Determinant factors of TFP convergence: Evidence from Vietnamese manufacturing firms from 2000-2012

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Abstract

The paper finds an evidence for a beta-convergence in TFP of Vietnamese manufacturing firms during the period 2000-2012. It appears that an unconditional convergence shows a lower speed than conditional one. In addition, the firms' TFP convergence is rather related to their characteristics than their geographic location and/or industrial characteristics.

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1 Introduction

Productivity convergence is a long-term process, in which two kinds of convergence can be considered: *beta-convergence* and *sigma-convergence*. *Beta-convergence* implies that lower productivity entities (countries, industries, regions or firms) grow faster than higher ones. Otherwise, *sigma-convergence* predicts that cross-entity variance in productivity will be declining during the transition to the steady state (Barro and Sala-i Martin, 1992, 1997; Bernard and Jones, 1996).

It should be noticed that there have been a wide literature on productivity convergence. However, most of them focus on the *beta-* and/or *sigma-convergence* at country level (Baumol, 1986; Baumol and Wolff, 1988; Bernard and Jones, 1996; Bernard and Durlauf, 1996; Lee, 2009) or industry/region level (Barro et al., 1991; Pascual and Westermann, 2002; Wang and Szirmai, 2013; Rodrik, 2013). In addition, these studies are only interested in labor productivity. There is hence a little literature examining the TFP convergence at firm level, which is associated with developed countries as Japan (Nishimura et al., 2005), U.S. (Fung, 2005), France (Chevalier et al., 2012) or Spain (Escribano and Stucchi, 2014).

It should be also underline that most of aforementioned literature is related to an unconditional/unexpected productivity convergence. There are few studies examining different factors which may affect that convergence. However, they undertake only one or some factors as recession (Escribano and Stucchi, 2014), knowledge spillovers (Nishimura et al., 2005; Fung, 2005), globalization (Lee, 2009; Chevalier et al., 2012; Gomes Neto and Veiga, 2013).

The purpose of this paper is double. On the one hand, it tries to find evidence for the existence of a *beta-convergence/divergence* of Vietnamese firms' TFP during the period 2000-2012. On the other hand, different determinant factors of this convergence/divergence are taken into account. They are divided into three groups: firm characteristics, industrial characteristics, and firm geographic location.

The remainder of the paper is organized as follows. Section 2 provides the econometric strategies of the research, followed by a description of the data and variables. Section 3 reports the main findings and some conclusions and remarks are given in Section 4.

2 Data and Econometric strategies

2.1 Econometric strategies

To investigate whether there is a convergence/divergence in TFP of Vietnamese firms, the estimation takes place in two stages. Firms' TFP is first estimated. At the second stage the existence of convergence/divergence in this TFP is then taken into account.

Measurement of firms' TFP

Firms' TFP can be in truth estimated through their production function. However, the estimation of this function can face the simultaneity problem occurring between unobservable productivity shocks and input selection of firms. If it is true, ordinary least squares (OLS) estimating for production function are biased. To deal with this problem, the present research uses the firm-level production function estimation suggested by Olley and Pakes (1996); Levinsohn and Petrin (2003) and Petrin et al. (2004). Indeed, these authors develop a two-step estimation in which in the first stage, semi-parametric methods are employed to estimate the parameters for variable inputs. The second step aims to identify the coefficient for capital. While Olley and Pakes (1996) use investment to proxy for unobserved productivity, Levinsohn and Petrin (2003) (LP for short) propose intermediate goods as a proxy variable for such unobservable. The main reason is that the investment proxy may not smoothly respond to unobserved productivity shocks, then violating the consistency condition.

Following LP method, material (m_{ijt}) is used in the research as controlling variable for unobserved productivity. Let assume that the decision-maker of a given firm would maximize expected profit from a Cobb-Douglas production function under uncertainty. The estimation equation has the following form (in logarithm)

$$y_{ijt} = \alpha + \beta_l l_{ijt} + \beta_m m_{ijt} + \beta_k k_{ijt} + \omega_{ijt} + \varepsilon_{ijt} \tag{1}$$

where index ijy implies for firm i in industry j during year t. Variable y, l, k, m represent respectively production level, labor, capital stock and materials of the firm in question. Variable ω_{ijt} is observed productivity shock, and known by the decision-maker. It is assumed to be correlated with l_{ijt} and m_{ijt}, thereby causing simultaneity bias. The error ε_{ijt} has not been known by the decision-maker, representing unpredictable shocks. It has zero mean of actual productivity after inputs are selected.

