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Effects of bribery on natural resource efficiency in Vietnam: moderating effects of market competition and credit constraints

Le Thanh Ha[a], Doan Ngoc Thang[b] and To Trung Thanh[a]

[a]National Economics University, Hanoi, Vietnam; [b]Banking Academy of Vietnam, Hanoi, Vietnam

ABSTRACT
This article uses small and medium-sized enterprises' (SMEs) survey data in Vietnam from 2007 to 2015 to examine the effects of bribery on the natural resource efficiency of firms facing credit constraints and market competition. We also employ the disaggregated resource intensity by water, fuel, and electricity. Credit-constrained firms are broken down into those who have had formal loan applications denied (credit rationed) and those who do not apply for formal loans due to either the process being too difficult or the interest rate being too high (discouraged borrowers). Applying instrumental variable method to take into account the endogeneity problem, the empirical results provide evidence to support the 'sanding-the-wheels of resource efficiency' hypothesis. Among the three natural resources, inefficiency is most evident in water consumption. Furthermore, the effects become more sizable for micro-sized and informally registered firms since they have a lower bargaining power vis-à-vis public officials. Credit constraints and market competition pressure can reduce a firm's ability to use natural resources efficiently.

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1. Introduction

Since the implementation of the Doi Moi economic reform in 1986, Vietnam's economy has grown at a rapid rate. However, this has caused the degradation of natural resources and environmental problems (Shahbaz et al., 2019). Konstadakopulos (2008) indicates the environmental depletion caused by small firms in the North of Vietnam. An environmental treaty for small and medium-size firms (SMEs) becomes increasingly important in Vietnam as these firms accounts for around 90% of the firm population. In the report of the Party 12th National Congress of the Socialist Republic of Vietnam, it is pointed out that Vietnam should avoid the trade-off between a clean environment and economic development, and therefore firms in Vietnam should be concerned with resource efficiency. Meanwhile, corruption, which

CONTACT To Trung Thanh thanhtt@neu.edu.vn
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is recognized as one of the main characteristics of a transition economy, may adversely affect firms' ability to transform inputs into outputs. The low level of economic development is positively associated with corruption (Moiseev et al., 2020; Remeikienė et al., 2020). Bribery has become a common issue in developing areas where there is a prevalence of government corruption (Cuervo-Cazurra, 2006) and the salary of public officials is low (Nguyen et al., 2015). Being a transition economy, the severity of corruption in Vietnam has received a lot of attention from economic scholars (Bai et al., 2013; Malesky et al., 2020; Nguyen & Van Dijk, 2012). In Vietnam, scholars have affirmed that paying bribes is acknowledged as an accepted social norm (Nguyen et al., 2016) or a possible way to deal with requests of public officials (Nguyen et al., 2020). More recently, Ha et al. (2021) indicate the severity of corruption issue in Vietnam, and then investigate the impacts of corruption on environmental innovation implementations. The environmental degradation has become a serious issue in Vietnam (Ha et al., 2021). Hence, it is pivotal to study the nexus between bribery and resource efficiency in Vietnam's context.

This article investigates the effects of bribery extensity on a firm's natural resource inefficiency by using panel data for Vietnamese firms from 2007 to 2015. We use the resource intensity, which is the ratio of input value to the amount of output, to measure resource inefficiency. We further consider the relationship between bribery and natural resources, broken down into electricity, fuel, and water. For robustness checks, bribery intensity is also examined. As market competition and credit constraints may play a role, we re-regress the benchmark model on the sub-samples to test our predictions. This article employs the sector-location average as instrumental variables for bribes to mitigate the endogeneity issue that may arise due to the inverse causality between bribery and resource efficiency and the existence of unobserved omitted variables.

Our contributions are three folds. First, we confirm the 'sanding-the-wheels of resource efficiency' hypothesis. Firms that give bribes to local officials tend to use more inputs than non-bribing firms, and this result holds for all three natural resources. Second, this effect becomes more pronounced for micro-sized and informally registered firms as they possess a lower bargaining power with public officials. Third, the effect of bribery on resource inefficiency shrinks when firms face market competition or have no credit constraints. These findings suggest several policy implications. First, in order to improve resource efficiency, governments should pay attention to combating corruption. Second, the positive effect of bribery on resource inefficiency will be reduced by enhancing the firm's bargaining power, boosting the market competition, or alleviating the credit constraints.

The rest of this article is organized as follows. Section 2 provides the theoretical foundations and hypothesis development; Section 3 describes the methodology. Section 4 discusses the empirical results. Section 5 concludes.

2. Theoretical background and hypothesis development

2.1. Bribery and firm resource efficiency

The prior studies investigate the determinants of energy intensity and efficiency. For example, Lin and Chen (2019) examine the impact mechanism of economic infrastructure on the energy consumption and energy intensity of China's manufacturing industry, while Bithas and Kalimeris (2018) are interested in exploring the association between resources and development. An assessment of water resource sustainability through three dimensions, including water resources quantity, water intensity and water efficiency is performed in the study of Xu et al. (2019). The present study develops the hypothesis that bribes can reduce efficiency in using resources – the 'sanding-the-wheels of firm resource efficiency' hypothesis. The discussions in the literature provide both theoretical and empirical evidence to support our belief. First, bribery dampens resource efficiency by leading to a divergence of managerial effort from input coordination. Dal Bó and Rossi (2007) build a simple model to show that bribery raises firms' input requirements as it undermines the managerial effort. They further provide empirical results by using panel data for Latin American energy firms. Second, from the macro perspective, Fredriksson et al. (2004) develop a bribery model by assuming that the government cares about aggregate social welfare and bribery. The government takes bribes from lobbying groups in exchange for an energy policy that allows higher energy use in the production process. They demonstrate their theory with the panel data for OECD countries in the energy sector. The negative association between corruptibility and energy efficiency suggests the adverse impacts of corruption on energy policy outcomes.

Third, bribery causes resource inefficiency through the resource misallocation channel. Bertrand et al. (2007) and Aidt (2016) argue that local officials impose the rent costs that force firms to bribe. As a consequence, more resources are allocated to inefficient activities. He et al. (2007) show that the effect of corruption on resource distribution may result in environmental issues as firms in high-pollution and high-energy-consumption sectors can compensate for environmental costs via bribery. Wei and Li (2017) and Yang et al. (2018) indicate that corruption distorts resource allocation, which decreases the efficient use of energy. Wang et al. (2020) further point out that the distortion of resource distribution caused by corruption has a negative effect on ecological efficiency. Along this research line, Fredriksson et al. (2004), Ivanova (2011), and Sheng et al. (2016) highlight that corruption relaxes environmental regulations.

Krammer (2014) claims that bribes help firms to overcome bureaucratic inefficiencies and sub-par public services such as licenses and permits. In the case of Vietnam's enterprises, Ha et al. (2021) have recently indicated the positive relationship between bribery and the probability of firms adopting an environmental standard certificate. This relationship might suggest that firms which are willing to pay bribes to obtain the environmental standard certificate may use their resources ineffectively.

Based on our discussion, we believe that there may exist a positive association between bribes and firm resource inefficiency. We hypothesize:

H1: Bribery of public officials by firms is positively associated with firm resource inefficiency.

2.2. Moderating effects of market competition

The literature has mentioned two lines of thought to explain the bribery behaviour of firms. The first line is the social norm view, which considers bribes as an accepted norm in the business environment (Sundström, 2019). In this consideration, paying bribes means conforming to an accepted rule or being isomorphic to the environment, which helps them to gain legitimacy and survive (DiMaggio & Powell, 1983). The second line is the rent-seeking view, which states that firms pay bribes with an expectation of earning abnormal rents (Rose-Ackerman, 1978). Based on these two lines of thinking, prior scholars indicate how increased competition among firms may influence the likelihood that firms engage in bribery. In particular, according to the social norm view, increased competition among firms results in higher pressure and long queues in obtaining public services, which may cause firms to pay bribes. This bribery behaviour, however, may depend on whether bribery is considered to be an accepted norm by firms and public officials (Malesky et al., 2020). Alexeev and Song (2013) and Diaby and Sylwester (2015) base their research on the rent-seeking view to show that firms' profits can diminish to zero due to higher pressures from competition, thus reducing the probability of paying bribes. It is, however, worth noting that if the profits of firms do not reduce to zero; therefore, they still have motivations to engage in bribery and earn benefits from paid bribes.

