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Corporate social responsibility & firm efficiency: evidence from endogenous cost inefficiency stochastic frontier analysis

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ABSTRACT

This paper investigates the relationship between firms' performance in corporate social responsibility (CSR) and cost efficiency. We use a newly developed panel data model of stochastic frontier analysis that endogenizes cost efficiency. The dataset consists of 1,673 firms from ten provinces in Vietnam over three years: 2009, 2011 and 2013. Our results suggest that CSR can enhance cost efficiency of firms. This positive effect of CSR on efficiency can be masked if cost efficiency is treated as exogenous or endogeneity is not handled appropriately. The upshot is that our results challenge the widely held view of the existence of a trade-off between CSR and firm efficiency.

Introduction

Corporate social responsibility has been gradually coming to the centre stage not just in business and corporate governance but also in academia and policy circles. Long gone is the traditional view that 'the business of business is business'.[1] There is some evidence to suggest that many firms routinely engage in some form of socially beneficial activities that are 'beyond compliance with the laws and regulations prevailing in the jurisdictions in which they operate' (Portney 2008; Crifo and Forget 2015; Gillan, Koch, and Starks 2021), partly in order to signal their legitimacy and social acceptance (Lee, Yoon, and O'Donnell 2018). While there is not a generally agreed-upon definition of these 'socially beneficial activities', we find the key features of these societal responsibilities in UNIDO (2022) definition of CSR which goes as 'Corporate Social Responsibility is a management concept whereby companies integrate social and environmental concerns in their business operations and interactions with their stakeholders. CSR is generally understood as being the way through which a company achieves a balance of economic, environmental and social imperatives ("Triple-Bottom-Line-Approach"), while at the same time addressing the expectations of shareholders and stakeholders.'

Notwithstanding the rudimentary evidence on CSR practice and corporate websites boasting CSR engagements, questions surrounding CSR still abound. Why do firms engage in CSR? Can and do firms voluntarily engage in CSR sustainably? Would concerns about CSR standards be an influence on firms' location choices? Is CSR necessarily profit sacrificing? At the heart of such perennial questions that arise in the debate on CSR is the question: what is the precise relationship between firms' corporate social performance and economic/financial performance?

Loosely speaking there are two long-running views on this relationship: the mainstream (neo-classical) view and what one might call the 'revisionist' view (see e.g. Portney 2008). The main conclusion of the former is that corporate social engagement will inevitably involve profit sacrificing in the interest of social welfare because such firms see their costs rising, putting them at a competitive disadvantage vis-à-vis their competitors and resulting in a transfer of wealth from shareholders to stakeholders (see e.g. Devinney 2013). The latter, in contrast, purports that corporate responsibility to stakeholders might actually pay off in terms of profit by enhancing the company's reputation,

[1]This traditional view is typically associated with Friedman (1970).

appealing to socially minded consumers, investors and workers to create a double dividend or win-win situation (see e.g. Porter and Kramer 2011; Ahn and Park 2018). In between these polar opposite views, we also find a middle ground that goes as "firms are not always better off with CSR compliant operations . . ." but there also circumstances when they can be better off depending on cost of compliance and risk of exposure (Bian et al. 2021, 915). The main argument by the authors is that CSR compliance costs could be sufficiently low justifying implementation of CSR measures, given the risk of reputation damage when exposed to the public by third-party organizations such as Non-Governmental Organizations.

Ultimately, whether and how CSR relates to firm performance and value is arguably an empirical question. There is a burgeoning literature on CSR and a range of measures of firm performance. Many focus on CSR and financial performance (see e.g. Belu and Manescu 2013; Cavaco and Crifo 2014; Adegbite et al. 2019; Albuquerque, Koskinen, and Zhang 2019; Lee and Yang 2021); others deal with CSR and firm productivity (e.g. Newman et al. 2020); some examine CSR and corporate longevity (Ahn and Park 2018); still others investigate CSR and firm value (see e.g. Chen and Lee 2017).

A widely cited early review of this vast body of empirical literature concluded: "[T]he preponderance of evidence indicates a mildly positive relationship between corporate social performance and corporate financial performance" (Margolis et al. 2009, p. 22). In a review including more than 2000 publications in fields such as management, accounting, finance and economics, Friede, Busch, and Bassen (2015, 210) also concluded that "roughly 90% of studies find a nonnegative ESG/CFP (Corporate financial performance) relation. More importantly, the large majority of studies reports positive findings". Overall, however, recent empirical evidence is inconclusive (see e.g. Cavaco and Crifo 2014; Crifo and Forget 2015; Newman et al. 2020).

The aim of this paper is to evaluate the above-mentioned competing hypotheses directly by posing the question: are firms with higher corporate social performance/standard more or less efficient than other firms? To that end, we use a newly developed model of *stochastic frontier analysis* to examine the impact of CSR on firm cost efficiency.

