

FDI and Efficiency convergence, the case of Vietnamese Manufacturing industry

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 upstream, downstream, and supply-backward linkage effects is to construct the linkages from dynamic input - output tables. The way to test efficiency convergence 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 linkages, is to investigate whether technical efficiency convergence process occurred in the presence of FDI through spillover effects in Vietnamese manufacturing industry.

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]).

Our methodology proceeds in three steps. First, we construct an empirical representation of the frontier technology for a given set of sub- industries. Second, we discuss the results on a

statistical base in order to see if FDI spillover effects on technical efficiency. Finally, we 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.

We apply this methodology to the total sample of sub-industry in Vietnamese manufacturing industry (sub-industries includes (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.

2. METHODOLOGY

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:

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

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) and free disposal hull 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.

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

subject to

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

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

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

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

2.1.2 Free Disposal Hull models

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:

$$\begin{aligned}
 [D(x, y)]^{-1} &= \text{Max} \theta_{it} \\
 \text{subject to} \\
 \theta_{it} y_{kit} &\leq \sum_{i=1}^N \lambda_{it} y_{kit} \quad k = 1, 2, \dots, K \\
 \sum_{i=1}^N \lambda_{it} x_{jit} &\leq x_{jit} \quad j = 1, 2, \dots, J \\
 \sum_{i=1}^N \lambda_{it} &= 1, \quad \lambda_{it} \in \{0, 1\} \quad i = 1, 2, \dots, N; t = 1, 2, \dots, T
 \end{aligned} \tag{2}$$

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

2.1.3 Second –Stage Regression

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

$$TE_{it} = \gamma_0 + \gamma_1 Sf_{ijt} + \gamma_5 Hori_{jt} + \gamma_2 Back_{jt} + \gamma_3 Forw_{jt} + \gamma_4 Sback_{jt} + \alpha_t + \alpha_i + \varepsilon_{it} \tag{3}$$

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

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

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

$$hor_{jt} = \frac{\sum_{j \in J} fs_{ijt} * X_{ijt}}{\sum_{j \in J} X_{ijt}}$$

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

$$back_{jt} = \sum_{k \text{ if } k \neq j} \gamma_{jkt} hor_{kt}$$

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

Forward (forw): The same way, we define the forward spillover variable $forw_{jt}$ as

$$forw_{jt} = \sum_{l \text{ if } l \neq j} \delta_{jlt} hor_{lt}$$

Where the Input - Output tables reveal the proportion δ_{jlt} of industry j 's inputs purchased from upstream industries l . Input purchased within the industry ($l=j$). Thus the greater the foreign presence in sectors supplied by are also excluded, since this is captured by Horizontal.

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

$$sback_{jt} = \sum_{i \text{ if } i \neq j} \delta_{jlt} back_{it}$$

Where δ_{jlt} -the proportion of industry j 's inputs is purchased from upstream industries l that in turn supply the downstream industries of foreign firms as measured by variable $back_{jt}$.

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130 2.2 Efficiency convergence among firms

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132 2.2.1 Unconditional convergence

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134 Following Alam and Sickles (2000) [1], we regress average growth rates on a constant and
135 the initial technical efficiency levels. The basic form of the equation of unconditional
136 convergence is:

$$137 \frac{1}{T} [\ln TE_{i,final} - \ln TE_{i,initial}] = \alpha + \beta \ln TE_{i,initial} + \varepsilon_t \quad (4)$$

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

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142 2.2.2 Conditional convergence

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144 To consider whether technical efficiency (from CCR and FDH models) convergence
145 occurred in the presence of FDI through spillovers to domestic firms. Since, it may take more
146 time before FDI's spillovers effects on domestic firms' technical efficiency, we include lagged
147 foreign share (*Sf*), Horizontal (*Hori*), Backward (*Back*), Forward (*Forw*) and supplybackward
148 (*Sback*) linkage measures into the model . The new equation of conditional convergence is:

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$$150 \frac{1}{T} [\ln TE_{i,final} - \ln TE_{i,initial}] = \alpha + \beta \ln TE_{i,initial} + \sum_{t=2000}^{2011} \delta_t^{(1)} Sf_{jt} + \sum_{t=2000}^{2011} \delta_t^{(2)} Hori_{jt} + \sum_{t=2000}^{2011} \delta_t^{(3)} Back_{jt} \\ + \sum_{t=2000}^{2011} \delta_t^{(4)} Forw_{jt} + \sum_{t=2000}^{2011} \delta_t^{(5)} Sback_{jt} + \varepsilon_t \quad (5)$$

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

3. RESULTS AND DISCUSSION

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

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 Sf , $Hori$, $Forw$, $Back$ and $Sback$. The estimated results are presented in Table 1. *Foreign share (Sf)* bears a significant and positive sign (in CCRT models) but insignificant and negative sign (in FDHT models). *Hori* 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 *Hori* 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.

