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What are the characteristics of an efficient firm in developing countries' private sector? The case of Vietnam

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Abstract. *The private sector is the primary source of local development in developing countries. Previous research in developing countries has documented many factors contributing to firm-level efficiency. However, which of these factors are most likely to correlate with efficiency? This paper studies the relative importance of the firm-level efficiency determinants in a transitional economy, using a firm-level panel dataset in Vietnam between 2005 and 2015. The empirical results show that firm-specific production and labor characteristics are the most significant determinants of efficiency. Thus, firms actively seeking to improve their own production process and labor force can be well-rewarded. Moreover, government technical supports and human resource training programs, combined with anti-corruption efforts, are beneficial for firm-level efficiency, thereby improving the living standards in developing economies.*

Keywords: efficiency, SMEs, transitional economy

JEL Codes: D2, L2, O25

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1. Introduction

Private enterprises are the main contributor to local development in developing countries [1]. Previous research on firms' performance in developing countries have identified many factors that contribute to firm-level efficiency [6, 7, 8]. Yet, due to limited availability of data, little is known about the relative importance of these efficiency determinants. For this reason, many efforts have been made to improve the quality of the firm-level data in developing countries. In light of the recent improvements in firm-level data for developing countries, this paper presents a comprehensive analysis on the contribution of various internal and external factors to the profitability of private enterprises in developing countries.

Specifically, I ask the following research questions. First, how efficient are firms in developing countries? Second, what are the most important characteristics of an efficient firm? Finally, what policy is the most effective at improving the firm-level efficiency? I answer these questions by combining the stochastic frontier

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framework, an econometric technique commonly used in the study of productive efficiency, with a detailed firm-level panel dataset of Vietnamese firms between 2005 and 2015.

Vietnam is an interesting site to study the above research questions. First, as a transitional economy, Vietnam shared many similarities to other developing countries. For example, small and medium firms comprise most of the Vietnamese private sector and hire the largest share of the Vietnamese labor force [5]. Moreover, like other transitional economies, Vietnam has undergone several reforms, which transformed the country from a closed economy to an open market economy. Second, since 2005, the Vietnam Central Institute for Economic Management (CIEM) has established the Small and Medium Enterprise survey to improve the understanding of firms' performance in Vietnam [2]. This comprehensive survey covers multiple industries and geographical regions and includes both formally-registered and informal firms. The detailed information provided by this dataset is useful to analyze the relative importance of various determinants of firm-level profitability in a transitional economy.

To study the relative importance of the firm-level efficiency determinants, I employ a stochastic profit frontier framework, a technique commonly used in the study of productive efficiency [9]. Under this framework, firms maximize profits by choosing a combination of inputs and outputs, taking as given technology and prices. Compared to the regular linear regression model, this profit frontier model has two advantages. First, it allows the estimation of the gap between firms' actual profit and their maximum attainable profit. Second, the stochastic frontier model allows the separation of firms' deviations from the optimal profit into two categories, in contrast to regular linear regression models which lump all deviations from a firm's optimal profit level into one symmetrically distributed random error term. The first type of deviation is due to randomness in the production process such as weather or other acts of nature, therefore, it either positively or negatively influences firm's profitability and is modelled using the symmetrically distributed error term, as in traditional linear regression models. The second type of deviation comes from the firms' inability to allocate their resources efficiently, given technology, prices and the existence of random events. This resource allocation failure negatively impacts the firm's profitability; therefore, it is modelled as a one-sided error that only takes negative values. The direct modelling of this resource allocation failure is a useful tool to study the relative importance between the main determinants of firm-level efficiency.

The estimation results show that on average, private manufacturing firms in Vietnam lose about 29.9% of annual profit due to inefficiency, where the problem of inefficiency is more severe in heavy industries than light industries. Moreover, I find that firm's size is the most significant internal characteristic of an efficient firm, followed by innovation and human capital. Thus, policies that encourage firms to improve their own internal strength, such as improved access to the labor market, innovation incentives and labor training programs, can promote the firm-level efficiency. Other external characteristics such as competition and exporting activity also matter for the firms' efficiency, where firms who face competition or engage in exporting activity are more profitable. In addition, better access to credit and lower bribery also increases the firm-level efficiency. The results imply the importance of creating a healthy competitive business environment and improving the transparency of the legal system in the growth of small and medium firms.

This paper is related to the extensive literature studying firm-level productivity growth. This literature has identified a long list of factors that influence the firm-level productivity, however, little has been known about the relative importance of these factors, due to the lack of a comprehensive firm-level dataset in

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developing countries [13]. Therefore, while previous studies gain useful insights into the role of individual factors in determining productivity growth, they also present a challenge for policymakers to identify the most important policy targets. Using a detailed firm-level panel dataset in Vietnam, this paper provides practical policy recommendations to increase productivity growth in developing countries through ranking various efficiency determinants by their orders of effectiveness. As the firm-level productivity is known to be an important indicator of aggregate industry- or country-level productivity [1], this paper also contributes to the literature studying the sources of aggregate productivity growth by identifying the most important productivity drivers at the micro level.

The rest of the paper is organized as follow. Section 2 presents the econometric framework while section 3 describes the empirical context of the study. Section 4 discusses the main estimation results and section 5 presents the robustness analysis. Finally, a concluding remark is provided in section 6.

