

FDI and Efficiency convergence, the case of Vietnamese Manufacturing industry

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ABSTRACT

The scope of this study is twofold. We aim to test efficiency convergence hypothesis among firms in Vietnamese manufacturing industry, and to analyze the influence of foreign direct investment (FDI) on efficiency and efficiency convergence. Technical efficiency measures are derived for a sample of Vietnamese manufacturing firms during 2000-2012 using nonparametric data envelopment analysis (DEA). The approach to find the impacts of FDI on efficiency and efficiency convergence through horizontal and vertical spillover effects is to construct the linkages from dynamic input - output tables. The way to test unconditional convergence in the two technical efficiency measures from DEA is used the regression in the form of the Barro equation. The same approach is employed in order to test the influence of FDI as conditioning factor over firms' efficiency. We find the evidence that increase foreign presence within an industry rises the speed of convergence, and impact of FDI on efficiency and efficiency convergence through channels and time are quite different.

Keywords: Data envelopment analysis (DEA); Free disposal hull (FDH); Manufacturing; efficiency; foreign direct investment (FDI); Convergence.

1. INTRODUCTION

The literature investigating the relationship between FDI and technical efficiency has been focusing on technological spillover effects resulting from foreign direct investment. In some case, the contribution of FDI to technical efficiency and TFP via spillovers have been confirmed while in others, it has been rejected, depending on the nature of the data used and also on specific empirical methodologies.

Our objective, beyond presenting evidence of technical inefficiency and FDI's spillover effects via horizontal and vertical linkagesⁱ, is to investigate whether technical efficiency convergence process occurred in the presence of FDI through spillover effects in some sub-industries of Vietnamese manufacturing industryⁱⁱ. Sub-industries in Vietnamese manufacturing industry (sub-industries include (1) food products and beverages and tobacco products (F); (2) textiles and wearing apparel (T); (3) footwear (W) and (4) wood and wood products (WD)) and the sample of domestically owned firms in those sub-industries.

Cross-country productivity convergence have received attention both at the country level (Dorwick and Nguyen (1989) [6]; and at the industry level (Bernard and Jones (1996) [2]). It should be noted that the growth of a country results from the growth of industries, which comes from the growth of firms. Ultimately, the improvement in technical efficiency is an important aspect of the process of growth. However, there has been little empirical work at the firm level on technical efficiency convergence (Alam and Sickles, 2000 [1]).

This paper is organized into four sections as follows. The next section sets out the theoretical framework underlying the empirical analysis and results. Section 3 describes the data, reports the estimation results of the models and discusses the results obtained, with special emphasis on the contributions of FDI to increase the speed of convergence . The final section concludes the paper.

2. METHODOLOGY

Our methodology proceeds in three steps. First, we construct an empirical representation of the frontier technology. Second, we set out the models for analyzing the influence of foreign direct investment . Finally we present the models for testing unconditional convergence and conditional convergence for a given set of sub- industries.

2.1 Efficiency Measurement

The production technology H^t for the transformation of inputs, $x_t \in R_+^N$ into outputs, $y_t \in R_+^K$, at for each time period $t=1,2,...T$ can be defined as:

$$H^t = \{(x_t, y_t) : x_t \text{ can produce } y_t\},$$

where H^t is assumed to satisfy certain axioms to define meaningful output distance functions. The efficiency scores are the distances from the frontier. An output- based distance function can be defined as:

$$D(x, y) = \min\{\theta : (x, y/\theta) \in H\} = [\max\{(x, \theta y) \in H\}]^{-1} = [D(x, y)]^{-1}.$$

The distance function is defined as the inverse of the maximal proportional increase of output vector y , given input x . It is also equivalent to the reciprocal of Farrell's (1957) measure of output efficiency. An output – inefficient firm has $D(x, y) < 1$. In the case of the non-parametric method, we use the methods of data envelopment analysis (DEA), especially Charnes, Cooper and Rhodes (CCR) model and free disposal hull model to define the boundary of H .