This paper contributes to the literature on CSR and economic performance in three major ways. First, we adopt a recent methodological innovation, endogeneity in stochastic frontier models (Amsler, Prokhorov, and Schmidt 2017; Karakaplan and Kutlu 2017, 2019) and treat CSR as endogenous when studying firm efficiency. While the stochastic frontier framework is the workhorse for empirical efficiency analysis in different fields of economics and business, the framework has not been widely used in corporate governance studies. The few exceptions are Khiari, Karaa, and Omri (2007), Becchetti and Trovato (2011) and Liu et al. (2020). Nonetheless, none of these studies considers the issue of endogeneity of the *environmental variable*, CSR.[2] This, in our view, is a potential caveat because it is possible that relatively efficient firms (or financially well-performing firms) are likely to have higher corporate social performance or standards (Garcia-Castro, Ariño, and Canela 2010; Baron, Harjoto, and Jo 2011; Crifo and Forget 2015). Elaborating the endogeneity mechanism, Garcia-Castro, Ariño, and Canela (2010) point out that CSR standards are likely to do with broader, and hard to observe and measure CEO values/company culture, which itself is also related to financial performance. Moreover, inappropriate handling of endogeneity, such as in a two-stage procedure (e.g. Liu et al. 2020), can result in biased estimates in the first stage contaminating second stage estimates (Kutlu, Tran, and Tsionas 2019). We would like to mention here two more advantages with the stochastic frontier framework in analysing efficiency. First, it is an empirical framework that explicitly starts from a realistic premise that firms are not necessarily profit maximizers or cost minimizers; i.e. some degree of inefficiency is inherent in the real world. Second, it is not data demanding; all it needs, for example, in the context

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[2]It has to be mentioned that (Becchetti and Trovato 2011) consider the endogeneity of 'production structure' in their stochastic frontier analysis of firm sales. Garcia-Castro et al. (2010), Albuquerque, Koskinen, and Zhang (2019) and Newman et al. (2020) also treat CSR as endogenous in their analysis but their framework is not stochastic frontier.

of cost functions is total cost, input prices, level of output (and possibly output characteristics). While this is generally an attractive feature for an empirical model, it becomes even more so in the context emerging countries where data availability tends to be an issue.

Second, our use of a rich panel dataset of about 1,673 firms in Vietnam is also a major contribution to the literature – a literature dominated by cross-section analysis of data from developed countries – rather than fast-growing transition emerging economies like Vietnam. Studies show that cross-section frontier models are likely to muddle unobserved heterogeneity with inefficiency – leading to biased estimates of inefficiency (Karakaplan and Kutlu 2019, 1737). Furthermore, as argued by Garcia-Castro, Ariño, and Canela (2010, 108) one major reason for the heterogeneity of the empirical findings in the literature could be ' ... social performance and financial performance may have a relationship that changes with circumstances ... '. This suggests that a focus on the mechanisms driving CSR and its impact on firm efficiency in emerging economies can provide insight into cross-regional differences on the question under investigation. The concept of CSR was first introduced in Vietnam through a number of codes of conduct and international standards (e.g. SA8000, ISO 9001, and ISO 14001) in 2007. This was the same time Vietnam joined the World Trade Organization (WTO), which in turn increased the need for CSR to ensure the sustainable integration for Vietnamese firms into global supply chain (Newman et al. 2020).[3] The rapid economic transformation in Vietnam has still resulted in negative effects on the environment and labour conditions (Nguyen, Bensemann, and Kelly 2018). There were reports in the mass media of workers experiencing exhaustion and fainting in multinational companies. Nike had to implement 'equitable manufacturing' to improve working conditions in its supplier firms in Vietnam and other countries (Bian et al. 2021). By evaluating the implementation of CSR in Vietnam, this study can complement the developed-country-based literature and take the research into new directions.

Third, unlike the typical focus in the CSR literature on financial performance which is measured by accounting or market-based indicators (see e.g. Garcia-Castro, Ariño, and Canela 2010; Cavaco and Crifo 2014), we investigate cost efficiency. Market-based indicators such as Tobin's Q are based on the stock market valuation – reflecting future growth potential of a firm. Accounting measures such as ROA and ROE capture past financial performance, i.e. profitability. While widely accepted, the two measures of financial performance are not free from controversy. There is a longstanding debate in the literature about the relationship between the two measures and the evidence is mixed; some suggested a positive relationship while others have documented a negative one (Gentry and Shen 2010). This is indeed an important issue because "it concerns whether firm financial performance can be treated as a single unidimensional construct" (Gentry and Shen 2010, 515).

Our measure of cost efficiency focuses in the main on a non-financial aspect of firm performance. It can be argued that, for example, a cost reduction due to workers' productivity (owing to employee friendly work environment) and management/production (re)arrangements in response to addressing environmental protection measures is not necessarily reflected in market-based indicators. Empirical studies have found that firms can improve labour productivity through internal dimensions of CSR, such as the policies on the employee, responsibility in process quality and product quality (Sánchez and Benito-Hernández 2015) though the evidence on environmental dimensions of CSR is inconclusive. Whereas such effects on cost resulting from CSR measures should theoretically have a bearing on the standard financial performance measures, the relationship is not automatic or immediate. Ultimately, we should consider "accounting measures as reflections of past or short-term financial performance, and market measures as reflections of future or long-term financial performance" (Gentry and Shen 2010, 514).