From this set-up, Equation (1) can be rewritten as

$$y_{ijt} = \beta_l l_{ijt} + \phi_t(m_{ijt}, k_{ijt}) + \varepsilon_{ijt} \tag{2}$$

where $\phi_t = \alpha + \beta_m m_{ijt} + \beta_k k_{ijt} + \omega_{ijt}$.

Since $E[\varepsilon \mid m_{ijt}, k_{ijt}] = 0$, the difference between Equation (2) and its expected value with respect to materials and capital is given as

$$y_{ijt} - E[y_{ijt} \mid m_{ijt}, k_{ijt}] = \beta_l \left(l_{ijt} - E[l_{ijt} \mid m_{ijt}, k_{ijt}]\right) + \varepsilon_{ijt} \tag{3}$$

Equation (3) can be estimated by OLS (without intercept) to acquire consistent estimation parameters for inputs. The conditional expectations of output and labor as the function of (m_{it}, k_{it}) can be acquired by using linear weighted least square regression (LWLS). The function $\phi_t(\cdot)$ is derived from the LWLS regression of $(y_{it} - \hat{b}_l l_{it})$ with respect to (m_{it}, k_{it}). To have a consistent estimate of (β_m, β_k), we assume that productivity follows the first-order Markov process

$$\omega_{ijt} = E[\omega_{ijt} \mid \omega_{ijt-1}] + \xi_{ijt}$$

where ξ_{ijt} is the unexpected productivity shock and independently and identically distributed.

Using collected coefficients of the production function, firm's TFP can be computed as follows

$$TFP_{ijt} = y_{ijt} - \hat{\beta}_l l_{ijt} - \hat{\beta}_m m_{ijt} - \hat{\beta}_k k_{ijt.} \tag{4}$$

Estimate for convergence/divergence of firms' TFP

In what follows, firm's TFP obtained in Equation (4) is employed to find evidence for convergence/divergence by using both cross-section data (or OLS) and panel data methods.

The cross-section method is based on the following equation

$$\frac{1}{T}\log\left(\frac{TFP_{ij,t_0+T}}{TFP_{ij,t_0}}\right) = \beta_0 + \beta_1 \log(TFP_{ij,t_0}) + \gamma X_{ij,t_0} + u_{ij,t_0,t_0+T} \tag{5}$$

where t_0 is the beginning date and T is the length of the period. X is a group of controlling variables, including firm characteristics, industry characteristics, and firm geographic location.

As for the panel data method, the random effect model is used by basing on the following regression

$$\log\left(\frac{TFP_{ij,t+k}}{TFP_{ij,t}}\right) = \alpha_i + \beta_1 \log(TFP_{ij,t}) + \gamma X_{ij,t} + \varepsilon_{i,t} \tag{6}$$

If the coefficient $\hat{\beta}_1$ estimated in Equations (5) and (6) takes a positive value, then there is a divergence in terms of TFP between firms. Otherwise, if that value is negative, a convergence is found. As a consequence, the associated speed of convergence ($\beta-$convergence) can be computed as

$$\beta^{ols} = -\frac{\ln(1+\hat{\beta}_1^{ols}T)}{T} \tag{7}$$

$$\beta^{rd} = -\frac{\ln(1+\hat{\beta}_1^{rd})}{T} \tag{8}$$

where $\hat{\beta}_1^{ols}, \hat{\beta}_1^{rd}$ are respectively the estimated coefficient associated with the initial firm's TFP obtained from Regressions (5) and (6). Parameters β^{ols}, β^{rd} are the associated speed of convergence.

Hence, the half-life time (hl) can be calculated as

$$hl = \frac{\ln 2}{\beta} \tag{9}$$

where $\beta = \beta^{ols}, \beta^{rd}$. The half-life time is "the time it takes for half the initial gap to be eliminated" (Barro and Sala-i Martin, 1995). In this research, it is the necessary time for firm TFP in the associated year to be half way between the initial and the steady-state values.

