# THE DETERMINANTS OF TFP AT FIRM-LEVEL IN VIETNAM

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**Abstract**

*This paper investigates the determinants of TFP at firm level using a sample of 370 firms located in 58 cities and provinces of Vietnam. These firms participated in the business census of the General Statistics Office of Vietnam in 2015 and reported R&D activities. The regression result indicates that for firms in Vietnam, factors have a significant and positive effect on TFP include absorptive capacity (proxied by R&D activities), spatial spillovers, export activities and financial constraints. Nevertheless, there is not enough evidence to conclude that political affiliation affects TFP for Vietnamese firms.*

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**Keywords:** TFP at firm-level, R&D, Marshallian spillovers, Jacobian spillovers, financial constraints

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## 1. Introduction

The economic development of Vietnam in the past decades mainly depends on the accumulation of cheap labor and material cost. As these inputs are limited, it is crucial to improve the efficiency of capital and labor input factors or increase the total factor productivity (TFP). TFP is associated with the application of technical advances, technological innovation, improvement of management methods, improvement of workers' skills, which indirectly lead to enhance the labor and capital productivity. Given the importance of TFP as a contributor to the long-run economic growth, it is necessary to determine which factors are likely to affect the TFP and act correspondingly to facilitate TFP growth. Given that one of the most influential factors affecting TFP is research and development (R&D) activities, this study aims at examining the relationship between R&D spending and other factors on TFP at firm level. Even though studies about determinants of TFP at firm level are common worldwide but in Vietnam there are a few relevant studies, especially on the impact of R&D on TFP at firm level. One of the papers related to TFP at firm level in Vietnam is Thangavelu and Chongvilaivan (2013), which find that liquidity and access to external credit boosts firm productivity, with

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the latter particularly imperative for exporting and/or importing firms. Nevertheless, the paper does not investigate the impact of R&D activities on TFP at firm level. As a result, we analyze The determinants of TFP at firm-level in Vietnam using a quantitative method.

***Literature review on the TFP and determinants of TFP***

***1.1. TFP***

TFP is defined as the proportion of output that is not explained by the contribution of input factors (Comin, 2006). TFP reflects how efficiently and productively the input factors are used to generate output. Accordingly, one of the ways to enhance TFP is to improve the quality of inputs such as labor and capital. With the same amount of input, the amount of output could be larger owing to improved quality of labor, capital and the efficiency of these resources.

TFP can be measured using the OLS estimation with the following production function:

$$Y_{it} = A_{it} K_{it}^{\beta_k} L_{it}^{\beta_l} M_{it}^{\beta_m} \quad (1)$$

In the above function, $Y_{it}$ represents the output of firm i at time t, $K_{it}$ represents the capital input, $L_{it}$ represents the labor input, $M_{it}$ represents the intermediate input, and $A_{it}$ represents total factor productivity. $\beta_k$, $\beta_l$ and $\beta_m$ represent the elasticity of output with respect to capital, labor and intermediate inputs, respectively. After applying natural logarithms to both sides of the equation (1), it becomes:

$$y_{it} = \beta_0 + \beta_k k_{it} + \beta_l l_{it} + \beta_m m_{it} + \varepsilon_{it} \quad (2)$$

In Equation (2), TFP is given by:

$$\ln A_{it} = \beta_0 + \varepsilon_{it} \quad (3)$$

A firm's observed TFP is given by the average firm efficiency level $\beta_0$ and the observed component (v_it) of the deviation (ε_it) from this average:

$$TFP \equiv \omega_{it} = \beta_0 + v_{it} \quad (4)$$

TFP is estimated by the OLS method and calculated as a residual representing the level of output not attributable to the capital, labor and material inputs:

$$TFP = \hat{\omega}_{it} = \hat{\beta}_0 + \hat{v}_{it} = y_{it} - \hat{\beta}_k k_{it} - \hat{\beta}_l l_{it} - \hat{\beta}_m m_{it} \quad (5)$$

The TFP level can be obtained by solving for $exp(\hat{\omega}_{it})$.

Additionally, the estimation of TFP based on Equation (5) could be facilitated in two different methods including output method and value-added method. TFP is obtained as a residual from the valued-added based Cobb-Douglas production function, in which real value added is used as the target measure. An alternative would be to use the output-based approach, according to which TFP is obtained as a residual from the output-based production function and intermediate production factors (such as raw materials, energy and intermediate goods and services) are included as additional determinants of production in the estimation. It has been argued that this approach is theoretically more appropriate as it permits the explicit consideration of intermediate production factors in the technologically-driven sector-level growth (Jorgenson & Stiroh, 2000). Nevertheless, the lack of data on deflated intermediate inputs in the data set makes the value-added approach more reliable.

Applying the value-added method and considering that value added (VA) is defined

as value of gross output (y) minus value generated by intermediates:

$$\ln VA_i = y_i - \beta_M m_i \quad (6)$$

Thus, equations (6) and (5) then becomes:

$$\hat{TFP}_i = \beta_X X_i \equiv \ln VA_i - \hat{\beta}_L l_i - \hat{\beta}_K k_i \quad (7)$$

### *1.2. Determinants of TFP*

The determinants of TFP presented in this section are absorptive capacity, political affiliation, spatial spillovers, export activity, and financial constraints.