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[3]Newman et al. (2020) is a remarkable exception we are aware of that analyses data from an emerging economy, Vietnam.

Therefore, our focus on the economic 'fundamentals' that underlie financial performance measures can be regarded as complementary to the literature focusing on accounting and market-based measures, which have tenuous relationship to one another. Moreover, given our focus on small- and medium-size firms in an emerging economy (Vietnam)standard financial performance measures are arguably unreliable or possibly non-existent altogether.

Our main result is that corporate social performance has a significant positive effect on cost efficiency of firms. Treating corporate social performance as exogenous can mask this significant relationship.

The remainder of this paper is organized as follows. Section II introduces the econometric framework. In Section III, we present our estimating equation, the variables and our data. Results are presented and discussed in Section IV. Section V concludes the paper.

Econometric model

Our econometric model is that of Karakaplan and Kutlu (2017, 2019) [4]and here we reproduce the basics of their model leaving out the more technical details.

A standard stochastic cost frontier for the ith firm in time t can be expressed as[5]

$$E_{it} \geq C(x_{it}; f\beta)e^{v_{it}}, \tag{1}$$

where E_{it} is expenditure on all sorts of inputs (contributing to both quantity and quality aspects of output);

$$CI_{it} = E_{it}/C(x_{it}; \beta)e^{v_{it}} \tag{2}$$

Since $E_{it} \geq C(x_{it}; \beta)e^{v_{it}}$ we have $CI_{it} \geq 1$. Assuming a log linear formulation of the cost frontier, the model in (1) can be written as

$$lnE_{it} \geq lnC(x_{it}; \beta) + v_{it}. = lnC(fx_{it}; f\beta) + v_{it} + u_{it} \tag{3}$$

where u is the non-negative cost inefficiency component. Using (2) we also have $CI_{it} = e^{u_{it}}$.[6]

This is the traditional exogenous stochastic frontier model where x_{it}, v_{it} and u_{it} are independent. The point of departure for the endogenous model of Karakaplan and Kutlu (2019, 2017) is allowing two types of endogeneity: correlation between the 'frontier inputs', x_{it} and the two-sided error term, v_{it}; and correlation between the one-sided efficiency term, u_{it} and the two-sided error term, v_{it}. The latter is equivalent to assuming correlation between 'environmental inputs' such as CRS and the two-sided error term.[7]

Formally, the Karakaplan and Kutlu model can be specified as follows:

$$lnC_{it} = x_{yit}\beta + v_{it} + u_{it}$$

$$x_{it} = Z_{it}\beta + \in_{it}$$

$$\begin{bmatrix} \tilde{\in}_{it} \\ v_{it} \end{bmatrix} \equiv \begin{bmatrix} \Omega^{-1/2-\in_{fit}} \\ v_{it} \end{bmatrix} \sim N\left(\begin{bmatrix} 0 \\ 0 \end{bmatrix}, \begin{bmatrix} I_p & \sigma_{v\rho} \\ \sigma_{v\rho} & \sigma_v^2 \end{bmatrix} \right)$$

where i indexes firm and t indexes time; lnC_{it} is cost; fx_{yit} is a vector of exogenous and endogenous variables; fx_{it} is a vector of all endogenous variables excluding lnC_{it}; $Z_{it} = I_p \otimes z_{it}$ where z_{it} is a vector of exogenous variables. v_{it} and $\in_{it}$ are two-sided error terms, whereas $u_{it} \geq 0$ is the cost inefficiency term. $f\Omega$ is a variance-covariance matrix of $\in_{it}$, $f\sigma_{fv}^{2f}$ is the variance of fv_{it} and ρ is a vector of the correlation between $\tilde{\in}_{it}$ and fv_{it}. Thus, a potential correlation between the frontier regressors and the two-sided term is allowed. Let fx_{2it} be a vector of exogenous and endogenous variables and suppose u_{it} is a function of fx_{2it} and a unit specific random component, u_i^*; this is actually the common assumption in the stochastic frontier literature that the efficiency term depends on 'environmental variables' (see Amsler, Prokhorov, and Schmidt 2017).

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[4]Kutlu, Tran, and Tsionas (2019) is an extension of the earlier models presented in Karakaplan and Kutlu (2017) and hence our application here. The key feature of this extension is allowing both the heterogeneity and the inefficiency to vary over time – an issue that is especially important if the panel long. Our panel being short – only three time periods – there is no particular need for this framework.
[5]See e.g. Kumbhakar and Lovell (2000).:
[6]π is a parameter to be estimated and T is the end year of the time series.
[7]Note that one could go further and assume correlations of both types of endogenous variables with the efficiency term (see Amsler, Prokhorov, and Schmidt 2017).