2.2 Data and Variables explanation

The data used in this research are conducted from the annual Enterprise Surveys undertaken by the General Statistic Office (GSO) of Vietnam. These surveys beginning in 2000 concern all business entities existing at the end of the surveyed-year and cover different information about their commercial activities (industrial classification, type of business, labor, stock of capital, total wage, production value ...). Until 2014, thirteen surveys from 2000-2012 are conducted and diffused.

After examining the raw data, selecting manufacturing firms and deleting those with missing and/or incorrect information (negative value of the number of labor, production ...), we have a panel data including 37,767 observations. The database is unbalanced including firms appearing in all thirteen years from 2000 to 2012 or less than. The dependent variable (TFP growth: $\Delta \log TFP$) is calculated from the firm TFP.[1] Independent variables are divided as aforementioned into 3 groups. The definition of these variables is shown in Table 1.

Table 1: List of independent variables

Variables	**Definition**
Firm characteristics	
Firm size (with the definition of the Word Bank)	
$= 1$	if very small firm (firm less than 5 employees)
$= 2$	if small firm (firm between 5 and 19 employees)
$= 3$	if medium firm (firm between 20 and 99 employees)
$= 4$	if large firm (firm between 100 and 499 employees)
$= 5$	if very large firm (firm more than 500 employees)
Institutional form of firms	
$= 1$	if public firm
$= 2$	if private firm
$= 3$	if foreign firm
Firm market power	$= \frac{y_{ijt}}{\sum y_{ijt}}$ where y_{ijt} is the output level of firm i in industry j during year t
Labor qualification	$= \frac{w_{ijt}}{l_{ijt}}$ where w_{ijt}, l_{ijt} respectively represent total wage and number of labor of firm i in industry j during year t. Average wage is used as a proxy for labor qualification (Liu et al., 2000; Todo et al., 2009). The mean reason is that the higher wage, the more labor is qualified, all things being equal.
Industrial characteristics	
Capital intensity	$= \frac{\sum k_{ijt}}{\sum k_{ijt} l_{ijt}}$ where k_{ijt} is the capital stock of firm i in industry j during year t
Exporting industry	$= 1$ if an exporting industry
Importing industry	$= 1$ if an importing industry
Firm geographic location	
city	$= 1$ if firm locates in a city
Region	
$= 1$	if firm locates in the Red River Delta
$= 2$	if firm locates in the Northern midlands and mountain areas
$= 3$	if firm locates in the Northern Central and Central coastal areas
$= 4$	if firm locates in the Central Highlands
$= 6$	if firm locates in the Mekong River Delta

[1]See Table 3 in Appendix for Descriptive statistics of this variable

3 Econometric results

Table 2 reports the estimates of Regressions (5) and (6) described above. Columns (1) to (4) illustrate the estimates using the cross-section data method while the last four columns show those using the random effects model. For each method, Model 1 represents the unconditional convergence. In Model 2, firm characteristics are controlled for, and in Model 3 and Model 4, industrial characteristics and firm geographic location are respectively added. The Breusch and Pagan test is statistically significant in all columns (5) to (8) justifying the relevance of the random effects model.

