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ABSTRACT

We study the effects of corruption on firm efficiency using a unique dataset of private firms from 14 Central and Eastern European countries from 2000 to 2013. We find that an environment characterized by a high level of corruption has an adverse effect on firm efficiency. This effect is stronger for firms with a lower propensity to behave corruptly, such as foreign-controlled firms and firms managed by female CEOs, while local firms and firms with male CEOs are not disadvantaged. We also find that an environment characterized by considerable heterogeneity in the perception of corruption is associated with an increase in firm efficiency. This effect is particularly strong for foreign-controlled firms from low corruption countries, while no effect is observed for firms managed by a female CEO.

1. Introduction

Corruption imposes significant costs to many countries (e.g., Mauro, 1995; Shleifer and Vishny, 1993). A major cost is that by rewarding firms willing to engage in such activities, corruption allows inefficient firms to survive, reduces the rewards that efficient firms can obtain, and more generally attenuates the competitive pressures leading to efficiency. In this paper we examine how corruption affects efficiency at the firm level. Since engaging in corruption typically requires the participation, or at least

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the tacit consent of owners and top managers, especially in private firms, we also examine the role of these key stakeholders when operating in corrupt environments.

We argue that (i) firms operating in an environment perceived to be more corrupt will be less efficient than those operating in one which is perceived as less corrupt, but that (ii) heterogeneity in the perceptions of corruption may have a positive effect on firm efficiency. This effect may arise because differences in perceptions of corruption may signal the presence of different "sub-environments". Even in an environment that is very corrupt on average, there may be sectors and geographical zones where firms with a lower propensity to bribe can still operate relatively freely. In these sub-environments, competitive forces may operate to full effect and firm efficiency may be high. Thus, greater heterogeneity in perceptions of corruption may be associated, on average, with more efficiency.

We expect the intensity of these two (mean and variance) effects to be stronger for firms with a lower propensity to corruption. These "honest" firms are the ones most likely to be adversely affected when doing business requires engagement in corrupt activities. However, if they can choose to operate in areas of the economy where bribes are less common, their incentives to raise efficiency may still be high.

We examine a number of firm attributes that are likely to be associated with a lower propensity to bribe. For private firms, corporate decisions and, in particular, the decision whether or not to bribe are most likely determined by two groups of stakeholders: owners and managers. Accordingly, we examine how characteristics of owners and managers affect the efficiency-corruption relationship. An extensive literature in international business argues that foreign-controlled firms plausibly exhibit a lower propensity to bribe, in part because they are less likely to know whom and how to bribe in the local market (Calhoun, 2002). The lower propensity to bribe may be particularly pronounced for foreign-controlled firms from low-corruption countries, as their behavior is affected by their cultural and legal imprint (Fisman and Miguel, 2007; Cuervo-Cazurra, 2008). Foreign firms also tend to follow responsible business practices and care about their reputation (D'Souza and Kaufmann, 2013). There is also direct evidence that foreign firms exhibit a lower propensity to bribe (Kouznetsov and Dass, 2010; Gueorguiev and Malesky, 2012; D'Souza and Kaufmann, 2013).

Firms run by a female CEO may also be especially reluctant to engage in criminal activities such as bribery (Dollar et al., 2001; Swamy et al., 2001). This could be due to factors such as higher risk-aversion (Bertrand, 2011; Charness and Gneezy, 2012; Faccio et al., 2016), less overconfidence (Deaux and Farris, 1977; Lundeberg et al., 1994; Barber and Odean, 2001), or more pro-social attitudes than men (Eckel and Grossman, 1998; Alesina and Giuliano, 2009; Funk and Gathmann, 2011).

We test our hypotheses using a unique panel dataset that combines information on business environment characteristics (and corruption in particular) from the EBRD-World Bank Business Environment and Enterprise Performance Survey (BEEPS) with financial, ownership, and managerial information available in the Amadeus database maintained by Bureau van Dijk. Our final dataset contains 76,552 firm-level observations and covers 14 countries (Bosnia and Herzegovina, Bulgaria, Croatia, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Russia, Slovakia, Slovenia and Ukraine) from 2000 to 2013. To our knowledge, it is among the largest and most comprehensive firm-level datasets to study the effects of corruption.

We find strong support for most of our hypotheses. Firm efficiency is on average lower in environments characterized by a high level of corruption. A 1% increase in the average level of corruption is associated with a 2.04% decrease in average firm efficiency. However, greater variance in corruption perceptions is associated with greater efficiency. A 1% increase in corruption perception variation improves firm efficiency by 0.61%. This suggests that firms with a lower propensity to bribe, and for which, therefore, a low corruption environment is particularly important, are able to locate in sub-environments where corruption is less prevalent. The effects are stronger for foreign-controlled firms, especially if their headquarters are located in low-corruption countries. For example, while a 1% increase in the average level of corruption leads to a 3.16% decrease in efficiency of foreign firms, this effect jumps to 4.53% for foreign-controlled firms from countries with low levels of corruption. Having a female CEO is detrimental to efficiency in high-corruption environments; however, we do not find a significant effect for the variance in corruption perceptions.[1]

This paper makes several contributions to the corporate finance literature. First, most papers analyzing the effects of corruption on firm performance focus on accounting performance measures (e.g., Fisman and Svensson, 2007; Mironov, 2015). In contrast, we look at the effect of corruption on firm efficiency, defined as the ability of a firm to produce the most output with a given amount of inputs. This is important because theory suggests that fair competition will lead to higher efficiency (Leibenstein, 1966; Nickell, 1996). In addition, it might be more important, or easier, for firms to manipulate financial figures (Demsetz, 1997; Schulze et al., 2001) than input-output figures.[2] Thus, there may be a more direct and observable relationship between corruption and firm efficiency than between corruption and firm performance.

Second, we demonstrate that different characteristics of a corrupt environment have different implications for firm efficiency. Specifically, we show that simply examining measures such as the average level of corruption, without considering dispersion across sectors or regions, may be misleading. Our evidence is consistent with the idea that firms self-select into the areas of the economy where they want to operate, and that more "honest" firms choose to operate in sub-environments characterized by less corruption.

[1] Interestingly, we do not observe any differences in efficiency between firms managed by male and female CEOs. We only observe a difference when we condition on the local corruption environment. This is consistent with the argument that women are not, on average, different from men in terms of ability, but they differ in their preferences for risk and propensity to abide by the law.

[2] For example, the standard profit-based measures could be biased. First, firms with higher current or expected profits may not only have a higher probability to bribe, but would also pay larger amounts (Svensson, 2003). Second, firms with low profits may start bribing in order to survive and/or grow. Third, bribing firms can also use bribes to pay lower taxes, extract and/or hide profit. For a comprehensive overview of firm bribery motives we refer to Svensson (2005)

Third, this paper contributes to our understanding of how a firm's key stakeholders influence its policies in different economic environments. Previous work on corruption examines the performance implications when managers have different propensities to engage in corrupt activities. These papers generally focus on a single country or region, and hence implicitly take characteristics of the environment as given. For instance, Mironov (2015) focuses on firms in a highly corrupt environment (Russia), while Amore and Bennedsen (2013) focus on firms in a low corruption environment (Denmark). In contrast, we examine how the effect of key stakeholders with a different propensity to engage in corrupt activities changes as characteristics of the corrupt environment change. Foreign-owned firms and firms run by female CEOs may be at a particular disadvantage in highly corrupt environments, though these adverse effects may be reduced if there is a larger dispersion in the level of corruption across sectors or regions. Therefore, our study contributes to a better understanding of how ownership structure and CEO characteristics affect firm performance in corrupt environments.

The paper is structured as follows. Section 2 develops the hypotheses. Section 3 describes the dataset. Section 4 outlines the modeling strategy and Section 5 discusses the results. Section 6 concludes.