2.1.1 Data Envelopment Analysis

DEA creates an “envelop” of observable production point (Charnes, Cooper and Rhodes(1978) [3]). DEA is based on linear programming techniques. It provides for flexible piecewise linear approximations to model the “best practice” reference technology. The output–based efficiency score is obtained from the following linear programming problem for each sub-industry.

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$$[D(x, y)]^{-1} = \text{Max} \theta_{it}$$

subject to

$$\theta_{it} y_{kit} \leq \sum_{i=1}^N \lambda_{it} y_{kit}, \quad k = 1, 2, \dots, K \quad (1)$$

$$\sum_{i=1}^N \lambda_{it} x_{jit} \leq x_{jit}, \quad j = 1, 2, \dots, J$$

$$\lambda_{it} \geq 0, \quad i = 1, 2, \dots, N, \quad t = 1, 2, \dots, T$$

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θ is level technical efficiency and denoted by TE and the model is called the CCR model.

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2.1.2 Free Disposal Hull models

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The Free Disposal Hull (FDH) is first formulated by Deprins, Simar and Tulkens (1984) [5] and developed and extended by Tulkens and others. The basic motivation is to ensure that efficiency evaluations are affected only by observed performances. The FDH Frontier is obtained by replacing the last line in the model above, it means that the model can be as follows:

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$$[D(x, y)]^{-1} = \text{Max} \theta_{it}$$

subject to

$$\theta_{it} y_{kit} \leq \sum_{i=1}^N \lambda_{it} y_{kit} \quad k = 1, 2, \dots, K \quad (2)$$

$$\sum_{i=1}^N \lambda_{it} x_{jit} \leq x_{jit} \quad j = 1, 2, \dots, J$$

$$\sum_{i=1}^N \lambda_{it} = 1, \quad \lambda_{it} \in \{0, 1\} \quad i = 1, 2, \dots, N; t = 1, 2, \dots, T$$

102 $\lambda_j \in \{0, 1\}$ means that the components of λ are constrained to be bivalent. It can explain

103 as : they must all have values of zero or unity so that $\sum_{i=1}^N \lambda_{it} = 1$, one and only one of the

104 performance actually observed can be selected (see Bardhan et al (1996)).

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106 θ is level technical efficiency and denoted by TE and the model is called FDH model.

107 The efficiency results obtained from CCR and FDH models will be regressed
108 on variables presenting channels of FDI's spillover effects on
109 domestic firms in the second –stage regression..

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2.1.3 Second –Stage Regression

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112 To examine the impact of foreign presence on firms' efficiency, the efficiency results
113 obtained from (1) and (2) are regressed on the variables capturing different aspects of
114 foreign presence through some spillover channels. We estimate the following equation:

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$$TE_{i,t} = \gamma_0 + \gamma_1 fs_{ij,t} + \gamma_5 hor_{j,t} + \gamma_2 back_{j,t} + \gamma_3 forw_{j,t} + \gamma_4 sback_{j,t} + \alpha_t + \alpha_i + \varepsilon_{it} \quad (3)$$

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118
119 Where subscripts i and t refer to firm and time respectively. α_t capture time and α_i firm
120 specific fixed effects. The above model is estimated using Ordinary Least Square Method
121 (OLS) with time and fixed effects.

122 fs_{ijt} (Foreign share) is define as the share of firm i 's total equity owned by foreign
123 investors, and X_{ijt} is its real output, for i^{th} firms in sector j at time t .