With some further algebra, the stochastic frontier equation can be written as follows.

$$lnC_{it} = x_{yit}\beta + (x_{it} - Z_{it}\delta)'\eta + e_{it},$$

where e_{it} is conditionally independent from the right-hand-side variables given x_{it} and z_{it}. The term in the brackets, $(fx_{it} - Z_{it}\delta)'\eta$ is a correction term for bias. A test for endogeneity is based on the significance of η.

The effect of variables on efficiency is modelled as:

$$u_i = \sigma_u(x_{2i}; \emptyset_u)^{u*},$$

where x_{2i} is a vector of exogenous and endogenous variables; $fu_{fi}^{f*}f\tilde{N}^+(0,1)$ is a firm-specific random term; $\sigma_{ui}^2 = exp(x'_{2i}, \emptyset_u)$. The formula for predicting efficiency is: $EFF = e^{-u_{it}}$.

Overall, Karakaplan and Kutlu's (Karakaplan and Kutlu 2017, 2019) SFM appropriately handles endogeneity and hence complements recent contributions in the SFM literature that treat the environmental variable as exogenous (Lopez-Gomez and Parmeter 2020; Hu and Pei 2020). It also complements Tsionas, Assaf, and Andrikopoulos (2020) that address endogeneity of the frontier variables, specifically the correlation between these variables and the two-sided error term but unlike them our model also allows for correlation between the environmental variable and the two-sided error term. Unlike the standard control function methods where estimations involve a two-tier SF construction (Hu and Pei 2020; Liu et al. 2020), this model estimates the parameters in a single stage and is easier to apply compared to other Bayesian counterparts (Tsionas, Assaf, and Andrikopoulos 2020).

Estimating equation, variables and data

In implementing the above endogenous cost frontier model, we will explore both the simple Cobb-Douglas model and the translog model from which the former can be derived as a special case. The translog function is a flexible specification that does not impose restrictions on substitution possibilities among inputs and allows scale economies to vary over output levels (Christensen and Greene 1976). The basic translog cost function for n inputs can be written as.

$$\begin{aligned}
LnC = {} & \beta_0 + \sum_{i=1} n\beta_i LnP_i \\
& + 1/2 \sum_{i=1} n \sum_{j=1} n\beta_{ij} LnP_i LnP_j + \beta_Y LnY \\
& + 1/12\beta_{YY} LnYLnY + \sum_{i=1} n\beta_{ij} LnP_i LnY \\
& + \vartheta + u
\end{aligned}$$

(4)

where LnC is the natural logarithm of total cost, LnY represents the natural logarithm of firm sales, and LnP_i is the natural logarithm of the price of input i and $\beta_{ij} = \beta_{ji}$.

Total cost is measured as all costs incurred by a firm including working expenditures and capital costs. Total sales is a proxy for the level of output, which is the standard variable employed in production functions. Prices of three major factor inputs are considered. These are labour, material and information technology.

The price of labour (P_L) is measured as labour total remuneration divided by total number of workers. Hence, we have average wage. This is a rather common way of measuring the price of labour (see e.g. Truett and Truett 2003; Karakaplan and Kutlu 2017).

Information technology (IT) is one of the most important inputs by firms and its nature and impact is considered to be different from general capital because IT capital brings positive externalities and is known to distinctly contribute to the productivity growth and output of the firm (Jorgenson 2001; Kumar Sahu and Narayanan 2011). As is common in the literature (McCarthy and Urmanbetova 2011), we use a proxy for the price of IT (P_T) that is the weighted price deflator from 2009 to 2013 by SMEs covered in the sample, where the year 2009 is the base year. Material input represents various kinds of materials other than IT related material used by firms. The price of raw material (P_M) is similarly proxied by the weighted price deflator from 2009 to 2013 by SMEs covered in the sample, where the year 2009 is the base year (McCarthy and Urmanbetova 2011). All variables are measured using Vietnamese currency, VND.

Measuring CSR is a complex task because of its multidimensional nature; it aims to capture such varied aspects ranging from environmental and employee considerations to community engagement, diversity and human rights (see, e.g. Blasi, Caporin, and Fontini 2018). Sánchez and Benito-Hernández (2015, 710) further argue that the various dimensions of CSR can be grouped into internal orientation (e.g. relationship with employees and good corporate governance) and external orientation (e.g. relationship with the community and the environment). As argued by Newman et al. (2020, 1456) "Observing the full range of firm activities is difficult and so is measuring CSR …" Hence, researchers have had to use a subset of the varied potentially relevant aspects of CSR. Our measure is no exception; it focuses on limited aspects of CSR activities. However, in defence of our CSR measure, it can be argued that our indicator captures the prominent two aspects of CSR – one from 'internal' (i.e. employee care) and the other from 'external' (i.e. environmental protection).

