Does Firm Size Increase Corruption?
Evidence from a Quasi-Experimental Design

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Abstract Despite the extensive discussion on the role that firm size plays in corruption, it is not clear from prior literature whether increased firm size truly causes greater corruption and bureaucratic burdens on firms. In order to address reverse causality between firm size and corruption, this paper utilizes the instrumental variable strategy based on price shocks in international commodity markets. Applying this innovative identification strategy to surveys of firms, primarily in transition economies, this paper provides some of the first rigorous evidence on the positive impact of firm size on corruption. It was determined that a one standard deviation increase in sales leads to approximately one standard deviation increase in bribes as percentage of revenue, at the 99 percent confidence level, and to 1.1 standard deviation increase in the proportion of management time spent dealing with public officials, at the 95 percent confidence level. This paper also provides evidence for the diminishing positive effect of firm size on corruption burdens. The positive effect of firm size on corruption burden is highest at the lowest levels of firm size such as micro and small firms, and becomes diminished as firm size increases to medium and large.

1 Introduction

A growing body of micro-level evidence has accumulated suggesting that firm heterogeneity plays a major role in explaining corruption. There has been extensive discussion of the role of firm size and profitability in corruption. Through a survey of bribe-payers in Uganda, Svensson (2003) estimated that firms spent about 8% of their total costs for bribe payments which were largely explained by their "ability to pay" and "refusal power". In particular, differences in profitability and choice of technology determine firms' ability to pay and refusal power which can explain a large

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part of the variation in bribes among firms. Schiffer et al (2001); Clarke and Xu (2004); Martin et al (2007); Wu (2009) have linked firm size to corruption, while providing mixed results. For instance, using the Business Environment and Enterprise Performance Surveys (BEEPS) 1999 data, Clarke and Xu (2004) found that large enterprises were less likely to pay bribes than small enterprises and paid lower amounts of bribes. Martin et al (2007) used the World Business Environment Surveys (WBES) 2000 data from 80 countries and found contrasting effects of firm size on the engagement of firms in bribery activity depending on which measure of firm size was used. Using the WBES 2000, Schiffer et al (2001) showed that firm size is negatively associated with corruption.

One key missing factor from this literature is the endogeneity of firm size and performance, leading the previous studies to lack a rigorous research design capable of providing robust estimates. The main econometric challenge to examine the link between firm size and corruption is addressing their plausible reverse causality. Corruption might reduce the size of firms through adversely affecting their performance and growth, which is known as "sand the wheels" view on corruption. Particularly, corruption might act as a tax on business, however, it is more costly than taxation because of its uncertain and secretive nature (Wei 1997). For instance, Beck et al (2005) used firm-level data in 54 countries and found that corruption affects firm growth adversely. Fisman and Svensson (2007) found that a 1 percentage point increase in the amount of bribes reduces firm growth by 3 percentage points. In addition, rampant corruption and red tape might distort the firm size distribution because of "threshold effects". Numerous statutory and regulatory exemptions exist for small businesses (Bradford 2004), a small firm thereby bears more burdensome regulations as it begins to expand its operations. As a result, some more productive firms choose to remain below the statutory threshold to avoid this burden (Garicano et al 2016). To the contrary, corruption might bring about better economic outcomes such as receiving a public contract, getting a license, and saving on taxes (Tonoyan et al 2010), the concept known as the "grease the wheels" view on corruption.

This paper applies an innovative identification strategy and the instrumental variable method which allow examination into the impact of exogenous changes in firm size on corruption to answer the following questions. Does firm size increase corruption burden, and if so, is this a non-linear relationship? Three types of corruption burden are investigated: bribery burden, as a firm's reported bribe payments to public officials as percentage of sales to get things done; kickbacks, as informal payments to secure government contracts; and time burden, as management time wasted with bureaucrats. The pooled nationally-representative surveys of firms primarily in Eastern Europe and Central Asia between 2002 and 2005, the BEEPS, is the primary dataset of this study. The BEEPS are widely acknowledged to have important merit to its designs. Endogenous firm size is instrumented by price shocks in international commodity markets. World price of a particular commodity is estimated by its world exports value and net weight which are collected from the UN Comtrade database. The trade data of more than 5700 commodities are mapped to 32 industrial groups by using a concordance. Plausibly, world price of commodities is exogenous to corruption activities of this study's sample because the included firms are primarily small and medium firms in transition economies. The identification strategy and richness of the BEEPS's database allow

this paper become the first study to provide rigorous evidence on the causal link between firm size and corruption.

This study contributes to the existing empirical literature in several ways. First, departing from prior literature which treats firm size as exogenous, this paper addresses the plausible endogeneity bias by a strong instrumental variable strategy based on price shocks in international commodity markets. World price of a particular commodity might cause changes in a firm's sales and its performance, for firms whose main product line is that commodity. In contrast, Schiffer et al (2001); Clarke and Xu (2004); Martin et al (2007); Wu (2009) only provide the association between firm size and corruption based on their ordinary least squared estimations (OLS). Svensson (2003) attempted to instrument profits by several firm-specific variables including qualifications and experience of the owner/manager, firm age, and foreign ownership, as well as by industry-location averages of profits. However, these excluded instruments tend to violate the exclusive restriction assumption, that valid instruments do not have any direct effect on the dependent variable or any effect running through omitted variables. For example, the owner/manager's previous experience from working abroad might directly link to his firm's corruption activity.

Second, this paper differs from earlier work in that the hypothesis of a non-linear relationship between firm size and corruption hypothesis is examined. The robust IV approach allows this study to provide evidence on the pattern of the causal link between firm size and corruption. A diminishing effect of firm size on corruption is supported by the data. The positive effect of firm size on corruption burden is highest at the lowest levels of firm size such as micro and small firms, and becomes diminished as firm size increases to medium and large.

This paper is organized as follows. Section 2 presents the key data acquired in the study. Section 3 discusses the empirical strategy, methodology, and specifications. In Sections 4 and 5, the results are reported and analyzed for the effects of firm size on bribery burden and the effect of firm size on other corruption burdens respectively. Section 6 summarizes the key findings and discusses implications.

2 Data

The BEEPS, a nationally-representative survey of firms mainly in Eastern Europe and Central Asia, is the main data set of this study. The data were pooled from 10762 observations of the BEEPS in 2005 and 6678 observations of the BEEPS in 2002 (only 1500 firms were interviewed in both rounds). The list of 28 covered countries in the BEEPS sample is presented in Table 1 along with their aggregate corruption burden on firms and firm size. In the analysis sample, a typical firm reported to pay 1.05% of their revenue for informal payments to public officials and 1.41% of contract value as kickbacks, as well as to spend 4.93% of management time to deal with public officials. On average, an Azerbaijan firm paid the largest rate of bribes among observed countries, 3% of revenue, while a half of Azerbaijani firms reported to pay bribes. Despite consisting of mostly transition and developing economies, the sample covers several high-income countries such as Ireland and Spain. Irish and Spanish firms, the most sizable companies regarding their sales, are

least likely to pay bribes. Figure 1 portrays an interesting reverse U-shaped relation between firm size and bribe rate, the focus of this study. Small firms with employment between 10-50 employees tend to bear significantly higher bribery burden than medium-sized and large firms.

