite small. In any event, based on our findings, we infer that size of the Czech firms cannot be associated with better efficiency in general.

Overall, the age of firms is also consistently statistically significant, also small, and with a negligible effect to improve efficiency; this feature is invariant with respect to the crisis. Moreover, the coefficients' values do not materially differ for all or just large firms (Tables 2 and 3). Hence, the age of firm does not allow for much of variety in inference but its not-improving impact on efficiency should not be exaggerated as the effect is rather small economically.

The effect of the capital structure on firm efficiency is found to be rather strong by the fact that the respective coefficients are large, negative and statistically significant overall. This means that from the aggregate point of view the more leveraged firms are getting closer to the efficiency frontier. Still, an interesting observation can be inferred from the differences

between firms and periods. The improving impact of the leverage is evident from negative and significant coefficients that also differ before and after the crisis (Table 2). Based on the coefficients' values, we infer that large firms are driving the result (Table 3). This finding is quite interesting as it shows that the debt helps large firms to improve their efficiency at a greater extent. The finding is also intriguing in that it does not conform to a prevailing common wisdom on the damaging effects of the GFC. We further shed more light into this issue as in our data set we also have firms for which we do not have complete information on their leverage. In order not to lose track of these (chiefly small) firms we include a special dummy (missing leverage information). Based on the coefficients we see that firms, with limited indication on their capital structure do not exhibit improvement in efficiency and this is invariant over both periods (Table 2). The similar result is evidenced for large firms but here the impact is lower and decreases after crisis (Table 3). Important is also the fact that both effects are economically significant. Our evidence yields support for the Jensen (1986) hypothesis on the positive effect of capital structure in general. On other hand, in firms where proper information on their capital structure is missing, we find quite an opposite effect. The question remains whether improper reporting on their leverage is not already an indication of their poor efficiency.

Finally, we infer the impact of the low versus high competition environment. The overall effect is mixed in a sense that manufacturing firms do not have statistically significant coefficients (Table 2) while firms in services do (Table 3). Since we differentiate between high and low competition the results are interpreted with respect to the moderate competition category. Hence, we have two broad results. Low competition environment exhibits mildly economically significant contributing effect to firms' efficiency and high competition environment does not (Table 2). This finding goes against the *x*-inefficiency hypothesis. The judgement for large firms is precluded by the general lack of statistical significance; on other hand coefficients are quite small anyway (Table 3). Further, the contributing effect of the low competition increases during the post-crisis period, while the non-improving effect of the high competition decreases its impact. Additional inference can be made with the help of the dummy variable that captures the effect of the proportion of a firm in the sector's concentration measured by the HHI. For both groups of firms we observe that the larger proportion of the concentration (that a firm captures) does exhibit less contribution to improve individual firm's efficiency (Tables 2 and 3). This means that when firms face less competition on individual level, this buffer does not improve their efficiency. However, caution should be exercised because the effects are very small in their economic impact. To

sum up our results, we do not find any evidence for the *x*-inefficiency hypothesis on individual level or aggregate levels.

5.2 Effect of ownership

We now proceed with assessment of the Hypothesis 2 on the effect of different ownership categories defined in Section 4. The overall observation is that all ownership categories produce economically significant effects while their statistical significance varies and sometimes its lack prevents more elaborate assessment.

The key *Majority ownership* category clearly shows its ability to affect improvements in efficiency. Domestic majority owners improve efficiency of the firms during the pre-crisis period more than foreign owners in general (Table 2). Foreign majority owners, on other hand, exhibit quite a contributing effect before crisis in large firms (Table 3). However, it is evident that both domestically or foreign controlled firms are further from their efficiency frontier during the post-crisis period, albeit domestic owners exhibit a better record (Tables 2 and 3).

Ownership category enabling control of the firm without majority (*Controlling non-majority ownership*) does not allow for assessment before-crisis as the coefficients are statistically insignificant (Table 2 and 3). During the post-crisis period firms under this ownership category are not close to their efficiency frontier and, thus, the category exhibits similar pattern as majority ownership. Still, there is a difference because firms under domestic ownership are markedly further from their efficiency frontier than those under foreign control..

The *Combined controlling minority ownership* consistently shows the least contributing effect to efficiency when compared to the previous two categories. Ccoefficients are positive an larger than those of the two categories enabling to control the company, which mens that under such ownership firms are even further from their efficiency frontier (Tables 2 and 3). In all (Table 2), as well as large firms (Table 3) the foreign owners perform slightly better than domestic ones, albeit such comparison can be made only during the post-crisis period. It seems as if foreign minority owners in the Czech firms form marginally better efficiency-improving coalitions than domestic owners. The result is in opposite to earlier findings of Hanousek et al. (2012) that was obtained solely for the pre-crisis period, though. Further, the difference in distances from the efficiency frontier is not large for domestic and foreign owned firms and, therefore, the result does not point at particularly strong differences between both categories.