#### *Absorptive capacity*

A firm with a high level of knowledge is likely to show greater productivity compared to a firm with a relatively low level. The firm can use its knowledge for productive purposes by developing absorptive capacity. Absorptive capacity can be explained as "the ability of a firm to recognize the value of new, external information, assimilate it, and apply it to commercial ends. We label this capability a firm's absorptive capacity and suggest it is largely a function of firm's level of prior related knowledge". Most studies seem to have followed the suggestion of Cohen and Levinthal (1989), in which R&D is used as a proxy for absorptive capacity. The authors describe a dual role for R&D. In one aspect, it develops absorptive capacity, which enables a firm to identify, absorb and exploit external knowledge for productive purposes, which are likely to indirectly result in higher TFP. In another aspect, R&D generates products and process improvements within a firm, which are likely to directly lead to higher TFP. This dual role suggests that R&D is the most valuable proxy for absorptive capacity because it has both direct and indirect effects on TFP.

#### *Political Affiliation*

In the literature, politically affiliated firms have been found to enjoy significant advantages over non-politically affiliated ones. Firstly, politically connected firms tend to benefit in terms of preferential access to credit. This argument was suggested by Johnson and Mitton (2003), who used a sample of 424 Malaysian firms over the period of 1997-1998 for analysis and find that the imposition of capital controls following the onset of the Asian financial crisis largely benefited firms linked to the country's then prime minister.

Secondly, politically affiliated firms tend to benefit from government contracts. Goldman et al. (2013) examined the importance of political connections in the United States by analyzing a sample of companies belonging to the S&P500 before and after the 1994 midterm and 2000 general US elections. Their results show that companies with connections to the winning party tend to experience an increase in procurement contracts.

Thirdly, politically connected firms also benefit in terms of regulatory protection. Faccio (2010) analyzed the differences between politically connected and non-politically connected firms in a sample of 16,191 companies across 47 countries. Her findings suggest that politically connected firms, in comparison with non-connected ones, have higher leverage, lower taxation, poorer accounting, greater market power, lower ROA and lower market valuation. Moreover, differences with non-politically corrected firms were found to be wider when firms are based in countries characterized by high corruption and when political connections are closer, as it is the case for

connections with company owners and ministers.

The above empirical results suggest that politically connected firms are likely to benefit from preferential access to credit, government contracts, regulatory protection, and lower taxation. Since such benefits make it easier for a firm to operate, political connections are likely to result in higher TFP levels. However, for Vietnamese firms in particular, the empirical evidence is mixed, suggesting that political affiliation has both positive and negative effects on performance.

***Spatial Spillovers***

The spillovers, or technological externalities, are defined as the pool of general knowledge to which a firm has access. A firm can obtain this knowledge in the following ways: by being based in a particular location (spatial spillovers); from its industrial relations (intra and inter-industry spillovers); from its export activities (export spillovers); from R&D activities (R&D spillovers); and from FDI (FDI spillovers). "Spatial spillovers or agglomeration externalities are benefits that accrue to plants from being located in the vicinity of a large concentration of other plants" (Harris & Moffat, 2011). In general, such spillovers can be classified as either Marshallian or Jacobian.

Marshallian spillovers, also known as agglomeration, location or specialization externalities, were first suggested by Marshall (1922). He described spillovers as a range of benefits for a firm arising from being in close proximity to industry peers. Therefore, as suggested by Marshall, if a firm develops an TFP-enhancing innovation such as a new working practice or an innovative product, other firms are likely to imitate and adopt it. A contagion, thus, develops from one firm to another, which is likely to result in higher TFP growth for the industry as a whole. Other than imitation/demonstration, Marshallian spillovers can manifest themselves in other ways. The close geographical distance of firms belonging to the same industry fosters cooperation, potentially resulting in higher industry TFP.

Firstly, firms can exploit synergies, for example, by collaborating on R&D projects to improve products and processes. Secondly, firms located at different levels within an industry supply chain can develop commercial relationships. Thirdly, firms based in the same geographical area can benefit from sharing assets. For example, two firms can reduce their input transportation costs by jointly leasing or renting trucks. Fourthly, as Marshall (1922) suggests, externalities can be manifested through the development of an industry-related labor market pool. This means that in an industry-specific geographical area, workers will develop industry-specific skills. This provides two benefits. On the one hand, workers benefit in terms of the ease of mobility from one firm to another. On the other hand, firms benefit from the opportunity to more easily hire specialized workers than in the case of a more industry-diverse geographical area. These spillovers are likely to result in higher TFP for the industry as a whole.

Different from Marshallian spillovers are Jacobian spillovers, also known as diversification or urbanization externalities. According to Harris and Moffat (2011), these occur when plants located in an industry-diverse area benefit from the economies of scope such a location provides. Compared

to Marshallian externalities, Jacobian externalities manifest themselves across economic units belonging to different industries.