2. Hypotheses development

Conventional wisdom suggests that corruption reduces efficiency by giving an unfair advantage to firms which have a higher propensity to behave corruptly and are connected to officials willing to accept bribes. Studies focusing on the macroeconomic effects of corruption have found that it has an adverse effect on investment (Mauro, 1995), foreign direct investment, and capital inflows (Wei, 2000). It has also been shown to reduce country-level productivity and economic growth (e.g., Mauro, 1995, 1998; Mo, 2001). At the micro level, corruption can also have an adverse effect on firm efficiency as it distorts the efficient allocation of capital (e.g., Shleifer and Vishny, 1993; Bertrand et al., 2007; Harstad and Svensson, 2011).

There are very few empirical studies at the firm level that examine the effects of corruption on performance. This is most likely due to the illicit nature of the activity and associated difficulties in collecting data. d Studies mainly focus on a particular country and there are very few cross-country analyses. For example, using a sample of 243 Ugandan firms, Svensson (2003) finds that the number of corrupt payments is conversely related to the tangibility of assets, because firms adopt inefficient “fly-by-night” production technologies to counter corruption pressures. Further exploring the Ugandan data, Fisman and Svensson (2007) report that both the rate of taxation and bribery rate are negatively related to firm growth. In a cross-country analysis, Bardhan (1997) argues that the inherent uncertainty of illegal agreements creates the wrong incentives for firms. A firm will choose to invest in less productive general capital, and not in the more productive specific capital, because the former can easily be relocated (Henisz, 2000). Thus, corruption would affect the quality of investment, causing a decrease in efficiency.

Challenging this conventional wisdom, some scholars argue that corruption may be conducive to greater efficiency. Leff (1964), among others, argues that it enables individuals or firms to work around misguided government policies, rigid laws, bureaucratic bottlenecks, and red tape (See also Lui, 1985; Méon and Weill, 2010). Empirical evidence which supports this positive effect is mainly limited to certain regions in Asia. Rock and Bonnett (2004) report a significant positive relationship between economic growth and corruption in China and Indonesia. Vial and Hanoteau (2010) focus on the Indonesian manufacturing industry from 1975 to 1995 and find that plant-level corruption increases output and productivity. The authors argue that the positive effect arises from the long-term relationship between government and firms, which facilitates the latter's ability to overcome red tape and barriers to doing business. However, Asia, and specifically Southeast Asia, is a singular region, where f economies are based on relationships, contracts are not well-enforced and capital is scarce (Rajan and Zingales, 1998).

In formulating hypothesis 1, we follow the conventional view of the effects of corruption on firm performance.

H1. Corruption has an adverse impact on firm efficiency.

Heterogeneity in perceptions of corruption within a given environment could be caused by firms having different experiences with officials. There are, in principle, two possible effects that this heterogeneity in experiences may have on efficiency. First, greater uncertainty over whom to bribe and how much to pay would likely increase uncertainty and may reduce investment (Wei, 1997; Bloom, 2009). Thus, greater variance in perceptions of corruption may be associated, on average, with lower efficiency.

Alternatively, significant heterogeneity in perceptions of corruption may indicate the existence of sub-environments that are characterized by different degrees of corruption. For example, Rose-Ackerman (1999) argues that corruption in contracting occurs even in low-corruption countries. Similarly, Transparency International's 2002 Bribe Payers' Index names the public works/construction sector to be the most vulnerable to corruption in emerging economies worldwide. Corruption may also be more or less pronounced in different parts of the same country; for instance, it is considerably higher in Southern Italy than in Northern Italy (Golden and Picci, 2006

H2. Heterogeneity in perceptions of corruption is positively related to efficiency.

The effects of corruption on firm efficiency are likely to be more pronounced for firms with a lower propensity to bribe. These firms are the most likely to be adversely affected when corruption is high. They may lose contracts to bribing firms, possibly resulting in capital and labor being severely under-utilized. On the other hand, they should be the first to move their operations to less corrupt sub-environments (e.g., from the South to the North of Italy), thus benefitting the most in terms of efficiency from regional or sectoral differences in corruption.

A key empirical challenge is how to identify firms with a lower propensity to bribe. Owners and managers are the stakeholders most likely to set the firm's strategic direction. We investigate how the characteristics of these key stakeholders moderate the relationship between the corrupt environment and firm efficiency. We examine two observable key stakeholder characteristics that could be associated with a lower propensity to bribe: foreign ownership, especially if the headquarters of the firm is based in a low-corruption country, and female CEO.[3,4]

While foreign firms can certainly be involved in corruption, we expect foreign-controlled firms to have, on average, a lower propensity to behave corruptly for several reasons. First, cultural norms are an important determinant of corruption. For example, Fisman and Miguel (2007) show that the social behavior of diplomatic leaders abroad is highly correlated with their home-country-specific corruption scores. We therefore expect foreign firms from low corruption countries to have a lower propensity to bribe. Second, foreign firms could be the subject of strict anti-bribery regulation in their home country.[5] For instance, Cuervo-Cazurra (2006, 2008) demonstrates that implementation of the OECD Anti-Bribery Convention made investors from countries that adopted the Convention, and even investors from the US already bound by the FCPA, less likely to invest in corrupt countries. Third, foreign firms are also more concerned about their reputation and tend to follow more responsible business practices. In fact, many voluntary codes of corporate conduct contain anti-bribery provisions. Multinational firms, even when their headquarters are based in high-corruption countries, often have such codes and enforce them. Fourth, lack of knowledge of the local environment may prevent foreign firms from getting involved in corruption (Zaheer, 1995; Zaheer and Mosakowski, 1997; Cuervo-Cazurra et al., 2007; Bell et al., 2012). Fifth, existing empirical evidence suggests that foreign firms have a lower propensity to bribe (Kouznetsov and Dass, 2010; Gueorguiev and Malesky, 2012; D'Souza and Kaufmann, 2013). For example, D'Souza and Kaufmann (2013) conduct a large cross-country study analyzing procurement bribery data from 11,000 enterprises in 125 countries. They find that smaller domestic firms are more likely to bribe than larger and foreign-owned firms. To the extent that the propensity not to bribe can be proxied by foreign ownership, especially for firms whose headquarters are based in low-corruption countries, we suggest that mean and variance effects (H1 and H2) are mediated as follows:

H3. The adverse impact of corruption on firm efficiency is particularly strong for firms controlled by foreign owners. The effect is strongest for owners whose headquarters are based in low-corruption countries.

H4. Heterogeneity in corruption perception has a particularly strong positive effect on efficiency of firms controlled by foreign owners. The effect is strongest for owners whose headquarters are based in low-corruption countries.

We also expect female CEOs to be, on average, less predisposed toward corruption and less likely to get involved in it (Dollar et al., 2001; Swamy et al., 2001). For example, Goetz (2007) suggests that greater female participation in government is associated with lower corruption and is driven by the relative exclusion of women from networks traditionally dominated by men. Women are also found to be less likely to be asked for a bribe (Mocan, 2008). They are more reciprocal in the context of gift-exchanges (Croson and Buchan, 1999; Buchan et al., 2008) and less likely to lie when it is costly to the other side (Erat and Gneezy, 2012).

Further, as bribery may be detected and participants punished, women may be less willing to participate in such activities (Levin et al., 1988; Paternoster and Simpson, 1996). This could be due to different attitudes toward risk between women and men. A large experimental literature that compares how men and women value risky gambles or choose between gambles, documents systematic differences in risk preferences, with women being more risk-averse than men (see Croson and Gneezy (2009) and Eckel and Grossman (2008) for an extensive review of this literature). Higher risk-aversion of women is also reflected in financial decisions (Barber and Odean, 2001; Sapienza et al., 2009; Neelakantan, 2010), decisions made by financial professionals (Dwyer et al., 2002; Beckmann and Menkhoff, 2008) and even by top executives (Bandiera et al., 2015; Belenzon et al., 2016; Faccio et al., 2016). Higher risk-aversion of women is often explained by their relatively lower overconfidence (Lundeberg et al., 1994; Barber and Odean, 2001). This lower overconfidence has also been documented for female top executives, who are demonstrated to be less likely to engage in acquisitions and to issue debt than their male counterparts (Huang and Kisgen, 2013). Lack of overconfidence may also imply that women's perceived likelihood of being caught is higher and hence their propensity to bribe is lower.