To be precise, our CSR measure is constructed on the basis of firms' efforts/actions in relation to environmental and labour (employee) conditions. These two 'social and environmental' conditions are by far the most commonly used indicators in the literature to represent firms' corporate social engagement (Crifo and Forget 2015; Newman et al. 2020). The efforts of environmental condition consist of waste (solid and air) treatment and treatment of noise pollution. These are measured in three-point scale, one is low consideration while two and three are, respectively, average and high consideration. With respect to labour conditions, the variable relates to considerations of employee wellbeing that consists of varied indicators such as health and safety standards at work and entertaining workers such as arranging occasional visits to historical and cultural sites. These are also measured by three-point scale: one representing low consideration, two and three are, respectively, medium and high consideration. The CSR variable is the simple average of the two sets of indicators, i.e. indicators of the environmental and labour conditions.

As pointed out in Section I, our measure of CSR is potentially endogenous i.e. firms' level of corporate social activities might respond to their efficiency and profitability. In particular, it is possible that relatively efficient firms (or financially well performing firms) are likely to have relatively higher corporate social performance or standards (Garcia-Castro, Ariño, and Canela 2010; Baron, Harjoto, and Jo 2011; Crifo and Forget 2015).

Motivated by arguments advanced in the literature, we explore three variables as instruments for CSR. Our main instrument for CSR is 'type of industry' because some industries attract relatively more attention by the public such as the food Industry (Garcia-Castro, Ariño, and Canela 2010). Thus, we employ the food Industry dummy variable as an instrument for CSR. This variable is arguably highly correlated with CSR but might not be directly linked to cost efficiency (Tang and Tang 2018). The alternative instruments are 'firm size' and 'education of manager/owner/director'. Size (measured here in value of assets) is arguably a good candidate instrument because of 'visibility' – meaning if a firm is big, it becomes visible by different stakeholders such as customers, the media and government. Similarly, education can be argued to raise awareness of and thus engagement in social and environmental endeavours. Table 1 presents descriptive statistics of the variables.

The source of our data is surveys by Central Institute for Economic Management (CIEM) of the Ministry of Planning and Investment, Vietnam. The SME survey, originating in 2005, is conducted every two years, and it covers about 2,500 enterprises across 10 provinces on each census; and a large proportion of these are repeats from previous years. The most recent readily available data are 2013 while the latest census results are being complied. With the aim of maximizing our sample of a balanced panel data, we have focused on the period 2009–2013. Over this period, the survey design and the questionnaires were maintained hence we are assured to have a consistent dataset over the sample period. The ten provinces

Table 1. Descriptive statistics of variables.

	2009		2011		2013	
Variable	Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation
Total cost (C) (mil. VND)	3648.57 (n=1673)	12623.47	8607.50 (n=1673)	195488.70	4089.21 (n=1673)	14,127.40
Sales (Y) (mil. VND)	3701.71	12.90	9049.00	202.84	4519.81	16.37
Labour price (mil. VND/labour)	13.73	12.96	14.43	16.56	26.46	29.65
Price for materials (P_M) weighted price deflator from 2009 to 2013, 2009=100	2.13	5.60	2.96	18.67	2.04	1.90
price of IT (P_{IT}): weighted price deflator from 2009 to 2013, 2009=100	3.72	3.16	4.19	7.80	4.45	6.80
CSR	1.98	0.85	2.26	0.63	2.34	0.60
FoodSector (1= food sector; 0= otherwise	0.31	0.46	0.31	0.46	0.31	0.46
Firm Size (assets in mil. VND)	13.65	1.84	14.20	1.74	14.10	1.70
Education (1= primary school; 2= Middle school; 3=High school; 4= College/University	3.39	0.82	3.48	0.74	3.63	0.61

covered are Hanoi, Hai Phong, Ho Chi Minh City, Ha Tay, Phu Tho, Nghe An, Quang Nam, Khanh Hoa, Lam Dong and Long An. After exclusion of observations with missing data, we have 5,019 firm-year observations, with 1,673 firms for each census.

Estimation results and discussion

Estimation results are reported in Table 2.[8] The two sets of results in the table refer, respectively, to a translog specification stated above and a Cobb-Douglas version – to explore a potential parsimony.

Table 2. Estimation results: translog and Cobb-Douglas specifications.