Moreover, Jacobs (1970) suggests that the diversity in terms of industry and occupation that characterizes urban economies favors the spillover of innovations across different industries. For example, an automotive firm can benefit from knowledge acquired by interacting with scientists from a university's mechanical engineering research department. This interaction generates knowledge spillovers from the research department to the firm, bringing benefits in terms of product or process improvements and ultimately being likely to result in higher TFP. Jacobian externalities can also occur, for example, when a firm involved in the production of aluminum, absorbs knowledge from a food production firm located nearby. This example suggests that by being located in the same geographical area, firms belonging to different industries can obtain mutually benefits that are likely to result in higher TFP.

***Exporting***

Empirical results indicate that exporting has a positive effect on TFP in two contrasting views. One suggests that TFP is likely to determine a firm's decision to export and hence to self-select into a new market. This is because only the most productive firms might be able to afford the sunk costs that entering into an export market entails. Roberts and Tybout (1997) analyzed the entry and exit of plants in four industries in the Colombian manufacturing sector during the years 1981-1989 and suggest that a plant's decision to export in the current year is influenced by whether it exported in the past year. Specifically, a plant has a 60% higher probability to export in the current year if it exported in the past year, compared to a plant that has never exported. This suggests that after a firm has overcome the cost of entry, it is more likely to keep exporting than a firm that still is facing such costs. The study suggests that sunk costs constitute a hurdle that a firm must overcome in order to enter into foreign markets. Only the most productive firms are able to overcome such a hurdle and thus they self-select into the export market. In making the decision of whether to export, a firm is likely to consider different factors including TFP. Therefore, TFP might determine whether or not a firm self-selects into a new market.

In contrast to the "self-selection" view is the "learning by exporting" view. According to this view, a firm learns how to become more productive and competitive through actually exporting. The more a firm exports, the more it is able to increase its productivity. Moreover, exporters are likely to benefit from the commercial interactions that exporting entails, as suggested by Grossman and Helpman (1991). Therefore, according to the "learning by exporting" view, a firm learns how to improve its productivity by engaging in exporting activities.

***Financial Constraints***

The mechanism through which financial health shapes the productivity prospects of a firm is that availability of funds stands a firm in good stead to leverage on ample business opportunities, to make superior investment decisions, and ultimately to enjoy exceptional business capacity and ability to survive in the market. Addressing this issue is vital in that financial constraints have affected multinational activities especially in

developing countries where the development of financial markets is usually limited. A study by Alfaro et al. (2010) shows that firms in countries with well-developed financial markets tend to experience positive gains in FDI. Thus, reducing the financial constraints of firms by developing financial markets could have positive impacts on the productivity of firms. This is because if firms are facing difficulties in obtaining external financing, they must rely on their own internal funds. Such a situation would constrain firms' ability to pursue productivity-enhancing projects such as R&D expenditures and capital investments. Therefore, financial constraints, or the lack thereof, is indicated to have an impact on TFP. Based on the empirical evidences, it is expected that firms with lower financial constraints enjoy higher levels of productivity.

## 2. Methodology

### *2.1. Hypotheses*

By combining the existing evidences in the literature, this section provides a list of factors and hypotheses about their impacts on TFP at firm-level. The list of factors includes R&D, human capital utilization, state ownership, exporting, Marshallian spillovers, Jacobian spillovers, and financial constraints. Table 1 summarizing the factors and hypotheses is available at the end of this section.

#### *Absorptive capacity*

As mentioned in the above papers, R&D is one of the proxies of absorptive capacity. Based on empirical results of Griliches (1998) and Harris and Moffat (2011), R&D spending is expected to have a significant and positive effect on Vietnamese firms' TFP.

#### *Political Affiliation*

Based on the empirical results of Nguyen and Dang (2017), an increasing share of state-owned paid-in capital, which represents political affiliation, is expected to have a negative effect on firms' TFP.

#### *Spatial spillovers*

For spatial spillover, we investigate Marshallian Spillovers and Jacobian Spillovers.

#### *Marshallian Spillovers*

Based on the discussion in the previous section and the empirical results from Harris & Moffat (2011), Marshallian Spillovers is expected to have a significant and positive effect on Vietnamese firms' TFP.

#### *Jacobian Spillovers*

Firms are likely to benefit in terms of higher TFP from the industrial diversity because it favors the transmission of innovations across different industries. Based on the discussion in the above section, Jacobian Spillovers is expected to have a positive effect on firms' TFP, meaning that Vietnamese firms are expected to benefit in terms of higher TFP from being based in areas characterized by industrial diversity.

#### *Exporting*

There is a "learning by exporting" effect that would lead to an increase in TFP once a firm starts exporting. By exporting, a firm is expected to become more productive since it faces a larger number of competitors, which will push it to undertake TFP-enhancing measures. Moreover, the firm is also likely to benefit in terms of higher TFP from the

commercial interactions that exporting entails. In summary, exporting is expected to have a positive effect on TFP.

***Financial Constraints***

Based on the empirical results of Thangavelu et al. (2010), debt financing is expected to be significant and to have a negative effect on TFP.