124 As in Javorcik(2004), the variable *Horizontal* (hor_{jt}) captures the extent of foreign presence
125 in subsector j at time t and is defined as a foreign equity participation averaged over all firms
126 in the sector, weighted by each firm's share in sectoral output . In other words,

$$127 \quad hor_{j,t} = \frac{\sum_{j \in J} fs_{ij,t} * X_{ij,t}}{\sum_{j \in J} X_{ij,t}}$$

128 *Backward* ($back_{jt}$) is a proxy for the foreign presence in the industries that are being
129 supplied by the sector to which the firm in question belongs and thus is intended to capture
130 the extent of potential contacts between domestic suppliers and foreign – owned firms. It is
131 defined in the following way:

$$132 \quad back_{j,t} = \sum_{k \text{ if } k \neq j} \gamma_{jk,t} hor_{k,t}$$

133 where $\gamma_{jk,t}$ is the proportion of sector j 's output supplied to sourcing industry k at time t
134 taken from the input-output tables at the two-digit level. The proportion is calculated
135 excluding products supplied for final consumption but including imports of intermediate
136 products. As the formula above, inputs supplied within the sector are not included, since this
137 effect is already captured by the *Horizontal* variable.

138 The same way, we define the forward spillover variable $forw_{jt}$ as

$$139 \quad forw_{j,t} = \sum_{l \text{ if } l \neq j} \delta_{jl,t} hor_{l,t}$$

140 Where the Input - Output tables reveal the proportion δ_{jl} of industry j 's inputs purchased from
141 upstream industries l . Inputs purchased within the industry ($l=j$) are excluded, since this is
142 captured by *Horizontal*.

143 *Supplybackward* (denoted by $sback_{jt}$) which captures the hypothesis of Markusen and
144 Venables is defined as:

$$145 \quad sback_{j,t} = \sum_{i \text{ if } i \neq j} \delta_{ji,t} back_{i,t}$$

146 Where $\delta_{ji,t}$ -the proportion of industry j 's inputs is purchased from upstream industries i that in
147 turn supply the downstream industries of foreign firms as measured by variable $back_{j,t}$.

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149 **2.2 Efficiency convergence among firms**

150 In this part, we present the models for testing unconditional convergence and
151 conditional convergence.

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153 **2.2.1 Unconditional convergence**

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155 Empirical tests of convergence hypothesis (e.g., Baumol, 1986; Barro,
156 1991; Barro and Sala-i-Martin, 1995; De Long, 1988; Islam, 1995; and Mankiw et al;
157 Alam IMS., Sickles RC,2000) determine whether or not there is a closing of the

gap between inefficient and efficient firms over time. One of approach is to regresses the log of firms' average growth rates in technical efficiency on the log of the firms' efficiency scores at the beginning of the sample period. The basic form of the equation of unconditional convergence is:

$$\frac{1}{T}[\ln TE_{i,final} - \ln TE_{i,initial}] = \alpha + \beta \ln TE_{i,initial} + \varepsilon_t \quad (4)$$

where T is number of years considered; TE is technical efficiency on the designated year for the firm i and catch-up is denoted by a negative coefficient of β . The speed of caching up is: $\lambda = 1 - (1 + \beta T)^{1/T}$

2.2.2 Conditional convergence

To consider whether technical efficiency (from CCR and FDH models) convergence occurred in the presence of FDI through spillovers to domestic firms. Since, it may take more time before FDI's spillovers effects on domestic firms' technical efficiency, we include lagged foreign share (*fs*), Horizontal (*hor*), Backward (*back*), Forward (*forw*) and supplybackward (*sback*) linkage measures into the model . The new equation of conditional convergence is:

$$\begin{aligned} \frac{1}{T}[\ln TE_{ij,final} - \ln TE_{ij,initial}] = & \alpha + \beta \ln TE_{ij,initial} + \sum_{t=2000}^{2011} \delta_{1,t} fs_{j,t} + \sum_{t=2000}^{2011} \delta_{2,t} hor_{j,t} + \sum_{t=2000}^{2011} \delta_{3,t} back_{j,t} \\ & + \sum_{t=2000}^{2011} \delta_{4,t} forw_{j,t} + \sum_{t=2000}^{2011} \delta_{5,t} sback_{j,t} + \varepsilon_t \end{aligned} \quad (5)$$

$t = 2000, 2001, \dots, 2011; j \in J = \{F, T; W; WD\}$ where subscripts i, and t refer to firm and time respectively.