Fig. 1: The mean bribe rate and its 95% confidence interval across employment size category
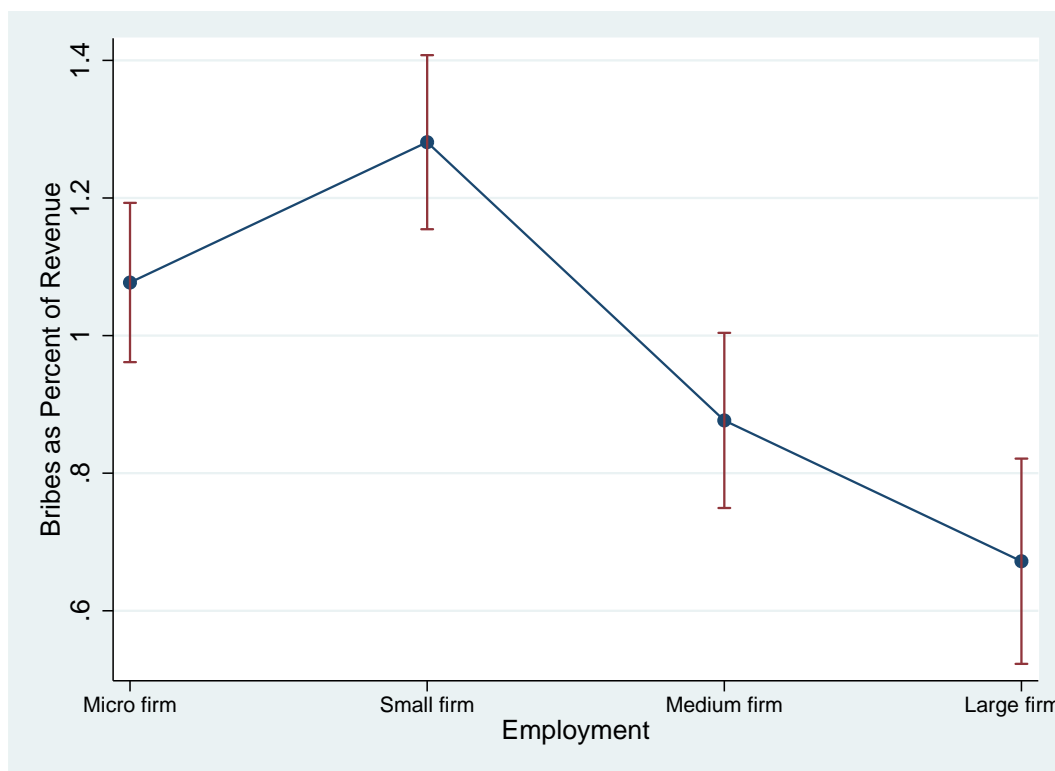
The BEEPS asked firm managers about their experiences and assessments of corruption and other business environment issues. Its center piece of information on corruption issues is bribery burden on a firm, defined as a firm's reported bribe payments to public officials as percentage of sales. The question about bribes was phrased benignly to preserve firm anonymity and encourage candid response. Questions in the BEEPS placed a greater emphasis on experience, and less on perceptions of firm managers, who may be discerned as a special category of "well-informed persons" (Knack 2007). Therefore, firm reported data from the BEEPS might be considered as a firm's experience about corruption. In addition, the BEEPS was designed for firm-level analyses, with numerous characteristics of the responding firms being tracked, and for taking care to preserve firm anonymity. Another merit of the BEEPS is that firm information tends to be independent from corruption judgments of others. The BEEPS data collection was based on random sampling, region-wide, and compatible survey methodology across countries. The survey sample was also designed to be representative of the population of firms in terms of their economic significance, sector, size and geographical location within each country (Fries et al 2003). In addition, Kaufmann et al (2000) evaluated the extent of potential systematic bias and found little evidence of country perception bias in the BEEPS. The BEEPS 2002 and 2005 yielded a survey completion rate of

36.93% and 37.71% of all contacts, respectively. These response rates are deemed acceptable for data collected from organizations, particularly in the context that the BEEPS guarantee their representativeness of the population of firms.[1]

Despite of the aforementioned merits of the BEEPS, there were changes in the questionnaire and methodology in the latest rounds of the BEEPS (2008-2009 and 2011-2014).[2] These changes allow the latest BEEPS to become compatible with the Enterprise Surveys implemented by the World Bank in other regions of the world since 2006. Nevertheless, they dropped significant information about corruption. For example, these rounds dropped questions about the uncertainty of a corrupt transaction and a firm's ability to walk away from a corrupt official. In addition, the respondent rates to the question on the bribe rate in the recent rounds were considerably smaller than those of the BEEPS 2002 & 2005. Particularly, in the 2002& 2005 surveys, 90% respondent firms answered to the bribe related question and 37.7% among them reported positive bribes. In the World Bank's Enterprise Surveys 2006-2014 (including the BEEPS in 2008-2009 and 2011-2014), 64% respondent firms answered the same question and 18% among them reported positive bribes. Thus, two compatible rounds of BEEPS, the 2002& 2005 surveys, were selected, which have richer information on corruption and firm performance than the later BEEPS and other enterprise surveys.

In addition to BEEPS data, the world price of commodities was estimated by its world exports value and net weight, which were collected from the UN Comtrade database. The country-level control variable data necessary for the present analyses were acquired from various data sets. These data sets will be discussed in detail in the following section.

3 Empirical Strategy

3.1 Identification and Instrumental Variable

The key econometric challenge to examine the link between firm size and corruption is addressing the possible reverse causality between these variables, distinctly plausible in the context that many firm characteristics may directly link to corruption. Corruption might reduce the size of firms through adversely affecting their performance and growth as well as discouraging productive firms from initiating growth. For instance, Beck et al (2005) used firm-level data in 54 countries and found that corruption affects firm growth adversely. Fisman and Svensson (2007) found that a 1 percentage point increase in the amount of bribes reduces firm growth by 3 percentage points. Additionally, some more productive firms, that would have been larger without threshold level regulatory burdens, choose to remain below the statutory threshold to avoid the relevant costs of its expansion (Garicano et al 2016). Conversely, corruption might bring about economically advantageous outcomes such as receiving a public contract, getting a license, and saving on taxes

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[1] Baruch and Holtom (2008) analyzed 1607 studies published between 2000 and 2005 and found that the average response rate for studies that employed data collected from organizations was 35.7%. In addition, Cook et al (2000) argue that response representativeness is more important than response rate in survey research.

[2] Five rounds of the BEEPS have been conducted by the European Bank for Reconstruction and Development and the World Bank in 1999-2000, 2002, 2005, 2008-2009, and 2011-2014.

(Tonoyan et al 2010). The instrumental variable method, a quasi-experiment research design to address endogeneity issues (Angrist and Pischke 2008), was employed in this current study to examine the causal link between firm size and corruption burdens.

This paper uses price shocks in international commodity markets to instrument the endogenous independent variable, firm size. The rationale for this IV is as follows. Variations in the world price of a particular commodity might cause changes in a firm's sales and its performance, for firms whose main product line consists of that commodity. World price of a commodity may strongly and positively link to its domestic price - the market price of a firm's output. A decline in the world price of a commodity might reduce the domestic price of a firm's output. If the demand of that commodity is price elastic, the price shock leads to the firm's increasing sales revenue as windfall gains. Plausibly, world price of commodities is exogenous to corruption activities of this study's sample because the included firms are primarily small and medium firms in transition economies. Therefore, world price of a firm's main product line might be a valid instrument, which does not have any direct effect on corruption or any effect running through omitted variables. This identification strategy allows this paper to examine the impact of the exogenous changes in sales revenues (firm size), the aforementioned windfall gains, on corruption burden.