1. Econometric framework

The goal of this study is to understand the relative importance of various factors in determining productive efficiency in developing countries. The literature studying productive efficiency is extensive and can be dated back to the theoretical work by [4], who defines firms' efficiency as the distance between firms' current productive status and their maximum attainable outcome based on criteria such as production output, cost or profit. Econometric specification of firms' production behavior that allows for the existence of inefficiency is known as stochastic frontier analysis. This technique assumes that firms operate on or beneath a productive frontier, which captures the optimal allocations of production activities such that firms' production cost (profit) is minimized (maximized). Firms who operate on the productive frontier are considered efficient while firms who operate underneath the productive frontier are considered inefficient. The further a firm is from its productive frontier, the more inefficient it is.

Stochastic frontier analysis assumes two factors that affect firms' deviations from their productive frontier. The first characterizes the randomness in the production process (for example, weather or other acts of nature) and thus takes on both positive and negative values. The second characterizes the possibility that the firm is operating inefficiently and thus takes on only negative values. Thus, econometric specification under stochastic frontier analysis departs from the assumption of a symmetric random error in traditional ordinary least squares (OLS) regressions. Instead, it involves both a two-sided error term that captures the randomness in production and a one-sided error term that captures firms' inefficiency. This allows the estimation of the mean and variance of efficiency, thereby informing policymakers about the extent to which efficiency vary among firms [9].

Many previous studies rely on the estimation of production or cost frontiers to determine the efficiency level of a decision-making unit. Under this approach, firms choose between different combinations of inputs to produce an exogenous level of output. While the assumption of exogenous output is appropriate in some settings, in most cases, producers are responsible for choosing both the input and output quantities. To account for this, the estimation of firms' efficiency measurement should involve a profit frontier

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specification. In this paper, I employ the stochastic profit frontier framework to estimate the profit efficiency of Vietnamese SMEs and to analyze the factors that contribute to the performance of these firms. Following (Kumbakar 2015), the specification of the stochastic profit frontier model is as follow:

$$\ln \pi_{it}^{a} = \ln \pi (p_{it}, w_{it}, k_{it}) + \epsilon_{it} - u_{it} + \eta_s + \eta_t + \eta_{st}, \quad (1)$$

where i denotes firm and t denotes time. π_{it}^{a} denotes a firm's actual short-run profit, which is calculated as its revenue minus its variable costs (the sum of labor and material costs). $\pi(p_{it}, w_{it}, k_{it})$ represents the firm's short-run profit frontier, which is the maximum attainable profit the firm could achieve, given the variable input price vector (w_{it}), the output price (p_{it}) and the quantity of fixed input (k_{it}). This econometric framework assumes that firms are price-takers, which is a reasonable assumption for small and medium firms.

Two factors contribute to the deviation of firm's actual profit from its profit frontier. First, there exists randomness in the production process, due to an unusually favorable (or unfavorable) operating environment (for example, weather or other acts of nature), which may cause firms to perform better (or worse) than their potential. This randomness in the production process is captured in the mean-zero error term ϵ_{it}. Second, a firm can deviate from its profit frontier because it was operating inefficiently, where its chosen production plan does not lead to the maximum attainable profit. These mistakes in the production of outputs and uses of inputs are captured in the non-negative random inefficiency parameter u_{it}. Finally, η_s, η_t, and η_{st} capture industry-, time- and industry×time fixed effects. The fixed effects capture the variations between industries and over time of the profit frontier.

Estimating the model in (1) requires parametric specifications of the functional form of $\ln \pi (p_{it}, w_{it}, k_{it})$ as well as the distributions of ϵ_{it} and u_{it}. I assume that the profit frontier $\ln\pi(p_{it}, w_{it}, k_{it})$ takes the form of a translog profit function. This profit function must satisfy homogeneity of degree one in input and output prices. This can be achieved by normalizing the input prices and profit by the output price. Let $ln\pi_{it} = \ln \pi (p_{it}, w_{it}, k_{it})$, the normalized translog profit frontier ($\ln \frac{\pi_{it}}{p_{it}}$) is as follow:

$$\ln \frac{\pi_{it}}{p_{it}} = \alpha_0 + \sum_j \alpha_j \ln \frac{w_{jit}}{p_{it}} + \alpha_k \ln k_{it} + \frac{1}{2}\sum_j \sum_q \delta_{jq} \ln \frac{w_{jit}}{p_{it}} \ln \frac{w_{qit}}{p_{it}} + \frac{1}{2}\delta_{kk}(\ln k_{it})^2 + \sum_j \delta_{jk} \ln \frac{w_{jit}}{p_{it}} \ln k_{it} \quad (2)$$

, where w_{jit} denotes the price of variable input j for firm i during period t and j is equal to m (raw materials) or l (labor).

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Combining (1) and (2) yields the following estimation equation:

$$\ln \frac{\pi_{it}^{a}}{p_{it}} = \alpha_0 + \sum_j \alpha_j \ln \frac{w_{jit}}{p_{it}} + \alpha_k \ln\ k_{it} + \frac{1}{2}\sum_j \sum_q \delta_{jq} \ln \frac{w_{jit}}{p_{it}} \ln \frac{w_{qit}}{p_{it}} + \frac{1}{2}\delta_{kk}(\ln\ k_{it})^2 + \sum_j \delta_{jk} \ln \frac{w_{jit}}{p_{it}} \ln\ k_{it} + \epsilon_{it} - u_{it} + \eta_s + \eta_t + \eta_{st}. \quad (3)$$

In addition to the homogeneity restriction, the above profit function also satisfies a symmetry condition, namely $\delta_{jq} = \delta_{qj}$ and $\delta_{jk} = \delta_{kj}\ \forall j, q, k$. Finally, ϵ_{it} follows a normal distribution ($lon \sim N(0, \sigma_{\epsilon}^2)$) and u_{it} follows a truncated normal distribution ($u \sim N^{+}(0, \sigma_u^2)$).