Based on these two lines of thought, the present article argues that the association between bribery and resource efficiency may be negatively affected by increased competition among firms. There are several reasons that explain this relationship. According to the social norm view, firms must pay bribes if they want to survive in an environment where others do the same (Fisman & Golden, 2017). The bribery behaviour of other firms may put pressure on firms and cause them to behave in the same way (Alon & Hageman, 2013; Venard, 2009). As argued by Venard (2009), an increasing number of competitors who engage in bribery raises the probability of other individual firms paying bribes. In the case that corruption is a social norm in the operation environment, firms may pay high bribe amounts (Malesky et al., 2020). Furthermore, the increased competition reduces firms' bargaining power vis-à-vis public officials, which causes firms to pay more considerable bribe payments in order to build and maintain their relationship with public officials (Rose-Ackerman, 1978). The lower bargaining power also reduces firms' opportunities to engage in benefit-seeing bribes and to receive preferential treatment (Galang, 2012). In short, the social norm view indicates that firms are more likely to experience less preferential treatment and higher transaction costs. Subsequently, innovative activities become less attractive commercially (Luo, 2005) if firms engage in bribery to implement innovation or production process alternations. Based on our discussion, increased competition leads to a reduction in innovative activities or technology investments. As a consequence, the probability of resource inefficiency may rise.

According to the rent-seeking view, we follow North (1990) and Williamson (2000) to use the predictability of policies to explain the effects of market competition on the relationship between bribery and firm resource efficiency. As stated by Galang (2012) and Zhou et al. (2013), firms have more opportunities to shape regulations, make changes in policy decisions, or receive preferential treatments such as access to resources, licenses, and contracts in restricted areas in the environment that feature less predictable policies. By contrast, the likelihood that firms engage in bribery diminishes in a more predictable environment. Moreover, Malesky et al. (2020) show that firms are more likely to pay additional bribery costs if the policy implementation is less predictable. The predictability level of policy implementation is then contingent on market competition. Specifically, increased market competition among firms increases policy uncertainty (Alexeev & Song, 2013). In other words, market competition may affect the predictability of policy implementation, and thus the bribe amount. An increase in the number of competitors in the market may reduce firms' incentives to invest in technology and process alternations. As a consequence, the resource efficiency of firms paying bribes declines if there is increased market competition.

Based on these two strains of thought in the literature regarding the sources of bribery and the effects of market competition, we hypothesize:

H2: Market competition negatively moderates the effect of bribery on firm resource efficiency.

2.3. Moderating effects of credit constraints

In this article, we argue that resource efficiency stems from environmental innovation. The reasons are as follows. As defined by Triguero et al. (2013), environmental innovation refers to any novel product, process, or business model that reduces environmental risks, pollution, and other negative impacts of resources use. Therefore, firms that implement environmental innovation tend to utilise lower amounts of resources per unit product. In the case of SMEs in Vietnam, Fadly (2020) also provides empirical evidence to support the fact that resource-saving happens for firms adopting environmental standard certification. As argued by OECD (2015) and Kemp and Arundel (1998), this environmental management system in Vietnam could be regarded as an environmental innovation.

The aforementioned discussion helps us to investigate the dynamics between bribery and resource efficiency. We propose that if firms do not face credit constraints, they pay bribes to improve their resource efficiency. Debates among scholars in the literature provide some explanations for our belief. First, Jaffe et al. (1995), Bansal and Bogner (2002), and Babakri et al. (2003) reveal that firms pay additional costs in the form of installing new technology, training costs, and maintenance fees to either treat environmental issues or improve resource efficiency. The massive costs pertaining to production process changes and technology investments are beyond SMEs' financial capacities in most cases (Frijns et al., 2000; Punte et al., 2005). Hence, credit constraints are always an issue for SMEs wishing to adopt environmental standard certification.

Second, while being preferred, internal funding is often inadequate for the implementation of major innovations in SMEs (Hottenrott & Peters, 2012). However, securing bank loans for these types of projects proves to be a great obstacle. Innovation projects often involve long-term investment and have a high level of complexity and uncertainty (Hottenrott & Peters, 2012), which discourages bank lending. Additionally, financial markets in developing economies are also characterized by a heavy dependence on tangible collateral in the face of asymmetric information, which might not be available in innovation projects (Hall & Lerner, 2010). Firms with financial constraints are therefore less interested in innovating (Brown et al., 2011). Similarly, a negative financial shock, which worsens the credit condition, was shown to have strong negative effects on innovative activities (Hall, 1992, 2002; Himmelberg & Petersen, 1994). On the contrary, firms with secured funding are more active in pursuing innovation. Amore et al. (2013) showed evidence that an increase in credit supply would lead to beneficial effects on the implementation of innovative activities in the case of banking deregulation. A similar discussion can be applied to environmental innovation, which seems to be a very complicated task (Dermody & Hammer-Lloyd, 1996). Obstacles associated with credit constraints disincentive firms to implement environmental innovation. As a consequence, resource efficiency may be dampened. Based on our argument, we hypothesize:

> **H3:** Credit constraints negatively moderate the effect of greasing bribery on firm resource efficiency.

3. Model specification

Following Fadly (2020), the model is specified as follows:

$$RI_{it} = \beta_0 + \beta_1 Bribe_{it} + \beta_2 Control_{it} + \lambda_t + \varepsilon_{it,} \quad (1)$$

where the subscripts i and t denote the firm i and year t, respectively. λ_t is the year-fixed effects that captures the macroeconomic variabes affecting all firms in each year. Resource inefficiency, RI_i, is the measure of firm resource intensity. Following the OECD (2011) argument, the resource intensity represents materials from natural resources, including fuel, water, and electricity, that are employed to produce one unit of product. As revealed by Bahn-Walkowiak and Steger (2015), a reduction in resource intensity implies an improvement in how firms use their resources. We follow Fadly (2020) to express RI as follows:

$$RI_{it} = \frac{M_{it}}{Y_{it}} \quad (2)$$

where M_{it} denotes the real total costs of natural resources, including fuel, water, and electricity of firm i at time t. These costs are deflated to prices in 2010. Y_{it} represents the total units of products of firm i at time t. For further analysis, we also consider electricity intensity, fuel intensity, and water intensity to analyze the efficiency level of firm resource use. It is worth mentioning that by using total units of products, RI reflects the resource intensity per unit. Even though it is not advisable to make a comparison between RI of two different manufacturing units, Gharfalkar et al. (2018) contended that it is essential to have lower values of resource intensity per unit for an output unit to be resource efficient than the other. Hence, we can use this measure of resource intensity when the data of value added is not available.

The key explanatory variable, $DBri_i$, is a dummy variable that takes the value of one if firms pay bribes. We also use the bribing amount ($SBri$), which is the share of total annual sales paid as informal payments to bureaucrats. $Control_i$ is a set of other explanatory variables that includes the adoption of the Environmental Standards Certification (*ESC*). This is a dummy variable, taking the value of one if firms adopted an environmental standard certification and zero otherwise. Other explanatory variables are the log of firm size (*lnsize*); the log of firm age (*lnage*); the input share (*inputshare*), which depicts the total raw material cost as a proportion of total indirect costs; the member association (*association)*, which is a dummy variable taking the value of one if firms belong to one or more business associations and zero otherwise; the log of capital-labour ratio (*lncaplabor*); firm capacity (*capacity*), which is a dummy variable taking the value of one if firms have the capacity to increase their production capacity by 25 percent or more; and government assistance (*assistance*), which is a dummy variable taking the value of one if firms receive assistance from the government and zero otherwise.

The relationship between bribery and resource efficiency is first investigated. To evaluate the dependence of this relationship on firm bargaining power, we re-estimate equation (1) in the sub-sample based on firm size and legality. Since we proposed that credit constraints and market competition may influence this relationship, we compared the impacts of bribery on resource intensity for the sub-sample of firms encountering firm credit constraints and market competition, and those facing no constraints. For further analysis of the moderating effects of credit constraints, we broke the firms down into those who have had formal loan applications denied (credit rationed) and those who do not apply for formal loans due to either the process being too difficult or the interest rate being too high (discouraged borrowers). In further analysis, we have investigated the effect of bribery on the efficiency level of resource use across sectors.