**Table 1. The determinants of TFP and their hypotheses**

| Factor | Hypothesis |
|---|---|
| Research and Development | **positive** effect |
| State Ownership | ***negative*** effect |
| Marshallian Spillovers | **positive** effect |
| Jacobian Spillovers | **positive** effect |
| Exporting | **positive** effect |
| Financial Constraints | ***negative*** effect |

***2.2. Estimation Model***

In this study, TFP is measured through a log-linear Cobb-Douglas production function represented below:

$$y_i = \beta_i + \beta_l l_i + \beta_M m_i + \beta_K k_i + \beta_X X_i + \varepsilon_i \quad (8)$$

where y, l, m, and k are the natural logarithms of real gross output, employment, intermediate inputs, and the capital stock, respectively, for each firm i. X_i is a vector ofvariables determining TFP including ownership, exporting, Marshallian spillovers, Jacobian Spillovers, financial leverage, R&D, and human capital utilization.

In the original census of the General Statistics Office of Vietnam, there does not exist any variable that captures the amount of value-added of each firm. Nevertheless, it can be calculated using other data from the census. Considering that a firm's profit can be expressed by the subtraction of its total input from its total output:

Profit = total output - total input (9)

In which, total input can be decomposed into different components, including labor wages, depreciation costs, financing costs, taxes and fees, intermediate inputs and other costs. Equation (9) is expressed as follows

Profit = total output - labor wage - depreciation cost - financing cost - tax and fees - other cost - intermediate inputs (10)

Since value-added is measured by total output minus intermediate inputs, Equation (11) then becomes:

Value added = profit + labor wage + depreciation costs + financing costs + taxes and fees + other costs (11)

### *2.3. Variable Definition and Calculations*

**Table 2. Variable names, calculation and the source of calculation method**

| Name | Calculation | Source |
|---|---|---|
| *Output* | Natural log of firm's added value | Gehringer et al. (2013) |
| *Capital* | Natural log of fixed assets | Harris & Moffat (2011) |
| *Labor* | Natural log of number of labor | Harris & Moffat (2011) |
| *R&D* | Equal to 1 if a firm invests in R&D; 0 if otherwise | Harris & Moffat (2011) |
| *R&D Over Sales* | Ratio of R&D spending to total sales revenue | Author |
| *R&D Staffs* | Proportion of staffs that engage in R&D activities | Author |
| *State Ownership* | Proportion of paid-in capital owned by the State | Tocco (2015) |
| *Marshallian Spillovers (Industry agglomeration)* | Natural log of percentage share of industry output (2-digit SIC codes) in a province | Harris & Moffat (2011) |
| *Jacobian Spillovers (Industry diversity)* | Natural log of the proportion of 3-digit industries (maximum 239) located in a province | Harris & Moffat (2011) |
| *Exporting* | Equal to 1 if a firm exports; 0 if otherwise | Tocco (2015) |
| *Export Over Sales* | Direct export value divided by total sales revenue | Author |
| *Leverage* | Total debt over total assets | Thangavelu et al. (2010) |

*Source: by author*

### *2.4. Data*

The dataset of firms is constructed from the Annual Statistical Censuses & Surveys of Enterprises in 2015, gathered by the General Statistics Office of Vietnam. It contains firm-level information on state ownership and production characteristics, such as the number of workers, gross revenue, working capital, materials, profits, and export/import status, as well as financial attributes such as liquid assets, fixed assets, liabilities and equity, among many others. Nevertheless, it does not include data on foreign ownership.

This study attempts to determine which factors is likely to affect TFP at firm-level. One of the variables-of-interest is R&D spending, which is a proxy for knowledge acquisition. The data gathered by the General Statistics Office is filtered to only include the firms that report their R&D activities.

Therefore, the final dataset for this study includes 370 observations, with firms located in 58 out of 63 cities and provinces in Vietnam.

## 3. Results

### *3.1. Descriptive results*

Table 3 shows the descriptive statistics of the variables used in estimating TFP of firms.

**Table 3. Variables descriptive statistics**

| Variable | Mean | SD | Min | 0.25 | Median | 0.75 | Max |
|---|---|---|---|---|---|---|---|
| *Output* | 8.95 | 2.52 | 0.69 | 7.11 | 9.11 | 10.75 | 15.24 |
| *Labor* | 4.10 | 1.72 | 0.00 | 2.71 | 4.11 | 5.37 | 8.99 |
| *Capital* | 9.20 | 2.62 | 0.00 | 7.37 | 9.41 | 10.84 | 16.72 |
| *R&D* | 0.36 | 0.48 | 0.00 | 0.00 | 0.00 | 1.00 | 1.00 |
| *R&D Over Sales* | 0.01 | 0.06 | 0.00 | 0.00 | 0.00 | 0.00 | 0.62 |
| *R&D Staffs* | 0.11 | 0.19 | 0.00 | 0.00 | 0.03 | 0.12 | 0.90 |
| *State Ownership* | 0.03 | 0.09 | 0.00 | 0.00 | 0.00 | 0.00 | 0.49 |
| *Marshallian Spillovers* | 0.50 | 1.94 | -7.29 | -0.73 | 0.55 | 1.74 | 4.29 |
| *Jacobian Spillovers* | 4.18 | 0.33 | 3.22 | 3.96 | 4.18 | 4.53 | 4.56 |
| *Exporting* | 0.21 | 0.41 | 0.00 | 0.00 | 0.00 | 0.00 | 1.00 |
| *Export Over Sales* | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.09 |
| *Leverage* | 0.53 | 0.32 | 0.00 | 0.27 | 0.57 | 0.76 | 2.36 |

*Source: calculations by author*

### *3.2. Correlation Analysis*

Table 4 shows the Pearson Correlation values among independent variables.