The objective of this paper is not only to estimate the level of efficiency for Vietnamese SMEs but also to identify the factors that contribute to inefficiency. To do so, I model the distribution function of the inefficiency parameter u_{it} as a function of other explanatory variables. Specifically:

$$\sigma_{u,it}^2 = \exp\,(\boldsymbol{z}_{it}^{T}\beta_u), \quad (4)$$

where $\boldsymbol{z}_{it} = (z_{1it}, z_{2it}, \ldots, z_{kit}, \ldots, z_{Kit})$ is a firm-specific vector of variables which may influence the efficiency of a firm and $\beta_u = (\beta_{1u}, \beta_{2u}, \ldots \beta_{ku}, \ldots \beta_{Ku})$ is the corresponding coefficient vectors. The efficiency explanatory vector $\boldsymbol{z}_{it}$ includes firm-specific characteristics that determine a firm's success or failure at allocating their resources in a profit-maximizing manner. Since u_{it} captures the amount of profit lost due to inefficiency, a positive $\beta_{ku}(k = 1, \ldots K)$ indicates a positive relationship between the efficiency explanatory variable $z_{kit}, (k = 1, \ldots K)$ and a firm's inefficiency level, thereby suggesting a negative relationship between z_{kit} and afirm's profitability. On the other hand, a negative $\beta_{ku}(k = 1, \ldots K)$ suggests a positive relationship between $z_{kit}, (k = 1, \ldots K)$ and a firm's profitability.

Equations (3) and (4) are simultaneously estimated using a maximum likelihood estimator. Based on the estimation results, the profit efficiency can be defined as:

$$PE_{it} = \frac{\pi_{it}^{a}}{\pi_{it|u_{it}=0}^{a}}, \quad (5)$$

where PE_{it} measures the actual profit for firm i at time t relative to the profit of a fully efficient firm who is subject to the same prices and fixed input quantity.

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Finally, following [9], the implied changes in expected profit from changes in the efficiency explanatory variables ($\frac{\Delta E[ln\ \pi_{it}^{a}]}{\Delta \boldsymbol{z}_{it}}$) are derived from the estimated values of β_u and $\sigma_{u,it}^2$. Specifically, the marginal effect of the kth element of $\boldsymbol{z}_{it}$ is given by:

$$\frac{\Delta E[\ln\ \pi_{it}^{a}]}{\Delta z_{kit}} = -\beta_{ku}\frac{\sigma_{u,it}}{2}\left[\frac{\phi(0)}{\Phi(0)}\right], \tag{6}$$

where z_{kit} denotes the kth element of $\boldsymbol{z}_{it}$ and β_{ku} is the corresponding coefficient estimated from equation (4). $\phi(.)$ and $\Phi(.)$ are the probability density and probability distribution functions of a standard normal variable. The magnitudes of the estimated marginal effects in equation (6) allows us to quantify the relative importance of various factors on the firm-level efficiency.

2. Data

To understand the role of different variables on firm-level efficiency in developing countries, I analyze the stochastic profit frontier model in the context of Vietnam. As a transitional economy, Vietnam shares several similarities with other developing countries. First, the private sector, which consists primarily of small and medium enterprises (SMEs), is crucial to economic development [5]. Second, like other transitional economies, Vietnam has undergone several reforms for the last three decades, which transforms the country from a closed, centrally-planned economy to an open, market-oriented economy.

The common characteristics between Vietnam and other developing countries make Vietnam a good case study of the business environment in developing countries. Additionally, since 2005, the Vietnam Center Institute for Economic Management (CIEM) has established the Small and Medium Enterprise (SME) survey to better understand the operation of SMEs [2]. This comprehensive dataset covers different types of ownership, industries and geographical regions of Vietnam and contains rich firm-level information, such as their financial accounts, production and sales structure, employment and cost structure, economic constraints and potentials. Therefore, taking advantage of the rich Vietnam SME dataset, this paper aims at ranking the contributions of various factors to the firm-level productivity. Table 1 shows the distribution of firms across types of ownership and industry.

I employ the stochastic profit frontier approach discussed in section 2 as the main empirical framework. The econometric specification of a firm's stochastic profit frontier consists of two components: (i) the profit frontier component that describes firms' optimal level of profits given their input and output prices (equation (3)); and (ii) a component that models the sources of inefficiency for each firm (equation (4)). Therefore, it requires two sets of variables. First, estimating the profit frontier in equation (3) requires information on firm-level annual profits, fixed inputs, and firm-level prices of output and variable inputs. Second, estimating

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the efficiency explanatory equation (4) and the marginal effects of different variables on efficiency (equation (6)) requires data on the internal and external factors that potentially contribute to the discrepancy between firms' current profit and their optimal profit level. Next, I describe in detail the variables needed to estimate this profit frontier model.

Table 1. Distribution of firms across ownership types and industries.