	translog				Cobb-Douglas			
Variables	Model EX		Model EN		Model EX		Model EN	
Dependent variable: LnC								
Constant	2.606	(1.601)	1.935	(1.612)	0.167	(0.106)	0.025	(1.109)
LnY	0.897***	(0.091)	0.933***	(0.091)	0.983***	(0.004)	0.991***	(0.004)
LnL	0.081***	(0.008)	0.078***	(0.008)	0.091***	(0.007)	0.084***	(0.007)
LnM	−0.691**	(0.254)	−0.658*	(0.258)	−0.163***	(0.008)	−0.150***	(0.009)
LnT	−0.318*	(0.147)	−0.275	(0.258)	−0.018**	(0.006)	−0.016*	(0.006)
LnYLnY	−0.007	(0.004)	−0.007	(0.147)				
LnLLnL	0.019	(0.011)	0.024*	(0.004)				
LnMLnM	−0.016***	(0.004)	−0.015***	(0.011)				
LnTLnT	0.011	(0.007)	0.012	(0.004)				
LnYLnL	−0.005	(0.006)	−0.005	(0.006)				
LnYLnM	0.028***	(0.008)	0.027***	(0.008)				
LnYLnT	0.015***	(0.004)	0.013***	(0.004)				
LnLLnM	−0.002	(0.010)	−0.002	(0.010)				
LnLLnT	−0.005	(0.004)	−0.007*	(0.004)				
LnMLnT	0.024	(0.014)	0.023	(0.014)				
Dependent variable: ln(σ^2 _u)								
Constant	−2.559***	(0.150)	−1.534***	(0.192)	−3.553***	(0.144)	−2.489***	(0.221)
CSR	−0.765***	(0.086)	−1.348***	(0.128)	−0.247***	(0.067)	−0.836***	(0.142)
Dependent variable: ln(σ^2 _v)								
Constant	−3.277***	(0.026)			−3335***	(0.023)		
Dependent variable: ln(σ^2 _w)								
Constant			−3.308***	(0.027)			−3.350***	(0.023)
eta1 (CSR)			0.046***	(0.007)			0.041***	(0.007)
eta Endogeneity Test			χ^2=36.95	p=0.000			χ^2=29.38	P=0.000
Observations	3857		3857		4957		4957	
Log Likelihood	539.64		−3482.19		872.15		−4399.19	
Mean Cost Efficiency	0.903		0.901		0.903		0.903	
Median Cost Efficiency	0.913		0.919		0.910		0.914	

Notes: Standard errors are in parentheses. Asterisks indicate.
Significance at the 0.1% (***), 1% (**) and 5% (*) levels.

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[8]We used (Karakaplan 2017) xtsfkk command in STATA 13.

While the results from the two specifications are broadly similar, in the Cobb-Douglas model, the estimated coefficients of the price of information technology and the price of materials have the wrong signs and are significant. In the translog model, some of the estimated coefficients of the frontier equation are not significant at conventional levels of significance and do not have the expected signs. However, it should be noted that in stochastic frontier analyses, it is the disturbance terms that are the focus, and the parameters of the cost function are often "of secondary interest" (Greene 2000, 395). A log-likelihood test for overall comparison of the two models shows that the translog model is to be preferred.[9] Hence, from here on our discussion will be based on the results from translog model.

The negative estimated coefficient of the quadratic term of the output variable (LnYLnY) implies a non-linear cost function suggesting the existence of scale economies. We can also evaluate economies scale directly on the basis of the first-order estimates of the cost function as follows: $economies\ of\ scale = 1 - \partial LnC/\partial LnY = 0.07$, the positive sign indicating the existence economies scale.

Model EX and Model EN refer, respectively, to exogenous and endogenous model of the 'environmental variable': corporate social responsibility (CSR). The chi-square test for endogeneity, *eta* shows that CSR is indeed endogenous; in other words, the correction for bias resulting from exogeneity is required.

In both exogenous and endogenous models, CSR has a significant positive effect on cost efficiency (a negative effect on cost inefficiency). However, this positive effect of CSR on cost efficiency is much larger (almost twice as large: −0.765 versus −1.348) in Model EN where CSR is treated as endogenous than in Model EX where its endogeneity is ignored.

As pointed out above, estimation of our model is done in a single stage. Hence using the phrase 'first-stage regression' might lead to confusion. Instead, we use the term prediction equation (Karakaplan and Kutlu 2017). The prediction equation is reported in Table 3. In this equation, we find that all excluded variables are significant. Especially for

CSR, the *z* statistic is 4.71 (the rule of thumb for significance – to justify the validity of an instrument – is $\sqrt{10}$).

As already pointed out above, by way of checking robustness of our results, we have further explored, respectively, with our alternative instrumental variables: firm size and education of owner/ manager/director. The results are presented in the Appendix Table A1. The results in Table A1 are largely similar to the main results presented in Table 2.

Detailed comparison of our results with those documented in the literature is a challenge because of differences in study characteristics including study sample (developed versus emerging economies) and specific focus of analysis (such as financial performance versus efficiency). Nonetheless, some broad comparison with the results of key recent studies is in order. Our finding somewhat contrasts with Garcia-Castro, Ariño, and Canela (2010) who investigate the relationship between financial performance and social performance using US-based firms (most of them listed in S&P500 and Domini 400 social index). Despite addressing the potential endogeneity of CSR standards, they find support only for 'a neutral relationship between social performance and financial performance'. Belu and Manescu (2013) who consider a strategic CSR framework, and using publicly traded companies listed on the main international stock exchanges, find 'at best a neutral relationship between CSR standards and Return on Assets'. Similarly, based on a study of Taiwanese firms, Lee and Yang (2021) also came up with a contrasting conclusion that firms with higher CSR standards saw negative effects on their profitability.