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
<i>Sf</i>	0.029*** (0.010)	-0.005 (0.014)		
<i>Hori</i>	-0.040** (0.015)	0.053*** (0.020)	-0.020 (0.017)	0.048** (0.023)
<i>Back</i>	0.080*** (0.016)	0.095*** (0.021)	0.134*** (0.018)	0.091*** (0.023)

	-0.086***	0.071**	-0.055*	0.095**
<i>Forw</i>	(0.025)	(0.033)	(0.029)	(0.037)
	0.117***	0.041	0.085***	0.035
<i>Sback</i>	(0.026)	(0.035)	(0.030)	(0.039)
	0.127***	0.315***	0.123***	0.326***
<i>_cons</i>	(0.005)	(0.007)	(0.006)	(0.008)
<i>/sigma_u</i>	0.144	0.242	0.145	0.236
<i>/sigma_e</i>	0.150	0.201	0.158	0.207
<i>Rho</i>	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 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.

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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. The coefficients of initial technical efficiency from models 1, 2, 3 and 4 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:	Speed of Year
<i>The average year to year growth in the technical efficiency scores</i>	<i>catching up</i>

(a) Total sample of sub-industry					
Model 1 (TE from CCR model)	$DLnCCR_i^{2011} = -0.2217^{***}$ (0.0091)	-0.0769^{***} (3.61E-06)	$LnCCR_i^{2000}$	15.63%	8.66
	$R^2 = 0.43; DW = 1.79; \text{Number of Observations} = 1038$				
Model 2 (TE from FDH model)	$DLnFDH_i^{2011} = -0.0892^{***}$ (0.0043)	-0.0627^{***} (0.0022)	$LnFDH_i^{2000}$	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 3 (TE from CCR)	$DLnCCR_i^{2011} = -0.0234^{***}$ (0.0097)	-0.0798^{***} (0.0029)	$LnCCR_i^{2000}$	17.39%	8.33
	$R^2 = 0.45; DW = 1.82; \text{Number of Observations} = 907$				
Model 4 (TE from FDH)	$DLnFDH_i^{2011} = -0.0895^{***}$ (0.0043)	-0.0644^{***} (0.0023)	$-LnFDH_i^{2000}$	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.

3.4 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-industry 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 $Hori_{2000}, Hori_{2001}, \dots, Hori_{2011}, Forw_{2000}, \dots, Forw_{2011}$ variables.

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 coefficient 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. From those models, FDI spillovers may accelerate convergence by increasing the technical efficiency of domestic firms, they may also contribute towards increased speed of convergence.

Table 3: Conditional convergence (2000-2011)

(a) For total sample of sub-industry with number of observations =1038	
(1)	$\Delta \ln CCRT_{i,2011} = -0.1532^{***} - 0.0836^{***} \ln CCRT_{i,2000} - 0.8835^{**} Back_{j,2000} + 0.0896^{**} Hori_{j,2001}$ $+ 0.2357^{**} Back_{j,2001} + 0.3062^{**} Forw_{j,2001} - 0.5397^{***} Sback_{j,2001} - 0.4663^{***} Forw_{j,2001}$ $+ 0.1024^{***} Hori_{j,2005} - 0.1559^{***} Back_{j,2005} + 0.025^{***} Sf_{j,2008} + 0.055^{***} Back_{j,2009}$ $+ 0.089^{***} Sf_{j,2010} + 0.135^{***} Forw_{j,2011}$ $R^2=0.5 \quad DW = 1.92$

Speed of catching up =20.48%

$$(2) \quad \Delta \ln FDHT_{i,2011} = - \frac{0.2366}{(0.0083)}^{***} - \frac{0.0832}{(0.0083)}^{***} \ln FDHT_{i,2000} + \frac{0.4873}{(0.0083)}^{***} Sback_{j,2000} - \frac{0.021}{(0.0099)}^{***} Hori_{j,2005} \\ + \frac{0.017}{(0.0089)}^{*} Back_{j,2008} + \frac{0.028}{(0.009)}^{*} Back_{j,2009} - \frac{0.049}{(0.0089)}^{***} Forw_{j,2009} - \frac{0.023}{(0.0083)}^{*} Hori_{j,2011} - \frac{0.024}{(0.0066)}^{***} Back_{j,2011} \\ + \frac{0.273}{(0.005)}^{***} Forw_{j,2011}$$