[3] While it might be preferable to directly estimate the propensity to bribe for each firm using information available in BEEPS, in practice one could face a number of problems. First, missing accounting information could lead to biased inference from the data analysis, as the worst-performing firms have an incentive not to report their financial information, but to complain the most about corruption (Jensen et al., 2010

Finally, prior studies also found women to be more likely to adopt a strict ethical stance (Weeks et al., 1999) and exhibit ethical behavior in the workplace (Bernardi and Arnold, 1997; Lund, 2008). They may also be more likely to behave honestly to teach their children appropriate values (Gottfredson and Hirschi, 1990).

Since female CEOs are likely to have a lower propensity to bribe, we suggest that the mean and variance effects (H1 and H2) are mediated as follows:

H5. Firms that operate in more corrupt environments are less efficient, especially when a firm has a female CEO.

H6. Heterogeneity in corruption perception is positively related to efficiency, especially when a firm has a female CEO.

3. Data

We obtain data on corruption and other business environment characteristics from the Business Environment and Enterprise Performance Survey (BEEPS) conducted by the European Bank for Reconstruction and Development (EBRD) and the World Bank Group (the World Bank). BEEPS is a firm-level anonymous survey of a representative sample of private firms that aims to gain an understanding of their perception of their operating environment. It covers a broad range of business environment topics including access to finance, corruption, infrastructure, crime, competition, and performance measures. We use four waves of the survey, completed in 2002, 2005, 2009 and 2013.[6]

In particular, BEEPS contains the corruption experiences of firm managers and is the most detailed data on corruption available at the firm level (Svensson, 2005). The corruption measure provided by BEEPS is superior to the country-level proxy indicators of corruption, as it reflects the variation and extent of corruption across industry, time, firm size and urban location, while country-level proxy indicators of corruption (e.g., Transparency International Corruption Perception Index) generally exhibit very little variation over time.[7] At the same time, a significant disadvantage of BEEPS data is the missing accounting information for a large number of firms, which could lead to biased inference from the data analysis, as the worst-performing firms have an incentive not to report their financial information, but to complain the most about corruption (Jensen et al., 2010). For example, about 40% of BEEPS firms have missing information on sales and assets.[8] To overcome the problem of missing accounting data we match BEEPS to the Amadeus database maintained by Bureau van Dijk, that contains comprehensive financial information on private companies across Europe. We focus on 14 countries in Central and Eastern Europe from 2000 to 2013.[9] The annual panel is constructed by combining multiple updates of the Amadeus database. This strategy helps to eliminate survivor bias because a firm that stops providing financial statements is removed from the database after four years. Therefore, using several snapshots of the database allows us to add back observations for firms that are not present in more recent updates. Moreover, as every update contains a snapshot of the currently active population of firms and up to the 10 most recent years of firms' financial data, our approach allows us to extend firms' historical financial data beyond the most recent decade.

The financial data are further combined with the ownership data obtained from Amadeus. It is important to highlight that each edition of the Amadeus database covers only the current ownership structure. Again, we use several snapshots of the database to reconstruct end-of-year ownership structures for the period under research. Finally, we add managerial data that became available with the latest Amadeus update. The data contain information on the manager's name, position, gender, nationality, and tenure. In particular, using the appointment dates we are able to match managers to specific firm-financial years.

Most firms in Amadeus report unconsolidated financial statements; consolidated statements are provided when available. In our dataset, we use unconsolidated financial statements to avoid double-counting firms and subsidiaries or operations abroad and exclude firms that only report consolidated statements. We also exclude the financial intermediation sector and insurance industries (NACE codes 64–66) since they have a different balance sheet and a specific liability structure.

3.1. Sample construction

Combining BEEPS and Amadeus data provides us with a unique firm-level dataset that contains proxies for business environment conditions and corruption perception at the firm level. To merge BEEPS data with the Amadeus database we first form mini-environments or clusters of firms in BEEPS based on their country, industry, size, size of the urban area in which they are registered, and the corresponding time period, to match BEEPS waves.[10] Then, by extracting responses to the statement “It is common for firms in my line of business to have to pay some irregular ‘additional payments or gifts’ to get things done with regard to customs, taxes, licenses, regulations, services, etc.” and normalizing them to between 0 (never) and 1 (always), we construct corrup-

[6] Detailed survey information is available at http://ebrd-beeps.com/about/.

[7] The variation in the country-level proxy indicators of corruption in the majority of cases could be captured by country-, region- or industry-specific effects, making it difficult to single out the corruption effect.

[8] While the issue of misreporting or not reporting at all is inherent in survey data, measurement errors are a minor concern in cross-country studies, provided they are not systematically related to the country characteristics (Svensson, 2005

tion measures. In particular, we compute the average perception of the corruption level (corruption mean) and the dispersion in the perception of the corruption level (corruption standard deviation) in each cluster. We further extract other characteristics of the business environment from BEEPS, including access to financing, tax rates, customs and trade regulations, business licensing and permits, labor regulation and the functioning of the judiciary environment. These variables are also normalized to between 0 and 1. The total number of BEEPS observations with non-missing data on corruption for the countries under scrutiny is 22,260. Imposing the constraint of at least 4 observations per cluster further reduces the number of observations to 15,975, with a total of 1529 clusters. Finally, these BEEPS clusters are populated with firms from the Amadeus database that are operating in the same cluster.[11]

As the BEEPS business environment measures and firm efficiency measure are constant over three-year periods, we also average the financial information from Amadeus over three years. This allows a reduction in the measurement error as well as the influence of any potential accounting adjustments. Details on the construction of the firm-level variables are provided in the Firm Efficiency Determinants section (Section 4.2) along with the sample descriptive statistics.

4. Modeling strategy

To study the effect of a corrupt environment on a firm's efficiency we employ a stochastic frontier analysis (SFA). First, we derive a firm's efficiency from the stochastic production possibility frontier and then relate the estimated firm efficiency to firm-specific characteristics, the firm's ownership and managerial structure, and the operating environment.

4.1. Firm efficiency – stochastic frontier analysis

Firm efficiency is estimated using the stochastic production frontier model. This approach compares companies to the most efficient company (i.e. the one with the "best practices") rather than the average company (e.g., an OLS regression).[12] First, we define the production function as:

$$y_{it} = f(x_{it};\beta) \cdot TE_{it}. \tag{1}$$

The first part of the equation relates the output y_t and the inputs x_t through a production function $y_t=f(x_t;\beta)$. Technical efficiency TE_i takes into account the efficiency of the use of the input variables. In other words, if $TE_i = 1$ then a company uses its inputs efficiently and thus achieves its maximum feasible outcome, while $TE_i < 1$ denotes some kind of inefficiency. Since the output is always positive, TE_i is therefore defined on the interval between (0,1]. Stochastic frontier analysis then makes two assumptions. Technical efficiencies, TE_i, is a stochastic variable that has a distribution which is common to all firms. We therefore denote it as $TE_i = \exp(-u_{it})$.[13] The error term is denoted as exp.(v_{it}) to account for random shocks in production (e.g. machinery breakdown). The stochastic production function model is then rewritten as

$$y_t = f(x_t;\beta)\cdot exp(-u_{it})\cdot exp(v_{it}) \tag{2}$$

and its logarithm form is

$$\ln y_{it} = \beta_0 + \sum_{j=1}^{k} \beta_{jit} \ln x_{it} + v_{it} - u_{it}, \tag{3}$$

where v_{it} is a two-sided normally distributed error term and u_{it} is the technical inefficiency variable. It is non-negative and measures the distance from the efficiency frontier.