Total sales, the primary measure of firm size, is instrumented by the one-year lagged world price of a firm's main product line. World price of a particular commodity is approximately estimated by its world exports value and net weight. The world exports value and net weight of 5703 commodities, all 6-digit HS (Harmonized Commodity Description and Coding Systems) commodities in 2001 and 2003, were collected from the UN Comtrade database. A concordance between the 6-digit HS and the 4-digit ISIC rev.2 (International Standard Industrial Classification) is used to map the trade data to industry. The concordance, developed by Jerzy Rozanski (the World Bank), is available in the CDROM that comes along with the book edited by B.Hoekman, A. Mattoo and P. English, "Development, Trade and the WTO: a Handbook" (Hoekman et al 2002). The trade data of 5703 commodities were mapped to 97 ISIC rev.2 industrial groups, then to 152 ISIC rev.3.1 (4 digit) industrial groups, and finally to 32 ISIC rev.3.1 (2 digit) industrial groups. World price of 32 ISIC rev.3.1 industrial groups is merged into the pooled BEEPS 2002& 2005 data which consisted of 45 aggregate ISIC rev.3.1 industrial groups. Firms in service sectors such as wholesales trade, transportation, hotels and restaurants were dropped out from the analysis due to nonavailability of service quantity data in the trade database.

3.2 Specifications and Variables

The bribe rate, defined as the share of revenues to a corrupt official that a firm informally pays in order to "get things done" (Clarke and Xu 2004; Wu 2009), was used to reflect the level of bribery burden on a firm. Bribe rate is proxied by the firm reported data under the BEEPS survey question "On average, what percent of total annual sales do firms like yours typically pay in unofficial payments or gifts to public officials?" Two additional type of corruption burden are kickbacks and time burden. The question of kickbacks is phrased as "When firms in your industry

do business with the government, how much of the contract value would be typically paid in additional or unofficial payments/gifts to secure the contract?" Time burden, management time dealing with bureaucrats, is measured by the percent of senior management time spent in dealing with officials, as reported in the BEEPS survey question "What percent of senior management's time over the last 12 months was spent in dealing with public officials about the application and interpretation of laws and regulations and to get or to maintain access to public services?"

The *bribe rate*$_{ijkt}$ of a firm i in industry j of country k at time t is a function of *firm size*$_{ijkt}$, firm-level characteristics F_{ijkt}, country-level characteristics $C_{k,t-1}$, time t, country-industry fixed-effects $IND_j * Ctry_k$, and a normally distributed unobserved error term u_{ijkt}, as the following:

$$Bribe\ rate_{ijkt} = \gamma_0 + \gamma_1 firm\ size_{ijkt} + \gamma_f F_{ijkt} + \gamma_c C_{k,t-1} + \gamma_t T + \gamma_{jk} IND_j * Ctry_k + u_{ijkt} \quad (1)$$

This study utilized two common indicators of firm size: dollar value of sales and number of full-time employees (Martin et al 2007). Table 1 summarizes definitions and descriptive statistics of the variables. The correlation matrix of these variables is presented in Table 2, which illustrates the negative associations between firm size (employment and sales) and bribery burden as well the negative associations between firm size and the IV.

Table 1: Descriptive statistics of variables

Variable	Definition	Mean	SD
Bribe rate	% of total annual sales typically paid in unofficial payments	1.05	2.58
Kickback rate	% of contract value typically paid in unofficial payments	1.46	3.81
Dealing time	% of senior management time spent in dealing with officials	5.00	9.57
Employment	Number of full-time employees	61.03	254.01
Sales	Total sales in 000 USD	4741.82	32309.90
1 year-lagged world price	USD/kg net weight	5.77	8.27
World price	USD/kg net weight	5.97	8.28
Under 5 years	Dummy variable. 1 = firm operated under 5 years	0.19	0.39
Age	Survey year - year firm began operation	15.47	19.07
Trade	Dummy variable. 1 = firm exports	0.303	0.46
Government sales	Dummy variable. 1 = firm has sales to government	0.169	0.38
Foreign ownership	Dummy variable. 1 indicating the firm has a foreign ownership	0.128	0.33
State ownership	Dummy variable. 1 = firm has a state ownership	0.087	0.28
Individual shareholder	Dummy variable. 1 = individual is firm's largest shareholder	0.601	0.49
Family shareholder	Dummy variable. 1 = family is firm's largest shareholder	0.115	0.32
City size 1	Dummy variable. 1 = firm located in a capital city	0.26	0.44
City size 2	Dummy variable. 1= located in a city over 1 million population	0.05	0.22
City size 3	Dummy variable. 1= located in a city between 250,000 to 1 million	0.16	0.37
City size 4	Dummy variable. 1= located in a city between 50,000-250,000	0.23	0.42
City size 5	Dummy variable. 1= located in a city under 25,000	0.29	0.46
Corruption structure	Firms can usually go to another official	0.70	0.46
Corruption certainty	Firms usually know in advance about informal payment	2.39	0.57
GDPPC	Constant GDP per capita, PPP	14527.22	9868.95
Import share	Imports of goods and services (% of GDP)	48.03	16.01
Democracy	Dichotomous democracy measure. 1 = democrat	0.70	0.46
Democracy index	Index of democratization	21.8965	9.3668

The selection of exogenous determinants of corruption burden was based on the previous studies. The key time-variant country-level determinants of corruption were controlled for, including one-year-lagged economic development, economic openness, and democracy in the baseline specification

(Treisman 2000; La Porta et al 1999). Economic development is measured by per capita income, measured as constant GDP per capita using international currency from the World Development Indicators (WDI). Economic openness is measured by imports of goods and services as a share of GDP, from the WDI. Democracy is measured by the Boix-Miller-Rosato dichotomous democracy measure. The authors define a country as democratic if it satisfies conditions for both contestation and participation. In an alternative specification, democracy is measured by the index of democratization. The index of democratization constructed by Vanhanen (2014) portrays the electoral success of smaller parties and the voting turnout in each election.

Two different dimensions of a corruption environment were aggregated at the industry-level by country, corruption structure (the extent to which a firm knows in advance about amounts of informal payments) and corruption certainty (how often a firm can walk away from the corrupt official and go to another official for the same service). Four industries in the sample include mining and quarrying, manufacturing, retail trade, and real estate. Based on the Shleifer and Vishny (1993) industrial organization perspective on corruption which emphasizes the roles of different structures of corruption markets in explaining the incidence of government corruption. Particularly, a firm tends to pay less for bribes in a more competitive network of officials. Another important aspect of corruption regimes is the certainty degree of a corruption transaction, which is highlighted by the Rodriguez et al (2005) two-dimension framework of corruption. In this paper, country-by-industry fixed-effects are also utilized instead of separate country and industry fixed-effects because corruption environment in the same industry may vary across countries.

The firm-level control variables include exporting capacity, under 5 years of operations, state sales capacity, ownership types, and its located city size. In particular, dummy variables indicating whether a firm exports, sells to the government, operates under 5 years, is owned by a private foreign company, is owned by government/state, has an individual as the largest shareholder, and has a family as the largest shareholder are also controlled for. Dummy variables of these control variables are used instead of continuous or discrete variables in order to capture exogenous and important firm-level determinants of corruption, thus avoiding potential endogeneity bias on their coefficients. For instance, foreign ownership as percentage owned by some private foreign company or organization tends to be endogenous. A more intensive foreign ownership may change corruption activities of a firm, however, corruption activities may reduce the percentage owned by the private foreign partner.