Two categories of control (*Majority ownership* and *Controlling non-majority ownership*) may be confronted with their control execution with presence of non-marginal minority owners. As we discussed earlier, the holders of *Blocking* and *Legal minority* ownership rights may exert their power by questioning or obstructing some decisions of the, otherwise seemingly, controlling owners. In firms, where domestic owners possess blocking and legal minority rights, the efficiency improvements exhibit economic effect during post-crisis period (Table 2). Foreign owners with blocking minority rights on other hand do not show particularly beneficial effect, albeit some improvement is visible after the crisis. Assessment of the large firms is limited by mostly statistically insignificant coefficients; still, evidence points at low non-contributing impact of both categories (Table 3). Taken together, there is non-negligible evidence of the positive disciplining effect on firm efficiency when a controlling owner must account for the presence of domestic minority shareholders. The finding is in line with related empirical works showing 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).

In sum, majority owners are found to be the most beneficial ownership category with respect to firm's efficiency when compared to other categories that enable control of the firms. In this respect our results are in favor of the agency theory as they show that a concentrated ownership structure leads to higher firm efficiency via superior monitoring of managers (Shleifer and Vishny, 1997; Hill and Snell, 1989). Further, minority ownership itself does not seem to improve a firm's efficiency decisively, as truly strong control is very likely to be missing in such an ownership structure. Economically significant effect is evidenced also when minority owners discipline stronger owners via their legally grounded powers. On other hand, owners in coalition-like position seem to be unable to exert a noteworthy disciplinary impact.

5.3 Effect of foreign ownership

The effect of foreign ownership (Hypothesis 3) differs with its type or ability to control. In case of *Majority ownership*, domestic owners seem to contribute more to their firms' efficiency than the foreigners in general (Table 2) but foreigners improve efficiency better in really large firms (Table 3). However, when foreign owners are able to control firms without sheer majority stake (*Controlling non-majority ownership*) then their contribution to reduce inefficiency is larger than that of domestic owners. This effect is especially pronounced in large firms (Table 3). When two owners are able to form majority (*Combined controlling*

minority ownership), then this category exhibits worse impact than previous two categories but foreign owners perform slightly better than domestic ones. When foreign owners are equipped with blocking or legal minority rights, they do not seem to exert any notable disciplining effect on controlling owners.

In sum, despite the fact that foreign majority owners perform worse than domestic ones, the effect of the foreign ownership is strongest when foreign owner controls a firm without needing majority of voting power. The result resonates with an earlier finding that foreign-owned firms in Europe involved in multinational operations do better in financial performance than purely domestic units (Mathur et al., 2004). The results also hint that coalitions of foreign minority owners are not necessarily overly helpful in improving efficiency of the Czech firms. A corollary to our finding is a documented link between the technological progress in the new EU countries and the foreign direct investments (Uzagalieva et al., 2012), intensive trade links (Hanousek and Kočenda, 2014), and further space for deepening trade and international production networks (Frensch et al., 2016). All those features involve foreign ownership in new EU firms and those in the Czech Republic in particular due to its high level of interconnectedness within the EU production and trade structures.

5.4 Effect of the crisis

Our results show that the effect of firm's characteristics and ownership categories changes over time before and after the crisis. However, the assessment of the Hypothesis 4 is conditional on the statistical significance of the coefficients' pairs in both periods. From our findings we infer that the effect of the GFC can be considered as negative in general. At the same time, the effect is unbalanced. While the effect of firms' characteristics remains unchanged or changes a little, the effect of ownership is more pronounced. During the post-crisis period, the ownership as controlling device exhibits efficiency worsening across the key categories. However, ownership as a disciplining device exhibits limited scope of efficiency improvement after the GFC, mainly thanks to domestic owners equipped with blocking and legal ownership rights.

In general, the findings show that a period of financial distress did not push less efficient firms to become more efficient in order to survive. It also seems that firms were losing efficiency due to a lack of pressure by their owners but a limited improvement effect can be traced to owners with rather secondary control potential. Other possible explanation of the worsened efficiency is via important trade channel. Since the Czech firms are heavily

engaged in international trade, especially within the EU (Hanousek and Kočenda, 2014; Frensch et al., 2016), worsening of the trade patterns during the GFC might negatively impact firms‘ efficiency as well.[11]

6. Conclusion

Our analysis deals with the questions of how do the size, age, competition, capital structure, ownership types, and global financial crisis impact efficiency of the Czech firms. For answering these questions we employ the stochastic frontier approach, use a large and detailed dataset, and cover time span 2001-2012.

We show that larger Czech firms cannot be associated with better efficiency in general but their age has only negligible impact. The impact of the capital structure on firm efficiency is shown to be strong and pronounced in large and more leveraged firms that tend to improve their efficiency after the crisis. We also find that higher competition is not fruitful with respect to efficiency neither on individual nor aggregate levels.

Further, we show that majority owners are most contributive with respect to firm's efficiency when compared to other categories we analyze. Interestingly, minority owners with legally grounded power are able to impose significant efficiency improvement. Remarkably, the effect of the foreign ownership is strongest when foreign owners control firms with less than majority of voting power. In contrast, improving impact is missing when minority owners have to share the control over a firm.