Table 2: Determinants of firms TFP convergence. Dependent Variable: dLog TFP

	Cross-section method				Random effects method			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
VARIABLES	Model 1	Model 2	Model 3	Model 4	Model 1	Model 2	Model 3	Model 4
log TFP	-0.038***	-0.056***	-0.056***	-0.057***	-0.234***	-0.342***	-0.351***	-0.354***
	(0.002)	(0.003)	(0.003)	(0.003)	(0.006)	(0.010)	(0.010)	(0.010)
Firm characteristics								
Firm size (reference: very small firm)								
Small firm		-0.049	-0.047	-0.042		0.097+	0.100+	0.113*
		(0.033)	(0.033)	(0.034)		(0.052)	(0.052)	(0.052)
Medium firm		-0.020	-0.016	-0.005		0.248***	0.258***	0.285***
		(0.033)	(0.033)	(0.034)		(0.052)	(0.052)	(0.053)
Large firm		-0.022	-0.016	-0.003		0.365***	0.383***	0.415***
		(0.033)	(0.033)	(0.035)		(0.053)	(0.053)	(0.054)
Very large firm		-0.010	-0.005	0.007		0.432***	0.456***	0.487***
		(0.034)	(0.034)	(0.035)		(0.054)	(0.054)	(0.055)
Institutional form of firm (reference: public firm)								
Private firm		-0.029***	-0.029***	-0.031***		-0.005	-0.010	-0.019
		(0.008)	(0.008)	(0.008)		(0.013)	(0.013)	(0.013)
Foreign firm		0.025***	0.022***	0.020**		0.119***	0.112***	0.092***
		(0.007)	(0.007)	(0.007)		(0.015)	(0.015)	(0.016)
Firm power		0.000	0.000	0.000		0.001**	0.001***	0.001***
		(0.000)	(0.000)	(0.000)		(0.000)	(0.000)	(0.000)
Firm investment		0.010***	0.009***	0.009***		0.028***	0.026***	0.027***
		(0.001)	(0.001)	(0.002)		(0.002)	(0.002)	(0.002)
Labor qualification		0.001+	0.001+	0.001+		0.001***	0.000***	0.000***
		(0.000)	(0.000)	(0.000)		(0.000)	(0.000)	(0.000)
Industrial characteristics								
Capital intensive			0.000+	0.000+			0.000***	0.000***
			(0.000)	(0.000)			(0.000)	(0.000)
Export industry			0.016**	0.015**			0.041***	0.029**
			(0.006)	(0.006)			(0.011)	(0.011)
Import industry			0.003	0.010			0.039**	0.048***
			(0.007)	(0.007)			(0.013)	(0.013)
Firm geographic location								
City				-0.018**				0.003
				(0.007)				(0.013)
Regional firm location (reference: Red River Delta)								
Northern midlands				0.005				-0.024
				(0.011)				(0.027)
Northern Central				0.018*				0.060**
				(0.009)				(0.019)
Central Highlands				-0.024				-0.067
				(0.016)				(0.044)
South-Est				0.011				0.079***
				(0.008)				(0.015)
Mekong River Delta				0.017+				0.112***
				(0.010)				(0.023)
Constant	0.147***	0.172***	0.160***	0.153***	0.788***	0.652***	0.626***	0.564***
	(0.006)	(0.033)	(0.033)	(0.036)	(0.020)	(0.057)	(0.058)	(0.061)
Observations	2,795	1,145	1,145	1,145	37,767	23,420	23,420	23,420
R-squared	0.154	0.325	0.331	0.345				
Number of idd					3,554	3,452	3,452	3,452

continued next page

Table 2: Determinants of firms TFP convergence. Dependent Variable: dLn TFP (continued)

Breusch and Pagan test					44.67***	44.65***	47.03***	46.97***
β-convergence (%)	5.07	9.3	9.3	9.6	2.22	3.5	3.6	3.6
Half-life time (years)	13.7	7.5	7.2	7.2	31.5	19.8	19.3	19.3

Robust standard errors in parentheses,
Significant levels : *** p<0.001, ** p<0.01, * p<0.05, + p<0.1.

3.1 Cross-section data analysis

Taking focus first on Model 1 of the cross section data method, the estimate shows a negative value of the coefficient β_1 associated with the variable $\log TFP$. Hence, there is a *β-convergence* in terms of TFP across Vietnamese manufacturing firms during the period 2000-2012. The speed of convergence is 5.07%, followed by a half-life time of 13.7 years.

A closer look at the convergence by controlling for firm characteristics, its geographic location, and industrial characteristics possibly brings more important understandings (Models 2, 3 and 4). Effectively, these models report a higher negative value of β_1 than that observed in Model 1 implying a higher speed of convergence. However, since the coefficient seems to be constant from Model 2 to Model 4 (-0.056 in Models 2 and 3, -0.057 in Model 4), it follows that firms' TFP convergence is related to their characteristics, but neither to their geographic location nor to industrial characteristics. Controlling for firm characteristics, including firm size, its institutional form, its market power, its investment level, and its labor qualification, the speed of convergence is 9.3% leading to a half-life time of 7.5 years.