The IV/two-state least squares regressions are implemented by the xtivreg2 package in Stata, which was developed by Schaffer et al (2015). Country-by-industry fixed-effects estimations were conducted instead of firm-level fixed-effects estimations because only 10% of the whole sample was surveyed repeatedly in the two survey rounds utilized. The standard errors are corrected for heteroscedasticity and clustered within country-industry groups. The first-stage and second-stage regression equations are as follows, respectively:

$$Firm\ size_{ijkt} = \alpha + \alpha_p world\ price_{s,t-1} + \alpha_f F_{ijkt} + \alpha_c C_{k,t-1} + \alpha_t T + \alpha_{jk} IND_j * Ctry_k + e_{ijkt} \quad (2)$$

Where e_{ijkt} is a normally distributed unobserved error term and $world\ price_{s,t-1}$ is the one-year lagged world price of a product line s (an ISIC rev.3.1 industrial group aggregated at 2 digit level).

$$Bribe\ rate_{ijkt} = \beta_0 + \beta_1 \widehat{firm\ size}_{ijkt} + \beta_f F_{ijkt} + \beta_c C_{k,t-1} + \beta_t T + \beta_{jk} IND_j * Ctry_k + v_{ijkt} \quad (3)$$

Where $\widehat{firm\ size}_{ijkt}$ is the fitted value from Equation 2.

In order to examine the plausible non-linear link between firm size and corruption burden, $firm\ size^2_{ijkt}$ is added to Equation 2 as a second endogenous variable. As suggested in (Wooldridge 2010, p.237), $\widehat{firm\ size}_{ijkt}^2$ is used as a single IV for $firm\ size^2_{ijkt}$ in oder to address endogeneity concerns.

4 Firm Size and Bribery Rate

4.1 Baseline Specification

Table 2 presents OLS and IV results from Equations 1, 2, and 3, where the dependent variable is the percentage of total sales typically paid in unofficial payments by a firm. Controlling country-level and firm-level time-invariant characteristics and country-by-industry fixed-effects, the OLS regression results indicate a negative association between firm size (sales and employment) and the bribe rate (columns 5 and 7). Using the Davidson-Mackinnon test for consistency of OLS estimates after the baseline IV fixed-effect regressions, the OLS consistency can be rejected (0.0016 and 0.102 as p-values for regressions of sales and employment respectively). This rejection confirms the plausible two-way causation between firm size and corruption and the potential bias of the OLS results. The direction of this bias depends upon whether the effect of corruption on sales is dominated by either detrimental or advantageous feedback effects ("sand the wheels" or "grease the wheels", respectively).

In contrast, the IV regressions imply that sales had a statistically significant and positive impact at the 99 percent confidence level on the bribe rate (columns 1 to 4). The results suggest that an exogenous increase in sales (firm size), as windfall gains thanks to price shocks in international commodity markets, leads firms to pay a larger proportion of their revenues as bribes to public officials. Column 1 of Table 2 shows the baseline specification which uses the one-year lagged world commodity price as the IV. The coefficient on log(sales) implies that a 10% increase in sales brings the bribe rate up by 0.044-percentage-points. Equivalently, a one-standard deviation increase in sales is linked to 2.54 additional percentage point of sales paid in bribes (approximately equal to one standard deviation increase in bribe rate). Therefore, the OLS estimates might be downwardly biased, when compared to the IV estimates. This downward bias might be a result of the potential detrimental feedback effect from corruption burdens on sales which dominates the "grease the wheels" effect of corruption on sales. In the same vein numerous macro-level studies such as (Mauro 1995; La Porta et al 1999; Treisman 2000; Dutta and Sobel 2016), Wei (1997) and Fisman and Svensson (2007) provide firm-level evidence for the "sand the wheels" effect of corruption; that is government corruption is harmful for economic growth. Additionally, in many transition economies,

Table 2: Effects of firm size on bribery rate

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Method	IV	IV	IV	IV	OLS	IV	OLS
Log(sales)	0.4378***	0.4293***	0.5709***	0.3983***	-0.0558**		
	(0.150)	(0.143)	(0.200)	(0.133)	(0.024)		
	[0.003]	[0.003]	[0.004]	[0.003]	[0.023]		
Log(employment)						0.4108*	-0.0552***
						(0.232)	(0.019)
						[0.077]	[0.004]
Under 5 years	0.4550***	0.4502***	0.5886***		0.1761†	0.3272**	0.1798*
Trade	-0.7097***	-0.6990***	-0.8938***	-0.6048***	-0.0854	-0.4548**	-0.0649
Government sales	0.1748†	0.1775†	0.0807	0.1865*	0.3294***	0.2078**	0.2542***
Foreign ownership	-0.4271***	-0.4214***	-0.5042***	-0.4630***	-0.0988	-0.2235	-0.0368
State ownership	-0.7095***	-0.7040***	-0.8061***	-0.5231***	-0.3921***	-0.5019***	-0.4018***
Individual shareholder	0.7222***	0.7144***	0.9208***	0.5988***	0.2724***	0.5738***	0.3136***
Family shareholder	0.7154***	0.7070***	0.9280***	0.5698***	0.2303**	0.5020***	0.2213**
City size 2	0.2045	0.2021	0.3556	0.1909	0.0637	0.1321	0.0726
City size 3	-0.1300	-0.1314	-0.1494	-0.1344	-0.2097†	-0.1415*	-0.1550*
City size 4	-0.2310**	-0.2316**	-0.2564**	-0.2325**	-0.2652***	-0.2261**	-0.2169**
City size 5	-0.1514*	-0.1536**	-0.1852*	-0.1657**	-0.2792***	-0.2177***	-0.2540***
Log(GDPPC)	-1.0730	-1.0647	-1.5627	-2.0795	-0.5923	1.6067	1.6876†
Imports share	0.0096	0.0096	0.0120	0.0018	0.0069	0.0077	-0.0008
Year 2004	-0.4794*	-0.4766*	-0.4969	-0.2699	-0.3190	-1.6346**	-0.6579**
Democracy	-2.3929***	-2.3914***	-2.5433***		-2.3015***	-2.4855***	-2.6610***
Corruption structure			0.2849				
Corruption certainty			-0.0848				
Log(age)				-0.3204***			
Democracy index				-0.0144			
Observations	5,779	5,779	4,554	5,779	5,784	7,392	7,399
Number of groups	96	96	91	96	101	97	104
Relevance test (F-stat 1)	108.10	110.12	75.46	124.43		51.44	
Relevance test (F-stat 2)	36.93	37.80	38.45	41.39		10.89	
R-squared					0.0755		0.0769
First-stage of IV regression - included instruments are not presented							
IV							
Lag1 world price	-0.1973***		-0.1863***	-0.2069***		-0.0958***	
	(0.033)		(0.030)	(0.032)		(0.029)	
	[0.000]		[0.000]	[0.000]		[0.001]	
World price		-0.1942***					
		(0.032)					
		[0.000]					
Observations	5,784	5,784	4,563	5,784		7,399	
R-squared	0.4741	0.4743	0.4829	0.4978		0.4806	

Statistics robust to heteroscedasticity and clustering on industry*country. F-statistic 1: Cragg-Donald Wald F statistic; F-statistic 2: Kleibergen-Paap rk Wald F statistic. Standard errors in parentheses, p-values in brackets. Constant coefficient is not reported. *** p<0.01, ** p<0.05, * p<0.1, † p<0.15.

where corruption and red tape are rampant, burdensome regulatory thresholds, triggered on larger firms as they grow, might discourage productive firms to grow.