		Ownership type					
Survey year	Industry	Household	Sole proprietorship	Partnership/ Collective/ Cooperative	Limited liability	Joint stock	Total
2005	Heavy	878	171	65	246	29	1,389
	Light	1,012	109	31	183	25	1,360
	Total	1,890	280	96	429	54	2,749
2007	Heavy	602	86	53	177	22	940
	Light	1,155	111	49	261	32	1,608
	Total	1,757	197	102	438	54	2,548
2009	Heavy	535	83	40	217	40	915
	Light	1,170	121	34	290	50	1,665
	Total	1,705	204	74	507	90	2,580
2011	Heavy	482	86	41	231	42	882
	Light	1,143	116	27	287	59	1,632
	Total	1,625	202	68	518	101	2,514
2013	Heavy	453	89	29	244	55	870
	Light	1,141	113	26	307	59	1,646
	Total	1,594	202	55	551	114	2,516
2015	Heavy	555	80	31	305	65	1,036
	Light	1,088	82	22	313	58	1,563
	Total	1,643	162	53	618	123	2,599
Light industries include firms producing food, beverages and tobacco products; textile and leather-related products; paper and printing products; and furniture manufacture. Heavy-industries include manufacturers of machinery and equipment, chemical, metal, rubber and non-metallic products.							

2.1. Profit frontier variables

The analysis of the profit frontier equation (3) requires the construction of firm-level profit (π_{it}^{a}), output price (p_{it}), variable input prices (w_{jit}), and fixed input (k_{it}), where variable inputs consist of labor (l) and raw materials (m).

Profit (π_{it}^{a}) is measured by the annual gross margin, which is the difference between a firm's revenue from production and its variable costs. Fixed inputs (k_{it}) is measured by the value of all productive physical

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assets, which includes the values of buildings, machinery and equipment. The price of labor (w_{lit}) is calculated by dividing the total wage expenditure by the number of employees (i.e. the quantity of labor).

While firm-level data on gross margin (π_{it}^{a}), capital stock (k_{it}), labor, total revenue and total input expenditure are available, firm-level data are not available on the price of raw materials and output. One approach to generate input and output prices is to use the industry-level price indices (e.g. [12]). To account for the price variations among firms, each price used in this study is weighed by the transactions made during the year through different market channels. Specifically, the price of output (p_{it}) and raw materials (w_{mit}) are proxied by:

$$p_{it} = s_{d,it}^{o} * P_{dt} + s_{f,it}^{o} * P_{ft}, \quad (7)$$

$$w_{mit} = s_{d,it}^{m} * W_{dt} + s_{f,it}^{m} * W_{ft}, \quad (8)$$

where i, t denotes firm and time. $s_{d,it}^{o}$ ($s_{d,it}^{m}$) is the share of output (raw materials) that is sold (acquired) domestically, while $s_{f,it}^{o}$ ($s_{f,it}^{m}$) is the share of output (raw materials) that is sold (acquired) internationally through exports (imports). P_{dt} represents the price index of domestic goods while P_{ft} is the price index of exported goods. Finally, W_{dt} is the price index of domestic raw materials and W_{ft} is the price index of imported raw materials. Data for the price indices are extracted from the Statistical Yearbook of Vietnam Statistical Yearbook of Vietnam [5]. The construction of the prices in equation (7) is based on two assumptions. First, firms are price takers in the output and input markets. And second, firms produce a single output and use only one type of raw material in production. In this case, the price-taking assumption is reasonable because small and medium firms in the dataset often operate industries with a large number of firms such as the food, tobacco and beverage industry or the textile industry, therefore, given their smaller sizes, these firms have little power over the market prices.

Table 2. Summary statistics of profit frontier variables by industry and by ownership status

	Profit	Raw material expenditure	Wage expenditure	Physical capital
By industry:				
Light industries	601.56 (4132.78)	3910.26 (88854.18)	469.36 (1852.43)	3403.83 (14246.52)
Heavy industries	871.03 (6395.50)	5677.73 (70372.75)	529.81 (1516.75)	4852.99 (20638.28)
By ownership status:				
Household firms	152.66 (393.80)	600.51 (2216.56)	102.72 (179.75)	1286.42 (3110.27)
Non-household firms	1805.7 (8950.7)	12132.91 (135281.7)	1156.33 (2623.96)	9163.98 (27987.82)
All numbers are in millions of Vietnam dongs. Numbers in parentheses are standard deviations.				

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Moreover, most firms in the dataset produce only one type of output and the average number of products that each firm produces is 1.16, therefore, without loss of generality, we can assume a single output price for every firm. On the other hand, raw materials typically include many different items. However, it is common in the literature to treat materials as a homogeneous input [10]. Table 2 reports the average profit, raw material expenditure, wage expenditure and value of the capital stock for all SMEs over the period of 2005-2015.

2.2. Efficiency explanatory variables

The profit frontier variables discussed above are helpful in estimating firms' maximum attainable profit, given the quantity of fixed inputs and the prices of output and variable inputs. The gap between this maximum profit and the actual profit allows us to infer about the level of profit efficiency for each firm. Possible factors that might affect this efficiency gap are modeled using the efficiency explanatory equation (4). These factors are either inherent within the firms themselves (the internal environment) or capture characteristics of the business and legal environment in which the firms operate (the external environment). Both the internal and external factors are available at the firm level and are discussed in detail below.

3.2.1. The internal determinants of profit efficiency

Internal factors such as human capital, firm's age, size and improvements of the production process have been known in the literature as important determinants of firm's performance (for example, [8, 11]). In this paper, human capital is proxied by both the characteristics of the firms' owner-managers and labor training activity. A firm's effort to upgrade its production process is captured by a dummy variable which equal 1 if the firm introduces a new product, modifies its existing product, or modify its production process in the previous year. Firm's age is measured as the number of years since the firm's establishment up until the survey year while firm's size is measured using the number of employees.