Technical efficiency is modeled using the Cobb-Douglas production function where its parameters are interacted with 2-digit NACE industry dummy variables to account for industry idiosyncrasies.[14] We specify the model of the efficiency frontier of I firms ($i = 1, \ldots,I$) in J two-digit NACE sectors ($j = 1, \ldots,J$) over T time periods ($t = 1, \ldots,T$) as:

$$\ln y_{it} = \sum_{j=1,\ldots,J} \left[\beta_{0j} + \beta_{1j} \ln c_{it} + \beta_{2j} \ln l_{it}\right] \cdot ID_{itj} + \phi_t + v_{it} - u_{it}. \tag{4}$$

The corporate output variable y_{it} is sales (i.e. the turnover variable in the Amadeus database). lnc_{it} is the log of the capital of each firm i. Capital is proxied by total fixed assets plus working capital, which is defined as current assets minus current

[11] This approach helps us to deal later with potential endogeneity between corruption and efficiency, unobserved firm level heterogeneity and selection bias that cannot be properly addressed when using BEEPS alone, as the dataset does not have a panel structure. A similar approach has been used by Commander and Svejnar (2011), Hanousek and Kochanova (2016), and Fungáčová et al. (2015).

[12] See Aigner et al. (1977) and Meeusen and van Den Broeck (1977) for stochastic frontier analysis and Schmidt and Sickles (1984), Kumbhakar (1990), and Greene (2005) for panel data application to stochastic frontier analysis. Kumbhakar and Lovell (2000) provide a detailed literature survey.

[13] Since technical efficiency TE_i is defined in the interval, u_{it} is non-negative.

[14] The Cobb-Douglas function is a standard and less restrictive production function. Recently, for example, Chirinko et al. (2011)

liabilities.[15] $\ln l_{it}$ is defined as the logarithm of the number of employees. Fundamentally, capital and labor represent inputs into production to generate output sales. ID_{ijt} stands for a vector of industry (j) dummy variables. All parameters of the production function in model (4) — the constant term and both production inputs (capital and labor) — are interacted with 2-digit NACE industry dummy variables to benefit from a flexible functional form. v_{it} is the random error and u_{it} represents the efficiency of the firm. If the firm is fully efficient then $u_{it} = 0$. Any inefficiency is represented through a non-negative u_{it}. The inefficiency component of the model (u_{it}) is not directly observable and has to be calculated according to classical assumptions where

$$\nu_{it} \sim iid\ N\left(0, \sigma_\nu^2\right) \text{ and } u_i \sim iid\ N^+\left(0, \sigma_u^2\right).$$

The minimum squared error predictor of the technical efficiency of the ith firm is then calculated as

$$E(\exp\{-u_{it}\}|\varepsilon_i) = E(\exp\{\beta(t)\cdot u_i\}|\varepsilon_i) = \frac{1-\Phi[\sigma_i^* - (\mu_i^*/\sigma_i^*)]}{1-\Phi(-\mu_i^*/\sigma_i^*)} \cdot\ exp\left\{-\mu_i^* + \frac{1}{2}\sigma_i^{*2}\right\},$$

where $\varepsilon_{it} = \nu_{it} - u_{it}$, $\mu_i^* = \frac{\mu\sigma_\nu^2 - T\varepsilon_i\sigma^2}{\sigma_\nu^2 + T\sigma^2}$ and $\sigma_i^{*2} = \frac{\sigma_\nu^2\sigma^2}{\sigma_\nu^2 + T\sigma^2}$.

Since u is identified by the minimum squared error predictor, v is the remaining difference ($\varepsilon - u$). Battese and Coelli (1992), Kumbhakar and Lovell (2000), and Greene (2008) provide excellent sources for the details.

Model (4) is estimated in a series of short panels (2000–2002, 2003–2005, 2006–2009, and 2010–2013) to account for time-varying changes in technical efficiencies. As demonstrated by Greene (2005), the short time periods over which the technical efficiency is estimated attenuate any potential bias of the estimated parameters in a fixed-effect stochastic frontier model and also allow a feasible estimation.[16] The estimation is performed country-by-country to account for the different efficiency levels of each industry between countries. From an econometrics standpoint, this is a preferred method because it is less restrictive than estimating the model with country dummies. Additionally, it is much more operational to estimate. Finally, we also include year dummy variables to account for time-specific effects, which in short panels allow us to capture industry-specific price variation.

4.2. Firm efficiency determinants

We further model a firm's efficiency as a function of firm-specific and business environment characteristics, to analyze the differences in efficiency from the "best practice" companies. Therefore, we use the distance from the efficiency frontier (estimated from Eq. (4)) and analyze it as a function of several factors that influence the firm. We are particularly interested in the role of corruption practices, firm ownership, and CEO characteristics in facilitating or hindering firm efficiency. The model is formalized as follows.

$$\begin{aligned} u_{it} = {} & \alpha_0 + \beta X_{it} + \sum_{k=1}^{2} \gamma_k^B Corruption_{rk}^k + \sum_{l=1}^{L} \gamma_l^E BusEnvt_{rt}^l \\ & + \sum_{m=1}^{M} \gamma\delta_m OwnC_{it}^m + \lambda_1 FemaleCEO_{it} + \lambda_2 MissingCEO_{it} \\ & + \tau_t + \eta_j + \varphi_s + \theta_c + \omega_f + \varepsilon_{it} \end{aligned} \tag{5}$$

for all $i = 1, \ldots, N$ (firm index); $t = 1, \ldots, T$ (time index); $r = 1, \ldots, R$ (cluster index), $c = 1, \ldots, C$ (country index); $j = 1, \ldots, J$ (double digit industry index); $s = 1, \ldots, S$ (firm size index); $f = 1, \ldots, F$ (urban area size index); $b = 1, \ldots, B$ (corruption measures); $e = 1, \ldots, E$ (business environment characteristics); and $m = 1, \ldots, M$ (ownership categories).

The variables in (Eq. (5)) are defined as follows. u_{it} is the distance from the efficiency frontier for a firm i at time period t; *Corruption* is represented by corruption mean and corruption standard deviation. *Corruption mean* represents the (mean) cost all firms have to incur to conduct business or respond to corruption demand. *Corruption standard deviation* characterizes the differences in the perception of the corruption level. The *BusEnvt* (*Business Environment*) vector contains business environment characteristics, comprised of access to financing, tax rates, customs and trade regulations, business licensing and permits, labor regulation, and functioning of the judiciary. Both the *Corruption* and *Business Environment* variables come from BEEPS and are calculated at the cluster level (see Section 3.1 for details).

Vector X_{it} contains a set of firm-specific characteristics (size, profitability, leverage, and cash balance) of firm i at time t. The ownership structure ($OwnC_{it}^m$) is defined for each firm i in year t. We differentiate between majority-controlled domestic and foreign firms, firms with minority non-controlling ownership, and with dispersed ownership. $FemaleCEO_{it}$ equals 1 if the CEO of the

[15] Adding working capital to total fixed assets is a common efficiency measure for several reasons: i) Working capital management is closely related to efficiency because it optimizes the allocation of short-term capital (Kim et al., 1998). ii) Working capital helps to manage the day-to-day operations of the company efficiently and any abundant cash holdings make companies targets for potential acquirers.

[16] The estimation performed on a series of short panels also takes care of the endogeneity concern that arises from the correlation between unobservable productivity shocks and input levels (see Griliches and Mairesse, 1999 for a detailed discussion). This approach has the advantage of a feasible assumption of constant inefficiency. We also expect that firm-specific, time-invariant heterogeneity would be taken care of by fixed-effect estimation (for example, the size of the firm, or technology, are unlikely to change rapidly). While estimation on short panels carries the advantage of limiting endogeneity concerns, it also carries a risk of a small time dimension. It has been mentioned by several authors that there is a potential bias resulting from a small T (number of periods). However, Greene (2005)

firm i at time t is female. Due to incompleteness of managerial data we also control for cases when CEO gender information is missing by including a *MissingCEO* dummy. Finally, we include country (θ_c), time period (τ_t), industry (η_j), firm size (φ_s), and urban area size (ω_f) fixed effects that correspond to the BEEPS-Amadeus matching clusters.

