VNU Journal of Economics and Business

Journal homepage: https://jeb.ueb.edu.vn

Original Article

Locational and firm-level determinants of total factor productivity in Vietnamese manufacturing

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Received: October 09, 2024
Revised: December 06, 2024; Accepted: December 25, 2024

Abstract: Total factor productivity (TFP) has received much attention from both academics and policy makers in the past decade, as it promises an answer to the question of sustainable growth in the context of limited inputs. This article examines the TFP of manufacturing companies in Vietnam and the factors at the firm level, in addition to locational drivers, especially at the provincial level, that drive the change in TFP. We use a strongly balanced panel dataset of 1,130 manufacturing firms from 2014 to 2018 and the Wooldridge method to calculate the TFP and a general least squares estimator with a heteroskedastic and uncorrelated error structure to examine the determinants. The results show that the TFP of firms is driven by factors at both the firm and the province levels. Specifically, firm size and capital intensity have a positive impact on TFP, while differences in firm type also influence TFP outcomes. Furthermore, six locational factors significantly impact firms' TFP, with a particular emphasis on Information and Communications Technology (ICT) readiness, transparency index, and corruption index. Most importantly, we found that transparency and corruption have a nonlinear inverse U-shaped association with the TFP of firms, implying that there is an optimal midpoint of governance quality that maximizes the TFP of firms. The article then provides certain implications for both policymakers and firms in improving their TFP.

Keywords: Total factor productivity, manufacturing, Vietnam.

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https://doi.org/10.57110/vnu-jeb.v4i6.273

1. Introduction

The question of how to increase and maintain sustainable economic growth has been the focus of economists and policy makers for a long time. Within this scope, the TFP has occupied a large volume of literature. Previous studies have measured and evaluated TFP from various angles. In different countries, TFP was also found to contribute significantly to economic growth (Arazmuradov et al., 2014; Park, 2012).

Due to the significant share of the cumulative growth process, studies on the composition of TFP have gradually emerged. Specifically, several determinants that have an impact on, or are at least associated with TFP growth, closely follow the orientation of two main branches, which are internal and external factors. The latter then includes integration and invariant; and competition, social dimension, and environment. Some studies stated that TFP depends on technological change and intangible factors such as the allocation of resources, the diligence of workers, and the management skills or process regulation of governments which were parts of "economic restructuring, economic recovery, and government involvement" (Mankiw et al., 1992). Furthermore, the channel to convert and improve knowledge and technology is always one of the most effective direct factors that have the greatest direct impact on TFP.

Vietnam is a developing country with an economy that formerly relied on input-intensive sectors such as agriculture. However, to ensure high and sustained growth, the Vietnamese government has shifted its focus towards productivity. Furthermore, the need to enhance TFP and productivity in general is more evident when the economy deals with negative externalities such as the recent COVID-19 epidemic. While the world economy experienced a slump in growth, the Vietnamese economy grew by 2.91% in 2020 (GSO, 2020) in which the processing and manufacturing industry played a key role in creating the most added value for the industrial sector and is the main driving force behind the country's continued economic growth. In the last decade, the Red River Delta region has received various key public investments. This is also the period that the region experienced a high growth rate. Given that, the Vietnamese government often ascribes this growth to the right investment policy or other institutional factors. This can be partly justified since top-down investments mainly focus on changing the characteristics of the business environment rather than changing the firms themselves. However, to our knowledge, the current literature has not seen any reliable empirical studies on the effect of locational and institutional effects on TFP in Vietnam. Therefore, this study aims to fill this gap by examining TFP and its drivers among manufacturing firms in the Red River Delta in North Vietnam.

2. Literature review and hypotheses

Locational factors can be considered equivalent to the aspect of location-specific advantages in which investors must consider aspects of the local environment to invest to maximize return. Cuervo-Cazurra et al. (2014) defined location-specific advantages as the advantage that firms in a certain geographical space have over firms in other locations. Firms benefit from their geographic location because they have access to resources that firms in other places do not. In that concept, it may include access to skilled labor, incentives, market premiums, access to growing markets, superior infrastructure, and cost savings.