Looking at different firm characteristics, it is very surprising that firm size and its market power have no impact on the growth of firms' TFP, and so is their TFP convergence. One possible reason explaining this strange result is that by using the cross-section data method, we only take into account value of these variables at the beginning period. It follows that firms' size and their market power are taken as constant in the compilation of their TFP convergence.

Firms' institutional form, their investment level and their labor qualification have an influence on their TFP convergence. The estimates indicate that private firms have a lower speed of convergence than public firms while the inverse is true for foreign ones. Furthermore, firms with a greater level of investment or skilled labor converge faster than their counterparts.

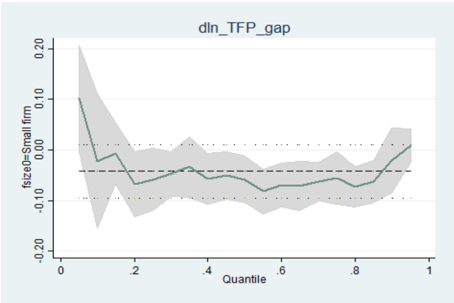
The astonishing results of firm size incite a wider analysis at different quantile distribution of firms' TFP growth. Figure 1 gives the answer.

We state that impact of firm size on the variation of its TFP, and so its speed of convergence only concerns firms at the 5% first quantile of the distribution. More precisely, only firms with a convergence speed greater than 17% are influenced by their size. Below this threshold, impact of firm size becomes insignificant. Among firms with the highest speed of convergence, it appears that the larger firm the quicker speed of convergence. However, the magnitude of this impact becomes marginal once firms reach a medium size.

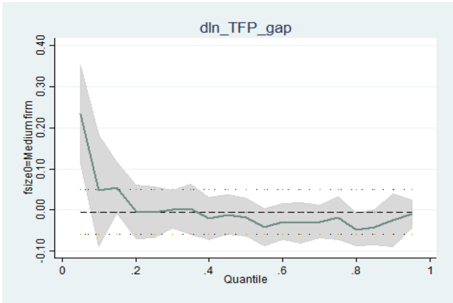
Since Table 3 reports a standard deviation of 1.17 for firms' TFP, using quantile regression method can bring more robust estimates. This method particularly takes into account misspecification errors related to non-normality and heterokedasticity in firms' TFP. The estimates' results are shown in Table 4 (cf. see Appendix). It appears that difference only concerns firms at the lowest (5%) and highest (90%) of the distribution in the manner that the former have a high convergence speed of 17.4% while that of the latter is about 10.3%. Other firms along the distribution have a similar convergence speed as that obtained in the cross-section data method (cf. 9.3% in quantile regression method v.s. 9.6% in cross-section data method). Very interestingly, Table 4 also reports that the magnitude and/or the sign of some control variables change across the distribution. Consequently, it shows the importance of taking into account the standard deviation of TFP in the second step estimation (cf. estimation for TFP convergence).

To sum up, it is noteworthy that using the cross-section data method only gives initial results about firms' TFP convergence. Some questions can arise. This method does not control for year effects (annual changes in firms TFP, their characteristics as well as industrial characteristics). In addition, it concerns only a year in the fact that the estimations only take into account observations at the beginning which are also presented

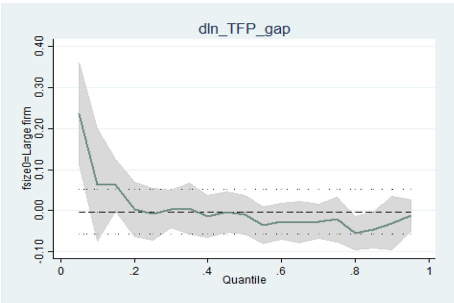
Figure 1: TFP gap at mean and different quantiles of firm



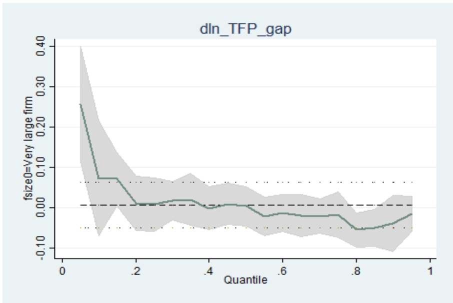
(a) Small firm v.s. very small firm



(b) Medium firm v.s. Very small firm



(c) Large firm v.s. Very small firm



(d) Very large firm v.s. Very small firm

at the end of the studied period. In other words, only firms appearing in 2000 and surviving until 2012 are taken in the estimates process. Hence, there is a loss of enormous observations. All reasons encourage us to use the panel data method.