The firm-specific characteristics are constructed as follows. *Profitability* is defined as a ratio of operating profit over total assets. *Industry-adjusted leverage* is calculated as the firm's leverage minus its industry mean leverage, where leverage is defined as the ratio of short- and long-term liabilities over total assets. *Cash* is defined as company cash holdings over total assets.

To control for the interference of ownership and CEO gender with the corrupt environment and to properly test hypotheses H3 and H5, we need to further extend model (5). In particular, we add the interactions of foreign-controlled firms (*ForeignC*) and a female CEO dummy (*FemaleCEO*) with the corrupt environment characteristics into the model. The resulting specification has the following form:

$$\begin{aligned} u_{it} = {} & \alpha_0 + \beta X_{it} + \sum_{k=1}^{2} \gamma_k^B Corruption_{rk}^k + \sum_{l=1}^{L} \gamma_l^E BusEnvt_{rt}^l \\ & + \sum_{m=1}^{M} \delta_m OwnC_{it}^m + \lambda_1 FemaleCEO_{it} + \lambda_2 MissingCEO_{it} \\ & + \upsilon_1 CorruptionMean * ForeignC_{it} + \upsilon_2 CorruptionStDev * ForeignC_{it} \\ & + \mu_1 CorruptionMean * FemaleCEO_{it} + \mu_2 CorruptionStDev * FemaleCEO_{it} \\ & + \tau_t + \eta_j + \varphi_s + \theta_c + \omega_f + \varepsilon_{it}. \end{aligned} \tag{6}$$

Using models (5) and (6), the hypotheses (H1–H6) formulated in Section 2 can be tested as follows.

If corruption has an adverse impact on firm efficiency (H1), then the coefficient on corruption mean (γ_1^B) will be positive. H2 states that heterogeneity in corruption perception is positively related to efficiency, and therefore the coefficient on corruption standard deviation (γ_2^B) is expected to be negative.

Table 1
Descriptive statistics.

Variable	Obs	Mean	Std. dev.	Min	Max
Dependent variable					
Efficiency	76,552	0.699	0.171	0.0002	0.986
Corrupt environment					
Corruption mean	76,697	0.234	0.141	0	0.8
Corruption std. deviation	76,687	0.223	0.010	0	0.707
Firm-specific financial variables[a]					
Total assets ('000,000)	76,630	7.401	36.17	0.0004	966
Size [ln(total assets)]	76,630	−0.647	2.43	−10.21	6.88
Profitability	76,630	0.076	0.213	−1.287	1.113
Industry adjusted leverage	64,315	−0.0004	0.174	−0.272	0.974
Cash	76,630	0.104	0.150	0.0002	0.873
Problematic factors for operation and growth[b]					
Access to financing[c]	76,697	0.390	0.160	0	1
Tax rates	76,697	0.604	0.165	0	1
Custom and trade regulations	76,634	0.206	0.161	0	0.875
Business licensing & permits	76,697	0.288	0.165	0	0.938
Labor regulations	76,697	0.268	0.162	0	0.833
Functioning of the judiciary	76,697	0.287	0.193	0	0.917
Ownership control[+]					

The particularly strong adverse impact of corruption on firm efficiency for majority-controlled foreign firms (H3), should be reflected in positive coefficients on the foreign-controlled dummy variable ($\delta_1^{ForeignC}$) and on the interaction term between foreign-controlled firms and corruption mean (υ_1). If the adverse effect of corruption on firm efficiency is stronger for foreign owners whose headquarters are based in low-corruption countries, then the coefficients on the foreign-controlled firms from low corruption countries will be larger than that on the foreign-controlled firms from the other countries ($\delta_1^{ForeignC\_LowCorruption} > \delta_1^{ForeignC\_Rest} > 0$ and $\upsilon_1^{ForeignC\_LowCorruption} > \upsilon_1^{ForeignC\_Rest} > 0$).

Similarly, the particularly strong positive effect of heterogeneity in corruption perception on firm efficiency for majority-controlled foreign firms (H4), should be reflected in a negative coefficient on the interaction term between foreign-controlled firms and corruption standard deviation (υ_2). If the positive effect of heterogeneity in corruption perception on firm efficiency is stronger for owners whose headquarters are based in low-corruption countries, then the following holds: $\upsilon_2^{ForeignC\_LowCorruption} < \upsilon_2^{ForeignC\_Rest} < 0$.

Finally, the additional adverse effect of corruption on firm efficiency for firms lead by a female CEO (H5) should be reflected in the positive coefficient on *FemaleCEO* ∗ *CorruptionMean* (μ_1), while the positive effect of heterogeneity in corruption on firm efficiency for firms lead by a female CEO (H6) will be evidenced by a negative coefficient on *FemaleCEO* ∗ *CorruptionStDev* (μ_2).

4.3. Descriptive statistics

Our final sample contains 76,552 observations and covers 14 Central and Eastern European countries from 2000 to 2013. The descriptive statistics for all variables are reported in Table 1. The average firm in the sample has USD 7.4 million of total assets, a profitability ratio of 0.076, a leverage ratio slightly lower than its industry mean (−0.0004), and a cash position of 0.10. The average efficiency is about 0.70, which is far from the "best practice" efficiency frontier; efficiency decreases as it moves away from 0 toward the maximum of 0.986 within this sample. Manufacturing firms and firms operating in the transportation sector have the highest representation among the top 5% and top 1% of efficient firms in the sample. The top 5% of efficient firms is mostly

Table 2
Firm efficiency and business constraints.

Independent variables	Dependent variable = firm efficiency							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Corrupt environment								
Corruption mean	0.031[a]	0.065[a]	0.031[a]	0.030[a]	0.036[a]	0.032[a]	0.033[a]	0.063[a]
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
Corruption std. deviation	−0.013[c]	−0.018[a]	−0.013[c]	−0.013[c]	−0.011	−0.012[c]	−0.012[c]	−0.014[b]
	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)
Firm-specific financial variables								
Size [ln (assets)]	0.019[a]	0.020[a]	0.019[a]	0.019[a]	0.020[a]	0.019[a]	0.019[a]	0.020[a]
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Size squared	0.001[a]	0.001[a]	0.001[a]	0.001[a]	0.001[a]	0.001[a]	0.001[a]	0.001[a]
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Profitability	0.030[a]	0.029[a]	0.030[a]	0.030[a]	0.030[a]	0.030[a]	0.030[a]	0.029[a]
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Missing leverage	0.059[a]	0.053[a]	0.059[a]	0.058[a]	0.058[a]	0.058[a]	0.059[a]	0.057[a]
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Industry adjusted leverage	−0.048[a]	−0.050[a]	−0.048[a]	−0.049[a]	−0.049[a]	−0.049[a]	−0.049[a]	−0.050[a]
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
Cash	0.131[a]	0.131[a]	0.131[a]	0.131[a]	0.131[a]	0.131[a]	0.131[a]	0.131[a]
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
Problematic factors for operation and growth[+]								

composed of micro firms, while the medium and large firms are the least represented. The share of foreign-controlled firms among 5% of the most efficient firms in the sample is 17.1%, increasing to 18.3% in the top 1%, though the share of foreign-controlled firms for the overall sample is only 15.4%.