**Table 4. Pearson Correlation matrix of independent variables**

| | Labor | Capt. | Export. | MAR Spillovers | Jacobian Spillovers | Lever. | R&D | R&D Staffs |
|---|---|---|---|---|---|---|---|---|
| *Labor* | 1.000 | | | | | | | |
| *Capital* | 0.724 | 1.000 | | | | | | |

| | Labor | Capt. | Export. | MAR Spillovers | Jacobian Spillovers | Lever. | R&D | R&D Staffs |
|---|---|---|---|---|---|---|---|---|
| *Exporting* | 0.395 | 0.353 | 1.000 | | | | | |
| *Marshallian Spillovers* | 0.080 | 0.032 | -0.008 | 1.000 | | | | |
| *Jacobian Spillovers* | 0.234 | 0.141 | 0.148 | -0.204 | 1.000 | | | |
| *Leverage* | 0.249 | 0.233 | 0.079 | 0.144 | 0.094 | 1.000 | | |
| *R&D* | 0.279 | 0.278 | 0.134 | -0.048 | 0.113 | -0.007 | 1.000 | |
| *R&D Staffs* | -0.188 | -0.041 | -0.056 | -0.264 | 0.159 | 0.038 | -0.034 | 1.000 |
| *Jacobian Spillovers* | 4.18 | 0.33 | 3.22 | 3.96 | 4.18 | 4.53 | | 4.56 |
| *Exporting* | 0.21 | 0.41 | 0.00 | 0.00 | 0.00 | 0.00 | | 1.00 |
| *Export Over Sales* | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | | 0.09 |
| *Leverage* | 0.53 | 0.32 | 0.00 | 0.27 | 0.57 | 0.76 | | 2.36 |

*Source: calculations by author*

Based on the result of Pearson Correlation matrix calculations, it can be stated that most of the independent variables does not have high correlation with each other.

### *3.3. Regression Analysis*

The coefficients for the determinants of TFP at firm-level in Vietnam are estimated using Equation (8). The independent variables include total capital and total labor input, and other variables representing determinants of TFP including ownership, exporting, Marshallian spillovers, Jacobian Spillovers, financial leverage, R&D and human capital utilization. The result of estimating the coefficients of the independent variables using ordinary least square regression is shown in Table 5.

**Table 5. Result of original model OLS estimation**

| Dependent variable: Output | Coefficient | Standard Error | t | P > t |
|---|---|---|---|---|
| *Labor* | 0.947*** | 0.049 | 19.35 | 0 |
| *Capital* | 0.215*** | 0.028 | 7.57 | 0 |
| *State Ownership* | 0.814 | 0.531 | 1.53 | 0.126 |
| *Exporting* | 0.305* | 0.158 | 1.93 | 0.054 |
| *Export Over Sales* | -5.402 | 6.001 | -0.9 | 0.369 |

| Dependent variable: Output | Coefficient | Standard Error | t | P > t |
|---|---|---|---|---|
| *Marshallian Spillovers* | 0.104*** | 0.028 | 3.72 | 0 |
| *Jacobian Spillovers* | 0.606*** | 0.161 | 3.76 | |
| *Leverage* | 0.401** | 0.186 | 2.16 | 0.032 |
| *R&D* | 0.277** | 0.114 | 2.43 | 0.015 |
| *R&D Over Sales* | -0.239 | 0.948 | -0.25 | 0.801 |
| *R&D Staffs* | 0.903*** | 0.299 | 3.02 | 0.003 |
| *Constant* | 0.016 | 0.675 | 0.02 | 0.981 |
| | *** p < 0.01, ** p < 0.05, * p < 0.1 | | | |

*Source: calculations by author*

**Table 6. Original model statistics summary**

| Obs. | F-statistics (11, 358) | Prob. > F | R-squared | Adjusted R-squared |
|---|---|---|---|---|
| 370 | 193.29 | 0.000*** | 0.8559 | 0.8515 |

*Source: calculations by author*

**Table 7. Original model analysis of variance**

| Source | Sum of Squares | Degrees of freedom | Mean square |
|---|---|---|---|
| Model | 1878.409 | 11 | 170.764 |
| Residual | 316.275 | 358 | .883 |
| Total | 2194.684 | 369 | 5.948 |

*Source: calculations by author*

The regression model has a relatively good fit. The value of adjust R-squared indicates that 85.15% of the variance of the dependent variable is explained by the independent variables. In other terms, 85.15% of the variance in added value of Vietnamese firms in the dataset was explained by labor, capital, and TFP.