3.2 Random effects model analysis

The second part of Table 2, columns (5) to (8), gives the estimates for Equation (6) using the random effects model.

The estimate reporting in column (5), which relates to an unconditional firms' TFP convergence/divergence, shows a negative value of coefficient β_1 associated with variable $\ln TFP$. Hence, an evidence for firms' TFP convergence is found. It is followed by a convergence speed of 2.2%, which is about 2.8 times lower than that obtained from the OLS model (cf. 5.07%). This difference implies that the speed of firms' TFP convergence is related to year-effects.

Taking care of firm characteristics, industrial characteristics, and firm geographical location, the estimates are illustrated in columns 5 to 8. We observe similar results as those obtained from the OLS model: the TFP convergence between firms is rather associated with their characteristics than their geographic location and industrial characteristics. Indeed, controlling for firm characteristics, the speed of convergence equals to 3.5%, which is a half higher than the unconditional speed of convergence of 2.22%. When industrial characteristics and firm geographic location are respectively added, the speeds of convergence are both equal to 3.6%, which is slightly higher than 3.5%.

Looking inside different firm characteristics, it appears that, except *private firm*, all remaining control variables are statistically significant. In addition, the impacts of these variables are positive. Let take for example the role of firm size. It follows that the larger that size the quicker speed of TFP convergence for the related firm. Furthermore, the magnitude of this impact is even more important when industrial characteristics and firm geographic location are respectively taken into account. Likewise, firm market power also has a positive impact on the speed of its TFP convergence. However, this impact remains robust when industrial characteristics and firm geographic location are respectively added.

To sum up, using the random effects model gives a lower speed of firms TFP convergence than that received from the cross-section data method. This indicates that firms' TFP convergence is time-related. However, it is noted that the standard deviation in panel data of firms' TFP is not taken into account. As shown in Subsection 3.1, it seems that the significance and the sign of different control variables reported in columns (6) to (8) of Table 2 may be changed once this factor of uncertainty is considered.

3.3 Discussions

Role of firm characteristics

As aforementioned, the convergence in firms' TFP is rather related to their characteristics than to industrial characteristics or their geographic location. It is important to give an economic analysis of these factors of convergence.

First, it appears that such convergence is associated with *Institutional form of firm*. Taking *public firm* as reference, it follows that *private firm* has a lower speed of TFP convergence while the inverse is true for *foreign firm*. This finding is "strange" since over the period 2000-2012, foreign firms have, in average, highest TFP followed by public firms and then private firms.[2] Hence, Vietnamese manufacturing firms counter-follow the *beta-convergence law* through which lower productivity entities grow faster than higher ones. However, this "strange" result appears to be logic for the following reasons. On the one hand, foreign firms are much more effective than domestic firms. We can even hypothesize that they are a factor of TFP divergence. On the other hand, in spite of many reforms to modernize and liberalize the economy by Vietnamese government, most relevant sectors are still controlled or dominantly regulated by public firms (Migheli, 2012).

Second, firm size has no impact on TFP convergence in the cross-section data method while the impact becomes positive and significant in random effects model. Additionally, the higher firm size the faster speed of convergence. Likewise, firm market power has a positive effect on TFP convergence in the random effects model but no impact in the other method. Hence, it seems that these impacts of firm size and firm power are time-related, and the more firm has a big size and/or market power, the more it has the capacity to improve its TFP leading to higher speed of convergence.

Third, firms' TFP convergence is positively related to their labor qualification in the two methods. The main reason is that the more a given firm uses qualified workers the higher its human capital level. It followed by a higher TFP level and so faster speed of convergence.

Last by not least, firm with greater level of investment have a quicker speed of convergence in TFP than its counterparts. Hence, it seems that firms in this study invest in new technology rather than in capital. In truth, according to Baumol (1986), an investment in capital raises capital share and therefore shrinking the speed of convergence. On the other hand, investing in performance (e.g., new technology, management methods) improves firm's TFP and hence increasing speed of convergence.