Our finding complements those of Newman et al. (2020) who, like us, study Vietnamese enterprises – albeit with a focus on the effect of firms' CSR adoption on labour productivity and how this impact might be moderated by the extent of the competitiveness of the industries. While our data, methodologies and the particular outcome

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[9]The test can be based on LR. The null hypothesis that the Cobb-Douglas is the preferred model equals $\lambda = > -2\ (872.15-1001.43) = 258.56$. This exceeds the critical value, $\chi^2\ (1\%) = 8.273$. Hence the null is rejected.

Table 3. Estimation results of the prediction equation.

Endogenous stochastic cost frontier model with normal/half-normal specification

					Number of obs = 3,857	
					Wald chi2 (14) = 156560.83	
Log likelihood = > −3482.192					Prob > chi2 = 0.0000	
	Coef.	Std. Err.	z	P>|z|	[95% Conf. Interval]	
Frontier_LnC						
LnY	0.933	0.091	10.21	0.000	0.754	1.1118
LnL	0.078	0.008	9.76	0.000	0.063	0.09423
LnM	−0.658	0.258	−2.55	0.011	−1.163	−0.01532
LnT	−0.276	0.147	−1.87	0.061	−0.564	0.0129
LnYLnY	−0.007	0.004	−1.91	0.057	−0.015	0.0002
LnLLnL	0.024	0.011	2.15	0.031	0.002	0.04569
LnMLnM	−0.015	0.004	−3.90	0.000	−0.023	−0.0076
LnTLnT	0.012	0.007	1.54	0.123	−0.003	0.0262
LnYLnL	−0.005	0.006	−0.79	0.427	−0.017	0.0069
LnYLnM	0.027	0.008	3.25	0.001	0.011	0.0429
LnYLnT	0.013	0.004	3.18	0.001	0.005	0.0211
LnLLnM	−0.002	0.010	−0.16	0.876	−0.021	0.0181
LnLLnT	−0.007	0.004	−2.06	0.040	−0.014	−0.0003
LnMLnT	0.023	0.014	1.64	0.100	−0.004	0.04995
_cons	1.940	1.610	1.20	0.228	−1.215	5.0949
ivrl_CSR						
DummyFoodSector	0.127	0.027	4.71	0.000	0.07406	0.1797
LnY	0.044	0.289	0.15	0.878	−0.5212	0.6102
LnL	−0.059	0.026	−2.32	0.021	−0. 10906	−0.00907
LnM	0.674	0.845	0.80	0.425	−0.9822	2.3293
LnT	−0.185	0.470	−0.39	0.693	−1.1073	0.7365
LnYLnY	0.004	0.013	0.30	0.768	−0.02087	0.0282
LnLLnL	0.183	0.036	5.08	0.000	0.1121	0.2532
LnMLnM	0.014	0.014	1.01	0.312	−0. 12972	0.0406
LnTLnT	0.057	0.024	2.34	0.019	0.0092	0.1046
LnYLnL	−0.019	0.019	−1.00	0.317	−0.0573	0.0185
LnYLnM	−0.062	0.028	−2.23	0.025	−0.1155	−0.0075
LnYLnT	0.006	0.013	0.49	0.628	−0.191	0.0316
LnLLnM	0.052	0.033	1.58	0.113	−0.0123	0.117
LnLLnT	−0.070	0.011	−6.08	0.000	−0.0924	−0.0473
LnMLnT	−0.020	0.045	−0.45	0.654	−0.1089	0.0684
_cons	0.168	5.090	0.03	0.974	−9.8076	10.1438
etal_CSR						
_cons	0.04555	0.0072	6.33	0.000	0.031	0.060
lnsig2u						
CSR	−1.348	0.128	−10.56	0.000	−1.598	−1.098
_cons	−1.534	0.192	−8.00	0.000	1.910	−1.158
lnsig2w						
_cons	−3.308	0.027	−124.25	0.000	−3.361	−3.256
	eta Endogeneity Test					
Ho	Correction for endogeneity is not necessary					
Ha:	There is endogeneity in the model and correction is needed					
(1) [eta_CSR]_cons=0						
	chi^2 (1)=40.01					
	prob > chi^2=0.0000					
Result: Reject Ho at 0.1% level						

variables are different, their findings are broadly similar to ours: higher CSR standards and economic performance can go hand in hand.

Concluding remarks

We investigate the impact of corporate social responsibility (CSR) on cost efficiency of firms. This issue is at the heart of the various questions surrounding CSR. Can and do firms voluntarily engage in Corporate CSR sustainably? Why do firms engage in CSR?

Would concerns in CSR standards affect firms' location choices? None of these questions would be meaningful if we believed that there was no potential cost to firms of adopting strict CSR standards.

