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Some Issues on the Vietnam Economic Growth[*]

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Abstract

We first consider the question of the productivity of the economy of Vietnam at the macro level. With theoretical models and empirical data, we find out the Leontief production function, and its associated TFP (Total Factor Productivity). We show that the TFP is one of the main engines of Vietnam economic growth.

However when we move to the micro level with the capital productivity of 2,835 State Owned Enterprises (SOEs), we discover there exists an over utilization of the physical capital and more importantly, diversion of the capital stock. This diversion may be due to a waste of capital stocks or to a special form of bribery we call "hidden overhead".

To summarize, economic growth in Vietnam my be enhanced by investing in the founding components of TFP such as new technology, Human Capital, better organisational system, but also by fighting the bribery and the over utilization of the physical capital

Keywords: Productivity; Production Function; TFP; Hidden Overhead

JEL: E60, O11, 053, P21

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1 Introduction

When the Vietnam War ended in April 1975, Vietnam was one of the poorest country in the world. By the mid-1980s, Vietnam GDP per capita was stuck between 200 USD and 300 USD. In recent years, Vietnam is one of the important emerging economies with growth of 6-7% and a GDP per capita around $2,000$ USD in 2017. The volume of goods trade is around 200% of the GDP. This shows Vietnam economy is very open. The important question is how Vietnam economy can go further.

Understanding the growth engines is therefore vital for policy makers, economists, and investors. Recently, there are discussions and concerns about the productivity of the economy of Vietnam, regarding TFP and labour productivity. Many papers and policy makers claim that labour productivity is crucial for Vietnam economic growth. We prove that the productivity of labour is not always an engine for growth. For sure , it is not when the production technology is of Constant Returns to Scale.

Before studying the growth mechanisms, one must find out the economic structure on which Vietnam economy relies. We show that the production function of Vietnam's economy actually is Leontief and the TFP has an important role .

As in Nguyen Duc Thanh & Ohno Kenichi (2018) we first consider the question of the productivity of the economy of Vietnam at the macro level. We make a comparison with China and Laos.

Macro level is not the only basis to study Vietnam economy. We hence move to the micro level and consider the capital productivity of the State Owned Enterprises (SOEs). The period under consideration is $2005 - 2017$.

The main findings of our paper are

- We have detected the production function of Vietnam is Leontieff.

- The TFP growth has a strong impact (42%) on the GDP growth of the three recent years.

- The TFP depends, with lag, on the GDP which is used as proxy of the expenditures for human capital, R&D, new technology.

- If the production function is Cobb-Douglas with constant returns to scale, then contrarily to the usual intuition, the rate of growth of labour productivity is negatively related to the GDP rate of growth. The reason is that the capital productivity and the labour productivity are substitutes.

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- The labour productivities of Laos and Vietnam in the three recent years (2015-2017) are quite comparable. However; for the same years, the average rate of growth of Vietnam labour productivity is higher than the one of Laos.

- Vietnam labour productivity and its growth rate are lower than the ones of China.

- We found that the production function of China is Cobb-Douglas with constant returns to scale, while the one of Laos is of increasing returns. For us, in view of the big differences of their economic structure, comparison of labour productivities of these three countries does not make sense.

- Using a census conducted by GSO in 2014, 2015 for 2,835 State Owned Enterprises (SOEs), we found that some of Vietnamese SOEs are very capital intensive.

- 1,832 SOEs make profit, the average profit rate is around 35.6%. They use 36.8% of the total capital of 2835 SOEs, their revenues represent 84.9% of the total revenue.

- It is interesting to discover that 545 SOES, the revenue of which representing only 15.1% of the total revenue, use 63.2% of the total capital. They make losses, the average rate of their deficits is 29%

- We know consider the issue of "hidden overhead". It is well known that when a Vietnamese SOE asks for say 1 billion of VND for its purchase of capital, it will receive $(1-\sigma)$ billion. But it has to declare receiving 1 billion, σ billion have been diverted. The number σ is called by us "hidden overhead". We found that the average distribution of σ is 50%.
  If we consider the $1,862$ SOEs (65.7% of the SOEs) which make profits, the value of σ is very small, around 0.4%. For the 545 SOEs who make losses, some of them have $\sigma = 60.\%$
  It is astonishing to see that a minority of SOEs is so capital wasteful.

The missing point in this paper is that we do not consider the private sector, in particular, the foreign firms. This point is explained by the fact we did not find time series about the capitals, revenues, employment, wages of this sector.

The rest of the paper is organized as follows. Section 2 presents some background information about production functions and productivity. Section 3 discusses the issues on Vietnam Economic Growth at the macro level. We attempt to build a series of capital stocks of the Vietnam economy and then run regressions in order to find out the production function with its associated TFP (Total Factor Productivity). Subsection 3.4 of this section exhibits the production functions of China and Laos and then compare the labour productivity of China, Laos and

Vietnam. Section 4 move to the micro level by focusing on the 2,835 State Owned Enterprises and show there exists an over utilization of the physical capital. We also question the issue of diversion of the capital in these SOEs. This diversion may be due to a waste of capital stocks or to a special form of bribery we call "hidden overhead". Section 5 concludes the papers with several remarks.

2 Literature

There are substantial numbers of papers discussing the production functions and productivity to explain the growth of different economies around the world. Solow (1957) established the steppingstone. He used a Cobb-Douglas production function with two basic inputs in production, labor and capital, and a multiplier that represents the change of the production function over time, which is called "technical progress". In the production process, the manager uses labor and capital, with the help of technical progress (denoted later by TFP), to produce the final product. Part of the finished product serves consumption and the rest is used for capital accumulation purposes. For an economy where every factor of labor and TFP steadily increases, using the Solow model can prove that the economy can grow indefinitely but the rate of growth is exogenous. Using US data from 1909-1949, Solow discovered TFP contributed 87.5% to US economic growth.

The model of Solow-Swan still had certain limitations, especially in the hypothesis of the exogenous nature of total factor productivity (TFP), leading to restrictions in policy orientation. Endogenous growth theory is then introduced in order to give the founding components of TFP. We will focus on the contributions of Romer (1986) and Lucas (1988).
Romer (1986)'s approach has the same starting point as Solow's, with a significant improvement in integrating "Knowledge" into capital. He argued that when economic entities accumulate knowledge, promote creativity, innovation, then positive externalities will be created, helping to increase capital productivity for the economy as a whole. Accordingly, TFP and capital productivity will not be limited and can always increase with new innovative technology ideas. Romer's model can be used to describe the impact of technology on growth.
The model of Lucas Jr (1988) shows that investment in education and training may be another founding element of growth engine through the rise of labor productivity.
Thus, endogenous growth theory not only transcends previous models in the ability to explain factors related to TFP, capital productivity and labor productivity, but also has clear policy implications. In particular, these models encourage the use of new technology, human capital

accumulation, and technological advances to promote growth.

While numerous research about production function and productivity has been carried out in developed countries, there is only small amount of research focusing on emerging markets, especially in Vietnam. Khương (2016) investigated the Vietnam labor productivity based on an application of growth accounting method (Jorgenson et al., 2005) in which GDP growth of an economy during the period can be divided into: the growth of capital, labor, and TFP. This research assumed the production function of Vietnam was of Constant return to scale. Nguyen Duc Thanh & Ohno Kenichi (2018) also assumed that the production function of Vietnam is Cobb-Douglas with the elasticity of the capital equals 0.35. The value of the elasticity was inspired by Collins et al. (1996). Therefore, most of these research were based on the assumptions about production function of Vietnam economy such as: Cobb-Douglas with Constant return to scale. In our paper, through regression equations, we first find out the economic structure on which Vietnam economy relies on, and then investigate the productivity at both macro and micro levels.

Van Thang and Freeman (2009) show there is a negative correlation between SOE growth and private sector growth. There is an evidence that SOEs are 'crowding-out' the private sector in Vietnam. Similarly, Nguyen and Van Dijk (2012) find that corruption hampers the growth of Vietnam's private sector but is not detrimental for growth in the state sector. For Takeyama (2018), if the Vietnamese government has made efforts for several years to promote the reform of SOEs, this process cannot be completed since will be required the introduction of regulations and systems to correct opaque financial situation and management techniques of SOEs.
We are not aware of papers which quantify the degree of capital waste and bribery in Vietnamese SOEs. This issue is studied in Section 5 of our paper.