Finally, we demonstrate that the impact of crisis is not balanced but can be regarded as negative in general. The firms' characteristics change only a little between pre- and post-crisis periods with the exception of the firm's capital structure: large and more indebted firms improve their efficiency after the crisis. The effect of ownership is more pronounced. The worsening impact of the crisis is evidenced for controlling ownership categories. Still, minority owners exhibit a limited disciplining effect to improve efficiency after the GFC.

[11] The regular international trade flows were severely affected during the global financial crisis (Chor and Manova, 2012) along with capital inflows to new EU countries (Globan, 2015).

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Table 1: Descriptive statistics: Firm level data

Group	Variable	Mean	Std. Dev.	Min	Max
Period 2001-2008	log (Total Assets)	12.27	2.22	3.66	23.92
	log (Fixed Assets)	11.39	2.52	3.66	23.60
	log(Working Capital)	10.85	2.50	3.64	20.79
	Log (Turnover)	12.53	2.56	3.59	23.25
	Leverage	0.13	0.25	-0.05	1.10
	Number of Employees	39.74	241	1	38,923
Period 2009-2012	log (Total Assets)	12.14	2.23	3.89	24.09
	log (Fixed Assets)s	11.50	2.42	3.92	23.90
	log(Working Capital)	10.76	2.47	3.88	20.73
	Log (Turnover)	12.21	2.49	3.87	23.38
	Leverage	0.14	0.25	-0.05	1.10
	Number of Employees	30.39	173.47	3	10,000

Note: The descriptive statistics corresponds to the sample used for the regression analysis. It means that period 2001-2008 represents 466,041 observations, while period 2009-2012 covers 555,566 observation. The total number of firm*year observations is 1,021,607.

Table 2. Efficiency of the Czech Firms:

General characteristics	Period (2001-2008)	Period (2009-2012)
Size (log of Total assets)	0.001***	0.001***
	(0.000)	(0.000)
Age of the firm (in years)	0.002***	0.002***
	(0.000)	(0.000)
Leverage (Debt/Total assets)	-0.007***	-0.010***
	(0.000)	(0.000)
Missing leverage information (0/1)	0.032***	0.032***
	(0.009)	(0.009)
Low competition	-0.005***	-0.013***
	(0.002)	(0.003)
High competition	0.031***	0.010***
	(0.002)	(0.002)
Firm market share (percent)	0.001***	0.002***
	(0.000)	(0.000)
Majority - domestic	-0.011***	0.007***
	(0.003)	(0.000)
Majority - foreign	0.013***	0.024***
	(0.001)	(0.000)
Control (no majority) - domestic	0.001	0.039***
	(0.008)	(0.002)
Control (no majority) - foreign	-0.001	0.019***
	(0.002)	(0.001)
Combined control - domestic	0.018***	0.032***
	(0.006)	(0.006)
Combined control - foreign	0.010	0.029***
	(0.008)	(0.001)
Blocking Minority - domestic	-0.008	-0.015***
	(0.006)	(0.001)
Blocking Minority - foreign	0.019***	0.005***
	(0.001)	(0.001)
Legal Minority - domestic	0.002	-0.003***
	(0.007)	(0.001)
Legal Minority - foreign	0.015***	0.005***
	(0.002)	(0.001)
Constant	0.768***	0.777***
	(0.003)	(0.004)
Industry fixed effects	YES	YES
R^2	0.076	0.243
Number of observations	466,041	555,566

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.
Base category: Medium competition, Dispersed/Unknown ownership.

Table 3. Efficiency of the Czech Large Firms (Number of employees ≥ 50)

General characteristics	Period (2001-2008)	Period (2009-2012)
Size (log of Total assets)	0.010***	0.005***
	(0.000)	(0.000)
Age of the firm (in years)	0.001***	0.001***
	(0.000)	(0.000)
Leverage (Debt/Total assets)	-0.052***	-0.057***
	(0.003)	(0.003)
Missing leverage information (0/1)	0.025***	0.021**
	(0.009)	(0.010)
Low competition	0.010**	-0.001
	(0.004)	(0.005)
High competition	-0.001	0.005
	(0.003)	(0.004)
Firm market share (percent)	0.001***	0.001***
	(0.000)	(0.000)
Majority - domestic	-0.005	0.018***
	(0.007)	(0.002)
Majority - foreign	-0.018***	0.015***
	(0.003)	(0.001)
Control (no majority) - domestic	-0.013	0.021***
	(0.016)	(0.007)
Control (no majority) - foreign	0.019	0.008***
	(0.013)	(0.002)
Combined control - domestic	0.000	0.026*
	(0.000)	(0.014)
Combined control - foreign	0.000	0.019***
	(0.000)	(0.005)
Blocking Minority - domestic	0.008	0.010**
	(0.012)	(0.004)
Blocking Minority - foreign	0.001	0.003
	(0.010)	(0.002)
Legal Minority - domestic	0.015	0.005
	(0.014)	(0.005)
Legal Minority - foreign	-0.011	0.009***
	(0.011)	(0.002)
Constant	0.652***	0.759***
	(0.008)	(0.008)
Industry fixed effects	YES	YES
R^2	0.138	0.232
Number of observations	39,823	33,046

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.
Base category: Medium competition, Dispersed/Unknown ownership.