According to the estimation result of the regression with the original model, eight out of eleven independent variables are significant. Since leaving insignificant variables in the model may leads to biased and inefficient estimates, a second variation of the model would be used to re-estimate the coefficient of the dependent variables. The result of which are then compared with the regression result of the original "full" model to determine whether the second variation resulted in decreased fit of the estimation. The second variation in this case is called a nested model, of which any variable it includes is also included in the original model. It omits some variables that is presented in the original

model. In other words, the second model is a subset of the first model, hence the term nested.

An approach to compare nested models is by using the likelihood ratio test (Lewis, et al., 2011). The comparison of the performance between two models is done by assessing the likelihood ratio test statistics (LRTS). It is conventional to reject the null hypothesis that the simpler model is consistent with the data and, therefore, to select the original model over the nested one if the LRTS Q exceeds the 95% quantile of the reference distribution. If the LRTS lies below this quantile, the null hypothesis is not rejected and the nested model is selected in favor of the original. The estimation results using the nested model are shown in Table 8.

**Table 8. Nested model with OLS estimation**

| Dependent variable: ln_value_added | Coefficient | Standard Error | t | P > t |
|---|---|---|---|---|
| *Labor* | 0.956*** | 0.047 | 20.19 | 0.000 |
| *Capital* | 0.219*** | 0.028 | 7.80 | 0.000 |
| *Exporting* | 0.224* | 0.129 | 1.74 | 0.083 |
| *Marshallian Spillovers* | 0.104*** | 0.028 | 3.72 | 0.000 |
| *Jacobian Spillovers* | 0.640*** | 0.160 | 4.00 | 0.000 |
| *Leverage* | 0.375** | 0.185 | 2.03 | 0.043 |
| *R&D* | 0.284*** | 0.107 | 2.66 | 0.008 |
| *R&D Staffs* | 0.903*** | 0.297 | 3.04 | 0.003 |
| *Constant* | -0.170 | 0.666 | -0.25 | 0.799 |
| *R- square* | 0.8545 | | | |
| *Adjusted R-squared* | 0.8513 | | | |
| | *** p < 0.01, ** p < 0.05, * p < 0.1 | | | |

*Source: calculations by author*

**Table 9. Nested model analysis of variance**

| Source | Sum of Squares | Degrees of freedom | Mean square |
|---|---|---|---|
| Model | 1875.388 | 8 | 234.424 |
| Residual | 319.296 | 361 | .884 |
| Total | 2194.684 | 369 | 5.948 |

*Source: calculations by author*

In comparison to the original model, the nested model omitted the state ownership, export over sales and total R&D spending over sales revenue variables. On the other hand, export over sales revenue and R&D spending over sales revenue are in the same category with the Exporting and R&D variables. They both account for the impact of exporting and R&D on productivity, respectively. Of eight independent variables that enter the nested model, all of them are significant at 10% level. The nested model has an adjusted R-squared figure of 0.8513. A first glance into the two adjusted R-squared figures reveals that there exists a relatively small difference between the two. It is expected that the original model does not provide a better fit than the nested model.

To evaluate the performance differences between the original model and the nested model, the likelihood ratio test must be carried out. The formal likelihood ratio test result using STATA *lrtest* command is available in Table 10.

**Table 10. Likelihood ratio test comparing original and nested model result**

| Likelihood ratio chi-squared statistics (3) | Prob. > chi-squared |
|---|---|
| 3.52 | 0.3185 |

*Source: calculations by author*

The likelihood ratio test statistics is not significant at 5% level. Thus, the null hypothesis is not rejected and the nested model is selected in favor of the original one.

### *3.4. Model Defect Testing*

#### *Test for Multicollinearity*

Table 11 shows the VIF value for each of the predictor in the nested model:

**Table 11. Original model analysis of variance**

| Variable | VIF | 1/VIF |
|---|---|---|
| *Labor* | 2.65 | 0.38 |
| *Capital* | 2.34 | 0.43 |
| *Exporting* | 1.2 | 0.83 |
| *R&D Staffs* | 1.17 | 0.85 |
| *Marshallian Spillovers* | 1.17 | 0.86 |
| *Leverage* | 1.16 | 0.86 |
| *Jacobian Spillovers* | 1.16 | 0.86 |
| *R&D* | 1.12 | 0.89 |
| *Mean VIF* | 1.50 | |

*Source: calculations by author*

The VIF values for the six determinants of TFP included in the model are small with the largest value being only 1.2. For Labor and Capital, the VIF values are larger than the rest but are still in the lower-end of the moderately-correlated range. With a mean VIF of 1.5, it can be concluded that there is no multicollinearity existing in the model.