3   Part 1: Issues on Vietnam Economic Growth at the macro level

3.1   Production Function and Total Factor Productivity

3.1.1   Capital stocks

In subsection 3.1.2 we will determine the production function for Vietnam economy, during the period 2005-2017. The first step is to build the series for Capital Stocks.
Our methodology is as follows. We use the formula

$$K_{t+1} = K_t(1 - \delta) + I_t \tag{1}$$

We have the data for the investments in constant price I_t. The depreciation rate δ is supposed equal to 0.05. We want to compute K_t for $t = 2005$ to $t = 2017$. We denote by $t = 0$ the year 2005. If we know K_0 we can generate the series $\{K_t\}, t = 1, \ldots, 12$. To have K_0 we suppose $K_0 = v_0 Y_0$ where Y_0 is the GDP at $t = 0$ and v_0 is the capital coefficient at date 0. Let ICOR_0 defined by

$$\text{ICOR}_0 = \frac{I_0}{Y_0 - Y_{-1}}$$

Suppose $K_{-1} = v_{-1} Y_{-1}$. This formula is immediate

$$I_0 = v_0 Y_0 - (1 - \delta) v_{-1} Y_{-1}$$

We suppose $v_0 = v_{-1} = v$. We then get

$$\text{ICOR}_0 = v \left(1 + \frac{\delta}{g_0} \right)$$
$$\text{where} \quad g_0 = \frac{Y_0}{Y_{-1}} - 1$$

We obtain $v = 2.886$. In the table 1, we present below the series of capital stocks generated by (1).

Table 1: The capital stocks of Vietnam from 2005 to 2017, (USD in millions)

Year	2005	2006	2007	2008	2009	2010	2011
K	246325.30	262821.25	281215.09	305856.77	328281.49	352350.79	376113.92

| Year	2012	2013	2014	2015	2016	2017	
K	393951.42	409568.74	425545.07	443131.31	463589.77	484026.07	

Source: Authors' calculations with World Bank data

For robustness check, we used also the Perpetual Inventory Method (PIM) which is usually employed by the OECD and other international institutions to generate the capital series (see, e.g., Kamps, 2006). The PIM consists of the capital accumulation equation above and the initial capital stock defined as $K_0 = I_0/(g_I + \delta)$ where g_I is the average annual growth rate of investment over the period of study. So, by using the series on investment flows, we can calculate g_I as $g_I = \sum_{t=1}^{n} (I_t - I_{t-1})/n$. [1]

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[1]There is a close relationship between our method based on ICOR and PIM method. Indeed, if we denote by s the rate of investment, then from PIM we get $K_0 = \frac{sY_0}{g_I + \delta}$. Our capital coefficient v equals $\frac{s}{g_I + \delta}$. The difference is: for PIM method investment and physical capital have the same rate of growth, while for our method assumes the capital coefficient is unchanged for the two beginning periods. If we use the Harrod model for the periods before the one taken as beginning period, the two methods coincide.

There is a divergence between K calculated using ICOR and K based on the PIM. Please refer to Figures 1 and 2, with respectively $\delta = 0.05$ and 0.07, for more details). However, when $\delta = 0.07$, the results obtained by the two calculations are very close.

Figure 1: K based on ICOR and K based on PIM, depreciation rate $\delta = 0.05$.
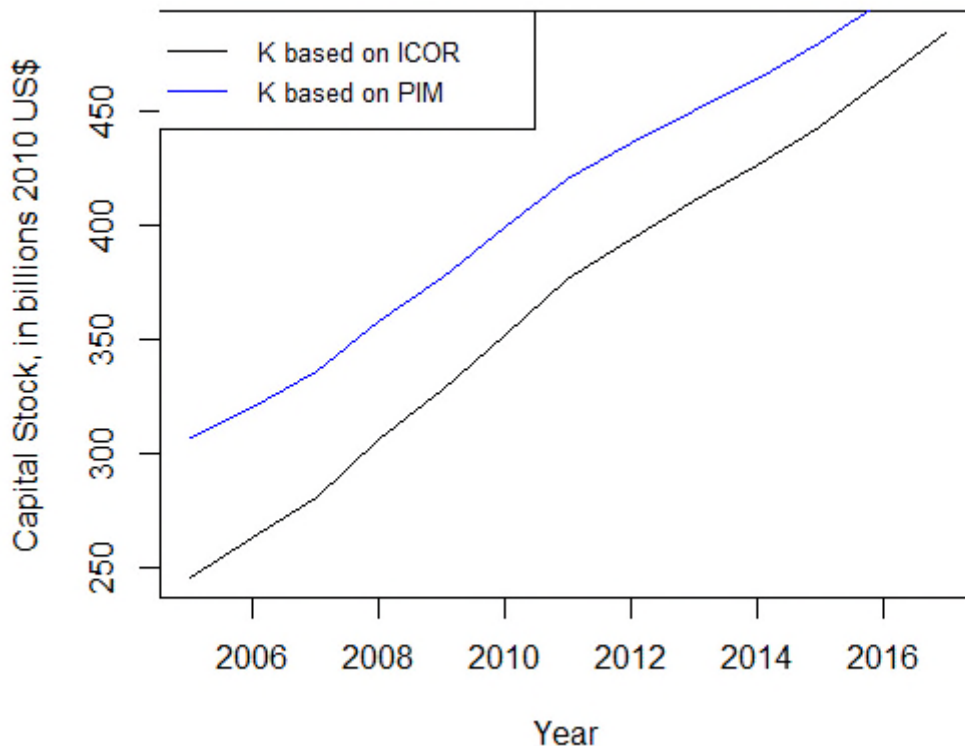
3.1.2 Production Function

The authors in Nguyen Duc Thanh & Ohno Kenichi (2018) assume that the elasticity of the capital in the production function equals 0.35. They use the value given in Collins et al. (1996). This approach is questionable. First, Collins et al. (1996) actually refer to Kim and Lau (1994) and Harrison (1994) who respectively $\alpha = 0.2$ and $\alpha = 0.4$ for Asia countries. The value 0.35 is arbitrarily chosen in the interval [0.2, 0.4].

Second, twenty years separate these papers and Vietnam in 2019.

Third, the value was obtained by cross-sectional regression with many countries.

Logically, once one has on hand, the data for capital stocks K_t, for labour N_t and GDP Y_t , one should run regressions to find out the elasticity of the capital stock, assuming the

Figure 2: K based on ICOR and K based on PIM, depreciation rate $\delta = 0.07$.
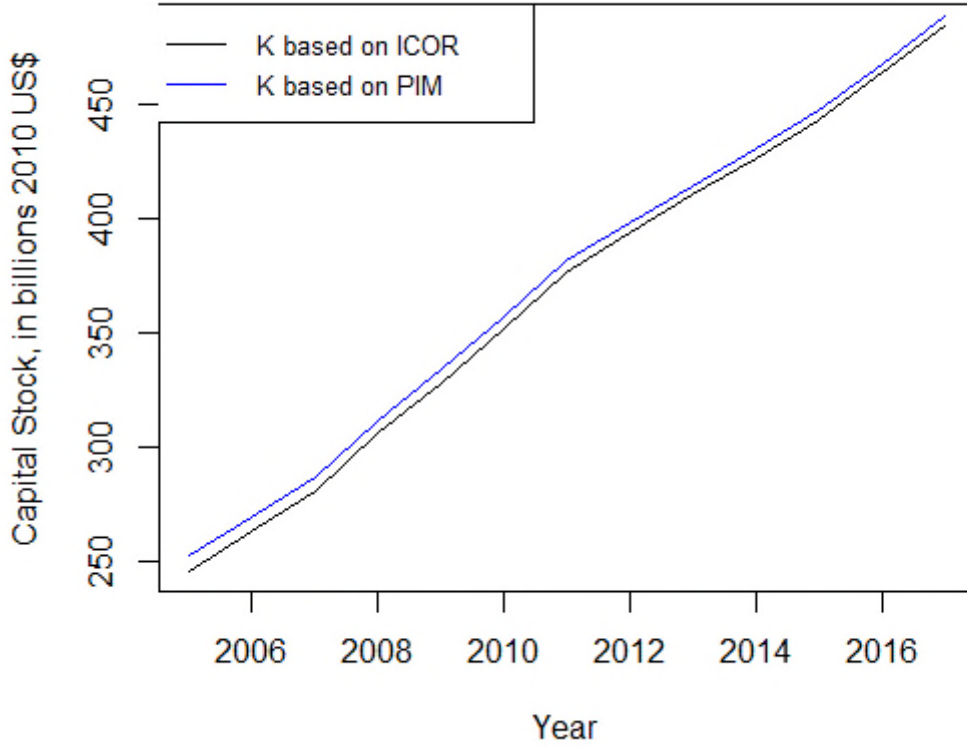
production function is Cobb-Douglas with constant returns to scale

$$\ln(\frac{Y_t}{N_t}) = A + \alpha \ln(\frac{K_t}{N_t})$$

That is what we did. The results of the regression are in Table 2. In view of the standard errors of the parameter α we assume that $\alpha = 1$. The production function is in fact

$$Y_t = A_t K_t \tag{2}$$

We then generate the series of TFP, A

$$A_t = \frac{Y_t}{K_t}$$

Having computed the series A_t we run the following regression

$$\frac{Y_t}{A_t} = bN_t$$

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Table 2: The regression for Vietnam's Production Function (1)