In our study, we argue that simultaneity might exist between bribery and RI, which would cause our results to be biased. There are plausible reasons why bribery and RI are potentially endogenous. First, reverse causality may arise due to the extent to which firms using resources efficiently are more likely to pay bribes. That is because bureaucratic officials assess a firm's ability to pay bribes by observing its performance. The investment in boosting resource efficiency is positively associated with a firm's growth performance (Özbuğday et al., 2020). Furthermore, saving more resources can improve firms' financial performance in the sense that they have more money left after production. Hence, more resource-efficient firms are more likely to pay bribes than others. Second, some unobserved omitted variables might influence both bribery and resource efficiency, causing our estimation to be biased. This discussion is advocated by Nguyen et al. (2016) and Ha et al. (2021) regarding firm conventional and environmental innovation capacity and bribery. Since there exists an association between environmental innovation capacity and the efficiency of resource uses, our belief still holds for resource efficiency. This raises the concern that our estimation may be biased.

To fix the issue of endogeneity bias, we follow Fisman and Svensson (2007) to use the sector-location average approach. In particular, we separate bribes paid by firms operating in the i-th industry at the j-th location (Bri_{ijt}) into two components:

$$Bri_{ijt} = bri_{ijt} + bri_{jt} \tag{3}$$

where bri_{ijt} refers to an idiosyncratic element and bri_{jt} is average amount of bribe that is common to all firms in the i-th industry at the j-th location at year t. The present article assumes that the sector-province average bribing rates are independent of the efficiency of resource use. We then use the sector-province average as our instrument in the case of Vietnam's enterprises. Our model with the instrumental variable can be expressed as follows:

$$RI_{it} = \beta_0 + \beta_1 Bri_{it}^{IV} + \beta_2 Control_{it} + \lambda_t + \varepsilon_{it} \quad (4)$$

where Bri_{it}^{IV} is the fitted value from the first-stage regression where bribery is regressed on location-province bribe average and other control variables. A two-stage least square (2SLS) estimator under IV regression is employed in this study. We report the second-stage results of all estimations.[1]

In this article, we employ SMEs' survey data in Vietnam from 2007 to 2015 conducted by the Central Institute for Economic Management (CIEM). The firms in the sample arise from 10 provinces, which jointly occupy for about 30% of non-state manufacturing firms in Vietnam. In each province, a 2-step sampling method was conducted to first choose a number of districts within each province employing proportion-to-size sampling and then select a number of firms within each district from the list of formal/registered non-state and household manufacturing firms. Information on informal manufacturing enterprises was chosen via snowballing techniques. In each district, the surveyors chose firms that were not in the 'formal' list but were visually present for interview (on-site identification), additionally, the enumerators were also asked to seek for as many additional informal firms as possible within each chosen site (block enumeration).

Another goal of the survey was to follow the same firm through year to obtain insights on their long-term development. Hence, a tracer survey was launched. The team re-interviewed surviving firms in following rounds of the surveys. Exit firms were replaced by applying two aspects: (1) a constant level of household enterprises had to be maintained from the 2002 Establishment Census and (2) the updated population of registered firms was used from the annual GSO's Enterprise Census data.

Table 1 reports the overall summary statistics for the dependent and explanatory variables in our study. There are 1,767 firms in our sample, out of which those that

Table 1. Descriptive statistics.

	Count	Mean	SD	Min	Max
lnRI	1,767	1.48	1.82	0.00	11.79
DBri	1,767	0.36	0.48	0.00	1.00
SBri	1,767	0.05	0.12	0.00	1.47
lnsize	1,767	2.41	0.98	0.69	5.20
lnage	1,767	2.60	0.53	1.39	4.11
ESC	1,767	0.21	0.41	0.00	1.00
lninputshare	1,767	0.13	0.13	0.00	0.85
association	1,767	0.10	0.30	0.00	1.00
lncaplabor	1,767	0.13	0.16	0.00	1.09
capacity	1,767	0.26	0.44	0.00	1.00
assistance	1,767	0.14	0.34	0.00	1.00

Source: Authors' calculation.

Table 2. Correlation matrix.

	DGBri	lnGBri	lnsize	lnage	EI	lninputshare	association	lncaplabor	capacity	assistance
DBri	1.00									
SBri	0.63	1.00								
lnsize	0.15	−0.03	1.00							
lnage	0.02	0.02	−0.10	1.00						
ESC	0.12	0.04	0.31	0.01	1.00					
lninputshare	−0.01	−0.11	0.04	0.01	−0.01	1.00				
association	0.08	0.05	0.29	0.08	0.12	−0.03	1.00			
lncaplabor	0.02	0.04	−0.16	0.06	0.06	0.07	−0.03	1.00		
capacity	−0.06	−0.01	−0.02	0.03	−0.00	0.05	0.03	−0.03	1.00	
assistance	−0.02	−0.04	0.10	−0.00	0.02	0.02	0.13	−0.07	0.05	1.00

Source: Authors' calculation.

pay bribes account for 36%. Table 1 also shows that 21% of firms have an environmental standard certificate. The correlation level between exogenous variables in the model is summarized in Table 2. The results imply that there is no problem of multicollinearity in our theoretical model.

4. Empirical results

4.1. Baseline model

Table 3 demonstrates the main results of our estimations. Columns 1 to 4 present the impacts of the dummy variable, *DBri*, on natural resource intensity, electricity intensity, fuel intensity, and water intensity, respectively. Our results show that *DBri* is statistically significant and has the expected positive signs in all models, implying that firms' bribery to public officials increases natural resource intensity. All of the results support hypothesis H1 that bribery sands the wheels of resource efficiency. In particular, column 1 shows that the effect of bribery is 0.65%. A positive association between bribery and inefficiency is consistent with the findings of Fredriksson et al. (2004), Dal Bó and Rossi (2007), and Wang et al. (2020). Resource inefficiency also arises if firms use vintage machines for production. The effect of ESC adoption is statistically significant at the 1% level and negative. The results imply that firms with ESC tend to save more resources than those without ESC. This finding is aligned with Fadly (2020). The efficiency level in resource use is also improved for large-sized or capital-intensive firms. These firms are expected to use resources more efficiently, thus reducing resource intensity. The coefficient on firm age is significant and positive, implying that older firms are inefficient in using natural resources. O'Toole and Tarp (2014) provide similar evidence on the effect of firm age and size on efficient allocations of capital. However, there is also an evidence that the government assistance (*assistance)* can reduce resource wastage.

Models 2, 3, and 4 provide a comparison of inefficiency levels due to bribery between specific types of resources, i.e., electricity, fuel, and water. While all conclusions still hold in these models, Table 3 also indicates that greater inefficiency comes from water consumption. Firms that pay bribes increase their water intensity by nearly 2%. Electricity intensity takes the second position – a firm that bribes public officials is more likely to use electricity wastefully. Electricity intensity increases by

Table 3. Estimation results of baseline model.