Using a recent panel data model of stochastic frontier analysis that endogenizes cost efficiency, we attempt to address the key caveats in the literature that are highlighted in a recent comprehensive review by Crifo and Forget (2015). These are omitted variables in the determinants of firm financial/economic performance, endogeneity, limited data, cross-

sectional analysis and the consequences for heterogeneity bias, and limited evidence from emerging economies on the role of CSR and firm performance.

The dataset consists of about 1,673 firms from ten provinces in Vietnam over three years: 2009, 2011 and 2013. Our results suggest that CSR enhances cost efficiency of firms. This positive effect of CSR on efficiency can be masked if cost inefficiency is treated as exogenous. The key conclusion is that our results challenge the widely held view of the existence of a trade-off between CSR and firm efficiency. The findings support the arguments advanced in the literature that socially and environmentally responsible firms might benefit from attracting motivated and skilled employees, with the resulting higher labour productivity (Delmas and Pekovic 2013; Nyborg 2014) and/or lower production costs from environmental-friendly measures (Crifo and Forget 2015).

Our results suggest that there is no evidence of a trade-off between economic performance and CSR compliance measures. If anything, certain CSR compliance measures appear to ameliorate cost efficiency. The results should encourage policymakers and managers not to be deterred from embracing CSR.

Of course, our evidence for a positive impact of CSR on cost efficiency is only tentative. Firm evidence on the issue should be based on a more comprehensive measure of CSR and more extensive data than used in this paper. However, this paper has introduced a hitherto unused empirical framework, in the literature, that can arguably take the literature forward to establishing the precise relationship between CSR and economic/financial performance.

Author contributions

Tu Van Binh: Conceptualization; datacollection; formal analysis; writing - original draft.

Abay Mulatu: Conceptualization; methodology;formal analysis; writing - review & editing.

BoyingXu: Literature search; writing - review & editing.

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Appendix

Table A1. ~TC~

	Education as instrument				Firm Size as instrument			
Variables	Model EX		Model EN		Model EX		Model EN	
Dependent variable: LnC								
Constant	2.606	(1.601)	2.260	(1.601)	2.606	(1.601)	1.970	(1.609)
LnY	0.897***	(0.091)	0.915***	(0.091)	0.897***	(0.091)	0.931***	(0.091)
LnL	0.081***	(0.008)	0.080***	(0.008)	0.081***	(0.008)	0.079***	(0.008)
LnM	−0.691**	(0.254)	−0.675**	(0.255)	−0.691**	(0.254)	−0.658*	(0.257)
LnT	−0.318*	(0.147)	−0.295*	(0.147)	−0.318*	(0.147)	−0.278	(0.147)
LnYLnY	−0.007	(0.004)	−0.007	(0.004)	−0.007	(0.004)	−0.007	(0.004)
LnLLnL	0.019	(0.011)	0.021	(0.011)	0.019	(0.011)	0.024*	(0.011)
LnMLnM	−0.016***	(0.004)	−0.016***	(0.004)	−0.016***	(0.004)	−0.016***	(0.004)
LnTLnT	0.011	(0.007)	0.011	(0.007)	0.011	(0.007)	0.012	(0.007)
LnYLnL	−0.005	(0.006)	−0.005	(0.006)	−0.005	(0.006)	−0.005	(0.006)
LnYLnM	0.028***	(0.008)	0.028***	(0.008)	0.028***	(0.008)	0.027**	(0.008)
LnYLnT	0.015***	(0.004)	0.014***	(0.004)	0.015***	(0.004)	0.013**	(0.004)
LnLLnM	−0.002	(0.010)	−0.002	(0.010)	−0.002	(0.010)	−0.002	(0.010)
LnLLnT	−0.005	(0.004)	−0.006	(0.004)	−0.005	(0.004)	−007*	(0.004)
LnMLnT	0.024	(0.014)	0.023	(0.014)	0.024	(0.014)	0.023	(0.014)
Dependent variable: $\ln(\sigma^2\_u)$								
Constant	−2.559***	(0.150)	−2.066***	(0.160)	−2.559***	(0.150)	−1.590***	(0.196)
CSR	−0.765***	(0.086)	−1.039***	(0.100)	−0.765***	(0.086)	−1.313***	(0.128)
Dependent variable: $\ln(\sigma^2\_v)$								
Constant	−3.277***	(0.026)			−3.277***	(0.026)		
Dependent variable: $\ln(\sigma^2\_w)$								
Constant			−3.295***	(0.026)			−3.306***	(0.027)
eta1 (CSR)			0.039***	(0.007)			0.043***	(0.007)
eta Endogeneity Test			χ^2=28.37	P=0.007			χ^2=33.74	p=0.000
Observations	3857		3857		3857		3857	
Log Likelihood	539.64		−2438.65		539.64		−3490.21	
Mean Cost Efficiency	0.903		0.902		0.903		0.901	
Median Cost Efficiency	0.913		0.915		0.913		0.919	

Notes: Standard errors are in parentheses. Asterisks indicate significance at the 0.1% (***), 1% (**) and 5% (*) levels.