3. RESULTS AND DISCUSSION

In this part, we discuss the results on a statistical base in order to see if FDI spillover effects on technical efficiency and estimate convergence regressions to determine the degree of firms' technical efficiency convergence and firms' technical efficiency convergence in the presence of spillover effects from FDI through horizontal and vertical spillovers.

3.1 Data

Our analysis is based on the data from annual enterprise survey conducted by the Vietnam General Statistical Office. The survey covers both manufacturing and non-manufacturing firms. Industry data is available at a 4-digit level. From this survey, we develop a longitudinal panel data set for the years from 2000 to 2011. We drop the firms from our sample set for which the firm-age (the year of the survey minus the year of establishment), total wages, tangible assets, and/or the number of workers are not positive and in cases with incomplete replies. We also drop firms' which enter or exit between year 0 and year T . We select "survivor" firms being survivors that continue to stay in the market between year 2000 and year 2011. The number of firms in our sample is 1038 observations and the sample of domestic firms is 907 observations for each year. To avoid a bias, we estimate efficiency using CCR and FDH models for the total sample, denoting CCRT and FDHT models, respectively and estimate efficiency using CCR and FDH models for sample of domestically owned firms, denoting CCRD and FDHD models, respectively.

3.2. Testing the effects of FDI spillovers on firms' technical efficiency

Table 1 shows the results of estimating models (CCRT, FDHT, CCRD and FDHD models). A fixed-effects regression is used to assess the impact of the spillover effects of FDI on domestic firms' inefficiency. Technical efficiency measures from CCR and FDH models are regressed on *fs*, *hor*, *forw*, *back* and *sback*. Columns (2)-(3) show the results using the total sample. Columns (4)-(5) present the results using the sample of domestic firms. *Foreign share (fs)* bears a significant and positive sign (in CCRT models) but insignificant and negative sign (in FDHT models). *Hor* coefficients in two cases (FDHT and FDHD models) are positive and statistically significant at 1% and 5% level for the total sample of sub-industry and domestic firms, respectively. While *hor* coefficients in the rest of cases are negative and statistically significant at 5% level in the CCRT model but insignificant in the CCRD model. Positive and significant coefficients on *Back* are found for four models CCRD, CCRT, FDHD and FDHT models. Backward spillovers go from the foreign firm to its upstream local suppliers. In these models, domestic firms draw apparently more benefits from their linkages to foreign firms. *forw* coefficients are statistically significant at least 10% level for all cases but they have the opposite sign. *Forw* coefficients are positive and statistically significant at 5% level in the cases of FDH models. *sback* coefficients are positive for all cases but *sback* coefficients of FDH models are insignificant. The results obtained from CCR models are similar to those in the literature. Javorcik (2004) estimates backward spillovers to be positive and forward spillovers to be negative but not statistically significant.

Table 1. Testing the Effects of FDI spillovers On Firms' Technical efficiency

Dependent variable	Fixed-effects regression			
	TE from total sample of sub-industry sample		TE from domestic	
	CCRT model	FDHT model	CCRD model	FDHD model
γ_0	0.029*** (0.010)	-0.005 (0.014)		
γ_1	-0.040** (0.015)	0.053*** (0.020)	-0.020 (0.017)	0.048** (0.023)
γ_2	0.080*** (0.016)	0.095*** (0.021)	0.134*** (0.018)	0.091*** (0.023)
γ_3	-0.086*** (0.025)	0.071** (0.033)	-0.055* (0.029)	0.095** (0.037)
γ_4	0.117*** (0.026)	0.041 (0.035)	0.085*** (0.030)	0.035 (0.039)
γ_5	0.127*** (0.005)	0.315*** (0.007)	0.123*** (0.006)	0.326*** (0.008)
_cons				
/sigma_u	0.144	0.242	0.145	0.236

/sigma_e	0.150	0.201	0.158	0.207
Rho	0.479	0.591	0.459	0.565

Note: 1) standard errors are given in the parenthesis;

2) */**/** Denotes significant at the 10, 5 and 1 percent levels, respectively.