***Test for Heteroscedasticity***

we tested the heteroscedasticity of the residual terms. One of the important assumptions of multiple linear regression using ordinary least square is that there should be no heteroscedasticity of residuals. The formal test for heteroscedasticity is done using the Breusch-Pagan test or the White's general test for heteroscedasticity (Williams, 2015). Both the Breush-Pagan test and White's general test show consistent results for the heteroscedasticity issue. Both tests reject the null hypothesis of homoscedasticity at 1% level. Thus, it can be stated that the current regression model exhibits heteroscedasticity issue. One solution to the heteroscedasticity problem is by using the Ecker-White standard errors (Croux, et al., 2003), which are defined as belonging to the group of robust standard errors. These standard errors are estimated without relying on the assumption of homoscedasticity. They remain valid when the error terms are not independent and identically distributed and suffer from heteroscedasticity or autocorrelation. A robust standard error consistently estimates the true standard error even for non-independent and identically distributed error terms. The regression results using Ecker-White standard errors are presented in Table 12.

It should be noted that the use of Ecker-White robust standard errors does not change coefficient estimates. Since the standard errors change, the test statistics provides more accurate p-values (Allison, 1998). After using robust standard error, all of the eight independent variables are significant. The only notable change is that Exporting now becomes significant at 5% level, while the Leverage significant level drops to 10%.

**Table 12. Result of OLS estimation with Ecker-White robust standard errors**

| Dependent variable: ln_value_added | Coefficient | Robust Standard Error | t | P > t |
|---|---|---|---|---|
| *Labor* | 0.956*** | 0.052 | 18.52 | 0.000 |
| *Capital* | 0.219*** | 0.039 | 5.64 | 0.000 |
| *Exporting* | 0.224** | 0.104 | 2.16 | 0.031 |
| *Marshallian Spillovers* | 0.104*** | 0.033 | 3.18 | 0.002 |
| *Jacobian Spillovers* | 0.640*** | 0.175 | 3.66 | 0.000 |
| *Leverage* | 0.375* | 0.199 | 1.89 | 0.059 |
| *R&D* | 0.284*** | 0.090 | 3.14 | 0.002 |
| *R&D Staffs* | 0.903*** | 0.297 | 3.04 | 0.003 |

| Dependent variable: ln_value_added | Coefficient | Robust Standard Error | t | P > t |
|---|---|---|---|---|
| *Constant* | -0.170 | 0.854 | -0.20 | 0.843 |
| | *** p < 0.01, ** p < 0.05, * p < 0.1 | | | |

*Source: calculations by author*

### *3.5. Discussion*

Our estimation results indicate that the elasticities of added value with respect to labor and capital are positive and significant. The results indicate the existence of increasing returns to scale for most industries with an average sum of output elasticities equal to 1.2, suggesting that firms produce more output from a given amount of inputs.

The results for the parameter estimates associated with $X_i$ can be discussed by grouping them into variables related to absorptive capacity (R&D), political affiliation (State ownership), spatial spillovers (Marshallian, Jacobian spillovers), and other variables (exporting and leverage). The effects of the state ownership on productivity are different from previous studies conducted in other countries. The coefficient for state ownership is positive but insignificant. The estimation result does not show support for the hypothesis that the increase in state ownership reduces the productivity levels in firm.

Spatial variables are included in the vector $X_i$ in order to measure whether firms benefit in terms of higher TFP levels from the spillovers arising from the location where they are based. These spatial variables are Marshallian spillovers and Jacobian spillovers. The coefficients for the variable representing Marshallian spillovers are statistically significant and positive. In line with the arguments of Marshall (1922), the existence of positive Marshallian spillovers indicates that firms are likely to benefit in terms of higher TFP levels from the externalities arising from being geographically close to industry peers. In such a situation, firms are likely to undertake TFP-enhancing actions, such as imitating and adopting ideas from other firms, cooperating through sharing assets, pursuing joint R&D projects or engaging in joint ventures. Moreover, by being based in the same area, firms are likely to develop commercial relationships with suppliers and customers and to enjoy the higher availability of an industry-specialized labor pool, enabling them to improve their productivity. From these results, it can be inferred that policy measures aimed at increasing industrial agglomeration within specific geographical areas are conducive to higher firm TFP. Regarding Jacobian spillovers, the coefficients for the variable representing Jacobian spillovers are statistically significant and positive at 1% level. The results suggest that Vietnamese firms are likely to benefit in terms of higher TFP from the spillovers arising by being located in an area characterized by different industrial activities. This is in line with Jacobs' (1970) argument that plants having different knowledge and capabilities can complement each other's skills sets, resulting in mutual benefits, and that the industrial and occupational diversity that characterizes urban economies favors the spillover of innovations across different industries,

ultimately resulting in higher TFP. The results indicate that policy measures aimed at increasing industrial diversity within specific geographical areas are likely to result in higher firm TFP.

In order to become more productive, a firm can take advantage of three variables included in the vector $X_i$, which are an R&D dummy (*R&D*) indicating whether a firm invests in R&D, a variable representing the ratio of R&D spending to sales (*R&D Over Sales*), and a variable representing proportion of labors that engage directly in R&D activities (*R&D Staffs*). The estimation results indicate that productivity improves by undertaking R&D expenditures, as indicated by the statistically significant and positive coefficients for R&D.