Specifically, according to Lewin and Volberda (1999), the interaction of two unique types of co-evolutionary processes, emergent and guided, is best understood as the process of creating a location advantage. This view is a combination of micro- and macro-problems in a unified framework at each process that is emergence and direction. This combination of multiple levels of extensive parallel analysis leaves room for new and random effects to emerge. Accordingly, local advantages are divided into two types including location savings and other local market features. Location savings arise from cost savings due to differences in the cost of operations, such as labor costs, real estate costs, information costs, or time costs. Other market features can be considered as local market attributes such as

purchasing power and preferences of indigenous people in the market. Regional growth causes an increase in demand for goods and products, affecting the level of competition in the market. Based on regional differences, firms can take advantage of regional characteristics to remain competitive and develop.

The component in investigating the determinants of the TFP of a company can be mentioned as a location-specific advantage, such as the regional environment of a company. Empirical studies have discovered that fiscal decentralization has a significant impact on TFP growth through transmission channels such as public sector efficiency (Adam et al., 2014), public capital investment (Destefanis & Sena, 2005), and local institutional environment (Song et al., 2018). In Vietnam, PCI is an index commonly used to assess the environment in provinces. Most of the research has examined how the quality of the environment of a province affects the TFP of a company. Some studies find developed capital markets (La Porta et al., 1997), a network of competitive firms (Gulati et al., 2000), or supporting institutions (Peng et al., 2008) and good regulations (Djankov et al., 2002) as location-specific advantages for firm's operation.

Concerning ownership, Barbera (2011) examines the relationship between firm ownership and productivity and shows that family labor and capital produce a wide range of production contributions when compared to nonfamily equivalents. In particular, family labor output contributions are much higher, whereas family capital output contributions are significantly lower. Interestingly, differences in TFP between family and nonfamily firms disappear when allowing for heterogeneous output contributions of family production inputs. In addition, there have been a number of studies conducted on the type of ownership such as Dvoulet and Blaková (2021). Driffield and Du (2007) show that the TFP growth of a corporation is reduced when it is transferred to state control. On the other hand, switching ownership to alternative types does not have a statistically significant effect on output.

Moreover, Griffith et al. (2003) concentrated on two processes by which foreign FDI can influence the level or rate of domestic productivity growth. They discover that foreign companies, as well as other high-productivity domestic companies, play a role in the convergence process. In addition to FDI, in technology transfer, ICT is also considered a constant breakthrough. Recently, ICT has played an important role in different aspects of human life.

3. Data and research methodology

3.1. Data

This study aggregated the firms' characteristics data based on the firms' financial statements from the Vietnam Enterprises Survey (VES) of the General Statistics Office (GSO) and the Provincial Competitiveness Index (PCI) for variables related to provincial specific advantages. The final data set includes 1,130 manufacturing companies in the 5 years 2014 to 2018. Furthermore, to assess the willingness to apply information technology, this study also applies the ICT index classified by province and extracted. The companies are located in 10 provinces of the Red River Delta including Ha-Noi, Hai-Phong, Ninh-Binh, Nam-Dinh, Thai-Binh, Vinh-Phuc, Hai-Duong, Hung-Yen, Bac-Ninh, and Ha-Nam.

Among 1,130 firm-level observations, the average number of laborers is 679. The average value of capital per employee is 1.4 billion VND. Among 225 firms in 5 years, an average studied firm has an annual profit of about 49 billion VND while the average profit margin is 4.7% and ROA is 18.7%. We use the number of laborers to classify firms into 4 levels of firm size, of which 63 are very small firms: 342 are small firms, 190 are medium firms, and the remaining 535 are large firms. There are three types of firm ownership, namely state-owned, foreign-owned, and private-owned. In terms of the ICT readiness index of provinces, most provinces during the study period have a low or medium level of ICT. There are two important variables that reflect a province's level of governance, namely transparency and

corruption. The former is a subindex from the PCI database that assesses the province's ability to be transparent about its public agenda. The higher this index, the easier it is for a province's constituents to update and understand the governing actions and to adjust their response accordingly. During the research period, Vinh-Phuc is the most transparent province with an average index of 6.678. For the latter variable, corruption is proxied by another subindex named "informal cost" that reflects additional fees a firm needs to pay to maintain its business operations. The higher the informal charges, the more likely the governmental authority is to be corrupt. Ninh-Binh is on average the most corrupt province with the informal costs index at 5.84, followed by Vinh-Phuc at 5.824.