The results suggest that given some windfall gains, a firm with an exogenous increase in sales tends to pay a higher amount of bribes paid to public officials. Therefore, the findings provide evidence against the argument for a uniform bribe rate regardless of size (Wu 2009) and supports the bargaining power argument in Svensson (2003). The bargaining power argument implies that larger firms may be more vulnerable and exposed to extortion by corrupt officials because of their higher "ability to pay". In addition, smaller firms can more easily slip into informal arrangements in order to avoid taxes, regulations, and interactions with bureaucrats Schiffer et al (2001). Thereby informality might help smaller firms avoid corruption burden. The IV results of this study are contrary to the OLS results presented by Clarke and Xu (2004), Wu (2009), and Rand and Tarp (2012). Clarke and Xu (2004) found that large firms paid lower amounts as share of revenues than small counterparts in the BEEPS 1999 data, which is similar to this study's OLS results. Using Asia firm surveys, Wu (2009) provides a positive OLS coefficient on the dummy variable for small firms (less than 500 employees), but it is statistically insignificant. Firm size, measured by log(employment), is found to be negatively and statistically insignificant associated with the magnitude of bribe payments in Rand and Tarp (2012).

The coefficients on the control variables in the baseline regression are generally statistically significant with signs consistent with theories and previous analyses. All firm-level determinants of bribe rate are statistically significant, including firms under 5 years of operations, export capacity, business with government, ownership, largest shareholders and located-city size. Firms under 5 years of operation bear more corruption burden than others in regard to the amount of bribes. Older firms might have more know-how and experience to deal best with corruption (Schiffer et al 2001). In addition, export firms tend to pay a lower rate of bribery than non-export firms do. Foreign-owned firms also pay a lower rate of bribery compared to domestic firms. For firms whose customers are government agencies the bribe rate is higher than their peers. With an advantage of state ownership, a state-owned firm bears a lower bribery burden from public officials. Firms with either individual or family as its largest shareholder might pay a higher bribe rate than might a firm with a corporate or governmental largest shareholder. In addition, firms located in a country's capital tend to pay higher amounts in bribes than other locations. The coefficients on the country-level time-variant control variables are less significant despite their expected signs. The dichotomous democracy measure is significantly and negatively associated with the rate of bribery. The result implies that firms in a democratic country pay less bribes than their counterparts in a non-democratic country. A firm operating in a country with a lower level of economic development might face more bribery burden from public officials, although this macro-economic variable is not statistically significant.

4.2 Robustness checks

Estimating the local average treatment effects of firm size on bribery by the IV method involves several assumptions. The Cragg-Donald Wald F statistic (F-stat 1) and the Kleibergen-Paap rk Wald F statistics (F-stat 2) are reported and used to test the relevance of the IV, the one-year lagged world price of commodities. Referring to the Stock-Yogo critical values for the relevance test, the F statistic exceeds 10 in the baseline estimation, which confirms the relevance of the IV in capturing exogenous variations in firm size. The first state regressions of the IV/2SLS estimations in Table 2 provide additional evidence on the relevance of the IV. The results indicate that sales and employment of a firm are negatively associated with world price of that firm's product line.

Although IV estimations are considered to be dependent on the data at hand, the IV estimates are robust across different specifications. Using the world price at the survey year as an alternative IV, the estimation produces results highly similar to the baseline regression (column 2 of Table 2). Column 3 presents the IV estimates with a different specification, which additionally controlled for the two variables of corruption structures: corruption structure and corruption certainty. This alternative estimation marginally modified the results of the baseline specification. Despite the unexpected signs of corruption structure and certainty, their coefficients are not statistically significant. Column 4 of Table 2 shows the IV regression which substituted both "under 5 years" dummy variable and dichotomous democracy measure by firm age and democracy index. This alternative estimation yields results highly similar to those reported in the baseline specification.

4.3 Diminishing Positive Effect on Bribe Rate

Figure 2 and Table 3 illustrate the estimated effects of exogenous changes in firm size on bribe rate using several sub-samples and the non-linear specification regarding firm size. The estimations provide moderate evidence for a reverse U-shaped relationship between firm size and corruption (Table 3, columns 2-4). Small firms which accounted for 30% of the sample tend to bear the largest bribery burden rise from bureaucrats, followed by micro firms, and lastly medium and large firms. The sample of micro firms (2-10 employees, accounting for 39% of the whole sample) yields a positive coefficient on log(sales) which is higher than the coefficient of the whole sample. The estimate using the sample of medium and large firms is positive and smaller than the coefficient of the whole sample, but it is statistically insignificant.

The quadratic term of firm size and the interaction between firm size and size classification were treated as additional endogenous variables included to the IV baseline regression . The results are presented in Table 3, columns 1, 5, and 6. The squared-fitted values from Equation 2 and the cross products of the fitted values and size classifications are used to instrument the newly added endogenous variables. The results in column 1 suggest diminishing positive effects of firm size on bribery rate, which is slightly different from the aforementioned results in sub-samples. Micro firms tend to face the largest bribery burden associated to their sales, followed by small firms, then medium and large firms. For large firms, the positive effect of firm size on bribery rate is significantly smaller than others. The smallest positive effects of firm size on bribery rate being

Fig. 2: Effects of firm size on reported bribery payments in different sub-samples
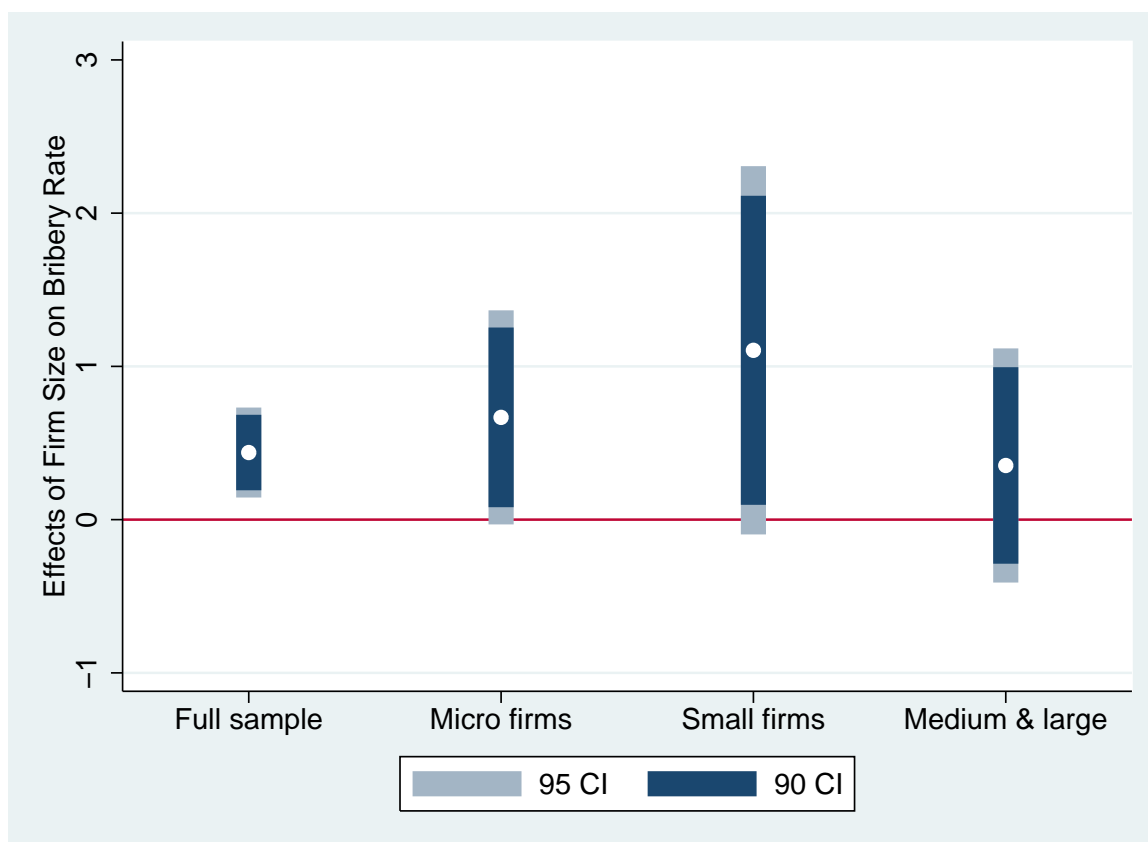
among large firms might be a result of stronger refusal power, political influence, and economies of scale. Particularly, though a large firm might be more exposed to demands from corrupt officials due to their increasing sizable revenues, this may be moderated by its stronger refusal power, political influence, and economies of scale. A large firm might possess some political powers and other means to resist predatory bureaucrats (Schiffer et al 2001). Also, informal payments to bureaucrats might be fixed costs on firms, consequently, a large firm can absorb these costs more easily. However, the quadratic terms in columns 5 and 6 are not statistically significant.