VARIABLES	(1) Resource Intensity	(2) Electricity Intensity	(3) Fuel Intensity	(4) Water Intensity	(5) Resource Intensity	(6) Electricity Intensity	(7) Fuel Intensity	(8) Water Intensity
DGBri	0.72***	0.76***	0.47**	1.78***				
	(0.229)	(0.217)	(0.194)	(0.532)				
lnGBri					7.18***	6.45***	6.27***	12.08**
					(2.647)	(2.429)	(2.350)	(5.740)
lnsize	−0.04	−0.04	−0.02	−0.42***	0.11	0.11*	0.11*	−0.13
	(0.053)	(0.048)	(0.042)	(0.115)	(0.068)	(0.062)	(0.057)	(0.127)
lnage	0.21***	0.21***	0.10*	0.47***	0.23**	0.22***	0.13	0.42***
	(0.068)	(0.063)	(0.053)	(0.138)	(0.092)	(0.084)	(0.076)	(0.160)
EI	−0.39***	−0.34***	−0.23***	−0.66***	−0.47***	−0.40***	−0.29***	−0.65***
	(0.100)	(0.091)	(0.080)	(0.203)	(0.134)	(0.123)	(0.111)	(0.241)
lninputshare	−0.85***	−0.67***	−0.53***	−2.22***	−0.23	−0.11	0.02	−0.61
	(0.214)	(0.195)	(0.169)	(0.562)	(0.385)	(0.353)	(0.330)	(0.876)
association	−0.00	−0.06	−0.05	−0.01	−0.16	−0.22	−0.19	−0.28
	(0.118)	(0.111)	(0.097)	(0.279)	(0.167)	(0.156)	(0.145)	(0.348)
lncaplabor	−0.44**	−0.31*	−0.40***	−0.63	−0.40*	−0.29	−0.34**	−0.62
	(0.183)	(0.170)	(0.131)	(0.456)	(0.228)	(0.211)	(0.171)	(0.546)
capacity	0.16**	0.14*	0.08	0.27	0.13	0.10	0.06	0.18
	(0.076)	(0.072)	(0.062)	(0.177)	(0.104)	(0.096)	(0.088)	(0.204)
assistance	0.14	0.11	0.18**	0.17	0.17	0.12	0.22**	0.09
	(0.107)	(0.100)	(0.089)	(0.233)	(0.128)	(0.119)	(0.109)	(0.275)
Constant	1.39***	1.00***	0.87***	−2.73***	0.76	0.47	0.22	−3.44***
	(0.233)	(0.216)	(0.184)	(0.486)	(0.467)	(0.425)	(0.411)	(0.908)
Observations	1,818	1,818	1,818	1,351	1,460	1,460	1,460	1,090
R − squared	0.260	0.216	0.167	0.349	0.075	0.046	0.046	0.233

Robust standard errors in parentheses
***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.
Source: Authors' calculation.

Table 4. Estimation results of sub-sample by environmental standard certification.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Resource intensity		Electricity intensity		Fuel intensity		Water intensity	
VARIABLES	No	Yes	No	Yes	No	Yes	No	Yes
DGBri	0.80***	0.24	0.84***	0.28	0.48**	0.24	2.07***	0.97
	(0.259)	(0.455)	(0.249)	(0.415)	(0.217)	(0.398)	(0.618)	(1.016)
lnsize	−0.10*	0.19**	−0.10*	0.18**	−0.06	0.16**	−0.58***	0.05
	(0.063)	(0.091)	(0.058)	(0.084)	(0.049)	(0.076)	(0.141)	(0.200)
lnage	0.22***	0.06	0.22***	0.04	0.10*	−0.01	0.56***	0.02
	(0.077)	(0.146)	(0.072)	(0.130)	(0.059)	(0.118)	(0.158)	(0.307)
lninputshare	−1.03***	−0.40	−0.81***	−0.39	−0.68***	−0.15	−2.40***	−2.05**
	(0.250)	(0.396)	(0.230)	(0.349)	(0.195)	(0.341)	(0.684)	(1.009)
association	0.01	−0.04	−0.07	−0.05	−0.10	0.06	0.15	−0.20
	(0.132)	(0.262)	(0.127)	(0.238)	(0.104)	(0.229)	(0.331)	(0.483)
lncaplabor	−0.52**	−0.17	−0.36*	−0.11	−0.49***	−0.05	−0.61	−0.71
	(0.216)	(0.331)	(0.202)	(0.309)	(0.154)	(0.231)	(0.550)	(0.841)
capacity	0.17**	0.10	0.13*	0.13	0.10	−0.05	0.36*	−0.06
	(0.085)	(0.184)	(0.079)	(0.174)	(0.069)	(0.146)	(0.204)	(0.346)
assistance	0.15	0.08	0.12	0.07	0.26**	−0.10	−0.11	0.91**
	(0.125)	(0.220)	(0.117)	(0.206)	(0.103)	(0.180)	(0.273)	(0.450)
Constant	1.52***	0.74	1.09***	0.56	1.00***	0.38	−2.75***	−3.16***
	(0.274)	(0.461)	(0.256)	(0.418)	(0.211)	(0.377)	(0.589)	(0.894)
Observations	1,471	347	1,471	347	1,471	347	1,045	306
R − squared	0.284	0.188	0.233	0.170	0.198	0.106	0.331	0.398

Robust standard errors in parentheses
***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.
Source: Authors' calculation.

nearly 0.7% if firms decide to pay bribes. The smallest waste of resources due to bribery is fuel consumption.

To make a robust check of our conclusions, we also use the natural logarithm of the share of sales paid (*SBri*) as bribery on resource intensity and report the estimation results in columns 5–8. In general, all discussions remain consistent. For further check on our findings, we also employ the Generalized Method of Moments (GMM). The GMM estimation results reported in Table A1 in Appendix reveal are consistent with those in Table 3.

As discussed previously, Table 3 represents the direct effects of ESC adoption in reducing resource intensity. We then investigate whether ESC adoption moderates the relationship between bribery and resource intensity by regressing the data in a sub-sample of firms owning or not owning ESC. The estimation results are reported in Table 4. We realize that a rise in resource intensity due to bribery only happens for firms without ESC. Since adopting the certification also involves production process alternation and technology investment (Frijns et al., 2000), the adoption of the environmental standard can help a firm to reduce the adverse impacts of bribery on resource efficiency. Hence, we find evidence that ESC adoption has both direct and indirect effects on resource-saving.

We then re-examine the moderating effects of firms' bargaining power, including firm size and legal registration, on the association between bribery and resource efficiency. Our first concentration is on firm size by regressing the data in sub-samples by size. According to the definition of SMEs specified in Decree 56/2009/ND-CP of Vietnam, micro-sized firms have fewer than 10 workers, while we define firms as small if they have between 10 and 200 workers. Based on this definition, most of the

Table 5. Estimation results of sub − sample by size.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Resource intensity		Electricity intensity		Fuel intensity		Water intensity	
VARIABLES	Micro	Small	Micro	Small	Micro	Small	Micro	Small
DGBri	0.77***	0.55	0.77***	0.64*	0.50***	0.35	1.69***	1.54*
	(0.234)	(0.398)	(0.225)	(0.375)	(0.194)	(0.339)	(0.618)	(0.830)
lnage	0.22***	0.19	0.21***	0.19	0.12**	0.05	0.45***	0.41*
	(0.078)	(0.123)	(0.073)	(0.114)	(0.060)	(0.094)	(0.164)	(0.243)
EI	−0.69***	−0.31**	−0.61***	−0.25**	−0.42***	−0.20*	−1.09***	−0.57**
	(0.126)	(0.136)	(0.114)	(0.125)	(0.090)	(0.114)	(0.288)	(0.260)
lninputshare	−1.13***	−0.70**	−0.91***	−0.55**	−0.69***	−0.45*	−2.57***	−2.21***
	(0.285)	(0.310)	(0.263)	(0.281)	(0.217)	(0.257)	(0.702)	(0.809)
association	−0.20	0.05	−0.22	−0.03	−0.29**	0.03	−0.63	0.12
	(0.179)	(0.152)	(0.179)	(0.141)	(0.134)	(0.128)	(0.475)	(0.338)
lncaplabor	−0.49**	0.02	−0.35*	0.08	−0.44***	−0.02	−0.59	−0.44
	(0.202)	(0.432)	(0.186)	(0.409)	(0.147)	(0.299)	(0.511)	(0.967)
capacity	0.16*	0.17	0.14	0.14	0.07	0.07	0.44**	0.13
	(0.088)	(0.134)	(0.084)	(0.123)	(0.069)	(0.110)	(0.211)	(0.303)
assistance	0.06	0.18	0.07	0.12	0.11	0.22*	−0.04	0.26
	(0.141)	(0.151)	(0.137)	(0.138)	(0.107)	(0.128)	(0.354)	(0.297)
Constant	1.39***	1.28***	1.02***	0.87**	0.81***	0.95***	−3.28***	−3.92***
	(0.259)	(0.408)	(0.240)	(0.378)	(0.208)	(0.336)	(0.590)	(0.833)
Observations	1,006	812	1,006	812	1,006	812	703	648
R − squared	0.329	0.210	0.284	0.169	0.204	0.149	0.387	0.320

Robust standard errors in parentheses
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.
Source: Authors' calculation.

firms in our sample are micro- and small-sized firms. The estimation results obtained by regressing the data in sub-samples by size are reported in Table 5. An increase in resource inefficiency is due to the fact that bribery just happens for micro-sized firms. Resource intensity increases by nearly 0.7% if micro-sized firms decide to pay bribes. Similar evidence can be found in the disaggregated resource intensity by electricity and fuel. Regarding water consumption, Table 5 demonstrates that bribery causes both micro- and small-sized firms to use water inefficiently.