Dependent Variable: Ln(Y/N)
Method: Least Squares
Date: 04/13/19 Time: 12:37
Sample: 2005 2017
Included observations: 13

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-1.4453	0.57801	-2.5001	0.0295
Ln(K/N)	1.0415	0.0650	16.0281	0.0000
R-squared	0.9589	Mean dependent var		7.8193
Adjusted R-squared	0.9552	S.D. dependent var		0.1532
S.E. of regression	0.0324	Akaike info criterion		-3.8789
Sum squared resid	0.0116	Schwarz criterion		-3.7919
Log likelihood	27.2126	Hannan-Quinn criter.		-3.8967
F-statistic	256.9006	Durbin-Watson stat		0.2769
Prob(F-statistic)	0.0000			

We obtain (see below, Table 3)

$$Y_t = A_t \times bN_t$$

with $b = 7506$. The production function of Vietnam, during the period 2005-2017, is Leontief

$$Y_t = A_t \min\{K_t, bN_t\}^2$$

For robustness of the results, we used also the series of capital stocks which are computed by the Perpetual Inventory Method. With $\delta = 0.05$, the regression results are not reasonable due to the negative elasticity for N. While with $\delta = 0.07$, the results are very consistent with the findings using the ICOR method. We report in Appendix 2, the results of regressions obtained with PIM. In both cases, we can conclude that the production function for the Vietnam economy is a Leontief function.

Remark (1) *In this remark we present another way to test whether the production function is Cobb-Douglas or Leontief*

Let us consider a more general function, i.e. CES function,

$$Y = A\left[aK^\alpha + (1-a)N^\alpha\right]^{1/\alpha} \tag{3}$$

where $s \equiv 1/(1-\alpha)$ is (constant) elasticity of substitution between capital and labor.

Now, suppose that the Vietnam economy satisfies the profit maximization program $\max_{K,N} Y -$

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[2]Actually during this period we have $Y_t = A_t K_t = A_t \times bN_t$. Implicitly, we suppose that all the representative firm of Vietnam maximizes the profit and hence $A_t K_t = A_t \times bN_t$.

$rK - wN$). *First-order conditions with respect to capital and labor lead to the following well-known equality:*

$$\frac{w}{r} = \frac{1-a}{a} \left(\frac{K}{N}\right)^{1-\alpha},$$ (4)

which states that real wage (LHS) is proportional to the capital-labor ratio. Real wage also depends on the relative share between capital and labor (i.e. $(1-a)/a$) and the inverse of elasticity of substitution (i.e. $1 - \alpha = 1/s$).

In order to use data to investigate the form of production function, we apply the log transformation and add an error term ε to equation (4):

$$\ln\left(\frac{w}{r}\right) = c + (1-\alpha)\ln\left(\frac{K}{N}\right) + \varepsilon,$$ (5)

where $c \equiv \ln\frac{1-a}{a}$ corresponds to the intercept. Estimation of equation (5) will provide the value of α. Using the property of the CES function, we can predict the form of production function. More precisely, it is a Cobb-Douglas if $\alpha = 0$, a Leontief if $\alpha = -\infty$, a linear function if $\alpha = 1$, or none of these forms otherwise.

We must therefore have data on wage and interest rate in constant prices (the reference year is 2010 as for investment and capital), capital stock (we can use either ICOR-based capital or PIM-based capital series) and labor (can be proxied by population aged 15 and 60). However, we have no data on Vietnam wages. We have data only for nominal incomes for every two years. This approach is very interesting. But it hits, in the case of Vietnam, the problem of data. If we have data for wages, but it is commonly known that the quasi totality of Vietnamese workers, in particular in the administrations, cannot live with their salaries. Almost of them have extra jobs. These incomes have been recorded. However, they are published once every two years. The samples are very too short to have significant regressions results.
This method may be used in the future when the annual data of incomes will be available.

3.2 Total Factor Productivity

In this section, we use the regression results obtained with the capital stocks generated by the method based on ICOR

The labour productivity of Vietnam is therefore expressed as

$$\frac{Y_t}{N_t} = A(t)\frac{K_t}{N_t}$$

We can conclude that the Vietnam labour productivity is low (high) if the economy is less

(more) intensive in capital than in labor or/and if the TFP is low (high).

We plot the graphs of A_t and of $\frac{\Delta A}{A}$

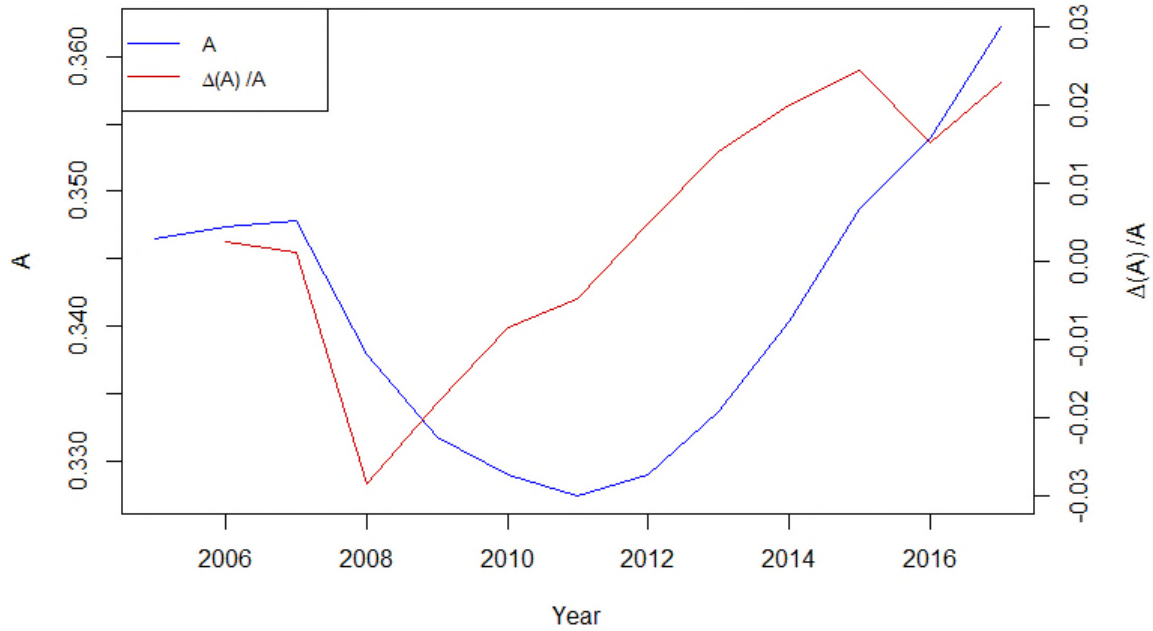Figure 3: Total-Factor Productivity of Vietnam

Table 3: The regression for Vietnam's Production Function (2)

Dependent Variable: Y/A
Method: Least Squares
Date: 04/17/19 Time: 17:18
Sample: 2005 2017
Included observations: 13

Variable	Coefficient	Std. Error	t-Statistic	Prob.
N	7506.7760	282.5649	26.5666	0.0000
R-squared	0.58252	Mean dependent var		3.67E+11
Adjusted R-squared	0.58252	S.D. dependent var		7.80E+10
S.E. of regression	5.04E+10	Akaike info criterion		52.1993
Sum squared resid	3.05E+22	Schwarz criterion		52.2428
Log likelihood	-338.2957	Hannan-Quinn criter.		52.1904
Durbin-Watson stat	0.07021			

We go back to (2). Let v denote the capital coefficient, g denote the annual GDP growth rate, s denote the Vietnam national investment rate. From Le Van and Dana (2003), Section 1.2 on the Harrod Model, we have the relation

$$g + \delta = \frac{s}{v} \tag{6}$$

Given the production function we found (2), (6) becomes

$$g + \delta = sA \tag{7}$$

where A is the TFP. Suppose the target for g is 0.07 then, with $\delta = 0.05$, we must have

$$sA = 0.12$$

This relation points out the importance of the investment rate and of the TFP as well.
For 2018, the Vietnam General Statistics Office (GSO) announces 7.1% for GDP growth, 33.5% for investment rate and the contribution of the TFP is 43%. [3]. We use (7) to compute the TFP for 2018 with $g = 0.071$ and $s = 0.335$. We get

$$A = \frac{0.121}{0.335} = 0.361$$

in accordance with the range of the values of TFP given above.