Comparing foreign spillover effects on technical efficiency between CCR and FDH models

Two models used here to measure the foreign spillover effects on firms' technical efficiency for the total sample of sub-industry and domestically owned firms of this sub-industry are based on nonparametric data envelopment analysis in the forms of CCR and FDH models. The impacts of foreign presence on firms' technical efficiency through *hor*, *back*, *forw* and *sback* variables are the same sign in CCRT, CCRD models (but difference in magnitude). To explain the differences in effects of FDI on firms' technical efficiency derived from the CCR and FDH models is that the set of constraints of CCR model is convex set, while the set of constraints of FDH model is not convex (Deprins et al. (1984)), since FDH model imposes one fewer restrictions on the data. Thus technical efficiency from FDH model is relative to an observed point on the frontier.

Comparing foreign spillover effects on efficiency between CCR and FDH models

Two models used here to measure the foreign spillover effects on firms' efficiency for the total sample of sub-industry and domestically owned firms of this sub-industry are based on nonparametric data envelopment analysis in the forms of CCR and FDH models. The impacts of foreign presence on firms' technical efficiency through *hor*, *back*, *forw* and *sback* variables are the same sign in CCRT, CCRD models (but difference in magnitude). To explain the differences in effects of FDI on firms' technical efficiency derived from the CCR and FDH models is that the set of constraints of CCR model is convex set, while the set of constraints of FDH model is not convex (Deprins et al. (1984)), since FDH model imposes one fewer restrictions on the data. Thus technical efficiency from FDH model is relative to an observed point on the frontier.

3.3 Estimated results of unconditional convergence

Table 2 displays the cross-sectional OLS estimates of unconditional convergence for the total sample of sub-industry and the sample of domestically owned firms in Vietnamese manufacturing industry (theoretical model 4 in section 2.2).

The coefficients of initial technical efficiency from models 4.1T, 4.2T, 4.1D and 4.2D are -0.0769, -0.0627, -0.0798, -0.0644, respectively and significantly different from zero at 1%, confirming the presence of unconditional convergence during the period of 2000-2011. The speed of convergence of those model are 15.63%, 10.09%, 17.39%, 10.59%, respectively.

Table 2: Unconditional convergence (2000-2011)

Dependent variable: <i>The average year to year growth in the technical efficiency scores</i>		Speed of catching up	Half-line
(a) Total sample of sub-industry			
Model 4.1T (TE from CCR model)		15.63%	8.66
$D\ln CCR_{i,2011} = -0.2217^{***} - 0.0769^{***} \ln CCR_{i,2000}$ (0.0091) (3.61E-06)			
$R^2 = 0.43$; DW = 1.79; Number of Observations = 1038			

Model 4.2 T (TE from FDH model)	$DLnFDH_{i,2011} = -0.0892^{***} - 0.0627^{***} LnFDH_{i,2000}$ (0.0043) (0.0022)	10.09%	10.7
$R^2 = 0.44; DW = 1.83; \text{Number of Observations} = 1038$			

(b) Domestically owned firms in the sub-industry

Model 4.1D (TE from CCR)	$DLnCCR_{i,2011} = -0.0234^{***} - 0.0798^{***} LnCCR_{i,2000}$ (0.0097) (0.0029)	17.39%	8.33
$R^2 = 0.45; DW = 1.82; \text{Number of Observations} = 907$			
Model 4.2D (TE from FDH)	$DLnFDH_{i,2011} = -0.0895^{***} - 0.0644^{***} LnFDH_{i,2000}$ (0.0043) (0.0023)	10.59%	10.41
$R^2 = 0.46; DW = 1.71; \text{Number of Observations} = 907$			

Note: 1) standard errors are given in the parenthesis;

2) */**/** Denotes significant at the 10, 5 and 1 percent levels, respectively.