5 Firm Size and Other Corruption Burdens

In this section, the relationship between firm size and a couple of other corruption related burdens will be examined, including management time spent in dealing with bureaucrats and kickback payments. The results suggest that an exogenous increase in firm size not only increases the amount of informal payments paid to corrupt officials but also causes firms to spend more, not less, management time to deal with public officials.

The effects of firm size on the proportion of management time spent dealing with public officials are reported in Table 4 and Figure 3. Spending more management time to deal with bureaucrats has a potential detrimental feedback effect on sales, therefore, time cost is treated as an endogenous

Table 3: Diminishing effects of firm size on bribe rate

	(1)	(2)	(3)	(4)	(5)	(6)
Sample	All	Micro size	Small size	Medium & large	All	All
Log(sales)	0.9839***	0.6673*	1.1049*	0.3534	0.2354	
	(0.332)	(0.356)	(0.613)	(0.390)	(0.271)	
	[0.003]	[0.061]	[0.071]	[0.365]	[0.386]	
Log(sales)*Small size	-0.2368***					
	(0.086)					
	[0.006]					
Log(sales)*Medium size	-0.4075***					
	(0.132)					
	[0.002]					
Log(sales)*Large size	-0.5227***					
	(0.166)					
	[0.002]					
Log(sales)^2					0.0172	
					(0.016)	
					[0.297]	
Log(employment)						1.1251
						(0.850)
						[0.186]
Log(employment)^2						-0.1277
						(0.114)
						[0.264]
Observations	5,779	2,254	1,714	1,774	5,779	7,392
Number of groups	96	69	79	72	96	97
Relevance test (F-statistic 1)	23.23	39.14	32.10	15.70	56.78	16.78
Relevance test (F-statistic 2)	7.86	17.58	29.42	13.18	18.82	14.19

Statistics robust to heteroscedasticity and clustering on industry*country. F-statistic 1: Cragg-Donald Wald F statistic; F-statistic 2: Kleibergen-Paap rk Wald F statistic. Standard errors in parentheses, p-values in brackets. Constant and control variables' coefficients are not reported. *** p<0.01, ** p<0.05, * p<0.1, † p<0.15.

variable in the estimations. For instance, when a firm's senior managers spend more time to deal with public officials, they consequently have less time available to deal with production, innovation, and other general management. As a result of wasted management time, it might limit sales and negatively affect performance of a firm. Using the similar identification strategy and baseline specification in the IV regressions of bribery rate, the data supported a positive non-linear effect of firm size on time cost.

On average, a 10% increase in sales leads a typical firm to spend an additional 0.18 percentage-point in management time, which is statistically significant at the 95% confidence level (Table 4, column 1). Equivalently, a one-standard deviation increase in sales causes 10.33 additional percentage point of time cost (1.1-standard deviation increase). Results in Table 4, columns 2 to 5 show significantly differential positive effects of firm size on time burden regarding size classification. Similar to bribery burden, micro and small firms tend to face the larger time burden associated to their sales than medium and large firms.

Fig. 3: Effects of firm size on management time spent dealing with bureaucrats
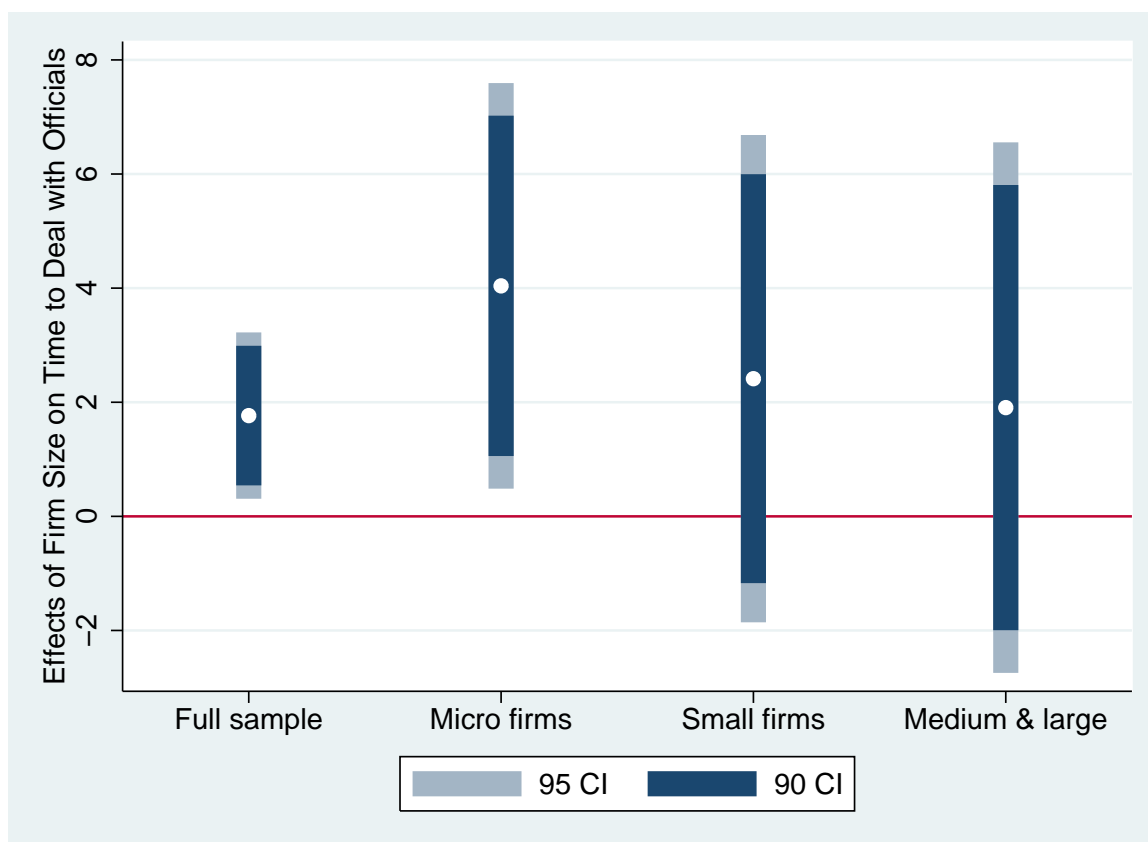
The non-linear link between firm size and time burden is examined and reported in column 6. The quadratic term of firm size is negative and statistically significant at the 95% confidence level. The point estimates of log(sales) and log(sales)^2 imply that the optimal firm size of the reverse U-shaped relationship between firm size and time burden is approximately US\$ 46.5 million (equivalently EUR 43.5 million). In the European Union, the range of medium firms' revenue is between EUR 10 million and EUR 50 million. Therefore, the results confirm the existence of the reverse U-shaped relationship between firm size and time burden. In particular, the positive effect of firm size on corruption burden is highest at the lowest levels of firm size such as micro and small firms, and becomes diminished as firm size increases to medium and large.