Role of macroeconomic variables

Overall, the econometric estimates show the existence of TFP convergence during the period 2000-2012 for Vietnamese manufacturing firms, whatever the methods (cross-section or panel data) and the control variables (firm characteristics, industrial characteristics, or firm geographic location). Since Vietnam is know as an emerging country, it is important to search for factors, over those previously studied, which are behind this convergence. It is noteworthy that such factors are common for all firms, and even could not be included in the cross-section data method, owning to the collinearity problem.

Over the period 2000-2012, the country is well known by a rapid economic growth with a real average annual growth rate of 6.5% (i.e., about 2.5 times higher than the worldwide rate during the same period).[3] Meanwhile, the country signed different bilateral and multilateral trade agreements with other countries (for example the Bilateral Trade Agreement with the U.S. in 2001, the Agreement on market access with the E.U

[2] During the studied period, foreign, public and private firms respectively have an average $\ln TFP$ of 3.77, 3.63, and 2.93 (calculated by the author based on the Vietnamese Enterprise Survey).

[3] Calculated by the author. Source: The World Bank database.

in 2005, or particularly the becoming a member of the WTO in 2007). These factors may be sources of firms' TFP convergence.

Most importantly, Vietnam is considered as one of the ten most attractive countries for FDI worldwide (UNCTAD, 2007, 2008, 2009), leading to an increasing amount of FDI inflows in the country during the studied period.[4] As a consequence, FDI spillovers are generated allowing domestic firms to improve their production and/or TFP as it is shown in the literature (Minda and Nguyen, 2013; Anwar and Nguyen, 2011; Newman et al., 2015, among other). Hence, firms' TFP convergence should be related to these factors of spillovers.

4 Conclusion and remarks

The present research determines the factors that may have an influence on the TFP convergence/divergence of Vietnamese manufacturing firms during the period 2000-2012. These factors are divided into three groups: (i) firm characteristics, (ii) industrial characteristics, and (iii) firm's geographic location. Two estimate methods are used: cross-section data method and random effects model.

The estimates show evidence for TFP convergence, whatever the used method. However, the random effects model gives a lower convergence speed of firms' TFP than that obtained from the other method. It implies that firms' TFP convergence is time-related. In addition, that convergence is rather associated with firm characteristics than with industrial characteristics/and or firm geographic location.

The existences of marginal impacts of industrial characteristics and/or firm geographic location as well as limits of methodology leave open some questions for future research on firms' TFP convergence. First, an analysis of such convergence within industry and within region including other industrial or regional variables such as FDI spillovers, level of public investment should be considered. Second, using quantile regression for panel data can allow to take into account the standard deviation of firms' TFP in panel data that the random effects model could not do. Last but not least, it should be noted that the year of 2007 when Vietnam becoming a member of WTO was also the beginning of the subprime crisis causing economic downturn and recession. It is a source of firms' TFP divergence. Hence, it is important to introduce the Supremum Wald test for a structural break (with unknown break date) in Vietnamese manufacturing firms' TFP convergence during the period 2000-2012. It seems that such structural break exists since the random effects model reports a convergence speed much lower than that obtained from the cross-section data method.

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[4]In 2000, the amount of FDI inflows in Vietnam was about 1.3 billions U.S. dollars. It then got up to its record in 2008 for an amount of 9.6 billions U.S. dollars. During the subprime crisis and its persistence, the country always received a high level of FDI inflows around 8 billions U.S. dollars. Take for example in 2010 when there were 8.3 billions U.S. dollars of FDI invested in Vietnam (i.e. about 7% of its GDP or 19.5% of its gross capital formation). Source: The World Bank database.