Another interesting thing when we want to find out the contribution of A growth to the GDP growth. For that, consider again (2). By differentiation we get

$$\frac{\Delta Y}{Y} = \frac{\Delta A}{A} + \frac{\Delta K}{K}$$

This implies

$$1 = \frac{\Delta A/A}{\Delta Y/Y} + \frac{\Delta K/K}{\Delta Y/Y}$$

If we look at the graph of $\Delta A/A$ in Figure 1, we may expect that its value will be around 0.03 for 2018. Since the rate of GDP growth in 2018 is 0.071 if we follow GSO, the contribution of A growth to GDP growth is

$$\frac{0.03}{0.071} = 0.422$$

i.e. 42.2% in accordance with the results given by GSO.

For 2019, suppose the target for g is 7%. If $s = 30\%$ then, from (6),we obtain $A = 0.4$. Since in 2017, the true value is $A = 0.36$, not very far from 0.4. We think that the target for g can be reached for 2019.

We will now attempt to explain the TFP. For that, we refer to Romer (1990) and Lucas Jr (1988). We introduce the concepts of effective capital $\tilde{K}$ and effective labour L defined as

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[3]See the link https://www.gso.gov.vn/default.aspx?tabid=382&idmid=2&ItemID=19041

follows.

$$\tilde{K} = \phi(\text{New technology, Innovation, Knowledge}) \times K$$

$$L = \psi(\text{education, training, working time}) \times N$$

The production function will now be

$$Y_t = A_0 \tilde{K}^\alpha L^\beta$$

where A_0 is a scaling constant. This production function can be rewritten as

$$Y_t = \left[A_0 \left(\phi(\text{Technology, Innovation, Knowledge}) \right)^\alpha \times \left(\psi(\text{education, training, working time}) \right)^\beta \right] K^\alpha N^\beta$$

The TFP A is therefore

$$A = \left[A_0 \left(\phi(\text{Technology, Innovation, Knowledge}) \right)^\alpha \times \left(\psi(\text{education, training, working time}) \right)^\beta \right]$$

The functions ϕ, ψ are non decreasing in their variables.

The TFP A depends on the New Technology, the innovation, knowledge, Human capital and working time. The working time is exogenous. It is commonly accepted that Innovation, New Technology, Knowledge, Education, Human capital depend on the percentages over GDP of the expenditures devoted to these factors. Since we have no data for these expenditures, we assume that the percentage of the expenditures is constant over time and use GDP Y as a proxy of the percentage over GDP of the expenditure for Innovation, New Technology, Knowledge, Education, Human capital. If our intuition is correct, the GDP Y will impact the rate of growth of the TFP. Moreover, we think the impacts are observed with some delay. We will run regression

$$\frac{\Delta A_t}{A_t} = a + b \frac{Y_{t-2}}{Y_{2010}} \tag{8}$$

We assume the lag is of two years[4]. The results are given below in Table 4. The coefficient b is positive and confirms our intuition.

This result suggests that the TFP is high or low according to amount we devote to invest in it. We design in Appendix 1 a simple two-period model of investment in TFP.

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[4]As the value of Y is too much higher than the value of $\frac{\Delta A_t}{A_t}$, we divided the Y_{t-2} by Y_{2010}. The regression result would be the same, but the coefficient b would be easier to observe.

Table 4: The impact of Innovation, New Technology, Knowledge, Education, Human capital on TFP

Dependent Variable: $\Delta(A_t)/A_t$				
Method: Least Squares				
Date: 04/13/19 Time: 23:39				
Sample (adjusted): 2007 2017				
Included observations: 11				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.0724	0.0170	-4.2691	0.0021
$Y_{(t-2)}/Y_{2010}$	0.0753	0.0165	4.5746	0.0013
R-squared	0.6992	Mean dependent var		0.0039
Adjusted R-squared	0.6659	S.D. dependent var		0.0175
S.E. of regression	0.0101	Akaike info criterion		-6.1919
Sum squared resid	0.0009	Schwarz criterion		-6.1195
Log likelihood	36.0553	Hannan-Quinn criter.		-6.2375
F-statistic	20.9273	Durbin-Watson stat		1.6002
Prob(F-statistic)	0.0013			

3.3 Labour productivity and GDP growth

3.3.1 Is the rate of growth of labour productivity the root of the GDP growth?

In Nguyen Duc Thanh & Ohno Kenichi (2018), at page 117, the authors claim that " the decrease of the labour productivity is the cause of the decrease of Vietnam GDP growth during the period 2005-2013"

Let us check this assertion from the theoretical point of view. We follow the authors by assuming that the production function of Vietnam economy is Cobb-Douglas of constant returns to scale. We denote by Y the GDP, by K, N respectively the capital and the number of workers. We have

$$Y = AK^\alpha N^{1-\alpha}, \alpha \in (0,1) \tag{9}$$

Log-linearizing this relation, we easily get

$$\alpha \frac{\Delta Y}{Y} = \frac{\Delta A}{A} + \alpha \frac{\Delta K}{K} - (1-\alpha)\left[\frac{\Delta Y}{Y} - \frac{\Delta N}{N}\right] \tag{10}$$

In other words

$\alpha\times$ Rate of growth of GDP= rate of growth of TFP + $\alpha\times$ rate of growth of the capital -

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$$(1 - \alpha)\times \text{ rate of growth of labour productivity}$$

Relation (9) can be rewritten as

$$1 = A \left(\frac{K}{Y}\right)^{\alpha} \left(\frac{N}{Y}\right)^{1-\alpha}$$

$$\text{or} \qquad 1 = \frac{1}{A} \left(\frac{Y}{K}\right)^{\alpha} \left(\frac{Y}{N}\right)^{1-\alpha} \tag{11}$$

In (10), we see that labour productivity growth negatively impacts GDP growth. To understand this result which seems counter intuitive look at relation (11). This one shows that actually the labour productivity and capital productivity are substitutes. If labour productivity decreases then capital productivity must increase. If the capital K and the TFP A are kept constant, then a diminution of labour productivity will imply an augmentation of the GDP. Both (11) and (10) show that our theoretical results contradict the claim of the authors.

Moreover, both Vietnam GDP growth rate and Vietnam labour productivity growth rates are positive during 2005-2013 (Table 5 and 6).

(10) points out the importance the sum :

$$\text{rate of growth of TFP } + \alpha\times \text{ rate of growth of the capital}$$

for the positiveness of GDP growth when labour productivity growth is negative (under the assumption of Cobb-Douglas constant returns to scale production function).