The mean level of corruption is about 0.23 and deviates from 0 to 0.8. As for the business environment characteristics, custom and trade regulations are reported to be the lowest obstacle for operations and growth (0.206), while tax rates are the highest obstacle (0.604) for doing business. About 23% of the companies in the sample have a domestic majority owner. Minority non-controlling ownership represents <1% of this sample. Finally, 4.2% of the firms in the sample are managed by female CEOs. No CEO information is available for 62% of the (smaller) companies.

5. Results

5.1. Main effects: mean and variance

Table 2 presents the estimation results for the relationship between corruption and firm efficiency. We first test whether corruption has an adverse effect on firm efficiency. The coefficient of interest is positive and highly statistically significant in all regressions (Models 1–8). A positive coefficient indicates an increased distance from the efficient production frontier. Thus, higher corruption is associated with lower firm efficiency. The estimated coefficient ranges from 0.031 (with standard error 0.006) for Model (1) to 0.065 (with standard error 0.006) for Model (2).[17] Put differently, a 1% increase in the average level of corruption is associated with a 2% decrease in average firm efficiency. These results support Hypothesis 1 and are consistent with the idea of corruption being an additional cost that distorts the optimal allocation of resources.

Next, in line with Hypothesis 2, we find that heterogeneity in corruption perception is positively related to efficiency. The negative coefficient on the corruption standard deviation variable signals that a larger variance in perceptions of corruption in the environment is conducive to efficiency for the average firm.[18] The estimated coefficients vary from −0.011 to −0.018 (with standard error 0.007) depending on the model. More specifically, a 1% increase in corruption perception variation is associated with an increase in firm efficiency by 0.61%. We could speculate that companies with a lower propensity to bribe are the ones improving their efficiency. The pressure put on increasing efficiency has its limits. When these limits are crossed, companies exit the environment. This happened, for example, to Shell Brazil when they sold their Agip service stations in 2000.[19]

All regressions (Models 1–8) in Table 2 are estimated on the sample of 76,542 firms and have R-squared values of about 31%. The estimated coefficients for the firm-specific control variables have expected signs with respect to efficiency and are highly statistically significant (<0.01 p-values). We discuss the coefficients of firm-specific variables reported in Column 1 of Table 2, but the estimated coefficients and their interpretations are consistent across all specifications. The estimated coefficient for firm size is 0.019 (with standard error 0.000), which indicates that larger firms are less efficient. We also control for potential non-linearity between firm size and efficiency by including a squared firm size variable, but the relationship remains positive. Firm profitability is negatively related to firm efficiency in our sample (estimated coefficient 0.03 with standard error 0.003). This is not particularly surprising as less profitable firms tend to watch every dollar more closely. For example, during recessions, companies tend to decrease discretionary spending, which forces the company into a "leaner" shape. Further, higher leverage is associated with greater efficiency: the coefficient is negative (−0.048) and statistically significant at the 1% level. Specifically, our adjusted leverage variable measures the difference between the company's leverage and the mean leverage ratio of the industry in the particular year. The larger the difference between firm leverage and the industry mean leverage, the higher the efficiency, provided firm leverage is higher than the industry mean. This is consistent with Jensen (1986), who argues that leverage serves as a disciplining tool and forces managers to improve efficiency. Lastly, consistent with the literature on the value of cash holdings and managerial discipline (e.g., Faulkender and Wang, 2006; Dittmar and Mahrt-Smith, 2007), firms with higher cash holdings are less efficient.

Models 2–8 in Table 2 also control for characteristics of the business environment that might shape the efficiency of firms. The results in Column 2 of Table 2 show that limited access to financing, high tax rates, difficulties with business licensing and permits, and inflexible labor regulation are associated with lower firm efficiency. Interestingly, customs and trade regulations and the functioning of the judicial system have the opposite effects. Columns 3–8 report regression results separately for each of the business environment characteristics.

5.2. Mediating effects: foreign ownership and female CEO

For foreign firms and firms led by a female CEO, the effect of corruption on firm efficiency would likely be amplified. First, we examine direct effects by including foreign ownership and female CEO indicators in our models.

Table 3 presents estimation results. All regressions include firm-specific controls and business environment characteristics. The estimated coefficients for these characteristics are consistent with the results reported in Table 2.[20] Column 1 reports the effect of

Table 3
Firm efficiency, ownership, and CEO gender.

Independent variables	Dependent variable = firm efficiency		
	(1)	(2)	(3)
Corrupt environment			
Corruption mean	0.068[a]	0.031[a]	0.034[a]
	(0.006)	(0.006)	(0.006)
Corruption std. deviation	−0.020[a]	−0.013[c]	−0.015[b]
	(0.007)	(0.007)	(0.007)
Ownership control[+]			
Foreign	0.014[a]		0.013[a]
	(0.002)		(0.002)
Domestic	0.002		0.002
	(0.002)		(0.002)
Minority - no control	0.006		0.006
	(0.005)		(0.005)
Managerial data			
Female CEO		−0.000	−0.000
		(0.003)	(0.003)
Missing CEO		−0.003	−0.002
		(0.002)	(0.002)
Control variables[++]			
Firm financials	YES	YES	YES
Obstacles to growth	YES	YES	YES
Constant	0.749[a]	0.751[a]	0.750[a]
	(0.014)	(0.014)	(0.014)
R squared	0.310	0.310	0.311
N (number of observations)	76,542	76,542	76,542

Symbols a, b, and c denote significance at the 1%, 5%, and 10% levels, respectively. Standard errors are shown in parentheses.
[+] An excluded category is dispersed and unknown ownership.
[++] The list of control variables is identical to Table 2

company ownership on firm efficiency. Note that majority foreign ownership is associated with lower efficiency compared to dispersed ownership; majority domestic ownership and non-controlling minority ownership are not disadvantaged in terms of efficiency. According to the results reported in Column 2, firms managed by female CEOs are as efficient as male-managed firms, which is consistent with our prior beliefs. Finally, in Model 3, we control simultaneously for both ownership structure and female CEO. However, the sign and magnitude of the coefficients of interest stay unchanged.[21]

We further analyze the interaction effects between firms with a lower probability of bribing (foreign ownership, and female CEO) and the characteristics of the corrupt environment. The estimation results are reported in Table 4. All regressions include both firm-specific characteristics and those of the business environment, which are not reported because of space considerations.[22] Models 1 and 3 account for the interactions between majority foreign ownership and characteristics of the corrupt environment. Consistent with our previous findings, foreign majority ownership is associated with lower efficiency (the estimated coefficient is 0.01 with standard error 0.003). Moreover, foreign-controlled firms are at an even higher disadvantage in a high-corruption environment. The coefficient estimate on the interaction term is 0.06 (standard error 0.017), meaning that a 1% increase in the average level of corruption is related to a 3.16% decrease in efficiency of foreign firms. At the same time, greater variance in perceptions of corruption is associated with higher efficiency for foreign-controlled firms. When corruption is not widespread (there are corruption-free or low-corruption sub-environments), foreign companies that focus on utilizing their resources improve their efficiency, as is supported by a negative statistically significant coefficient on the interaction term. We estimate that a 1% increase in variation of corruption perceptions is associated with a 1.53% increase in the efficiency of foreign firms. These results support Hypotheses 3 and 4.

Model 2 focuses on the interaction of female CEOs with the corrupt environment.[23] We find that female CEOs behave differently in corrupt environments than their male counterparts. This is consistent with the theoretical literature showing different gender preferences toward illegal activities. A higher corruption level is found to have a greater negative effect on the efficiency of firms managed by female CEOs compared to those managed by male CEOs. Specifically, a 1% increase in the average level of corruption is associated with a decrease in efficiency of firms managed by female CEOs by 2.80%. Further, a greater variance in the perceptions of corruption is not translated into higher efficiency for firms led by female CEOs. Even though the sign on the

[21] There is a notable coefficient change on corruption variables (e.g., the estimated coefficient on corruption mean drops from 0.068 in model 1 to 0.031 and 0.034 in model 2 and 3 respectively); however, this trend is reversed in subsequent models.
[22] The results are available upon request.
[23] We also analyze the descriptive statistics between the controlling shareholder and CEO gender. Overall, female CEOs lead the firm in 4.2% of cases. The main distribution of female CEOs among the controlled firms is as follows: about 5.5% of female CEOs work in foreign controlled firms, 4.5% work in a state controlled firm, and 6.2% in foreign family firms, while in local family owned firms the percentage reaches 12.1%. Note that most female CEOs work in firms with a combined, dispersed, or unknown ownership structure.