Subsequently, the moderating effects of a firm's bargaining power on the relationship between bribery and resource intensity are also examined by considering whether or not firms formally register their businesses. As reported in Table 6, we highlight the fact that the 'sanding-the-wheels' of resource efficiency hypothesis holds for firms regardless of their legal or illegal registration. Paying bribes leads to an increase in resource inefficiency. However, the inefficiency level in using resources becomes more pronounced for informally registered firms. In particular, bribing firms that formally register increase their resource intensity by 0.66% as opposed to 0.88% for those informally registering. These findings suggest that formally registered firms have a stronger bargaining power vis-à-vis public officials, thus they enjoy greater benefits from their paid bribes. Therefore, they are more likely to experience a lower level of resource inefficiency.

In the following analysis, we examine the effects of credit constraint on the association between bribery and resource intensity and report the results in Table 7. We find evidence to support the fact that credit constraints positively moderate the effects of bribery on resource inefficiency. In particular, the effects of bribery on firm resource intensity are statistically significant and sizable for firms facing credit

Table 6. Estimation results of subsample by legal registration.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Resource intensity		Electricity intensity		Fuel intensity		Water intensity	
VARIABLES	Formal	Informal	Formal	Informal	Formal	Informal	Formal	Informal
DGBri	0.72***	1.08**	0.75***	1.22**	0.47**	0.71*	1.70***	5.47*
	(0.260)	(0.515)	(0.247)	(0.504)	(0.222)	(0.402)	(0.557)	(3.182)
lnsize	−0.00	−0.07	−0.01	−0.03	0.01	−0.16	−0.34***	−1.96
	(0.055)	(0.192)	(0.051)	(0.177)	(0.043)	(0.152)	(0.115)	(1.197)
lnage	0.17**	0.31*	0.16**	0.31*	0.08	0.13	0.40***	1.31*
	(0.071)	(0.182)	(0.066)	(0.178)	(0.057)	(0.137)	(0.139)	(0.712)
EI	−0.37***	−0.31	−0.31***	−0.51	−0.23***	0.26	−0.59***	−4.38**
	(0.102)	(0.865)	(0.093)	(0.719)	(0.081)	(0.632)	(0.205)	(2.081)
lninputshare	−0.89***	−1.01*	−0.73***	−0.67	−0.54***	−0.64*	−2.31***	1.33
	(0.241)	(0.520)	(0.218)	(0.497)	(0.192)	(0.387)	(0.589)	(2.840)
lncaplabor	−0.47**	0.06	−0.35*	0.32	−0.36**	−0.44	−0.36	−0.01
	(0.208)	(0.539)	(0.193)	(0.512)	(0.146)	(0.401)	(0.489)	(1.783)
capacity	0.20**	−0.09	0.17**	−0.06	0.09	−0.04	0.33*	0.18
	(0.085)	(0.181)	(0.079)	(0.175)	(0.069)	(0.136)	(0.185)	(0.742)
assistance	0.10	0.27	0.05	0.31	0.16*	0.20	0.13	−0.04
	(0.116)	(0.259)	(0.107)	(0.252)	(0.097)	(0.207)	(0.242)	(1.196)
Constant	1.32***	1.54**	0.97***	0.98*	0.80***	1.27**	−2.85***	−3.72*
	(0.249)	(0.602)	(0.231)	(0.555)	(0.195)	(0.502)	(0.501)	(2.243)
Observations	1,551	267	1,551	267	1,551	267	1,238	113
R − squared	0.246	0.342	0.202	0.285	0.155	0.233	0.345	0.070

***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.
Source: Authors' calculation.

Table 7. Estimation results of subsample by credit constraints.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Resource intensity		Electricity intensity		Fuel intensity		Water intensity	
VARIABLES	No	Yes	No	Yes	No	Yes	No	Yes
DGBri	0.40*	1.67***	0.51**	1.48***	0.15	1.32***	1.19**	4.16***
	(0.239)	(0.496)	(0.223)	(0.460)	(0.205)	(0.430)	(0.578)	(1.342)
lnsize	0.02	−0.23*	0.01	−0.18	0.03	−0.15	−0.28**	−0.88***
	(0.057)	(0.128)	(0.052)	(0.116)	(0.045)	(0.107)	(0.124)	(0.322)
lnage	0.18**	0.28*	0.18**	0.28*	0.06	0.18	0.33**	1.04***
	(0.074)	(0.170)	(0.070)	(0.155)	(0.056)	(0.142)	(0.146)	(0.396)
EI	−0.40***	−0.40*	−0.35***	−0.32	−0.20**	−0.37*	−0.74***	−0.34
	(0.112)	(0.228)	(0.102)	(0.203)	(0.086)	(0.196)	(0.224)	(0.532)
lninputshare	−0.85***	−1.07	−0.65***	−1.01*	−0.56***	−0.62	−2.24***	−2.72*
	(0.215)	(0.676)	(0.197)	(0.596)	(0.162)	(0.607)	(0.587)	(1.567)
association	−0.01	0.25	−0.06	0.07	−0.08	0.28	−0.12	−0.10
	(0.129)	(0.265)	(0.123)	(0.242)	(0.101)	(0.232)	(0.303)	(0.711)
lncaplabor	−0.31*	−0.79	−0.19	−0.66	−0.32**	−0.50	−0.46	−0.92
	(0.189)	(0.582)	(0.178)	(0.516)	(0.133)	(0.435)	(0.479)	(1.390)
capacity	0.28***	−0.15	0.23***	−0.13	0.17**	−0.18	0.37*	0.26
	(0.087)	(0.167)	(0.082)	(0.151)	(0.071)	(0.135)	(0.196)	(0.450)
assistance	0.09	0.06	0.06	0.04	0.16	0.06	0.02	0.59
	(0.117)	(0.242)	(0.109)	(0.220)	(0.096)	(0.207)	(0.264)	(0.579)
Constant	1.39***	1.35**	1.02***	0.93*	0.88***	0.80	−2.45***	−4.57***
	(0.251)	(0.601)	(0.234)	(0.542)	(0.192)	(0.514)	(0.513)	(1.409)
Observations	1,349	451	1,349	451	1,349	451	986	351
R − squared	0.281	0.140	0.240	0.121	0.176	0.045	0.391	0.095

Robust standard errors in parentheses
***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.
Source: Authors' calculation.

constraints. Without credit constraints, the resource intensity increases by 0.38%, but it is not statistically significant. For firms having difficulties with accessing credit, the coefficient is roughly 1.5%, and it is significant at the 1% level. By disaggregating material costs into water, fuel, and electricity, we provide more empirical evidence to advocate the moderating effects of credit constraint. Paying bribes causes electricity, fuel, and water intensity to be enhanced from 0.49%, 0.13% and 1.30% to 1.30%, 1.21% and 3.30%, respectively. Hence, we provide evidence that credit constraints increase the adverse effects of bribery on resource intensity.

Following Casey and O'Toole (2014), we conduct further analysis of the moderating effects of credit constraint by breaking the data down into various credit issues. Specifically, we consider the following two cases: (1) firms that have formal loan applications denied (credit rationed) and (2) firms that do not apply for formal loans due to either the process being too difficult or the interest rate being too high (discouraged borrower). The results are presented in Panel A and B of Table 8. Regarding credit rationing, its moderating effects on the association between bribery and resource efficiency is not obvious. We find a rise in resource intensity for firms having no application denied. The effects of bribery on resource intensity tend to increase, but these coefficients are not statistically significant in all models. Therefore, we turn our attention to discouraged borrowers, which is a common credit issue for small-sized firms in developing countries. These are firms that had previously applied for loans or even those that had their application accepted, but then decided not to receive the loans and not to apply for others due to the high cost or the difficult process, as argued by Casey and O'Toole (2014). In our sample, being a discouraged borrower also displayed a positive moderating effect on the relationship between bribes and resource intensity. For firms that are discouraged borrowers, bribes will increase their resource inefficiency by 1.20%, compared to 0.51% in firms that are not. When we employ the disaggregated resource intensity by electricity, fuel, and water, the conclusion remains the same. The effects of bribery on resource intensity are always more considerable for firms that are discouraged borrowers.