Kickbacks in public procurement are payments made to secure procurement contracts, known as one type of the misuse of public office for private gain - a form of government corruption (Hellman et al 2002; Svensson 2005). Applying the same empirical strategy for bribe rate, the regression results of kickback rates portrayed in Figure 4 are less significant. The coefficients on log(sales) and log(sales)^2 are positive and negative respectively in the IV estimations, however, they are not significant at the 95% confidence level. The less robust positive effect of firm size on kickback payments might be attributable to the differences between the two forms of corruption: informal payments to get things done and rent-seeking kickbacks for government contracts.

Table 4: Effects of firm size on management time to deal with bureaucrat

|	(1)	(2)	(3)	(4)	(5)	(6)
Sample	All	All	Micro size	Small size	Medium & large	All
Log(sales)	1.7660**	3.2099**	4.0396**	2.4131	1.9058	3.9187***
	(0.744)	(1.610)	(1.813)	(2.179)	(2.372)	(1.306)
0.018	0.046	0.026	0.268	0.422	0.003	
Log(sales)*Small size		-0.6295†				
		(0.418)				
		[0.133]				
Log(sales)*Medium size		-1.1789*				
		(0.641)				
		[0.066]				
Log(sales)*Large size		-1.4637*				
		(0.797)				
		[0.066]				
Log(sales)^2						-0.1823**
						(0.078)
						[0.019]
Observations	6,003	6,003	2,324	1,789	1,859	6,003
Number of groups	96	96	70	80	77	96
Relevance test (F-statistic 1)	111.65	27.67	42.50	39.50	17.91	58.08
Relevance test (F-statistic 2)	37.06	9.62	18.97	39.11	13.90	19.08

Statistics robust to heteroscedasticity and clustering on industry*country. F-statistic 1: Cragg-Donald Wald F statistic; F-statistic 2: Kleibergen-Paap rk Wald F statistic. Standard errors in parentheses, p-values in brackets. Constant and control variables' coefficients are not reported. *** $p<0.01$, ** $p<0.05$, * $p<0.1$, † $p<0.15$.

6 Conclusion

This paper primarily examines whether increases in sales lead to greater corruption burdens on firms. Data from pooled nationally-representative firm surveys, mostly in Eastern Europe and Central Asia between 2002 and 2005, was analyzed by implementing the instrumental variables method. A credible quasi-experimental design has been implemented to address reverse causality between firm size and corruption, the instrumental variable strategy based on price shocks in international commodity markets. The non-linear relationship between firm size and corruption has also been investigated.

The results suggest that an exogenous increase in sales (firm size), as windfall gains thanks to price shocks in international commodity markets, causes a typical firm to pay a considerably larger proportion of their revenues as bribes to public officials as well as to spend more management time to deal with these officials. A one standard deviation increase in sales leads to approximately one standard deviation increase in bribe rate and 1.1 standard deviation increase in the proportion of management time to deal with public officials. This paper provides moderate evidence on the reserve U-shaped pattern of the link between firm size and corruption. In particular, the positive effect of firm size on corruption burden is highest at the lowest levels of firm size such as micro and small firms, and becomes diminished as firm size increases to medium and large. The less robust

Fig. 4: Effects of firm size on kickback rate
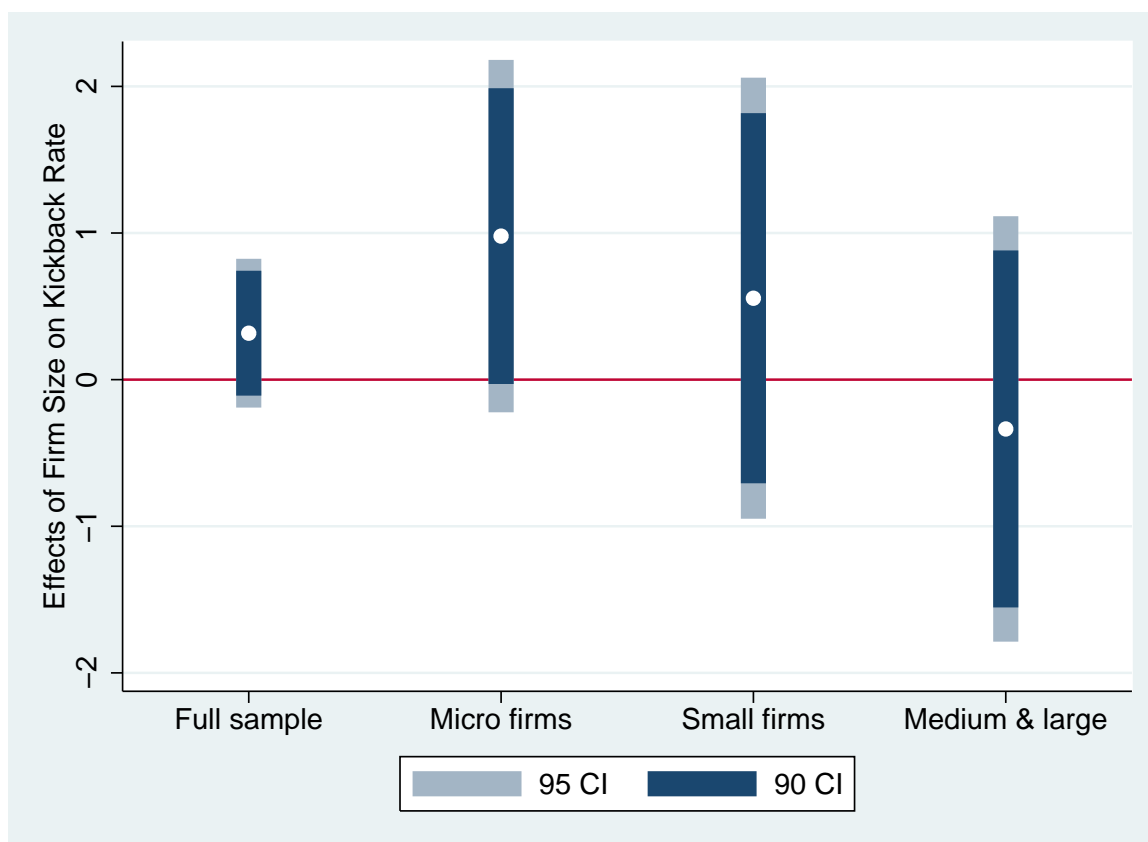
positive effect of firm size on kickback payments might be attributable to the differences between informal payments to get things done and rent-seeking kickbacks for government contracts which is an interesting avenue for future research.

This paper has an important policy implication in the context of the increasingly important roles of small and medium-sized enterprise development across globe (Aquilina et al 2006). The findings indicate that the smallest firms in Eastern Europe and Central Asia might face the most bureaucratic harassment during their growth. Accordingly, burdensome corruption and red tape, government-made obstacles, tend to weaken small and medium-sized enterprises' positions and opportunities in the playing field with larger firms. In addition, paying more bribes to public officials could not help a typical firm to circumvent the rigidity of bureaucracy. This paper provides evidence confirming the need to relax both formal and informal bureaucratic and regulatory constraints on small and medium-sized enterprises, especially in rampant corruption countries.