Table 1: Statistical description and definition of variables

Variable	Description	Mean	Std.Dev.	Min	Max
Firm level					
TFP	TFP of firm	1.415	3.619	0.001	100.070
Labor	Number of employees (people)	684.030	1,867.709	2	23,353
Capital	Total asset (million VND)	519,487.4	1,163,339	453.7	1.44e+07
Profit	Firm profit after tax (million VND)	50,190	124,506.8	2	1,095,136
Cost	Cost of goods sold (million VND)	1,015,248	3,733,249	57.1	6.72e+07
K-L	Assets-to-employment ratio (million VND/person)	1,397.087	2,165.674	2.593	26,681.51
ROA	Return on asset (%)	0.185	3.606	0.60e-4	121.239
Margin	Profit margin (%)	0.048	0.074	0.60e-4	0.974
FirmT	Firm type (dummy variable, 3 levels)	2.365	0.532	1	3
FirmS	Firm size (dummy variable, 4 levels)	3.059	0.998	1	4
Locational level					
Trans	Transparency index in public governance	6.033	0.401	4.88	7.11
Corrup	Informal costs as a proxy for corruption	5.026	0.623	4.21	6.97
ICT	Information and communication technology				
	readiness (dummy variable, 3 levels)	1.472	0.737	1	3
FDIat	Provinces give priority to FDI				
	attraction than private sector development (% agree)	51.128	7.504	33	65
HumaRes	Percent of workers completed training				
	at vocational schools or higher (%)	45.483	7.100	33.66	67.79
Population	Total population (people)	3,432,085	2,848,459	802,700	7,520,700
GDP	GDP per capita (million VND/person)	81.433	34.680	22.931	150.083
Unemployment	Unemployment rate (%)	2.072	0.007	0.55	3.9

Source: Authors.

3.2. TFP measurement method

Consider a Cobb-Douglas technology for firm *i* at time *t*:

$$Y_{it} = A_{it}K_{it}^{\alpha}L_{it} \quad (1)$$

where Y_{it} is the output of firm *i* at the period *t*, A_{it}, K_{it}, L_{it} are respectively TFP, capital and labor of firm *i* at period *t*.

Taking a logarithm of the Equation (1), we have

$$\ln Y_{it} = \ln A_{it} + \beta_k \ln K_{it} + \beta_l \ln L_{it} \quad (2)$$

Suppose: $\ln A_{it} = \beta_0 + \varepsilon_{it}$ and $y_{it} = \ln Y_{it}$, $k_{it} = \ln K_{it}$, $l_{it} = \ln L_{it}$, we have:

$$y_{it} = \beta_0 + \beta_k k_{it} + \beta_l l_{it} + \varepsilon_{it} \quad (3)$$

where: β_0 is mean productivity level over time. ε_{it} is the time and firm-specific deviation from the mean. At a particular deviation at time *t*, it can be decomposed into the predictable component v_{it} and unobservable component u_{it}. The latter is idiosyncratic output shock and can be referred to as white noise.

$$y_{it} = \beta_0 + \beta_k k_{it} + \beta_l l_{it} + v_{it} + u_{it} \quad (4)$$

with $w_{it} = \beta_0 + v_{it}$ represents firm-level productivity, and normally, firm productivity is calculated as follows:

$$\widehat{w}_{it} = \hat{v}_{it} + \hat{\beta}_0 = y_{it} - \hat{\beta}_k k_{it} - \hat{\beta}_l l_{it} - \hat{u}_{it}, \quad (5)$$

finally, TFP or productivity in levels will be the exponential of $\hat{w}_{it}$.

This study applies a method of instrumental variables estimator as formulated by Wooldridge (2009) and Petrin and Levinsohn (2012) (LP). These methods propose the solution for the simultaneity issue by using the proxy for unobserved productivity shock $\hat{u}_{it}$. In addition, this study uses a semi-parametric approach to LP estimation that includes a proxy of intermediate inputs rather than investment to overcome the simultaneity bias issue suggested by Wooldridge (2009) in adopting the generalized method of moments (GMM). In particular, he shows how to write the relevant moment restrictions in terms of two equations: these have the same dependent variable (y_{it}) but are characterized by a different set of instruments.