We further consider the role of market competition in the association between bribery and resource inefficiency. We compare the effects of bribery on resource intensity between firms with and without market competition and present the results in Table 9. For firms facing no market competition, we find no evidence for the relationship between bribery and resource inefficiency since this variable is not statistically significant in our sample. We only report the positive effects of bribery on resource intensity for firms facing market competition. In particular, paying bribes drives resource intensity up by roughly 0.58%. To obtain a clear conclusion on this issue, we then consider specific types of resource use. Columns 3–8 reveal the same results. These findings provide empirical evidence to support our proposal from both the social norm view and the rent-seeking view that market competition negatively moderates the relationship between bribery and resource efficiency.

4.2. Sector variation

To observe variants in effects of bribery on resource efficiency across sectors, we employ the taxonomy of Tomiura (2007) to classify firms into three sector groups:

Table 8. Bribery and EI with breakdown of credit issues.**Panel A: Credit rationed**

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Resource intensity		Electricity intensity		Fuel intensity		Water intensity	
VARIABLES	No	Yes	No	Yes	No	Yes	No	Yes
Panel A: Credit rationed								
DBri	0.55**	1.62	0.61***	1.14	0.29	1.81	1.63***	2.37
	(0.214)	(1.362)	(0.200)	(1.179)	(0.184)	(1.172)	(0.530)	(4.769)
lnsize	−0.09*	0.29	−0.09*	0.32	−0.07	0.33	−0.50***	0.14
	(0.055)	(0.297)	(0.050)	(0.254)	(0.042)	(0.290)	(0.120)	(0.694)
lnage	0.23***	0.99*	0.22***	0.77	0.10*	1.09**	0.51***	1.63
	(0.069)	(0.568)	(0.065)	(0.490)	(0.053)	(0.552)	(0.139)	(1.322)
ESC	−0.46***	−0.25	−0.40***	−0.15	−0.28***	−0.16	−0.83***	−0.04
	(0.099)	(0.563)	(0.091)	(0.503)	(0.076)	(0.518)	(0.210)	(0.924)
lninputshare	−0.96***	0.83	−0.77***	0.84	−0.64***	1.30	−2.19***	−3.38
	(0.213)	(1.669)	(0.194)	(1.388)	(0.162)	(1.705)	(0.577)	(3.679)
association	−0.00	−0.04	−0.06	−0.07	−0.05	−0.17	−0.13	0.24
	(0.122)	(0.561)	(0.115)	(0.497)	(0.099)	(0.553)	(0.296)	(1.076)
lncaplabor	−0.37**	−1.25	−0.25	−1.39	−0.40***	−0.06	−0.45	−0.95
	(0.189)	(1.745)	(0.176)	(1.519)	(0.134)	(1.455)	(0.481)	(4.138)
capacity	0.14*	−0.69	0.12	−0.57	0.06	−0.66	0.17	−0.36
	(0.078)	(0.426)	(0.072)	(0.367)	(0.062)	(0.403)	(0.182)	(0.884)
assistance	0.11	−0.82	0.08	−0.75	0.16*	−0.64	0.02	−0.52
	(0.110)	(0.526)	(0.102)	(0.475)	(0.090)	(0.503)	(0.246)	(0.989)
Constant	1.42***	−1.48	1.05***	−1.19	0.95***	−2.82	−2.74***	−7.85
	(0.242)	(2.089)	(0.225)	(1.842)	(0.189)	(2.005)	(0.503)	(5.292)
Observations	1,665	102	1,665	102	1,665	102	1,237	80
R − squared	0.294	0.160	0.253	0.192	0.199	0.005	0.381	0.213
Panel B: Discouraged borrower								
DBri	0.51**	1.20**	0.58***	1.09**	0.28	0.89**	1.52**	2.51**
	(0.234)	(0.496)	(0.219)	(0.463)	(0.200)	(0.437)	(0.609)	(1.137)
lnsize	−0.01	−0.47***	−0.01	−0.41***	−0.00	−0.31***	−0.35***	−1.17***
	(0.059)	(0.134)	(0.053)	(0.122)	(0.046)	(0.105)	(0.127)	(0.317)
lnage	0.23***	0.21	0.22***	0.23	0.12*	0.06	0.44***	0.79**
	(0.078)	(0.154)	(0.073)	(0.141)	(0.059)	(0.126)	(0.155)	(0.336)
ESC	−0.39***	−0.58***	−0.34***	−0.49**	−0.19**	−0.55***	−0.74***	−0.78
	(0.114)	(0.219)	(0.104)	(0.196)	(0.091)	(0.175)	(0.227)	(0.500)
lninputshare	−0.79***	−1.56**	−0.60***	−1.47**	−0.47***	−1.14**	−2.40***	−2.05
	(0.226)	(0.657)	(0.206)	(0.590)	(0.179)	(0.533)	(0.582)	(1.616)
association	−0.06	0.37	−0.10	0.13	−0.12	0.47*	−0.10	−0.37
	(0.131)	(0.273)	(0.124)	(0.236)	(0.104)	(0.257)	(0.299)	(0.898)
lncaplabor	−0.28	−0.87	−0.17	−0.75	−0.30**	−0.62	−0.29	−1.46
	(0.197)	(0.549)	(0.186)	(0.488)	(0.140)	(0.402)	(0.503)	(1.235)
capacity	0.20**	−0.15	0.17**	−0.14	0.11	−0.18	0.27	−0.01
	(0.087)	(0.170)	(0.082)	(0.152)	(0.071)	(0.137)	(0.194)	(0.439)
assistance	0.07	0.20	0.04	0.14	0.13	0.23	−0.01	0.20
	(0.114)	(0.296)	(0.106)	(0.271)	(0.093)	(0.248)	(0.253)	(0.637)
Constant	1.25***	2.11***	0.91***	1.64***	0.75***	1.51***	−2.80***	−2.50*
	(0.270)	(0.582)	(0.252)	(0.526)	(0.209)	(0.477)	(0.556)	(1.295)
Observations	1,426	341	1,426	341	1,426	341	1,052	265
R − squared	0.272	0.326	0.230	0.299	0.177	0.235	0.365	0.412

Robust standard errors in parentheses
***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.
Source: Authors' calculation.

supplier-dominated sector, scale-intensive sector, and science-based sector[2]. By regressing the same model specification for these groups, we provide result distinctions across sectors as in Table 10. In this dataset, the evidence for the association between bribery and resource inefficiency is recorded only for firms belonging to the suppler-dominated sector and the scale-intensive sector, whereas this coefficient is not statistically significant for firms in the science-based sector. As discussed by Cuerva et al. (2014), technological

Table 9. Estimation results of subsample by competition.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Resource intensity		Electricity intensity		Fuel intensity		Water intensity	
VARIABLES	No	Yes	No	Yes	No	Yes	No	Yes
DGBri	1.72*	0.64***	2.17**	0.66***	1.09	0.42**	4.51**	1.65***
	(0.965)	(0.236)	(0.937)	(0.224)	(0.830)	(0.200)	(2.172)	(0.546)
lnsize	−0.35*	−0.02	−0.38**	−0.02	−0.18	−0.01	−0.51	−0.42***
	(0.194)	(0.055)	(0.177)	(0.051)	(0.171)	(0.043)	(0.401)	(0.122)
lnage	0.25	0.21***	0.20	0.21***	0.20	0.08	0.92	0.48***
	(0.229)	(0.071)	(0.222)	(0.067)	(0.188)	(0.055)	(0.573)	(0.144)
EI	−0.34	−0.43***	−0.41	−0.36***	−0.24	−0.25***	−1.06	−0.69***
	(0.334)	(0.105)	(0.321)	(0.096)	(0.286)	(0.084)	(0.817)	(0.211)
lninputshare	−0.42	−0.91***	−0.03	−0.75***	−0.34	−0.57***	−0.49	−2.33***
	(0.576)	(0.228)	(0.552)	(0.208)	(0.430)	(0.182)	(1.837)	(0.588)
association	1.16*	−0.08	1.07*	−0.14	0.89*	−0.12	−0.51	−0.04
	(0.620)	(0.119)	(0.619)	(0.112)	(0.530)	(0.097)	(1.261)	(0.288)
lncaplabor	−0.84*	−0.38*	−0.40	−0.28	−0.72**	−0.36**	−2.69**	−0.44
	(0.456)	(0.205)	(0.489)	(0.191)	(0.355)	(0.144)	(1.159)	(0.501)
capacity	−0.24	0.18**	−0.34	0.15**	−0.23	0.09	−0.27	0.28
	(0.365)	(0.079)	(0.313)	(0.074)	(0.347)	(0.063)	(0.727)	(0.184)
assistance	−0.65	0.18*	−0.77*	0.15	−0.30	0.21**	−3.52***	0.39*
	(0.416)	(0.111)	(0.436)	(0.103)	(0.359)	(0.092)	(1.103)	(0.237)
Constant	1.29*	1.42***	0.89	1.02***	0.67	0.92***	−4.74**	−2.68***
	(0.735)	(0.244)	(0.741)	(0.228)	(0.601)	(0.191)	(1.960)	(0.502)
Observations	158	1,660	158	1,660	158	1,660	105	1,246
R − squared	0.134	0.273	0.270	0.232	0.118	0.177	0.270	0.362