Appendices

Table 1: List of countries in analyses and average corruption indicators

Country	Bribe rate	Bribe likelihood	Kickback rate	Dealing time	Employment	Sales
Bulgaria	2.21	0.47	3.37	3.66	6750.01	75.97
Albania	2.08	0.70	7.22	11.04	2295.64	48.50
Croatia	0.67	0.25	1.00	5.25	11464.36	131.72
Belarus	1.09	0.34	0.86	6.60	2081.00	58.77
Georgia	1.88	0.41	2.21	7.86	798.16	55.03
Tajikistan	1.42	0.50	1.25	3.76	608.61	78.14
Turkey	0.34	0.62	1.38	1.85	11497.41	68.41
Ukraine	1.90	0.53	1.98	10.72	1971.39	49.28
Uzbekistan	1.21	0.40	1.16	4.67	2016.56	61.07
Russia	1.05	0.62	1.56	7.66	2008.64	117.70
Poland	0.77	0.25	1.11	4.25	2613.80	48.53
Romania	1.07	0.37	0.91	2.36	1803.68	77.15
Kazakhstan	1.55	0.53	1.70	4.86	663.22	62.07
Moldova	1.49	0.46	0.78	5.95	645.22	80.02
Bosnia & Herzegovina	0.87	0.34	0.86	6.58	2512.03	59.09
Azerbaijan	2.92	0.51	5.43	1.87	883.73	103.82
FYR Macedonia	0.79	0.38	2.77	10.35	1968.47	44.55
Armenia	1.14	0.26	0.85	3.84	536.93	35.10
Kyrgyz Republic	2.46	0.67	2.25	6.76	788.52	76.78
Estonia	0.28	0.18	0.79	1.69	3985.93	39.08
Czech Republic	0.45	0.25	1.22	2.78	5492.46	115.26
Hungary	0.65	0.30	1.45	4.32	7035.60	66.17
Latvia	0.58	0.32	1.08	4.35	1604.88	20.38
Lithuania	0.70	0.42	1.18	6.88	3642.02	49.18
Slovak Republic	0.88	0.38	2.09	5.15	13181.45	156.07
Slovenia	0.31	0.12	0.31	4.45	15818.38	108.28
Spain	0.05	0.04	0.38	1.27	23073.93	107.60
Ireland	0.39	0.08	0.54	2.77	16444.37	68.00
Total	1.05	0.38	1.41	4.93	4741.82	70.97

Table 2: Correlation matrix

	Log(sales)	Log(employment)	Bribe	Dealing time	Kickback	Lagged international price	International price	Corruption structure	Corruption certainty
Log(sales)	1								
Log(employment)	0.607***	1							
Bribe	-0.147***	-0.0884***	1						
Dealing time	0.000762	0.00514	0.165***	1					
Kickback	-0.0577***	-0.0370***	0.379***	0.131***	1				
Lagged international price	-0.0697***	-0.104***	-0.0380***	-0.0456***	-0.0254*	1			
International price	-0.0639***	-0.0851***	-0.0415***	-0.0496***	-0.0280*	0.998***	1		
Corruption structure	0.174***	0.0702***	-0.0974***	-0.0659***	-0.0475***	0.0214	0.0279*	1	
Corruption certainty	-0.217***	-0.102***	0.221***	0.149***	0.201***	-0.0813***	-0.0974***	-0.446***	1

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

References

Angrist JD, Pischke JS (2008) Mostly harmless econometrics: An empiricist's companion. Princeton university press

Aquilina M, Klump R, Pietrobelli C (2006) Factor substitution, average firm size and economic growth. Small Business Economics 26(3):203–214

Baruch Y, Holtom BC (2008) Survey response rate levels and trends in organizational research. Human Relations 61(8):1139–1160

Beck T, Demirgüç-Kunt A, Maksimovic V (2005) Financial and legal constraints to growth: Does firm size matter? The Journal of Finance 60(1):137–177

Bradford CS (2004) Does size matter-an economic analysis of small business exemptions from regulation. J Small & Emerging Bus L 8:1

Clarke GR, Xu LC (2004) Privatization, competition, and corruption: how characteristics of bribe takers and payers affect bribes to utilities. Journal of Public Economics 88(9):2067–2097

Cook C, Heath F, Thompson RL (2000) A meta-analysis of response rates in web-or internet-based surveys. Educational and psychological measurement 60(6):821–836

Dutta N, Sobel R (2016) Does corruption ever help entrepreneurship? Small Business Economics 47(1):179

Fisman R, Svensson J (2007) Are corruption and taxation really harmful to growth? firm level evidence. Journal of Development Economics 83(1):63–75

Fries S, Lysenko T, Polanec S, et al (2003) The 2002 business environment and enterprise performance survey: Results from a survey of 6,100 firms. Tech. rep.

Garicano L, Lelarge C, Van Reenen J (2016) Firm size distortions and the productivity distribution: Evidence from france. The American Economic Review 106(11):3439–3479

Hellman JS, Jones G, Kaufmann D (2002) Far from home: Do foreign investors import higher standards of governance in transition economies? Available at SSRN 386900

Hoekman BM, Mattoo A, English P (2002) Development, trade, and the WTO: a handbook, vol 1. World Bank Publications

Kaufmann D, Hellman J, Jones G, Schankerman M (2000) Measuring governance, corruption, and state capture: How firms and bureaucrats shape the business environment in transition economies. World Bank Policy Research Working Paper (2312)

Knack S (2007) Measuring corruption: A critique of indicators in eastern europe and central asia. Journal of Public Policy 27(03):255–291

La Porta R, Lopez-de Silanes F, Shleifer A, Vishny R (1999) The quality of government. Journal of Law, Economics, and Organization 15(1):222–279

Martin KD, Cullen JB, Johnson JL, Parboteeah KP (2007) Deciding to bribe: A cross-level analysis of firm and home country influences on bribery activity. Academy of Management Journal 50(6):1401–1422

Mauro P (1995) Corruption and growth. The Quarterly Journal of Economics 110(3):681–712

Rand J, Tarp F (2012) Firm-level corruption in vietnam. Economic Development and Cultural Change 60(3):571–595

Rodriguez P, Uhlenbruck K, Eden L (2005) Government corruption and the entry strategies of multinationals. Academy of Management Review 30(2):383–396

Schaffer ME, et al (2015) xtivreg2: Stata module to perform extended iv/2sls, gmm and ac/hac, liml and k-class regression for panel data models. Statistical Software Components

Schiffer M, Weder B, et al (2001) Firm size and the business environment: Worldwide survey results. Tech. rep., IFC Discussion Papers

Shleifer A, Vishny RW (1993) Corruption. The Quarterly Journal of Economics 108(3):599–617

Svensson J (2003) Who must pay bribes and how much? evidence from a cross section of firms. The Quarterly Journal of Economics 118(1):207–230

Svensson J (2005) Eight questions about corruption. The Journal of Economic Perspectives 19(3):19–42

Tonoyan V, Strohmeyer R, Habib M, Perlitz M (2010) Corruption and entrepreneurship: How formal and informal institutions shape small firm behavior in transition and mature market economies. Entrepreneurship theory and practice 34(5):803–831

Treisman D (2000) The causes of corruption: a cross-national study. Journal of public Economics 76(3):399–457

Vanhanen T (2014) Measures of democracy 1810-2014. Finnish Social Science Data Archive URL http://urn.fi/urn:nbn:fi:fsd:T-FSD1289

Wei SJ (1997) Why is corruption so much more taxing than tax? arbitrariness kills. Tech. rep., National Bureau of Economic Research

Wooldridge JM (2010) Econometric analysis of cross section and panel data. MIT press

Wu X (2009) Determinants of bribery in asian firms: Evidence from the world business environment survey. Journal of Business Ethics 87(1):75–88