3.2.2. The external determinants of profit efficiency

Besides the internal characteristics of the businesses, external environmental factors also play a role in determining firm-level performance. These external factors represent the business and legal environment in which the firms operate.

First, the business environment is captured by dummy variables which show the various relationships between the firms and other business entities. Competition is measured by a dummy variable which equals 1 if the firm reports that they faced competition. A firm's exporting activity is measured by a dummy variable that equals 1 if the firm exports, while a firm's subcontracting activity is measured by a dummy variable that equals 1 if the firm is a subcontractor. Besides competition and business partnership, the ability to obtain capital also determines firm-level success [7]. In this paper, a firm's access to formal credit is measured by a dummy variable which equals 1 if the firm has difficulty in obtaining formal credit while a firm's use of informal credit is measured by a dummy variable which equals 1 if the firm use informal credit as a source of

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financing. Finally, to capture other characteristics of the business environment, dummy variables which indicate a firm's locations are also included in the analysis.

Besides the business environment, the legal systems can also influence a firm's performance [3, 15]. In this paper, I consider three main indicators of the legal environment, which are formalization, government assistance and corruption. Formalization is measured by a dummy variable which equals 1 if the firm is formally registered while government assistance is captured by a dummy variable which equals 1 if the firm receives assistance from the government. Finally, corruption is measured by the amount of bribery that firms pay as a percentage of total revenue. Table 3 provides the description of the efficiency explanatory variables included in this study and table 4 provide the summary statistics of these variables.

Table 3. Summary of efficiency explanatory variables

Variable	Description
Internal environment:	
Owner's education	=1 if owner finishes primary school
Labor training	=1 if the firm has provided training for its labor force since the last survey
Innovation	=1 if the firm introduces a new product, modifies its existing product, or modify its production process in the last survey.
Firm's age	=Survey year - Year of establishment.
Firm's size	Log of the number of workers.
Business environment:	
Competition	=1 if the firm faces competition.
Subcontracting	=1 if the firm is a subcontractor.
Exporting	=1 if the firm exports.
Formal credit constraint	=1 if the firm has had any difficulty in obtaining formal credit since last survey.
Informal credit usage	=1 if the firm has used informal credit since last survey.
Industrial zone	=1 if the firm is located inside an industrial zone.
Urban	=1 if the firm is located in an urban area.
Legal environment:	
Formalization	=1 if the firm is formally registered.
Assistance	=1 if the firm has received any government assistance since last survey.
Bribery	Amount of bribery (% of revenue).

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Table 4. Summary statistics of efficiency explanatory variables

	All firms	By industry		By ownership status	
		Light	Heavy	Household	Non-household
Internal environment:					
Owner's education	0.976 (0.153)	0.975 (0.156)	0.978 (0.148)	0.967 (0.179)	0.994 (0.080)
Labor training	0.162 (0.369)	0.138 (0.345)	0.192 (0.394)	0.086 (0.281)	0.309 (0.462)
Innovation	0.424 (0.494)	0.361 (0.480)	0.500 (0.500)	0.365 (0.482)	0.535 (0.499)
Firm's age	14.276 (10.362)	15.080 (10.749)	13.286 (9.775)	15.873 (10.679)	11.211 (8.960)
Firm's size	1.844 (1.169)	1.717 (1.176)	1.999 (1.141)	1.296 (0.774)	2.895 (1.076)
Business environment:					
Competition	0.876 (0.329)	0.858 (0.349)	0.899 (0.301)	0.847 (0.360)	0.933 (0.251)
Subcontracting	0.103 (0.305)	0.085 (0.279)	0.126 (0.332)	0.086 (0.281)	0.137 (0.344)
Exporting	0.062 (0.242)	0.074 (0.261)	0.049 (0.215)	0.013 (0.112)	0.158 (0.365)
Formal credit constraint	0.236 (0.424)	0.209 (0.406)	0.269 (0.443)	0.209 (0.407)	0.287 (0.452)
Informal credit usage	0.540 (0.498)	0.513 (0.500)	0.574 (0.495)	0.494 (0.500)	0.629 (0.483)
Industrial zone	0.054 (0.225)	0.044 (0.204)	0.066 (0.248)	0.015 (0.122)	0.127 (0.333)
Urban	0.437 (0.496)	0.386 (0.487)	0.500 (0.500)	0.318 (0.466)	0.665 (0.472)
Legal environment:					
Formalization	0.714 (0.452)	0.669 (0.471)	0.771 (0.420)	0.573 (0.495)	0.987 (0.114)
Assistance	0.227 (0.419)	0.219 (0.413)	0.238 (0.426)	0.209 (0.407)	0.262 (0.440)
Bribery	0.001 (0.011)	0.001 (0.007)	0.002 (0.014)	0.001 (0.011)	0.002 (0.010)
Observations	14,975	8,262	6,713	9,854	5,121
Numbers in parentheses are standard deviations.					

3. Main empirical results

This section presents the main estimation results. Table 5 reports the estimation results of the profit frontier equation (3), the efficiency explanatory equation (4) and the marginal effects on expected profit of each efficiency explanatory variable ($\frac{\Delta E[ln\ \pi_{it}^{a}]}{\Delta z_{it}}$) for the full sample (columns(1)-(3)), the light industries (columns (4)-(6)) and the heavy industries (columns (7)-(9)) between 2005 and 2015. Light industries include manufacturers of products such as food, beverages and tobacco products; textile and leather-related products; paper and printing products; and furniture manufacture. Heavy-industry firms include manufacturers of machinery and equipment, chemical, metal, rubber and non-metallic products.