Robust standard errors in parentheses
$^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$.
Source: Authors' calculation.

capacities and human capital are important determinants of both conventional and environmental innovation. Firms with technological capacities and human capital have more chances to develop environmental innovations, thus they are more likely to save more resources. Firms in the science-based sector enjoy more benefits from paid bribes while still using their resources efficiently. By contrast, firms classified into the supplier-dominated and the scale-intensive sectors, implying lower technological capacities are more likely to experience resource inefficiency due to bribery. Our results show that the most sizable increase in resource intensity for firms occurs in the scale-intensive sector.

5. Conclusions

This article investigated the impacts of bribery on natural resource efficiency in the case of a developing country, i.e., Vietnam. By using the two-stage least square (2SLS) for the SME survey data from the period 2007–2015, we provided empirical evidence to support the 'sanding-the-wheels' of resource efficiency hypothesis. Among the three considered natural resources, electricity, fuel, and water, inefficiency is most evident in water consumption. Furthermore, the effects became more pronounced for micro-sized and informally registered firms since they have a lower bargaining power vis-à-vis public officials. Firms facing difficulties with accessing credit but still paying bribes experienced a high inefficiency level. Our study also indicated that the increase in market competition pressure could worsen the inefficient use of natural resources due to bribery. Lastly, our results suggest that the lower technological capacities are more likely to experience resource inefficiency due to bribery.

Table 10. Estimation results of subsample by sectors.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Resource intensity			Electricity intensity			Fuel intensity			Water intensity		
VARIABLES	Supplier – dominated	Scale – intensive	Science – based	Supplier – dominated	Scale – intensive	Science – based	Supplier – dominated	Scale – intensive	Science – based	Supplier – dominated	Scale – intensive	Science – based
DBri	0.80**	0.32	0.25	0.80***	0.44*	0.34	0.34	0.23	0.16	3.35***	0.64	0.47
	(0.313)	(0.268)	(0.361)	(0.291)	(0.250)	(0.331)	(0.272)	(0.222)	(0.312)	(0.898)	(0.700)	(0.941)
lnsize	−0.14**	−0.03	0.04	−0.13**	−0.05	0.02	−0.08	0.02	0.02	−0.62***	−0.40**	−0.43
	(0.067)	(0.092)	(0.120)	(0.061)	(0.081)	(0.110)	(0.055)	(0.076)	(0.082)	(0.168)	(0.195)	(0.269)
lnage	0.29***	0.13	0.08	0.26***	0.11	0.12	0.13*	0.08	0.02	0.60***	0.47**	0.34
	(0.093)	(0.107)	(0.118)	(0.088)	(0.098)	(0.112)	(0.069)	(0.087)	(0.092)	(0.211)	(0.206)	(0.229)
ESC	−0.34***	−0.38**	−0.66***	−0.31***	−0.27*	−0.56***	−0.21**	−0.25*	−0.38**	−0.23	−1.37***	−1.10**
	(0.129)	(0.172)	(0.224)	(0.119)	(0.151)	(0.204)	(0.100)	(0.147)	(0.176)	(0.274)	(0.373)	(0.444)
lninputshare	−0.24	−1.37***	−2.15***	−0.16	−1.04***	−1.88***	−0.05	−1.04***	−1.44***	−1.46	−2.99***	−4.47***
	(0.312)	(0.321)	(0.344)	(0.282)	(0.291)	(0.310)	(0.246)	(0.236)	(0.265)	(1.013)	(0.818)	(0.773)
association	0.20	−0.24	−0.49**	0.13	−0.32*	−0.43**	0.05	−0.14	−0.43**	0.04	−0.22	−0.56
	(0.157)	(0.203)	(0.225)	(0.150)	(0.179)	(0.207)	(0.125)	(0.183)	(0.180)	(0.441)	(0.465)	(0.474)
lncaplabor	−0.29	−0.46*	−0.60*	−0.23	−0.31	−0.50*	−0.25	−0.52***	−0.48**	0.08	−0.97	−0.89
	(0.261)	(0.243)	(0.311)	(0.247)	(0.226)	(0.281)	(0.190)	(0.180)	(0.233)	(0.699)	(0.653)	(0.731)
capacity	0.13	−0.01	0.18	0.09	−0.01	0.22*	0.09	−0.10	0.02	0.42	−0.20	−0.13
	(0.104)	(0.111)	(0.131)	(0.097)	(0.101)	(0.122)	(0.085)	(0.089)	(0.105)	(0.260)	(0.264)	(0.286)
assistance	0.10	0.14	0.09	0.09	0.08	0.06	0.09	0.27	0.26	0.12	0.43	−0.02
	(0.128)	(0.193)	(0.265)	(0.121)	(0.170)	(0.235)	(0.098)	(0.171)	(0.247)	(0.329)	(0.402)	(0.457)
Constant	1.24***	1.68***	1.79***	0.98***	1.27***	1.26***	0.82***	0.95***	1.15***	−3.83***	−2.05***	−1.48*
	(0.328)	(0.368)	(0.436)	(0.301)	(0.344)	(0.416)	(0.260)	(0.300)	(0.335)	(0.736)	(0.763)	(0.897)
Observations	1,022	590	516	1,022	590	516	1,022	590	516	722	463	401
R – squared	0.283	0.317	0.378	0.240	0.280	0.343	0.185	0.215	0.313	0.262	0.442	0.439

Robust standard errors in parentheses,
***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.
Source: Authors' calculation.

On the policy front, our findings suggest several vital policy implications. First, it is essential for the government to combat corruption in order to improve resource efficiency. In the countries characterized by the common issue of corruption like Vietnam, the problems such as long delays, complex administration process, unfair competition are created by the monopolists of public officials for the firms that do not pay bribes lead to production inefficiencies and waste of resources. Second, the government could also propose policies to promote the efficiency in using the natural resources. Such policies such as a reduction of pressure and an ensure of fairness in competition as well as an access to credit can help firms improve the efficiency level in using natural resources. Furthermore, the technology platform plays a vital role in this goal, thus it is prerequisite that the government should propose policies to encourage firms to invest more in the research and development.

Although we give the best to control all issues, this article still suffers from some problems. In addition to firm bargaining power, credit constraints, and market competition, the quality institutional environment also plays a vital role in influencing the association between bribery and resource efficiency. Furthermore, there is an endogeneity issues arising from the simultaneity between bribery and resource efficiency and unobserved variables in the model that we use the instrumental method to deal with, but it is better to solve this issue by adapting other methods. The other issue is related to the data. Our data is not up-to-date due to its unavailability. Therefore, the policies to promote firms' resource efficiency may not work in the current time. These issues should be considered in the future research.

Notes

1. The first-stage results are available upon request. In this paper, we only report the full results of the baseline model in the Table A1 of Appendix.
2. The supplier-dominated sector consists of agriculture; food and beverages; tobacco; textiles; apparel; leather; wood; paper; publishing and printing; furniture; jewelry; and music equipment. The scale-intensive sector includes refined petroleum; rubber; non-metallic mineral products; basic metals; and fabricated metal products. The science-based sector includes chemical products; fabricated metal products; electronic machinery; computers; radio; and motor vehicles.