The Cobb-Douglas production function for firm i is given as:

$$v_{it} = \beta_0 + \beta_l l_{it} + \beta_k k_{it} + \omega_{it} + \varepsilon_{it} \quad (6)$$

in which: v_{it} is the log of value added, l_{it} is the log of number of laborers and k_{it} is the log of the capital stock. The error term is separated into ω_{it} which represents the unobserved productivity of the firm, and ε_{it} which captures both the measurement error of value added and unpredictable shocks.

3.3. Model specification

On the basis of an overview of theories, models, and related studies to evaluate the impacts of determinants on the TFP of firms the study proposes a research model of the impact research at the firm's characteristics level and provincial level as follow:

$$y_{ijt} = \gamma_t + \alpha X_{ijt} + \beta Z_{jt} + u_j + e_{ij} \quad (7)$$

where y_{ijt} is the TFP of the firm i located in province j at time t, γ_t is the mean TFP across all firms and all provinces at time t. X represents a vector of firm-level variables, Z presents the variables at the province level.

4. Results and discussion

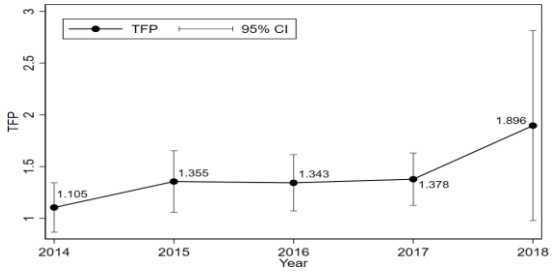
4.1. TFP in the Red River Delta

Figure 1a illustrates the average TFP in the period 2014 to 2018. As shown in the figure, TFP in the Red River Delta has gradually increased. Higher TFP shows a more efficient use of inputs among manufacturing firms.

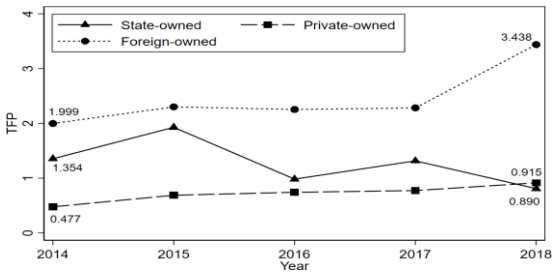
Figure 1b describes the heterogeneity of TFP among 3 types of business ownership: SOE, Private and Foreign. The average TFP in foreign-owned firms is always higher than the other types. That reflects that the type has greater technological improvement and does not depend on the intensive use of labor and capital compared to the other two types. Private enterprise has the lowest average TFP among the three types. However, the gap between private firm's TFP and others has narrowed over time. In 2018, private firms even outperformed state-owned firms in terms of TFP.

Figure 1c presents the changes in TFP among 4 types of firm sizes. While very small and large firms did not experience many changes in their TFP, the figures of small and medium firms show an upward movement. During the studied period, small companies gradually increased their TFP, from around 0.6 in 2014 to more than 1.4 in 2018. On the other hand, most of the changes in the TFP of medium firms happened between 2017 and 2018. Before 2018, the bigger firms tend to have a higher TFP. But due to the dramatic change in medium-sized companies in 2018, this group surpassed large companies and emerged on top of the TFP placement.

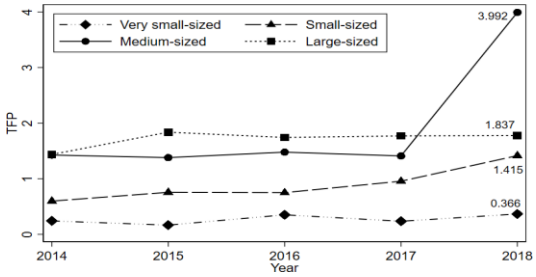
As shown in Table 2, the gap between the provinces in terms of average TFP is quite large. The highest TFP is 2.369 from Bac-Ninh, and the lowest TFP is 0.156 from Nam-Dinh. Furthermore, the standard deviations of the TFP distribution in some provinces such as Bac-Ninh, Ha-Noi, Hai-Duong, and Hai-Phong are larger than in others, indicating that the difference between firms in these provinces is considerable.