Table 4
Firm efficiency, ownership, and CEO gender interacting with a corrupt environment.

Independent variables	Dependent variable = firm efficiency		
	(1)	(2)	(3)
Corrupt environment			
Corruption mean	0.028[a]	0.029[a]	0.061[a]
	(0.006)	(0.006)	(0.006)
Corruption std. deviation	−0.013[c]	−0.012[c]	−0.019[b]
	(0.007)	(0.007)	(0.008)
Ownership control[+]			
Foreign	0.010[a]		0.009[a]
	(0.003)		(0.003)
Domestic	0.002		0.002
	(0.002)		(0.002)
Minority - no control	0.005		0.005
	(0.005)		(0.005)
Foreign ownership control interacting with bribery			
Corruption mean	0.068[a]		0.061[a]
	(0.017)		(0.017)
Corruption std. deviation	−0.048[b]		−0.034[c]
	(0.020)		(0.020)
Managerial data			
Female CEO		−0.010	−0.011
		(0.007)	(0.007)
Missing CEO		−0.003	−0.001
		(0.002)	(0.002)
CEO gender interacting with			
Corruption mean		0.071[a]	0.052[b]
		(0.023)	(0.023)
Corruption std. deviation		−0.029	−0.006
		(0.032)	(0.032)
Control variables[++]			
Firm financials	YES	YES	YES
Obstacles to growth	YES	YES	YES
Constant	0.751[a]	0.752[a]	0.777[a]
	(0.014)	(0.014)	(0.014)
R squared	0.311	0.310	0.316
N (number of observations)	76,542	76,542	76,479

Symbols a, b, and c denote significance at the 1%, 5%, and 10% levels, respectively. Standard errors are shown in parentheses.
[+] An excluded category is dispersed and unknown ownership.
[++] The list of control variables is identical to Table 2

interaction term between female CEO and the variance in perception of corruption is in line with our expectations, the estimated effect is not significant. Stated in terms of our alternative hypotheses, we reject the null hypothesis of H5 and fail to reject the null hypothesis of H6. These results complement Mironov (2015), who argues that one should hire a corrupt CEO in a corrupt country. Our results suggest that one could potentially benefit from hiring a male CEO in high-corruption environments.

Model 3 in Table 4 is the complete model of this study. It contains both foreign ownership and female CEO controls, interacted with the corruption environment characteristics. All previously reported results hold; a corrupt environment is particularly detrimental for those firms with a lower propensity to bribe.[24]

We further test whether the adverse impact of corruption on firm efficiency is more pronounced for foreign owners whose headquarters are based in countries with low corruption. We split the sample of foreign firms into firms from low corruption countries and the remaining foreign firms.[25] Then these subcategories are interacted with corruption characteristics of the environment. Estimation results are reported in Table 5. All regressions include both firm-specific characteristics and characteristics of the business environment. Models in columns 3 and 4 also include managerial data (female CEO) and the interactions of a female CEO with the corruption environment characteristics. In line with our expectations, foreign firms from low-corruption countries experience a much stronger effect of the corrupt environment on their efficiency. These results are robust across specifications. For example, in column 4, the estimated coefficient of the corruption mean on the efficiency of firms from low-corruption countries is 0.163 (standard error 0.074) compared to only 0.068 (standard error 0.017) for the remaining foreign firms. Put differ-

[24] We also test for foreign ownership and CEO gender complementarity with respect to efficiency by including their interaction term in the regression. Based on the regression results, foreign ownership and CEO gender do not complement each other in affecting the distribution of efficiency – the estimated coefficient of interest is negative and not significant. The results are available upon request.

[25] Low-corruption countries are the Top 25 countries (very clean) in the Corruption Perception Index (CPI) provided by Transparency International. Shareholders' low-corruption home countries that are present in our sample are Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Ireland, Japan, Luxembourg, Netherlands, New Zealand, Norway, Sweden, Switzerland, United Kingdom, United States.

Table 5
Firm efficiency, ownership, and CEO gender interacting with a corrupt environment.

Independent variables	Dependent variable = firm efficiency			
	(1)	(2)	(3)	(4)
Corrupt environment				
Corruption mean	0.068[a]	0.062[a]	0.066[a]	0.060[a]
	(0.006)	(0.006)	(0.006)	(0.006)
Corruption std. deviation	−0.021[a]	−0.020[a]	−0.021[a]	−0.020[a]
	(0.007)	(0.007)	(0.007)	(0.008)
Ownership control[+]				
Foreign- low corruption countries	0.050[a]	0.052[a]	0.049[a]	0.052[a]
	(0.005)	(0.010)	(0.005)	(0.010)
Foreign- rest	0.011[a]	0.004	0.011[a]	0.004
	(0.002)	(0.003)	(0.002)	(0.003)
Domestic	0.002	0.002	0.002	0.002
	(0.002)	(0.002)	(0.002)	(0.002)
Minority - no control	0.007	0.006	0.006	0.006
	(0.005)	(0.005)	(0.005)	(0.005)
Foreign ownership control interacting with corruption				
Corruption mean - low corruption countries		0.166[b]		0.163[b]
		(0.074)		(0.074)
Corruption mean - rest		0.072[a]		0.068[a]
		(0.017)		(0.017)
Corruption std. deviation - low corruption countries		−0.145[c]		−0.143[c]
		(0.078)		(0.078)
Corruption std. deviation -rest		−0.036[c]		−0.033
		(0.020)		(0.020)
Control variables[++]				
Managerial data & interactions	NO	NO	YES	YES
Firm financials	YES	YES	YES	YES
Obstacles to growth	YES	YES	YES	YES
Constant	0.774[a]	0.776[a]	0.777[a]	0.778[a]
	(0.014)	(0.014)	(0.014)	(0.014)
R squared	0.316	0.316	0.316	0.316
N (number of observations)	76,479	76,479	76,479	76,479

Symbols a, b, and c denote significance at the 1%, 5%, and 10% levels, respectively. Standard errors are shown in parentheses.
[+] An excluded category is dispersed and unknown ownership.
[++] The list of control variables is identical to Table 2

ently, a 1% increase in the average level of corruption is associated with a 4.53% decrease in efficiency of foreign-controlled firms that come from low-corruption countries. Also, foreign firms from low-corruption countries better utilize the presence of a corruption-free (or low-corruption) sub-environment. Greater variance in perceptions of corruption is associated with more efficiency for foreign-controlled firms. This effect is much stronger for foreign firms from low-corruption countries (estimated coefficient is −0.143 with a standard error of 0.078) and represents the average boost in efficiency of 4.29% when the variation of corruption perceptions increases by 1%.

To sum up, this paper shows robust correlations between corruption and firm efficiency motivated by theoretical considerations. To strengthen a causal interpretation of the results, we include a large number of control variables and firm fixed effects in all our specifications; however, we acknowledge that time-variant factors may also be affecting the key relationships of interest. Certainly, more research, perhaps relying on a natural experimental setting, would be desirable.

5.3. Robustness tests

In this section, we examine the robustness of our main findings to alternative subsamples and controls.

5.3.1. Difference in corruption levels

The alternative way of testing whether owners from countries with low corruption have a greater disadvantage in terms of efficiency when operating in the corrupt environment is to control for the difference in the levels of corruption between two countries. Results reported in Table 6 are consistent with our main results – the greater distance in corruption levels between home and host countries is associated with greater inefficiency. For example, the difference in the levels of corruption between two countries of 10 points (the host country is more corrupt than the home country) is associated with a decrease in efficiency of 1.43%.