Disclosure statement

No potential conflict of interest was reported by the authors.

ORCID

Doan Ngoc Thang http://orcid.org/0000-0003-4395-9476

Data availability statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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Appendix

Table A1. GMM estimation results.

Variables	(1) Resource Intensity	(2) Electricity Intensity	(3) Fuel Intensity	(4) Water Intensity	(5) Resource Intensity	(6) Electricity Intensity	(7) Fuel Intensity	(8) Water Intensity
DGBri	0.72***	0.69***	0.51***	1.11***				
	(0.233)	(0.219)	(0.190)	(0.394)				
lnGBri					1.07**	0.92**	0.85**	1.69**
					(0.475)	(0.438)	(0.381)	(0.751)
lnsize	−0.03	−0.02	−0.00	−0.35***	0.02	0.03	0.02	−0.26**
	(0.059)	(0.054)	(0.047)	(0.113)	(0.057)	(0.052)	(0.044)	(0.107)
lnage	0.20**	0.20***	0.10	0.39***	0.17**	0.17**	0.07	0.33**
	(0.080)	(0.074)	(0.063)	(0.146)	(0.079)	(0.074)	(0.061)	(0.142)
EI	−0.45***	−0.38***	−0.28***	−0.63***	−0.55***	−0.48***	−0.38***	−0.75***
	(0.125)	(0.113)	(0.102)	(0.222)	(0.118)	(0.107)	(0.094)	(0.216)
lninputshare	−1.03***	−0.83***	−0.69***	−1.95***	−0.91***	−0.73***	−0.58***	−1.76***
	(0.274)	(0.248)	(0.220)	(0.618)	(0.271)	(0.244)	(0.217)	(0.615)
Association	−0.06	−0.12	−0.09	−0.17	0.00	−0.07	−0.04	−0.03
	(0.138)	(0.129)	(0.117)	(0.300)	(0.136)	(0.127)	(0.113)	(0.293)
lncaplabor	−0.53**	−0.39**	−0.47***	−0.95*	−0.51**	−0.38**	−0.44***	−0.88*
	(0.208)	(0.192)	(0.150)	(0.494)	(0.209)	(0.194)	(0.149)	(0.494)
Capacity	0.21**	0.18**	0.12	0.25	0.20**	0.16*	0.12*	0.22
	(0.091)	(0.085)	(0.075)	(0.185)	(0.090)	(0.084)	(0.073)	(0.181)
Assistance	0.12	0.08	0.18*	0.09	0.19	0.14	0.23**	0.22
	(0.125)	(0.116)	(0.104)	(0.265)	(0.124)	(0.115)	(0.104)	(0.263)
Constant	1.41***	1.04***	0.83***	−2.33***	1.62***	1.24***	1.01***	−2.03***
	(0.276)	(0.255)	(0.221)	(0.501)	(0.267)	(0.246)	(0.210)	(0.481)
Observations	1,460	1,460	1,460	1,090	1,460	1,460	1,460	1,090

Robust standard errors in parentheses
***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.
Source: Authors' calculation.

Table A2. Benchmark results with two-stage reporting.

Variables	(1) First DGBri	(2) Second RI	(3) First DGBri	(4) Second ElecInten	(5) First DGBri	(6) Second FuelInten	(7) First DGBri	(8) Second WaterInten	(9) First lnGBri	(10) Second RI	(11) First lnGBri	(12) Second ElecInten	(13) First lnGBri	(14) Second FuelInten	(15) First lnGBri	(16) Second WaterInten
lnsize	0.06***	−0.04	0.06***	−0.04	0.06***	−0.02	0.06***	−0.42***	−0.01***	0.11	−0.01***	0.11*	−0.01***	0.11*	−0.01***	−0.13
	(0.013)	(0.053)	(0.013)	(0.048)	(0.013)	(0.042)	(0.015)	(0.115)	(0.003)	(0.068)	(0.003)	(0.062)	(0.003)	(0.057)	(0.004)	(0.127)
lnage	−0.05**	0.21***	−0.05**	0.21***	−0.05**	0.10*	−0.06**	0.47***	−0.01	0.23**	−0.01	0.22***	−0.01	0.13	−0.01	0.42***
	(0.021)	(0.068)	(0.021)	(0.063)	(0.021)	(0.053)	(0.024)	(0.138)	(0.006)	(0.092)	(0.006)	(0.084)	(0.006)	(0.076)	(0.006)	(0.160)
EI	0.04	−0.39***	0.04	−0.34***	0.04	−0.23***	0.04	−0.66***	0.01	−0.47***	0.01	−0.40***	0.01	−0.29***	0.00	−0.65***
	(0.030)	(0.100)	(0.030)	(0.091)	(0.030)	(0.080)	(0.033)	(0.203)	(0.009)	(0.134)	(0.009)	(0.123)	(0.009)	(0.111)	(0.010)	(0.241)
lninputshare	0.04	−0.85***	0.04	−0.67***	0.04	−0.53***	0.05	−2.22***	−0.10***	−0.23	−0.10***	−0.11	−0.10***	0.02	−0.09***	−0.61
	(0.078)	(0.214)	(0.078)	(0.195)	(0.078)	(0.169)	(0.091)	(0.562)	(0.016)	(0.385)	(0.016)	(0.353)	(0.016)	(0.330)	(0.018)	(0.876)
association	0.08**	−0.00	0.08**	−0.06	0.08**	−0.05	0.11***	−0.01	0.03***	−0.16	0.03***	−0.22	0.03***	−0.19	0.03**	−0.28
	(0.033)	(0.118)	(0.033)	(0.111)	(0.033)	(0.097)	(0.042)	(0.279)	(0.009)	(0.167)	(0.009)	(0.156)	(0.009)	(0.145)	(0.011)	(0.348)
lncaplabor	−0.24***	−0.44**	−0.24***	−0.31*	−0.24***	−0.40***	−0.21**	−0.63	−0.03**	−0.40*	−0.03**	−0.29	−0.03**	−0.34**	−0.04**	−0.62
	(0.070)	(0.183)	(0.070)	(0.170)	(0.070)	(0.131)	(0.082)	(0.456)	(0.015)	(0.228)	(0.015)	(0.211)	(0.015)	(0.171)	(0.016)	(0.546)
capacity	0.01	0.16**	0.01	0.14*	0.01	0.08	0.00	0.27	0.00	0.13	0.00	0.10	0.00	0.06	−0.00	0.18
	(0.024)	(0.076)	(0.024)	(0.072)	(0.024)	(0.062)	(0.028)	(0.177)	(0.008)	(0.104)	(0.008)	(0.096)	(0.008)	(0.088)	(0.008)	(0.204)
assistance	−0.03	0.14	−0.03	0.11	−0.03	0.18**	0.01	0.17	−0.00	0.17	−0.00	0.12	−0.00	0.22**	0.00	0.09
	(0.030)	(0.107)	(0.030)	(0.100)	(0.030)	(0.089)	(0.036)	(0.233)	(0.007)	(0.128)	(0.007)	(0.119)	(0.007)	(0.109)	(0.008)	(0.275)
GBri_ivb	0.95***		0.95***		0.95***		0.88***									
	(0.049)		(0.049)		(0.049)		(0.059)									
DGBri		0.72***		0.76***		0.47**		1.78***								
		(0.229)		(0.217)		(0.194)		(0.532)								
GBri_ivr									0.74***		0.74***		0.74***		0.75***	
									(0.179)		(0.179)		(0.179)		(0.179)	
lnGBri										7.18***		6.45***		6.27***		12.08**
										(2.647)		(2.429)		(2.350)		(5.740)
Observations	1,818	1,818	1,818	1,818	1,818	1,818	1,351	1,351	1,460	1,460	1,460	1,460	1,460	1,460	1,090	1,090
R − squared	0.179	0.260	0.179	0.216	0.179	0.167	0.167	0.349	0.167	0.075	0.167	0.046	0.167		0.163	0.233

Robust standard errors in parentheses
***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.
Source: Authors' calculation.