In addition to ownership affiliation, spatial and knowledge variables, other variables are included in the vector $X_i$ as potential determinants of TFP in Vietnamese firms. These are variables proxying for firms' export activity and financial constraints (Thangavelu, et al., 2010). The estimation results indicate that Vietnamese firms engaged in export activities are likely to be more productive than others as suggested by the statistically significant and positive coefficients of the variable representing an exporting firm (Exporting). This is in contrary to the previous study done by Thangavelu et al. (2010), which find only weak evidence that international trade exposure is correlated with the productivity of firms in Vietnam. Moreover, this result is in line with the arguments of Grossman and Helpman (1991).

Finally, the estimation results also indicate that the degree of financial constraint that a firm faces impacts its productivity as evident by the statistically significant and positive coefficient of the variable representing financial leverage (*Leverage*). From these findings, it can be inferred that when firms borrow more, they are under more pressure to be more productive.

In summary, the estimation results suggest that Vietnamese firms tend to benefit with the presence of Marshallian and Jacobian spillovers, exporting activities, R&D activities and higher leverage.

## 4. Conclusion and Recommendations

Total factor productivity is important because it generates benefits for both firms, which come largely from increasing efficiency and technological change, and society being the main driver of national long-run economic growth and higher living standards. Analyzing TFP and its determinants enables an understanding of which factors policymakers can target in order to achieve higher TFP. From the estimation results, suggestions for firms include promoting exports, building absorptive capacity by developing local innovation and enhancing human capital in R&D. There should be incentives to collaborate between firms and universities, R&D fiscal incentives and state funding of basic research, and encouragement for investment in R&D and human capital. Policies that encourage stronger links between firms and research, educational and training institutions to facilitate knowledge transfer should also be utilized. As for human capital development, policies should focus on investing in skills, encouraging the use of more skilled labor, specialized and efficient work, and making a greater use of training.

**References**


1. Alfaro, L., Chanda, A., Kalemli-Ozcan, S. & Sayek, S. (2010), "How Does Foreign Direct Investment Promote Economic Growth? Exploring the Effects of Financial Markets on Linkages", *Journal of Development Economics*, 91(2), pp. 242-256.
2. Asian Productivity Organization (2004),Total Factor Productivity Growth: Survey Report, Tokyo, *Asian Productivity Organization*.
3. Cohen, W. M. & Levinthal, D. A. (1989), "Innovation and Learning: The Two Faces of R&D", *The Economic Journal*, 99(397), pp. 569-596.
4. Comin, D. (2006), *Total Factor Productivity*, New York University and NBER, August.
5. Croux, C., Dhaene, G. & Hoorelbeke, D. (2003), *Robust Standard Errors for Robust Estimators*, Belgium: KU Leuven.
6. Faccio, M. (2010), *Differences between Politically Connected and Nonconnected Firms: A Cross-Country Analysis*, 39(3), pp. 905-928.
7. Foster, L., Haltiwanger, J. & Syverson, C. (2008), "Reallocation, Firm Turnover, and Efficiency: Selection on Productivity or Profitability?", *American Economic Review*, 98(1), pp. 394-425.
8. Gehringer, A., Martínez-Zarzoso, I. & Danziger, F. N.-L. (2013), "The Determinants of Total Factor Productivity in the EU: Insights from Sectoral Data and Common Dynamic Processes".
9. Goldman, E. Rocholl, J. & So, J.(2013), "Politically Connected Boards of Directors and The Allocation of Procurement Contracts", *Review of Finance*, 17(5), pp. 1-32.
10. Griliches, Z. (1998), *"Productivity and R&D at the Firm Level In: R&D and Productivity: The Econometric Evidence"*, University of Chicago Press, pp. 100-133.
11. Grossman, G. M. & Helpman, E. (1991), "Trade, Knowledge Spillovers, and Growth", *European Economic Review*, 35(2-3), pp. 517-526.
12. Harris, R. & Moffat, J.(2011), *"Plant-level Determinants of Total Factor Productivity in Great Britain, 1997-2006"*, London: Spatial Economics Research Centre.
13. Harris, R. & Robinson, C. (2010), "The Impact of Regional Selective Assistance on Sources of Productivity Growth: Plant Level Evidence from UK Manufacturing 1990- 1998", *Regional Studies*, 39(6), pp. 751-765.
14. Ho, B. D. (2012), *"Total factor productivity in Vietnamese agriculture and its determinants",* Australia: University of Canberra.

15. Petrin, A., Poi, B. P. & Levinsohn, J. (2004), " Production function estimation in Stata using inputs to control for unobservables", *Stata Journal*, 4(2), pp. 113-123.

16. Thangavelu, S. M., Findlay, C. & Chongvilaivan, A. (2010), FDI, Financial Constrains, and Productivity: Firm Level Study in Vietnam. In: Linkages between Real and Financial Aspects of Economic Integration in East Asia. *Jakarta: ERIA Research Project Report,* pp. 316-343.

17. Tocco, C. (2015), *An Analysis of the Determinants of Total Factor Productivity in China*, Durham theses, Durham University.