R²=0.89; DW =1.86

Speed of catching up =20.09%

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

$$(3) \quad \Delta \ln CCRD_{i,2011} = - \frac{0.1151}{(0.0343)}^{***} - \frac{0.0823}{(0.0028)}^{***} \ln CCRD_{i,2000} + \frac{0.2398}{(0.1043)}^{**} Back_{j,2000} + \frac{0.089}{(0.0376)}^{**} Hori_{j,2000} \\ + \frac{0.4011}{(0.1712)}^{**} Forw_{j,2000} + \frac{0.4507}{(0.1764)}^{**} Sback_{j,2000} - \frac{1.0611}{(0.4268)} Back_{j,2000}^{***} - \frac{0.2823}{(0.0976)}^{***} Forw_{j,2004} \\ - \frac{0.1515}{(0.0511)}^{***} Back_{j,2006} + \frac{0.1026}{(0.0473)}^{**} Hori_{j,2006} - \frac{0.2066}{(0.1712)}^{*} Forw_{j,2007} + \frac{0.0616}{(0.0321)}^{**} Back_{j,2011}$$

R²=0.52; DW =1.92

Speed of catching up =19.28%

$$(4) \quad \Delta \ln FDHD_{i,2011} = - \frac{0.0813}{(0.0083)}^{***} - \frac{0.0755}{(0.0027)}^{***} \ln FDHD_{i,2000} + \frac{0.1448}{(0.0300)}^{**} BACK_j^{2000} + \frac{0.0706}{(0.1043)}^{***} HORI_j^{T-10} \\ - \frac{0.2195}{(0.0888)}^{***} BACK_j^{T-8} - \frac{0.0875}{(0.0513)}^{***} FORW_j^{T-8} + \frac{0.738}{(0.0209)}^{***} BACK_i^{2009} - \frac{0.2527}{(0.0475)}^{***} SBACK_j^{2010} \\ + \frac{0.0848}{(0.0198)}^{***} BACK_j^{2011} - \frac{0.0966}{(0.0216)}^{***} HORI_j^{2011} + \frac{0.0944}{(0.0449)}^{**} FORW_j^{2011}$$

R²=0.52; DW =1.79

Speed of catching up =14.90%

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

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

From the estimated results (Table 2 and 3), we find that the speed of efficiency convergence from the conditional model through channels of FDI effects is faster than the speed of convergence of the unconditional models

4. CONCLUSION

This study analyzed horizontal and vertical productivity spillovers of foreign direct investment on technical efficiency convergence in Vietnamese sub-industry from 2000 to 2011. We found existence and the nature of the effect of FDI on firms' efficiency and efficiency convergence at firms levels in sub- industry in Vietnamese manufacturing industry. Dynamic I-O tables (2000 and 2005) were used to construct the linkages between domestic and foreign firms. Using a panel dataset covering sub-industry in Vietnamese manufacturing firms from 2000 to 2011, we found that (1) the impact of FDI on domestic firms' efficiency score and convergence at a firm level; (2) the effects of spillovers through horizontal or vertical effects on technical efficiency convergence were different and then the speed-of-convergence from models was different.

The contributions of this study are (i) to set the model in which several channels through which FDI may affect efficiency and efficiency convergence of the domestically owned firms; (ii) to show that the presence of FDI increase the speed of efficiency convergence in domestic firms.

REFERENCES

1. Alam IMS., Sickles RC. Time Series Analysis of Deregulatory Dynamics and Technical Efficiency: The Case of the U.S. Airline Industry. *International Economic Review*. 2000; 41(1): 203-218.
2. Bernard AB., Jones CI. Comparing Apples to Oranges: Productivity Convergence and Measurement Across Industries and Countries. *American Economic Review*. 1986; 86 (5): 1216–1239.
3. Charnes A., Cooper WW., Rhodes E. Measuring the efficiency of decision-making units, *European Journal of Operational Research*. 1978; 2(6): 429-444.
4. Cornwell C., Schmidt P., Sickles RC. Production Frontiers with Cross Sectional and Time Series Variation in Efficiency Levels. *Journal of Econometrics*. 1990; Vol 46, No 1-2: 185-200.
5. Deprins D., Simar L., Tulkens H. Measuring Labor-Efficiency in Post Offices, in: M. MARCHAND, e.a. (eds). *The Performance of Public Enterprises: Concepts and Measurement*. Elsevier, Amsterdam; 1984; 243-267.
6. Dorwick S., Nguyen DT. OECD Comparative Economic Growth 1950-85: Catch-Up and Convergence. *American Economic Review*. 1989; 79 (5): 1010–1031.
7. Farrell MJ. The measurement of Productive Efficiency. *Journal of the Royal Statistical Society*. 1957; 120: 253 - 281.
8. Haddad M., Harrison A. Are there Positive Spillovers from Direct Foreign Investment? Evidence from Panel Data for Morocco. *Journal of Development Economics*. 1993; Vol.42, No.1: 51-74.
9. Schmidt P., Sickles CR. Production Frontiers and Panel Data. *Journal of Business & Economic Statistics*. 1984; Vol.2, No. 4: 367-374.