(a) Average TFP by year



(b) Average TFP by type of business owned



(c) Average TFP by firm size

Figure 1: Average TFP by category

Source: Authors.

Table 2: Summary of TFP by province

Province	Freq.	Mean	Std. Dev.	Min	Max
Ha-Noi	389	1.253	2.119	0.003	16.971
Vinh-Phuc	25	1.140	1.091	0.011	3.800
Bac-Ninh	255	2.369	6.698	0.001	100.071
Hai-Duong	120	1.778	2.127	0.007	10.429
Hai-Phong	80	0.954	1.687	0.012	9.493
Hung-Yen	126	0.863	1.400	0.002	7.244
Thai-Binh	30	0.225	0.376	0.003	1.272
Ha-Nam	50	1.258	1.821	0.069	6.799
Nam-Dinh	25	0.156	0.116	0.011	0.410
Ninh-Binh	30	0.246	0.523	0.004	2.106

Source: Authors.

4.2. TFP determinants

4.2.1. Firm-level factors

Regarding factors at the firm level, the size of the firm represented by the number of firms' laborers shows a positive relationship to firm productivity at the 1% significance level. This result shows support for the hypothesis related to economies of scale (Silberston, 1972). Specifically, compared to very small firms, medium and large firms tend to have higher productivity due to comparative advantages in absorbing advanced technologies. Furthermore, it could also imply that large companies could produce more efficiently through greater access to technology, learning, and dealing with uncertainty and selection progress. Large firms have stronger negotiation power with sellers and suppliers. Therefore, this creates market entrance obstacles for new entrants (Serrasqueiro & Maçãs Nunes, 2008). As a result, large firms increase the industry's market power (Lee, 2009). Large firms also have more resources and expertise in product creation, technological innovation development, and, of course, stronger business strategy, marketing, and e-commerce implementation (Fillis et al., 2003; Helms et al., 2008). According to Halkos and Tzeremes (2007) large firms run more efficiently since they have better resources and utilize inputs more efficiently. This result aligns to previous studies on the relationship between firm size and productivity such as those of Fernandes (2008) and Van Biesebroeck (2005).

Table 3: Determinants of TFP

Variables	TFP		Profit margin		ROA	
	Coef.	Std.Err	Coef.	Std.Err	Coef.	Std.Err
Firm-Level Factors						
FirmT						
Private	-0.585***	0.125	-1.007*	0.154	-0.408**	0.124
Foreign	0.866***	0.123	0.748***	0.157	1.161***	0.129
FirmS						
Small	-0.122**	0.061	0.068	0.061	0.079	0.064
Medium	0.533***	0.080	0.473***	0.074	0.912***	0.084
Large	0.602***	0.078	0.519***	0.084	1.136***	0.082
K-L	0.285***	0.020	-0.039**	0.000	-0.259***	0.021
Locational factor						
ICT level						
Medium	-0.020	0.057	0.028	0.001	-0.010	0.056
High	0.054	0.066	0.128**	0.001	-0.060	0.066
Trans	1.801**	0.770	2.395***	0.652	2.174**	0.765
$Trans^2$	-0.115**	0.047	-0.127**	0.039	-0.140***	0.047
Corrup	1.323**	0.660	2.007**	0.585	1.322**	0.662
$Corrup^2$	-0.062*	0.037	-0.079**	0.033	-0.051	0.048
Trans × Corrup	-0.120*	0.071	-0.199**	0.063	-0.140**	0.071
Unemployment	2.092**	0.880	0.037	1.527	3.634**	1.449
FDI	0.009***	0.002	0.004**	0.002	0.009***	0.002
HumaRes	0.004**	0.001	0.005**	0.001	0.004**	0.001
GDP	0.572***	0.090	0.294***	0.082	0.548***	0.093
PCI	-0.004	0.008	-0.027**	0.009	0.001	0.009
Population	0.011	0.032	0.045	0.034	-0.001	0.035
Constance	-10.359**	3.572	-14.399***	3.084	-11.456**	3.543
Observations	1,130		1,130		1,130	
Wald Chi^2	4399.53		2475.11		3801.19	

Notes: * p < 0.1; **p < 0.05; ***p < 0.01.
Source: Authors.