3.1. How efficient are private firms in Vietnam?

The estimation results for the whole sample in table 5 show that the average profit efficiency of non-state manufacturing firms between 2005 and 2015 is 70.1%. In other words, on average, firms earn 29.9%

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less than their estimated maximum attainable profit due to inefficiency. To get a sense of the potential loss in profit, I compare this to the average profit of a firm in this dataset. The average reported annual profit for a firm in the dataset is 715.6 million Vietnam dongs (approximately 31,000 USD). An average efficiency level of 70.1% implies that firms could increase their annual profit by about 305.2 million Vietnam dongs (approximately 13,000 USD) if they perform at their best potentials. The industry-specific estimation results indicate that on average, firms in the light industries are slightly more efficient than firms in the heavy industries. The average profit efficiency is 70.8% for light-industry firms and 68.0% for heavy industry firms. The average reported profit for firms in the light industries is 601.5 million Vietnam dongs (approximately 26,135 USD), which implies that light-industry firms could increase their profit by 248 million Vietnam dongs (approximately 10,775 USD) if they operate efficiently. Similarly, the average reported profit for firms in the heavy industries is 855.5 million Vietnam dongs (approximately 31,170 USD) and a profit efficiency level of 68.0% implies that the average loss due to inefficiency of heavy-industry firms in the dataset is 402.6 million Vietnam dongs (approximately 17,500 USD).

In short, the results show that firms are not operating at their full potential. This finding is consistent with previous studies in other countries (e.g. [6, 14]). Next, I will analyze the relative importance of various internal and external characteristics on the firm-level efficiency.

3.2. What internal and external characteristics do an efficient firm possess?

The profit frontier model in section 2 not only reveals about the distance between a firm's current level profit and its maximum attainable profit, but also allows the identification of the determinants of efficiency. The bottom half of table 5 presents the estimation results of the efficiency explanatory equation (4) and the implied change or marginal effect of each variable that explains efficiency on expected profit. Overall, the profit efficiency level of a firm depends on characteristics of its internal environment, regardless of which industry it is in, therefore, a firm's action to improve its internal environment can be beneficial for its efficiency.

The estimation results in table 5 show that the three most important internal characteristics of an efficient firm are its size, its effort to upgrade the production process or to improve its products, with firms' size being the most significant contributor to the firm-level profitability. These results are consistent when the whole sample is divided into light-industry firms and heavy-industry firms (columns (4)-(9) of table 5). One explanation is that while the benefits from expanding a firm's size can be realized in the short run, the impact lag of other variables on efficiency is longer. For example, it takes more time for a new production process to be fully efficient and for new products to be accepted by consumers. Similarly, it takes more time for human capital improvements to be translated into higher profitability.

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Table 5. The profit frontier and determinants of profit efficiency between 2005 and 2015

	Whole sample			Light industries			Heavy industries		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Coef.	Std.Err.	$\frac{\Delta E[ln\ \pi_{it}^{a}]}{\Delta z_{..}}$	Coef.	Std.Err.	$\frac{\Delta E[ln\ \pi_{it}^{a}]}{\Delta z_{..}}$	Coef.	Std.Err.	$\frac{\Delta E[ln\ \pi_{it}^{a}]}{\Delta z_{..}}$
Profit frontier equation:									
α_m	1.761**	(0.887)		2.448**	(1.192)		-0.806	(1.385)	
α_l	-0.075	(0.074)		-0.401***	(0.098)		0.407***	(0.123)	
α_k	0.106***	(0.031)		0.209***	(0.039)		-0.125**	(0.053)	
δ_{mm}	1.850***	(0.380)		1.456***	(0.457)		1.768**	(0.817)	
δ_{ll}	0.032***	(0.009)		0.017	(0.012)		0.031*	(0.016)	
δ_{kk}	0.034***	(0.002)		0.031***	(0.002)		0.043***	(0.003)	
δ_{ml}	0.509***	(0.169)		0.687***	(0.227)		0.227	(0.266)	
δ_{mk}	-0.091	(0.089)		-0.181	(0.121)		0.206	(0.134)	
δ_{lk}	0.085***	(0.007)		0.119***	(0.010)		0.025**	(0.012)	
Constant	-0.837***	(0.147)		-1.569***	(0.184)		0.570**	(0.258)	
Average profit	70.1%			70.8%			68.0%		
Efficiency explanatory equation:									
Internal environment:									
Owner's	-0.291**	(0.145)	0.065	-0.219	(0.184)	0.05	-0.432*	(0.239)	0.105
Labor training	-0.205	(0.136)	0.046	-0.601**	(0.246)	0.138	0.025	(0.152)	-0.006
New product	-0.061	(0.111)	0.014	-0.082	(0.159)	0.019	-0.148	(0.146)	0.036
Product	-0.428***	(0.077)	0.096	-0.455***	(0.114)	0.104	-0.259**	(0.108)	0.063
Process	-0.470***	(0.145)	0.106	-0.667***	(0.223)	0.153	-0.119	(0.176)	0.029
Firm's age	0.013***	(0.002)	-0.003	0.013***	(0.003)	-0.003	0.012***	(0.004)	-0.003
Firm's size	-1.464***	(0.056)	0.329	-1.473***	(0.078)	0.337	-	(0.080)	0.331
Business environment:									
Competition	-0.160**	(0.069)	0.036	-0.152*	(0.085)	0.035	-0.207*	(0.125)	0.05
Subcontracting	0.231**	(0.102)	-0.052	0.216	(0.165)	-0.049	0.134	(0.130)	-0.033
Exporting	-1.130**	(0.498)	0.254	-1.749**	(0.883)	0.4	-0.909*	(0.550)	0.221
Formal credit	-0.094	(0.073)	0.021	-0.172*	(0.100)	0.039	-0.006	(0.108)	0.001
Informal credit	-0.154**	(0.061)	0.035	-0.159**	(0.079)	0.036	-0.171*	(0.099)	0.042
Industrial zone	-0.560*	(0.293)	0.126	-0.443	(0.385)	0.101	-0.712	(0.463)	0.174
Urban	-0.096	(0.175)	0.021	-0.127	(0.257)	0.029	0.072	(0.233)	-0.018
Legal environment:									
Formalization	-0.085	(0.077)	0.019	-0.031	(0.104)	0.007	-0.208*	(0.122)	0.051
Government	-0.086	(0.076)	0.019	-0.044	(0.100)	0.01	-0.071	(0.118)	0.017
Bribery	4.506	(2.898)	-1.011	12.969**	(5.111)	-2.969	12.389*	(7.133)	-3.018
Constant	1.290***	(0.262)		1.248***	(0.330)		2.226***	(0.400)	