5.3.2. Experience

It could be argued that male CEOs are simply more experienced in corrupting bureaucrats. While we do not have the detailed data on education and functional background of CEOs in our sample, the information on tenure is available. The average tenure of

Table 6
Robustness check: tenure and difference in corruption levels.

Independent variables	Dependent variable = firm efficiency	
	(1)	(2)
Foreign ownership control interacting with bribery+		
Corruption mean	0.060[a]	0.064[a]
	(0.017)	(0.017)
Corruption std. deviation	−0.033	−0.045[b]
	(0.020)	(0.020)
Difference in corruption level		0.001[a]
		(0.000)
Managerial data		
Female CEO	−0.012	−0.010
	(0.007)	(0.007)
CEO tenure	0.001[b]	
	(0.001)	
Missing CEO tenure	0.001	
	(0.003)	
Missing CEO	−0.002	−0.001
	(0.002)	(0.001)
CEO gender interacting with		
Corruption mean	0.052[b]	0.062[a]
	(0.023)	(0.023)
Corruption std. deviation	−0.005	−0.018
	(0.032)	(0.032)
Control variables++		
Firm financials	YES	YES
Obstacles to growth	YES	YES
Constant	0.762[a]	0.857[a]
Obstacles to growth	(0.016)	(0.015)
R squared	0.316	0.311
N (number of observations)	76,479	76,510

Symbols a, b, and c denote significance at the 1%, 5%, and 10% levels, respectively. Standard errors are shown in parentheses.
+ An excluded category is dispersed and unknown ownership.
++ The list of control variables is identical to Table 2

both male and female CEOs in our sample is about 11 years. We further investigate whether gender primarily captures differences in experience by controlling for the experience of CEOs in our regression analysis. We also control for cases when CEO tenure information is missing by including a Missing Tenure dummy, while missing CEO tenure is replaced with a constant, the mean of the observed values.

Table 6 presents the estimation results. Longer tenure of a CEO has an adverse effect on firm efficiency. The coefficient estimate for CEO tenure is significant at the 5% level but very small in magnitude.[26] However, the sign and magnitude of the coefficients of interest are similar to the main regression results.

5.3.3. Industrial variation

In some sectors corruption could be more important than in others (e.g., resource-intensive industries), so even firms with a lower probability of bribing (lead by a female CEO) may be more inclined to engage in illegal activities. To test this conjecture, we aggregate industries into groups based on their intensity. We differentiate between resource-, capital- and labor-intensive industries using Eurostat classification (Laafia, 2002).[27] While firms operating in capital- and labor-intensive sectors are more efficient, female CEOs do not appear to behave more corruptly if they operate in resource-, capital- or labor-intensive sectors. Other coefficients of interest are of the same size and magnitude as in our main regressions. These results are reported in Table 7.

5.3.4. Cost efficiency

We also analyze firm cost (in)efficiency as the dependent variable in our study. Unfortunately, due to data limitation, we cannot run a broadly defined and detailed cost function because we do not have any additional information on the price of the various forms of labor, capital and/or infrastructure. Therefore, we use a simple version of the cost function, where the dependent variables represent the cost of production (as collected in the EU accounting system) and the independent variables are once more the capital and labor involved. The overall results are in line with expectations. Higher heterogeneity in corruption perception is associated with higher cost efficiency. Foreign firms and firms run by female CEOs are more efficient in cost cutting when the corruption level is high. While these results are in line with our main results, they should be interpreted with caution because

[26] This is consistent with the existing evidence that more experienced (and older) managers tend to adopt more conservative strategies (Bertrand and Schoar, 2003) and have lower receptiveness to new ideas (Hambrick and Mason, 1984) that could result in lower firm efficiency.

[27] Resource intensive: NACE 5, 13, 14, 20, 21, 23, 26, 27; Capital (technology) intensive: NACE 24, 29, 30, 31, 32, 33, 34; Labor intensive: NACE 15, 16, 17, 18, 19, 35.

Table 7
Robustness check: accounting for industry intensity.

Independent variables	Dependent var. = firm efficiency		
	(1)	(2)	(3)
Corruption mean × *resource-intensive* industries+	−0.039 (0.098)		
Corruption std. deviation × *resource-intensive* industries	−0.010 (0.008)		
Corruption mean × *capital-intensive* industries		0.090 (0.146)	
Corruption std. deviation × *capital-intensive* industries		−0.106 (0.156)	
Corruption mean × *labor-intensive* industries			0.040 (0.066)
Corruption std. deviation × *labor-intensive* industries			−0.038 (0.079)
Dummy for *resource-intensive* industries	−0.010 (0.008)		
Dummy for *capital-intensive* industries		−0.054[a] (0.007)	
Dummy for *labor-intensive* industries			−0.052[a] (0.005)
Control variables++			
Firm financials	YES	YES	YES
Obstacles to growth	YES	YES	YES
Constant	0.788[a] (0.016)	0.778[a] (0.014)	0.778[a] (0.014)
R-squared	0.3158	0.3162	0.3167
N (number of observations)	76,479	76,479	76,479

+ We differentiate between resource-, capital- and labor-intensive industries using Eurostat classification (Laafia, 2002); Resource intensive: NACE 5, 13, 14, 20, 21, 23, 26, 27; Capital (technology) intensive: NACE 24, 29, 30, 31, 32, 33, 34; Labor intensive: NACE 15, 16, 17, 18, 19, 35.
++ The list of control variables is identical to Table 2

the second stage regression indicates a poor fit ($R^2 = 0.006$), suggesting that we need better information on the cost structure and its determinants, which we do not have. Further, the final cost (in)efficiency dataset is much smaller. We lose about 35% of observations, a significant number of countries and/or some time periods when we compare that dataset to the main one. Therefore, we do not report the results in the paper but they are available upon request.

6. Conclusion

This study offers a systematic analysis of how environmental characteristics – specifically those related to corruption – affect firm efficiency. Economic theory suggests that corruption should be highly detrimental to efficiency since bribes distort the competitive forces incentivizing the adoption of more efficient production and managerial practices. We suggest that the average level of corruption in an environment may, in general, be insufficient to fully characterize the effects of corruption on efficiency. While an environment may be highly corrupt on average, pockets of economic activity may still exist that are relatively corruption-free. In those sub-environments, the competitive forces leading to efficiency may work to full effect. The dispersion in the level of corruption across sectors or regions may also matter.

The paper has a number of implications for how different firms are affected by characteristics of the corrupt environment. Our results indicate that foreign-owned firms are adversely affected by high levels of average corruption. This can be viewed as a specific type of liability of foreignness. Because foreign owners do not know who to bribe or chose to comply with certain cultural or legal norms, they might be at a disadvantage, relative to local owners. Interestingly, however, we also find that foreign-owned firms can mitigate this liability by locating in sub-environments where corruption is less prevalent.

We also find that firms run by a female CEO, who for a number of reasons might be less disposed toward engaging in corruption (e.g., Levin et al., 1988; Croson and Gneezy, 2009; Bertrand, 2011), are disadvantaged by a high level of average corruption. However, unlike foreign owners, heterogeneity in the perceptions of corruption does not mitigate this adverse effect. We hypothesize that there may be differences in the extent to which foreign-owned firms and firms run by a female CEO can select their operating environment. Firms run by a female CEO may be established firms that at some point in their life-cycle have been handed over to a female heir. Thus, the female CEO might have less scope concerning the sub-environment where the firm should be located than foreign owners about to enter a new market, c. If this hypothesis is correct, then the paper points to the importance of both owners and managers being aware of the characteristics of the local operating environment. Those that want to conduct business honestly have the opportunity to escape the adverse effect of a highly corrupt environment (on average), by locating their businesses in sub-environments that are less affected by corruption.

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