3) Model 4.1T is model 4 in section 2.2, where TE estimated from CCR model and estimated using total sample; Model 4.2T is model 4 in section 2.2, where TE estimated from FDH model and estimated using total sample; Model 4.1D is model 4 in section 2.2, where TE estimated from CCR model and estimated using sample of domestic firms; Model 4.2D is model 4 in section 2.2, where TE estimated from FDH model and estimated using sample of domestic firms;

3.4 Estimated results of conditional convergence

To investigate whether there exist impacts of FDI's spillover effects on technical efficiency convergence, we estimate the unconditional convergence models with adding spillover variables. Table 3 presents the cross-sectional OLS estimates of conditional convergence for the total sample of sub-industries and the sample of domestic firms. We estimate 4 models for the total sample of sub-industry and sample of domestic firms. 60 variables conditioning in these models are $hor_{2000}, hor_{2001}, \dots, hor_{2011}, forw_{2000}, \dots, forw_{2011}$ variables.

Table 3: Conditional convergence (2000-2011)

(a) For total sample of sub-industry with number of observations =1038	
(5.1T)	$\Delta ln CCRT_{ij,2011} = -0.1532^{***} - 0.0836^{***} LnCCRT_{ij,2000} - 0.8835^{**} back_{j,2000} + 0.0896^{**} hor_{j,2001}$ $+ 0.2357^{**} back_{j,2001} + 0.3062^{**} forw_{j,2001} - 0.5397^{***} sback_{j,2001} - 0.4663^{***} forw_{j,2001}$ $+ 0.1024^{***} hor_{j,2005} - 0.1559^{***} back_{j,2005} + 0.025^{***} fs_{j,2008} + 0.055^{***} back_{j,2009}$ $+ 0.089^{***} fs_{j,2010} + 0.135^{***} forw_{j,2011}$ $R^2=0.5 \quad DW =1.92$ Speed of catching up =22.92% ; Half-line= 7.94

(5.2T)
$$\Delta \ln FDHT_{ij,2011} = -0.2366^{***} - 0.0832^{***} \ln FDHT_{ij,2000} + 0.4873^{***} + sback_{j,2000} - 0.021^{***} hor_{j,2005}$$

$$+ 0.017^{*} back_{j,2008} + 0.028^{*} back_{j,2009} - 0.049^{***} forw_{j,2009} - 0.023^{*} hor_{j,2011} - 0.024^{***} back_{j,2011}$$

$$+ 0.273^{***} forw_{j,2011}$$

$$R^2=0.89; DW =1.86$$
Speed of catching up =22.43% ; Half-line= 7.98

(b) For domestically owned firms of sub-industry with number of observations: 907

(5.1D)
$$\Delta \ln CCRD_{ij,2011} = -0.1151^{***} - 0.0823^{***} \ln CCRD_{ij,2000} + 0.2398^{**} back_{j,2000} + 0.089^{**} hor_{j,2000}$$

$$+ 0.4011^{**} forw_{j,2000} + 0.4507^{**} sback_{j,2000} - 1.0611^{***} back_{j,2000} - 0.2823^{***} forw_{j,2004}$$

$$- 0.1515^{***} back_{j,2006} + 0.1026^{**} hor_{j,2006} - 0.2066^{*} forw_{j,2007} + 0.0616^{**} back_{j,2011}$$

$$R^2=0.52; DW =1.92$$
Speed of catching up =21.42%;Half-line= 8.07

(5.2D)
$$\Delta \ln FDHD_{ij,2011} = -0.0813^{***} - 0.0755^{***} \ln FDHD_{ij,2000} + 0.1448^{**} back_{j,2000} + 0.0706^{***} hor_{j,2001}$$

$$- 0.2195^{***} back_{j,2003} - 0.0875^{***} forw_{j,2003} + 0.738^{***} back_{j,2009} - 0.2527^{***} sback_{j,2010}$$

$$+ 0.0848^{***} back_{j,2011} - 0.0966^{***} hor_{j,2011} + 0.0944^{**} forw_{j,2011}$$

$$R^2=0.52; DW =1.79$$
Speed of catching up =16.13% ; Half-line= 8.83

Note: 1) standard errors are given in the parenthesis;

2) */**/** Denotes significant at the 10, 5 and 1 percent levels, respectively.