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Log likelihood	-18801.88			-			-7233.26	
Observations	14,484			8,011			5,512	
Sub-industry	YES			YES			YES	
Year FE	YES			YES			YES	
Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1								

In addition to the firm-specific characteristics, the external environment in which the firms operate also plays a role in shaping their efficiency. The results show that competition, exporting and access to credit are the largest contributors to efficiency of firms in both heavy and light industries. Specifically, competition increases firm-level efficiency, as it motivates firms to improve its production and encourages inefficient firms to exit the market. Table 5 also suggests that firms who engage in exporting activities and have better access to credit tend to be more efficient. Finally, bribery is associated with lower level of profitability in both the light and heavy industries.

4. Robustness checks

This section presents some robustness check of the main estimation results in section 4. Specifically, I consider alternative sub-samples in the dataset and alternative specifications of the profit frontier models.

To account for the fact the different types of firms have access to different technology, I apply the stochastic profit frontier model in section 2 to various subsamples in the dataset. Specifically, I re-estimate the profit frontier model using only incumbent firms who are present in all six rounds of the survey between 2005 and 2015. This is to account for the potential bias from the inclusion of firms who are not present in all rounds of the survey. In addition, I further classify firms into household (family-owned) businesses and non-household businesses. Table 6 presents a summary of the estimation results of the above robustness checks for the whole sample (columns (1)-(4)), the light industries (columns (5)-(8)) and the heavy industries (columns (9)-(12)). Overall, the main estimation results still hold for these alternative sub-samples. However, household firms are more likely to benefit from formalization while non-household firms are more prone to bribery. This reflects that on average, non-household businesses pay bribery more frequently than household businesses. Thus, this also suggests the existence of a crowding-out effect between formalization and corruption.

Next, I estimate the profit efficiency for all firms in the sample under alternative specifications of the model described in section 2. This is to account for the potential correlations between closely related variables. Table 7 shows the marginal effects of each efficiency explanatory variable on the profit efficiency of the full sample, under alternative measures of human capital (columns (2)-(3)), production upgrading activities (columns (4)-(6)), access to credit (columns (7)-(8)) and firm's location (columns (9)-(10)). Overall, the main results in section 4 still hold under these alternative specifications.

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Table 6. Marginal effects on profit efficiency ($\frac{\Delta E[ln\ \pi_{it}^{a}]}{\Delta z_{it}}$), alternative sub-samples

	Whole sample				Light industries				Heavy industries			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	All firms	Incumbent firms only	Household firms only	Non-household firms only	All firms	Incumbent firms only	Household firms only	Non-household firms only	All firms	Incumbent firms only	Household firms only	Non-household firms only
Internal environment												
Owner's	+**	+*	+**	+	+	+	+	+	+*	+	+**	+
Labor training	+	+	+***	+	+**	+	+***	+	-	+	+	-
New product introduction	+	+	-	+	+	-	-	+	+	+	+	-
Product modification	+***	+	+***	-	+****	+	+***	-	+**	+	+***	+
New process	+***	+	+**	+**	+***	+	+***	+*	+	+	-	+
Firm's age	-***	-**	-***	-***	-***	-**	-***	-**	-***	-	-**	-**
Firm's size	+***	+***	+***	+***	+***	+***	+***	+***	+***	+***	+***	+***
Business environment												
Competition	+**	+***	+***	+	+*	+**	+*	-	+*	+	+	+
Subcontracting	-**	+	-**	-	-	+	-*	-	-	+	-	+
Exporting	+**	+	+	+**	+**	+	+	+	+*	+	-	+**
Formal credit	+	-	+	-	+*	-	+	+	+	+	+	-
Informal credit	+**	+*	+**	-	+*	+*	+**	-	+*	+	+	+
Industrial zone	+*	+	+	-	+	+	+	-	+	+	+	+
Urban	+	-	+***	+***	+	-	+**	+	-	-	+	+***
Legal environment												
Formalization	+	+	+***	-	+	+	+**	+	+*	+	+**	-
Government	+	+	+	-	+	-	+	-	+	+	+***	-
Bribery	-	-*	-	-***	-**	-	-	-*	-*	-*	-	-***
Observations	14484	4727	9644	4840	8011	2701	5722	2289	5512	1903	3244	2268
Industry FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
The table summarizes the marginal effects of each efficiency explanatory variable on the profit efficiency ($\frac{\Delta E[ln\ \pi_{it}^{a}]}{\Delta z_{it}}$) of various types of Vietnamese SMEs between 2005 and 2015.												
*** p<0.01, ** p<0.05, * p<0.1												