Table 5: The growth rates of Vietnam Gross Domestic Product, 2005-2017

Year	2005	2006	2007	2008	2009	2010	2011
	7.55%	6.98%	7.13%	5.66%	5.40%	6.42%	6.24%
Year	2012	2013	2014	2015	2016	2017	
	5.25%	5.42%	5.98%	6.68%	6.21%	6.81%	

Source: Authors' calculations with World Bank data

Table 6: The growth rates of Vietnam Labour Productivity, 2005-2017

Year	2005	2006	2007	2008	2009	2010	2011
	4.59%	4.05%	4.22%	2.81%	2.57%	3.59%	3.49%
Year	2012	2013	2014	2015	2016	2017	
	3.06%	3.84%	4.99%	6.40%	5.29%	6.02%	

Source: Authors' calculations with World Bank data

3.3.2 Comparison of the labour productivity between two countries

Let us consider two countries, say $1, 2$ with production functions

$$y^1 = A k^{1\alpha} N^{1 1-\alpha}$$
$$y^2 = A k^{2\beta} N^{2 1-\beta}$$

with $\alpha \in (0,1)$, $\beta \in (0,1)$. The capital stocks are respectively k^1, k^2 while the number of workers are N^1, N^2. The labour productivity of the two countries will be

$$\frac{y^1}{N^1} = A \left(\frac{k^1}{N^1} \right)^{\alpha}$$
$$\frac{y^2}{N^2} = A \left(\frac{k^2}{N^2} \right)^{\beta}$$

Suppose the ratios $\left(\frac{k^1}{N^1} \right)$ and $\left(\frac{k^2}{N^2} \right)$ are equal and greater than 1. If $\alpha > \beta$ then the labour productivity in country 1 is higher than the one of country 2. We obtain the opposite conclusion if $\alpha < \beta$. We see that the comparison of the labour productivity of these two countries does not make sense if we do not know their production functions. The exercise will be harder when one country has a production function with decreasing returns while the other one has increasing returns.

In this simple example we assume both countries have the same TFP A, and their production functions are Cobb-Douglas with constant returns to scale. We worry when people claim that the labour productivity in Vietnam is lower than the one in Laos without showing the production functions of these two countries. Maybe, their TFP are not the same and we are not sure that their technologies are Cobb-Douglas of constant returns to scale. Claiming that the labour productivity of Vietnam is lower of the one in Laos is not very useful if we have no information about the structure of the economy through the aggregate production functions.

Indeed, it is written in a report of the World Bank:

http://www.worldbank.org/en/country/lao/publication/lao-pdr-development-report-2014

"Lao PDR's economy is growing fast but growth is mainly driven by the hydro and mining sectors where very few jobs are created: only 22,000 people work in these sectors and this number is unlikely to increase much, given how capital intensive those sectors are."

Clearly, Lao economy is capital intensive and it may explain why the Lao labour productivity is higher than Vietnam labour productivity.

3.4 Production Functions of China and Laos Economies

In this section, first we will find the production functions of China and Laos. Second we try to compare the labour productivites of China, Laos and Vietnam.

We apply the same methodology as in 3.1.2 to generate the capital stocks of China and Laos from 2005 to 2017. We got the data of China, Laos, Vietnam about GDP, Investment from the "World Development Indicators" dataset of World Bank. Employment data of Vietnam and China come from the ADB (Asia Development Bank) dataset. For Laos employment, the data from the datasets of World Bank and ADB were mismatched. So, in our study, the employment of Laos is computed by using the data about total labor force and unemployment rate in the World Bank dataset. We will now give the production functions of China and Laos.

Table 7: The regression for China's Production Function

Dependent Variable: Ln(Y/N)				
Method: Least Squares				
Date: 04/15/19 Time: 23:09				
Sample (adjusted): 2005 2017				
Included observations: 13				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.8217	0.2681	3.0654	0.0107
Ln(K/N)	0.8129	0.0265	30.6557	0.0000
R-squared	0.9884	Mean dependent var		9.0335
Adjusted R-squared	0.9874	S.D. dependent var		0.3220
S.E. of regression	0.0362	Akaike info criterion		-3.6603
Sum squared resid	0.0144	Schwarz criterion		-3.5734
Log likelihood	25.7921	Hannan-Quinn criter.		-3.6782
F-statistic	939.7743	Durbin-Watson stat		0.4076
Prob(F-statistic)	0			

The production function of China is of **constant returns to scale** (Table 7). The elasticity of the capital is 0.81, the one of labour is 0.19.

From Table 8, the production function of Laos is of **increasing returns**.

$$Y = e^{-13.5} K^{0.74} N^{1.24}$$

The labour productivity in Laos depends not only on the ratio K/N but also on N.

To understand why this productivity is of increasing returns, we run the following regression

$$\ln(Y/N) = a + b\ln(K/N) + c\ln(N)$$

Table 8: The regression for Lao's Production Function (1)

Dependent Variable: LnY				
Method: Least Squares				
Date: 04/16/19 Time: 22:31				
Sample (adjusted): 2005 2017				
Included observations: 13				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-13.4913	1.338438	-10.0799	0
LnK	0.7421	0.092947	7.9845	0
LnN	1.2448	0.234771	5.3021	0.0003
R-squared	0.9993	Mean dependent var		22.7598
Adjusted R-squared	0.9992	S.D. dependent var		0.2928
S.E. of regression	0.0084	Akaike info criterion		-6.5133
Sum squared resid	0.0007	Schwarz criterion		-6.3829
Log likelihood	45.3365	Hannan-Quinn criter.		-6.5401
F-statistic	7220.6860	Durbin-Watson stat		0.7156
Prob(F-statistic)	0			

Table 9: The regression for Lao's Production Function (2)

Dependent Variable: Ln(Y/N)				
Method: Least Squares				
Date: 04/16/19 Time: 23:30				
Sample (adjusted): 2005 2017				
Included observations: 13				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-13.4913	1.3384	-10.0799	0.0000
Ln(K/N)	0.7421	0.0929	7.9845	0.0000
Ln(N)	0.9869	0.1428	6.9131	0.0000
R-squared	0.9985	Mean dependent var	7.8042	
Adjusted R-squared	0.9982	S.D. dependent var	0.1991	
S.E. of regression	0.0084	Akaike info criterion	-6.5133	
Sum squared resid	0.0007	Schwarz criterion	-6.3829	
Log likelihood	45.3365	Hannan-Quinn criter.	-6.5401	
F-statistic	3338.7460	Durbin-Watson stat	0.71556	
Prob(F-statistic)	0.0000			

The results are in Table 9:

$$\ln(Y/N) = -13.49 + 0.742 \ln(K/N) + 0.987 \ln(N)$$

This relation can be written as

$$Y = \left[e^{-13.49} N^{0.987} \right] K^{0.742} N^{0.258}$$

or

$$Y = A(N)K^{0.742}N^{0.258}$$

with $A(N) = \left[e^{-13.49}N^{0.987}\right]$.

The production function of Laos has a TFP which depends positively on N. An explanation of this positive dependence on N is given in Appendix 3.

We mentioned above in Subsubsections 3.3.2 that comparing the labour productivities of these countries with very different economic structures does not really make sense.

4   Part 2: Issues on Vietnam Economic Growth at the micro level

4.1   Vietnam SOEs capital uses

To study the use of capital in the SOEs in Vietnam, we use a Census conducted in 2014 by the General Statistics Office (GSO) of Vietnam (2014, 2015). In this census we have the data of 2,835 SOEs concerning the values of their outputs, their capital stocks and the labor costs. The average value of the ratios [Value of the capital stock/Labor cost] is 29.6 The Vietnam real interest rate in 2014 is 4.84%

See the link

Take the capital depreciation rate equal to 0.05. The average value of the ratios

[Investment cost/labor cost]

is therefore

$$(0.048 + 0.05) \times 29.6 = 2.9^{5}$$

However, there are $1,862$ SOEs those revenue represents 84.9% of the total revenue of $2,835$ SOEs, using 36.8% of the total capital, for which the ratio [Investment cost/labor cost] equals 1.8. Their capital coefficient is 0.6 which is very correct. The remaining firms represent 15.1% of the total revenue, but use 63.2% of the total capital. Their ratio [Investment cost/labor cost] is vertiginous: it equals 6.9 and their capital coefficient is impressive 9.7. This shows that the Vietnamese SOEs are very capital intensive. Some of them are extremely capital intensive. In developed countries, the ratio [Investment cost/labor cost] is 0.5. Maybe there is a waste of physical capital?

---

[5]Let qK be the value of the capital, and wN the value of total wages. q, w are respectively the price of the capital and labour wages. If r is the real interest rate and δ is the capital depreciation rate, then the ratio [Investment cost/labor cost] is $\frac{(r+\delta)qK}{wN}$

We now consider the profit rates of these SOEs. The profit rate $r(\pi)$ is defined by

$$r(\pi) = \frac{\text{value of the revenue - investment cost - labour cost}}{\text{value of the revenue}}$$

For the $1,862$ SOEs which have a relative low ratio [Investment cost/labor cost] correspond to those with a capital coefficient lower than 2 (we consider the norm for the capital coefficient is to be lower than 2). Then there rate of profit is positive and equals 35.6%. For the SOEs with a capital coefficient greater than 4 (their number is 545), their profit rate is negative and equals -29%.