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Appendix

Table 3: Descriptive statistic of the variable logTFP

Method		Mean	Std. Dev.	Min	Max	Observations
Cross-section data		2.89	1.17	-3.61	6.21	2795
Panel data	Overall	3.22	1.16	-7.08	8.89	$N = 41538$
	Between		1.01	-4.7	6.14	$n = 3706$
	Within		0.64	-5.29	7.66	$\bar{T} = 11.21$

Table 4: Determinants of firms TFP convergence - Quantile regression. Dependent Variable: dlog TFP

	(1)	(2)	(3)	(4)	(5)	(6)
Variables	0.05	0.15	0.20	0.50	0.75	0.90
ln TFP	-0.073***	-0.056***	-0.056***	-0.056***	-0.056***	-0.059***
	(0.009)	(0.003)	(0.003)	(0.002)	(0.002)	(0.004)
Firm characteristics						
Firm size (reference: very small firm)						
Small firm	0.101+	-0.007	-0.067	-0.058	-0.056	-0.020
	(0.059)	(0.078)	(0.083)	(0.041)	(0.044)	(0.035)

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Table 4: Determinants of firms TFP convergence - Quantile regression (continued)

Medium firm	0.233***	0.054	-0.004	-0.018	-0.019	-0.026
	(0.037)	(0.079)	(0.083)	(0.041)	(0.043)	(0.022)
Large firm	0.236***	0.062	0.003	-0.009	-0.021	-0.031
	(0.039)	(0.079)	(0.083)	(0.041)	(0.043)	(0.023)
Very large firm	0.257***	0.072	0.011	0.004	-0.017	-0.039
	(0.039)	(0.079)	(0.083)	(0.041)	(0.044)	(0.024)
Institutional form of firm (reference: public firm)						
Private firm	-0.086**	-0.042***	-0.033***	-0.021***	-0.014**	-0.010
	(0.028)	(0.008)	(0.007)	(0.006)	(0.004)	(0.008)
Foreign firm	-0.008	0.010	0.016+	0.017**	0.018***	0.017*
	(0.021)	(0.009)	(0.008)	(0.005)	(0.005)	(0.007)
Firm power	0.000	0.000	0.000	0.000	0.000+	0.000
	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Firm investment	0.007	0.011***	0.011***	0.009***	0.008***	0.009***
	(0.005)	(0.002)	(0.002)	(0.001)	(0.001)	(0.002)
Labor qualification	0.002*	0.001***	0.001**	0.000*	0.000	0.000+
	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Industrial characteristics						
Capital intensive	-0.000	0.000	0.000+	0.000***	0.000***	0.000+
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Export industry	0.016	0.019**	0.018*	0.011*	0.015***	0.008
	(0.019)	(0.007)	(0.007)	(0.005)	(0.004)	(0.006)
Import industry	0.044*	0.008	0.011	0.014**	-0.000	0.001
	(0.021)	(0.010)	(0.010)	(0.004)	(0.004)	(0.007)
Firm geographic location						
City	-0.051*	-0.026**	-0.024**	-0.018***	-0.015***	-0.008
	(0.022)	(0.009)	(0.009)	(0.005)	(0.004)	(0.006)
Regional firm location (reference: Red River Delta)						
Northern midlands	0.056	0.013	0.010	-0.002	-0.009	-0.019
	(0.067)	(0.020)	(0.019)	(0.011)	(0.012)	(0.013)
Northern Central	0.070*	0.039***	0.027*	0.005	0.003	-0.005
	(0.031)	(0.011)	(0.014)	(0.007)	(0.006)	(0.011)
Central Highlands	0.026	-0.035*	-0.045	-0.028	-0.029***	-0.051*
	(0.038)	(0.016)	(0.040)	(0.019)	(0.008)	(0.025)
South-Est	0.056+	0.027**	0.018	0.004	0.003	-0.006
	(0.029)	(0.009)	(0.012)	(0.005)	(0.005)	(0.007)
Mekong River Delta	0.113**	0.039***	0.023+	0.001	-0.004	0.008
	(0.039)	(0.012)	(0.013)	(0.010)	(0.009)	(0.021)
Constant	-0.173**	-0.000	0.076	0.170***	0.226***	0.275***
	(0.065)	(0.080)	(0.084)	(0.042)	(0.044)	(0.025)
Observations	1145	1145	1145	1145	1145	1145
R-squared	0.199	0.176	0.179	0.214	0.267	0.341
β**-convergence** (%)	17.4	9.3	9.3	9.3	9.3	10.3
Half-life time (years)	4	7.5	7.5	7.5	7.5	6. 7

Robust standard errors in parentheses,
Significant levels : *** p<0.001, ** p<0.01, * p<0.05, + p<0.1.