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Table 7. Marginal effects on profit efficiency ($\frac{\Delta E[ln\ \pi_{it}^{a}]}{\Delta z_{it}}$), alternative specifications of the profit frontier model

	Baseline	Alternative human capital measures		Alternative production upgrading measures			Alternative credit access measures		Alternative location measures		Interactive variables	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Internal environment												
Owner's education	+**	+***		+**	+**	+**	+**	+**	+**	+**	+**	+**
Labor training	+		+	+	+	+	+	+	+	+	+	-*
New product	+	+	+	+*			+	+	+	+	+	+
Product modification	+***	+***	+***		+***		+***	+***	+***	+***	+***	+***
Process upgrading	+***	+***	+***			+***	+***	+***	+***	+***	+***	+***
Firm's age	-***	-***	-***	-***	-***	-***	-***	-***	-***	-***	-	-***
Firm's size	+***	+***	+***	+***	+***	+***	+***	+***	+***	+***	+***	+***
Firm's age*Size											-***	
Labor training*Size												+***
Business environment												
Competition	+**	+**	+**	+***	+***	+***	+**	+**	+**	+**	+**	+**
Subcontracting	-**	-**	-**	-*	-**	-*	-**	-**	-**	-**	-**	-**
Exporting	+**	+**	+**	+**	+**	+**	+**	+**	+**	+**	+**	+**
Formal credit constraint	+	+	+	+	+	+	+	+	+	+	+	+
Informal credit usage	+**	+***	+**	+***	+**	+**		+***	+**	+**	+**	+**
Industrial zone	+*	+*	+*	+*	+	+*	+*	+*	+*		+*	+*
Urban	+	+	+	+	+	+	+	+		+	+	+
Legal environment												
Formalization	+	+	+	+	+	+	+	+	+	+	+	+
Other support	+	+	+	+	+	+	+	+	+	+	+	+
Bribery	-	-	-	-	-	-	-	-	-	-	-	-
Observations	14484	14484	14484	14484	14484	14484	14484	14484	14484	14484	14484	14484

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Industry FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
The table summarizes the marginal effects of each efficiency explanatory variable on the profit efficiency ($\frac{\Delta E[ln\ \pi_{it}^{a}]}{\Delta z_{it}}$) for the full sample of Vietnamese SMEs between 2005 and 2015 under various specifications of the profit frontier model.												
The baseline column (1) summarizes the marginal effects reported in column (3) of table 5.												
*** p<0.01, ** p<0.05, * p<0.1												

To capture the interaction between different variables, I also incorporate interactive variables into the analysis. Columns (11) and (12) of table 7 summarize the marginal effects of the efficiency explanatory variables with interactive variables between firm's age and size (column (11)) and between labor training and firm's size (column (12)). The marginal effects of the interaction variable between firm's age and size is negative and statistically significant (column (11)). This suggests that, while larger firms are more efficient, the marginal effect of expanding a firm's size on profit efficiency declines as the firm ages. This is in line with the fact that older firms are more likely to use older technology than their younger counterparts. Column (12) of table 7 explores the interaction between a firm's size and whether the firm provides training to their workers. The marginal effects of firm's size and the labor training*size interaction variable are positive and statistically significant, which implies that larger firms with labor training programs are more efficient than other firms.

One assumption of the profit efficiency model is that firms are pricetakers. Firms who do not face competition are often price setters, therefore the inclusion of those firms may bias the results. To this end, I re-estimate the profit frontier model, excluding firms not facing competition from the sample. Under this specification, the main conclusions in section 4 are still valid, which in line with the fact that nearly all firms in the sample report that they face some competition.

Finally, another concern is that the variables used to estimate the efficiency explanatory equation are influenced by the firms' profit level. To address this issue, I re-estimate the profit frontier model for the years 2007-2015 and use the information on the firm-specific internal and external environment in 2005 to estimate the efficiency explanatory equation. The results from these empirical exercises do not change the relative importance of the firm-specific characteristics documented in section 4.

5. Conclusion

As private firms play an important role in fostering local economic development, it is important to understand which factor is the most significant at boosting their performance. Yet, few studies have explored the relative importance of different variables on the firm-level efficiency, primarily because of the availability of data. Using a comprehensive dataset about firms in Vietnam, a transitional economy, this paper is among

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the first attempt at ranking the relative importance of various commonly-known efficiency determinants on private enterprises' profitability.

The results suggest that Vietnamese private firms are operating at about two-thirds of their potential profitability. This result is in line with previous studies in other developing countries, therefore, Vietnam provides a good case study for other private firms in the developing world. In addition to estimating the efficiency gap, this paper also documents the marginal impact of various commonly-known determinants of efficiency on the firm-level profitability. Specifically, firm-specific characteristics are more important in shaping the profitability of a firm than characteristics of the external environment in which the firm operates. This implies that policies that encourage firms to improve their own internal strength are crucial to promote the firm-level efficiency. For example, improved access to the labor market, innovation incentives to upgrade the production process and labor training programs are found to be the most significant policies for the development of the private sector. In addition, the results also imply the importance of improving the external business and legal environment on the firm-level performance. Specifically, policy that fosters healthy competition and business partnerships is beneficial for the growth of private SMEs. Finally, improving the transparency of the legal system will reduce firms' exposure to corruption, thereby increasing their profitability.

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