4.2   Capital diversion

We now check the diversion issue. Let λ_i denote the rate of waste, or of bribery of the physical capital of firm i. We call it also "hidden overhead". Why? It is well known that when a Vietnamese SOE asks for say 1 billion of VND for its purchase of capital, it will receive $(1 - \lambda_i)$ billion. But it has to declare receiving 1 billion. So, λ_i billion have been diverted. The effective production function of firm i is actually

$$Y_i = A[(1 - \lambda_i)K_i]^{\alpha} N_i^{\beta} e^{\varepsilon_i} \tag{12}$$

which includes a white noise disturbance (ε_i).

We found that the average distribution of λ (for inefficient firms) is higher than 60%.
If we consider the $1,862$ SOEs (65.7% of the SOEs) with [Investment cost/labor cost] equal to 1.8, the value of λ is very small, around 0.4%. For the other SOEs, some of them have $\lambda = 60.\%$
It is astonishing to see that a minority of SOEs is so capital wasteful.

Taking the logarithm of equation (12) gives

$$\ln Y_i = \alpha_0 + \alpha_K \ln K_i + \alpha_N \ln N_i + \varepsilon_i - \underbrace{[-\alpha_K \ln(1 - \lambda_i)]}_{u_i}, \tag{13}$$

where $\alpha_0 \equiv \ln A$. The new residual term corresponds to $\varepsilon_i - u_i$. Remark that $u_i \geq 0$ because $0 \leq \lambda_i \leq 1$.

Following the literature on stochastic frontier production (e.g. Kumbhakar and Lovell, 2003), u_i corresponds to the well-known stochastic technical inefficiency. Besides the normal distribution assumption for ε_i, we need an additional assumption about the distribution of u_i in order to calculate the maximum likelihood estimator of the model. For instance, we assume

that u_i follows a half-normal distribution $N^+(0, \sigma_u^2)$. Hence, the technical inefficiency u_i can be estimated by (see for example Jondrow et al., 1982):

$$\hat{u}_i = E(u_i \mid \varepsilon_i - u_i) = \tilde{\mu}_i + \tilde{\sigma} \left[\frac{\phi(-\tilde{\mu}_i/\tilde{\sigma})}{\Phi(-\tilde{\mu}_i/\tilde{\sigma})} \right], \tag{14}$$

where $\tilde{\mu}_i = -(\varepsilon_i - u_i)\sigma_u^2/\sigma_s^2$, $\tilde{\sigma} = \sigma_\varepsilon \sigma_u/\sigma_s$, $\sigma_s = (\sigma_\varepsilon^2 + \sigma_u^2)^{1/2}$. Note that $\phi(.)$ and $\Phi(.)$ are respectively the density and the cumulative distribution function of the standard normal distribution.

When an estimation of technical inefficiency (u_i) and output elasticity of capital (α_K) are available, one can recover an estimate for the hidden overhead (λ_i):

$$\hat{\lambda}_i = 1 - \exp\left(-\frac{\hat{u}_i}{\hat{\alpha_K}}\right). \tag{15}$$

In the following, we only discuss the Cobb-Douglas case. Remark 2 below presents difficulties to use the *translog* production function instead of Cobb-Douglas function.

We want to apply this modelling to the whole sample of Vietnamese SOEs. However, they are very heterogeneous and using all of them can produce imprecise estimates. Table 10 reports main descriptive statistics for firm production Y, capital stock K, labor L. We also calculate the ratio of capital in production K/Y. Data on these variables are in values (i.e. in monetary terms): we employ capital costs, labor costs, and revenue for K, L and Y respectively. As a result, the ratio K/Y represents the share of capital value in revenue.

We observe a very large heterogeneity in the sample as the ratio K/Y can vary from 0.026 to 62471. To limit the impact of this heterogeneity, we perform the analysis into two two separate subsamples, one with $K/Y <= 20$ and another with $K/Y > 20$. The first subsample includes 2686 firms for which the range of K/Y is between 0.026 and 19.921 while the second subsample only contains 149 firms with K/Y covering the interval from 20.359 to 62471 (see Table 11. We add another feature to control for data heterogeneity consisting of the heteroskedastic dispersion of firm's inefficiency u_i, i.e. $\sigma_{u,i}^2 = \exp(w_i'\gamma)$.

Table 15 reports estimation results of model (13) using maximum likelihood and bootstrap standard errors. It is shown that output elasticities of capital and labor are respectively 0.680 and 0.346, which correspond to a constant returns to scale (CRS) production function (the chi squared statistic for the null hypothesis of CRS is 1.17 with the p-value $= 0.28$). It is also shown that variance of technical inefficiency (σ_u^2) is heteroscedastic as it significantly depends on several variables like export activity, sectoral dummies and firm size. We remark the negative

Table 10: Data on SOEs in 2014.

Variable	Obs	Mean	Std. Dev.	Min	Max
K	2,892	1291.834	9903.845	.0231	399530.8
L	2,895	43.198	176.957	.002	6656.3
Y	2,840	908.086	5269.548	.001	154775.3
K/Y	2,835	41.116	1199.921	.026	62471

Notes. Source: GSO Enterprise Census 2014.

Table 11: Data on SOEs in 2014, subsample with $K/Y \leq 20$.

Variable	Obs	Mean	Std. Dev.	Min	Max
K	2,686	1226.485	9922.021	.023	399530.8
L	2,686	45.354	182.997	.085	6656.3
Y	2,686	958.308	5414.208	.035	154775.3
K/Y	2,686	2.212	2.984	.026	19.921

Notes. Source: GSO Enterprise Census 2014.

Table 12: Data on SOEs in 2014, subsample with $K/Y > 20$.

Variable	Obs	Mean	Std. Dev.	Min	Max
K	149	2530.804	10740.81	6.094	110069.5
L	148	14.966	56.040	.056	652.8
Y	149	24.707	76.036	.001	729
K/Y	149	742.429	5200.734	20.359	62471

Notes. Source: GSO Enterprise Census 2014.

Table 13: Distribution of firms over different sectors, subsample with $K/Y < 20$.

Sectoral dummies	Sector	Frequency	Percentage
1	Agriculture, Forestry & Fishing (Reference group)	315	11.73
2	Manufacturing, Mining & Quarrying	638	23.75
3	Electricity, Gas, Water Supply	279	10.39
4	Construction	326	12.14
5	Wholesale & Retail Trade	394	14.67
6	Transportation & Storage	222	8.27
7	Others	512	19.06
Total		2,686	100.00

Table 14: Firm size, subsample with $K/Y < 20$.

Size dummies	Size	Frequency	Percentage
Small	Small and very small firms (Reference group)	1,123	41.81
Medium	Medium firms	403	15.00
Large	Large firms	1,160	43.19
Total		2,686	100.00

Table 15: Estimation results of the Cobb-Douglas production frontier

Variable	Coefficient	Std.Err.
Capital	0.680***	0.018
Labor	0.346***	0.032
Intercept	2.502***	0.149
$\ln \sigma_\varepsilon^2$	-0.218***	0.032
$\ln \sigma_u^2$		
Economic zone	0.060	0.219
Export	-0.693***	0.193
Sectoral dummies		
2	-1.991***	0.135
3	-0.872***	0.079
4	-1.254***	0.107
5	-36.175***	1.292
6	-1.502***	0.156
7	-1.185***	0.112
Firm size dummies		
Medium	-0.357**	0.149
Large	-0.134	0.137
Intercept	1.158***	0.080

Notes. Number of observations: 2686 firms. Reference group for sectoral dummies is 'Agriculture, Forestry and Fishing'. Reference group for firm size is 'Super Small Firms'. Significance levels: ***1%, **5%, *10%.

impacts of sectoral dummies on σ_u^2 indicating that firms operated in all economic sectors are more efficient than the reference group (Agriculture, Forestry and Fishing sector). Moreover, large-size firms are not significantly different from small firms in terms of (in)efficiency while medium-size firms are more efficient (its coefficient is significantly negative).