3) Model 5.1T is model 5 in section 2.2, where TE estimated from CCR model and estimated using total sample; Model 5.2T is model 4 in section 2.2, where TE estimated from FDH model and estimated using total sample; Model 5.1D is model 4 in section 2.2, where TE estimated from CCR model and estimated using sample of domestic firms; Model 5.2D is model 4 in section 2.2, where TE estimated from FDH model and estimated using sample of domestic firms;

Estimated results of conditional convergence of technical efficiency from CCRT and FDHT , CCRD and FDHD models are given in Table 3. It allows us to draw some conclusions. The coefficients of initial technical efficiency from those models are negative and significant at 1%, showing there is evidence for convergence. Most of the conditional variables (representing impacts of FDI) were jointly insignificant, and some variables are significant . Such as, in equation 5.1T coefficients of hori₂₀₀₀, hori₂₀₀₅ are positive and significant at 5% and 1%, respectively while coefficients of back₂₀₀₀, back₂₀₀₅... are negative and significant... The coefficients of variables fs₂₀₀₈ and fs₂₀₁₀ are positive and significant at 1%, thus the expected spillover effect of FDI on efficiency convergence is confirmed. Considering total effects of FDI on technical efficiency convergence can be seen in Table 4.

Table 4. Comparing the speed of convergence from unconditional convergence models and conditional convergence models

	Unconditional convergence models				conditional convergence models (Impact of FDI on speed of convergence)			
	TE from total sample		TE from sample of domestic firms		TE from total sample		TE from sample of domestic firms	
	Model 4.1T	Model 4.2T	Model 4.1D	Model 4.2D	Model 5.1T	Model 5.2T	Model 5.1D	Model 5.2D
Speed of convergence	15.63 %	10,09%	17,39%	10,59	22,92%	22,43%	21,42%	16,14%
Half line	8.66	10,7	8,33	10,41	7.94	7.98	8.07	8.83

Table 4 displays the results of comparing the speed of unconditional convergence models and conditional convergence models. Columns 2, 3, 4, 5 report the results of speed of convergence and half-line of unconditional models. Columns 6, 7, 8, 9 present the results of speed of convergence and half-line of conditional models. The results show that the speed of conditional convergence models through channels of FDI effects must be faster than those from unconditional convergence models.

4. CONCLUSION

This study analyzed horizontal and vertical productivity spillovers of foreign direct investment on technical efficiency convergence in Vietnamese sub-industries from 2000 to 2011. Dynamic I-O tables (2000 and 2005) were used to construct the linkages between domestic and foreign firms and to set out the model in which several channels through which FDI could affect efficiency and efficiency convergence of the domestically owned firms. Using a panel dataset covering sub-industries in Vietnamese manufacturing firms from 2000 to 2011, We found the existence and the nature of the effect of FDI on firms' efficiency and efficiency convergence at firms levels in the sub- industries: (1) there were impact of FDI on domestic firms' efficiency score and convergence at a firm level; (2) the presence of FDI increased the speed of efficiency convergence in domestically owned firms.

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ⁱ Horizontal spillovers run from a foreign firms to a local firms in the same industry . On the other hand, vertical spillovers refers to local firms that may be able to improve their productivity (efficiency) as a result forward or backward linages with foreign firms (see Blomstrom and Kokko (1998). Forward spillover: domestically owned firms gain access to less costly intermediate inputs from FDI in upstream industries, while Backward spillovers of FDI refer to the technology transfer through supply chain from FDI to domestic supplier.

ⁱⁱ Vietnamese manufacturing sector is the most important sector in the country in terms of its contribution to economic growth. Four sub-industries: food products and beverages and tobacco products; textiles and wearing apparel; footwear and wood and wood products have contributed about more than 40% of Vietnamese manufacturing industries' total output during 2006-2013.