Firm types can also be another factor that affects the TFP of firms. Compared to SOEs, private firms show to have significantly lower TFP while foreign firms show otherwise. This finding agrees with the findings of several previous research papers (Giang et al., 2019). Foreign companies are considered one of the main sources of enterprise improvement through the knowledge that can be obtained from the home country. These sources of knowledge are determined as international knowledge spillovers (Liu et al., 2010). Cole et al. (2008) suggested that foreign ownership may provide greater access to new technology. Giang et al. (2019) came to the same conclusion that foreign firms had the highest productivity in the agricultural sector. In terms of inefficiency of private firms, Hung et al. (2021) showed that the development of the size of the business of Vietnamese private companies has been ineffective despite the increase in the number in this sector. Capital per laborer also has a significant impact on TFP. That means the firms that are higher capital intensive are found to be at a higher level of TFP. That result on the relationship between capital intensity and productivity coincides with Solow (1962) on the positive contribution of capital to productivity. Such results in the Red River Delta can be explained by the fact that the government is paying attention. The development of the Red River Delta is really the pioneer area of the whole country to implement 'strategic breakthroughs', economic restructuring, successfully renovating the growth model and thus becoming the locomotive of the whole country. Additionally, large enterprises often exploit capital markets as well as public debt markets with lower capital costs (Ozcan et al., 2017).

4.2.2. Locational factors

We examine 9 provincial factors in our models, in which 6 factors show significant impact on the TFP of firms. Our interests lie mainly in three factors: ICT readiness, transparency index, and corruption index. We also used other common provincial factors to control for the characteristics of provinces such as unemployment rate, GDP per capita, and population. From our main results in Table 3, ICT levels in provinces where a firm operates are not associated with its productivity. We also found that the interaction term of transparency and corruption has a negative effect on the TFP of the firms. This means, in a highly transparent province, increasing corruption would link to lower TFP; and vice versa.

5. Conclusion and implications

Based on Vietnam's annual datasets, the study analyzes the determinants of the TFP of manufacturing firms in the Red River Delta, especially those related to the locations where the companies operate. Keeping common characteristics such as GDP per capita, CPI, or the unemployment rate unchanged, we observed nonlinear relationships between the transparency and corruption of the province where firms operate with their TFP. We found that a province that is too opaque or too transparent would be associated with its firms being less productive. Thus, there is an optimal midpoint of transparency to maximize the TFP of the firms. The same conclusion can be applied to corruption: firms operating in a too corrupted or non-corrupted provinces are currently less productive than firms in other provinces. However, due to the scope, data and the estimation strategy of this paper, these results are not causal. Therefore, this does not imply that provinces should be more corrupted or less transparent to achieve a higher level of TFP for their firms. These results only reflect current trends in governance characteristics that TFP firms associate with. We also found other associations between the TFP of firms and provincial characteristics such as human resource, FDI inflow, or ICT readiness level.

From that result, we draw certain implications for both policy makers and firms. First, for local government, there is a need for government policies encouraging and supporting capital inflow to their provinces throughout openness, transparency, stability, infrastructure, and effective provincial management organization towards an e-government. Technological advancement is known as an important element of increasing TFP; thus, provincial governments need to promote technology transformation and improvement by supporting technology communications adoption, technology transfer, and R&D. Moreover, to enhance the quality of human capital there is a need to encourage local human resources to participate in skills training programs and improve skills. In addition, it is necessary to have vocational education and training programs that match the general trend. Second, for manufacturing firms, businesses need to plan a long-term scale development strategy based on existing resources, such as improving the effectiveness of using capital and labor. Moreover, it is vital to focus on businesses' strength to attract foreign investment capital and maintain exchange with FDI enterprises. From the above research results, it can be concluded that to promote the development of an industry, it is necessary to have oriented development from both sides, from the businesses themselves to the government levels. In addition, having long-term strategies to match the characteristics of the industry, the characteristics of the enterprise need to take advantage of the advantages at the provincial level where firms are located.

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