Figure 4 presents the distribution of λ_i for the subsample with $K/Y \leq 20$. There is an important group of SOEs (exactly 394 firms) which have a λ_i close to zero, meaning that they employed capital efficiently. These firms correspond to those operating in Wholesale & Retail Trade sector. The remaining 2292 firms in other sectors have the average λ of 0.623, which is considerably high.

Remark (2) *Instead of the Cobb-Douglas function, we can use the* translog *production function. In this case, we have the following regression equation*

$$
\begin{aligned}
\ln Y_i = {} & \beta_0 + \beta_K \ln K_i + \beta_N \ln N_i + \beta_{KK}(\ln K_i)^2 + \beta_{NN}(\ln N_i)^2 + \beta_{KN} \ln K_i \ln N_i + \varepsilon_i \\
& - \underbrace{\left\{ -(\beta_K + 2\beta_{KK} \ln K_i + \beta_{KN} \ln N_i) \ln(1 - \lambda_i) - \beta_{KK} \left[\ln(1 - \lambda_i)\right]^2 \right\}}_{u_i}, \quad (16)
\end{aligned}
$$

This part is too complicated to estimate because of endogeneity of K_i and N_i (because $E(K_i u_i) \neq$
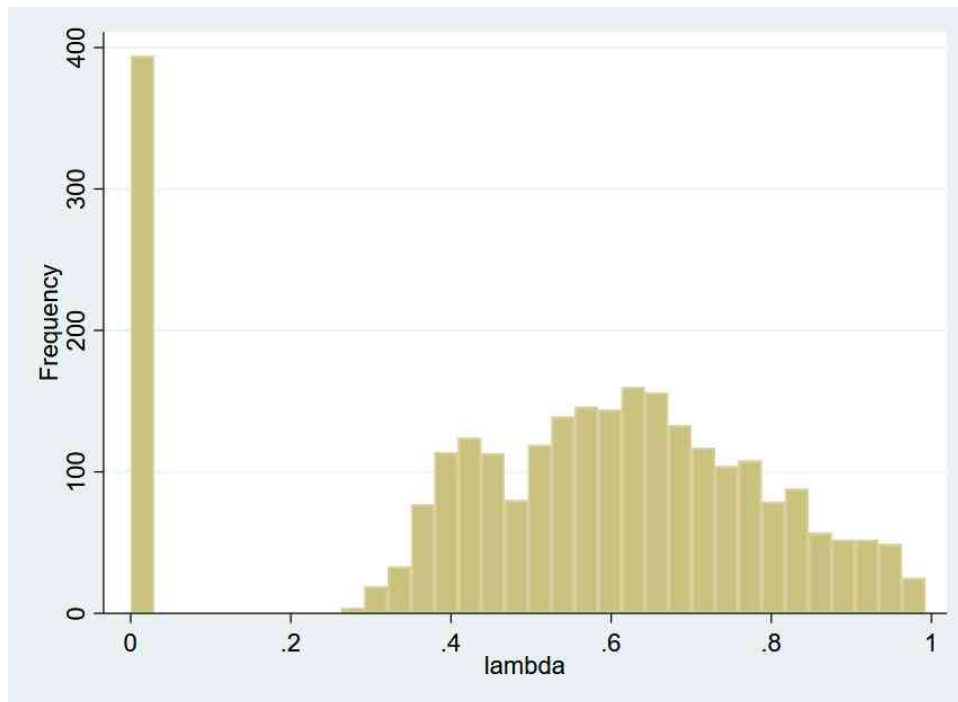
Figure 4: Distribution of $\hat{\lambda}_i$, firms with $K_i/Y_i < 20$.

0 *and* $E(N_i u_i) \neq 0$*)*.

5 Concluding remarks

1. As we mentioned above, the contribution of TFP growth to GDP growth is important. How could we increase this impact of TFP on growth? From Romer (1990) and Lucas (1988) it should depend on the expenditures for knowledge, education, health. In this respect, we observe that the Vietnam public expenditures are very small (6.5% of GDP). We can compare them with those in China, or developed countries such as Germany or France. For China, one finds 14%. For Germany and France, more than 20%). See the links

https://www.ceicdata.com/en/country/vietnam

https://www.ceicdata.com/en/country/germany

https://www.ceicdata.com/en/country/france

https://www.ceicdata.com/en/country/china

2. The calculations of the capital stock are not satisfactory. We use the amount of investments given by GSO. This includes also investments in construction, in health and education infrastructure. GSO should decompose this amount in its components in order to obtain the productive investment. However, the result we get for Vietnam production function seems to show that Vietnam economy depends strongly on investments, maybe, in particular, investments in infrastructure, construction. In any case this point should be clarified if GSO gives more information on the several investments. For sure Vietnam economy depends on FDI, but from the production function it depends on the TFP A too. For the sustainability purpose, Vietnam should rely less on FDI and more on TFP.

3. To study the TFP, we would like GSO publishes the expenditures for health, education too. It is very important to have these information in order to study their impact on the TFP. Relation (7) shows the importance of the TFP for the GDP growth rate.

4. Obviously, investing in New Technology, Innovation, Digital Economy 4.0, Education and Health, Open Data uses,... is very important. We do not insist anymore on these recommendations since there exists an abundant literature on these topics.

One can only worry about the number of researchers in Vietnam and the investment in R&D:

4.1. In Vietnam, there are 675 researchers by million of inhabitants, while in China, there are 1,113, in Korea, 6,899.

4.2. In 2013, Vietnam invested in R&D 0.37% GDP, while China 2.07% in 2015, Korea 4.23%

in 2015. [6]. Vietnam should attract scientists of Vietnamese origin who are actually dispersed over the world. [7]

5. We can address critics to the current literature (including the present paper) on labour productivity that it seems to focus only on macro data. We should go to the micro level.

5.1. For instance, Vietnam should conduct surveys on the number of calories the workers obtain with the meals in the canteens of firms and also at home. If the number of calories is low, it will not be a surprise that labour productivity is also low. Moreover, the food safety in Vietnam still remain poor and the living conditions of workers need to be improved much (Research Center for Employment Relations, 2016).

5.2. Vietnam should also conduct surveys on the needs of types of labour of the firms in different sectors and to see whether the skills of workers correspond to the needs of firms. These information are important to implement appropriate teaching programs in the Colleges, Universities.

5.3. Everybody finds the life in big cities in Vietnam very stressing with the volumes of motor bikes. This is probably harmful for health and hence for labour productivity. It might be interesting to correlate labour productivity in big cities with the number of motor bikes by square meters in these cities.

5.4. High blood pressure, diabetes, cardiovascular diseases are frequently mentioned in the newspapers. We think that these diseases strongly impact the quality of labour.

5.5. Pollution in the big cities is very probably harmful for the workers. What should Vietnam authority do? A big concern!

5.6. Young and less young male populations drink too much beer! This custom, for sure, will not be benefit for health. Should the Vietnamese Health authority "educate" these populations?

5.7 The missing point in the present paper is the consideration of the private sector, in particular the foreign firms.

6. Finally, from our production function we see that TFP has a very important role for Vietnam economy. We suggest Vietnam to implement policies to push up the TFP. The roadmap we suggest is as follows:

6.1. Invest in health, education, training. The priority is for low- income population and low skilled workers.

6.2. In parallel, investigate the needs of firms in labor and technology in order to renovate the

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[6]Sources: *World Development Indicators*, World Bank

[7]Recently, an interesting forum in Paris, jointly organized by Association of Vietnamese Scientists and Experts and the State Committee for Overseas Vietnamese gathered around 200 scientists, experts, entrepreneurs of Vietnamese origin around the world

contents of teaching in the high schools, colleges and universities.

6.3. Invest in research on numerical economy, innovation, new technology, economics, organizational management.

6.4. Improve the functioning in the administrations with open data uses. But the most difficult point is to increase the income of the employees of these administrations including high schools, colleges and universities too. With higher incomes, they will be more motivated and hence more efficient. This point should be deepened by the Vietnamese authority and is beyond the scope of our paper.

6.5. It would be important to know exactly the expenditures devoted for health, education, training. If the percentage over GDP of these spending is low, the quality of health care and education suffer of this weakness. A low number of public expenditures may be explained by the fact that the collected taxes are very little. If the incomes become higher and transparent we should collect, in principle, more tax.

7. We have to point out the weakness of this paper. It relies on the short length of the data: $2005 - 2017$, 13 years. We are not able to check whether some of the time-series we use are stationary or not. The test requires at least 20 years. In this case, we meet the difficulty that from 1996 to 2004, it is hard to claim that the Vietnam economy during this period was really a market economy as the one after 2005.

6 Appendix 1: A simple two-period model of investment in TFP

Consider the model with a social planner who wants to maximizes the intertemporal utility of a representative agent. This utility is $\ln(c_0) + \beta \ln(c_1), \beta \in (0, 1)$. The constraints are

$$
\begin{aligned}
c_0 + k_1 &= (1 - \theta)Ak_0 \\
c_1 &= A\zeta(\theta Ak_0)k_1
\end{aligned}
$$

with $k_0 > 0$.

The consumptions per head are c_0 for period 0, c_1 for period 1. In period 0, the agent buys k_1 capital stock per head which will be used in period 1 to produce consumption good. The production functions are linear (as for Vietnam). Here $\theta \in [0, 1]$ is the part of the output Ak_0 of the first period $t = 0$ devoted for improving the TFP A in the second period ($t = 1$). The function ζ is strictly increasing and satisfies $\zeta(0) = 1$. Hence if $\theta > 0$ the TFP in period 1 becomes $A\zeta(\theta Ak_0) > A$.

The optimal value for the capital stock per head k_1^* is

$$k_1^* = \frac{\beta}{1+\beta}(1-\theta)Ak_0$$

The rate of growth of output at period 1 is

$$g = \frac{A\zeta(\theta Ak_0)(1-\theta)Ak_0\beta/(1+\beta)}{(1-\theta)Ak_0} - 1 = A\zeta(\theta Ak_0)\frac{\beta}{1+\beta} - 1$$

Assume $A\beta < (1+\beta)$ and $A\zeta(Ak_0)\beta > (1+\beta)$. Then there exists $\theta \in (0,1)$ for which $g > 0$. Suppose the government fix a target g^*. If g^* satisfies

$$(1+g^*) \leq \zeta(Ak_0)A \times \frac{\beta}{1+\beta} \tag{17}$$

then the part devoted to investment in TFP is given by

$$g^* = A\zeta(\theta^* Ak_0)\frac{\beta}{1+\beta} - 1$$

The value θ^* satisfies $\theta^* \in (0,1)$. The condition (17) on g^* means that the government should not be too ambitious and fixes a too high target for the rate of GDP growth g^*.

7 Appendix 2: Regression results with PIM

Table 16: The regression for Vietnam's Production Function with PIM, $\delta = 0.05$

Dependent Variable: Ln(Y/N)				
Method: Least Squares				
Date: 07/31/19 Time: 23:49				
Sample: 2005 2017				
Included observations: 13				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-6.573999	0.633661	-10.37463	0.0000
Ln(K_1/N)	1.595797	0.070251	22.71573	0.0000
R-squared	0.979127	Mean dependent var	7.819346	
Adjusted R-squared	0.977230	S.D. dependent var	0.153227	
S.E. of regression	0.023122	Akaike info criterion	-4.555452	
Sum squared resid	0.005881	Schwarz criterion	-4.468536	
Log likelihood	31.61044	Hannan-Quinn criter.	-4.573317	
F-statistic	516.0046	Durbin-Watson stat	0.411381	
Prob(F-statistic)	0.000000			

Note: K_1 is the series of capital stocks which are computed by the Perpetual Inventory Method with $\delta = 0.05$

In table 16, we see that the elasticity of labour is negative (-0.405). We reject this regression

result.

Table 17: The regression for Vietnam's Production Function with PIM, $\delta = 0.07$ (1)

Dependent Variable: Ln(Y/N)				
Method: Least Squares				
Date: 07/31/19 Time: 23:43				
Sample: 2005 2017				
Included observations: 13				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-1.872534	0.586587	-3.192253	0.0086
Ln(K_2/N)	1.087842	0.065833	16.52433	0.0000
R-squared	0.961275	Mean dependent var	7.819346	
Adjusted R-squared	0.957754	S.D. dependent var	0.153227	
S.E. of regression	0.031494	Akaike info criterion	-3.937404	
Sum squared resid	0.010911	Schwarz criterion	-3.850489	
Log likelihood	27.59313	Hannan-Quinn criter.	-3.955269	
F-statistic	273.0534	Durbin-Watson stat	0.282489	
Prob(F-statistic)	0.000000			

Note: K_2 is the series of capital stocks which are computed by the Perpetual Inventory Method with $\delta = 0.07$

Table 18: The regression for Vietnam's Production Function with PIM, $\delta = 0.07$ (2)

Dependent Variable: Y/A_2				
Method: Least Squares				
Date: 07/31/19 Time: 23:47				
Sample: 2005 2017				
Included observations: 13				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
N	7602.865	275.2466	27.62201	0.0000
R-squared	0.593926	Mean dependent var	3.72E+11	
Adjusted R-squared	0.593926	S.D. dependent var	7.71E+10	
S.E. of regression	4.91E+10	Akaike info criterion	52.14685	
Sum squared resid	2.90E+22	Schwarz criterion	52.19031	
Log likelihood	-337.9545	Hannan-Quinn criter.	52.13792	
Durbin-Watson stat	0.070569			

Note: The series of TFP A_2 is generated by $A_2 = \frac{Y}{K_2}$. K_2 is the series of capital stocks which are computed by the Perpetual Inventory Method with $\delta = 0.07$

8 Appendix 3

To explain the dependence of the TFP of Lao economy, on the number of workers , we suppose, for simplicity, that Lao economy is composed by two firms which have as production functions

$$Y^1 = AF^1(K^1, N^1),\ Y^2 = AF^2(K^2, N^2)$$

They have the same TFP A which depends posivitely on the total employment $N = N^1 + N^2$. The functions F^1, F^2 are increasing, concave with decreasing returns to scales. When N increases (respectively decreases), communication, deliveries, ... between the two firms become faster (respect. slower) hence more (resp. less) efficient. The aggregate production function is

$$\begin{aligned}
\mathcal{F}(K, N) &= \max_{N^1+N^2=N, K^1+K^2=K} \left\{ A(N^1 + N^2) \left[F^1(K^1, N^1) + F^2(K^1, N^2) \right] \right\} \\
&= A(N) \max_{K^1+K^2=K} \left\{ \left[F^1(K^1, N^1) + F^2(K^1, N^2) \right] \right\} \\
&= A(N)G(K, N)
\end{aligned}$$

One can check that the function G is increasing, concave with decreasing returns to scales. Assume $A(N) > 1$ when $N > \tilde{N}$, $A(\tilde{N}) = 1$. Let $\tilde{Y} = G(K, \tilde{Y})$. When the functions F^1, F^2 have no TFP, say $A(x) = 1, \forall x$ then given K, Y the quantity of labor N necessary to produce is dertermined by the equation

$$G(K, N) = Y$$

We will prove if $Y > \tilde{Y}$ then when F^1, F^2 have a TFP which depends positively on N, the number of workers N' which satisfy

$$A(N')G(K, N') = Y$$

will verify $N' < N$. The labour productivity is better with TFP than without TFP. First we prove that $N' > \tilde{N}$. If not we will have

$$Y = A(N')G(K, N') \leq A(\tilde{N})G(K, \tilde{N}) = G(k, \tilde{N}) < G(k, N) = Y$$

and that is a contradiction. Second we prove that $N' < N$. Indeed, we have

$$G(K, N') = A(\tilde{N})G(K, N') < A(N')G(K, N') = Y = G(K, N)$$

This implies $N' < N$.

We now prove that when $Y < \tilde{Y}$ then $N' > N$. Since $G(K, N) = Y$ we have $N < \tilde{N}$. Assume the contrary. Then $N' \leq N < \tilde{N}$. We have a contradiction

$$Y = A(N')G(K, N') < A(\tilde{N})G(k, N') = G(K, N') \leq G(K, N) = Y$$

The labour productivity is lower with TFP than without TFP.

To summarize, when $Y > \tilde{Y}$, the labour productivity of Laos is high in the sense it is higher than the one obtained with a production technology without TFP. And when $Y < \tilde{Y}$, the labour productivity of Laos will be low, in the sense it is lower than the one we get with a technology without TFP.

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