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IMPACT OF INTERNATIONAL JOINT VENTURE ON THE TECHNICAL EFFICIENCY – EVIDENCE FROM TAIWAN'S FDI IN CHINA

Cheng-Ping Cheng[1], Manh-Trung Phung[1,*], Huai-Jie Tsai[1] and Ju-Chun Cheng[2]

[1]Department of Finance
National Yunlin University of Science and Technology
No. 123, Section 3, University Road, Douliou, Yunlin 64002, Taiwan
cpcheng@yuntech.edu.tw; *Corresponding author: pmtrung@vimaru.edu.vn

[2]Department of Economics
Soochow University
No. 56, Section 1, Kueiyang Street, Chungcheng District, Taipei City 100, Taiwan

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Abstract. *The paper uses a stochastic frontier production model to explore whether different forms of international joint ventures would affect the technical efficiency of production abroad. Our data consists of 1665 Taiwan's manufacturing firms from 2001 to 2005, surveyed by the Ministry of Economic Affairs of Taiwan. The empirical results show that in both Global and China cases, relative to the form of "jointed with Taiwan's firms", those firms, which invest abroad by adopting the forms of "independent firms" and "jointed with foreign firms" can significantly increase technical efficiency. However, the effects of "jointed with local firms" in these two groups are totally different. That is, jointing with China's local firms would significantly decrease the technical efficiency of Taiwanese firms.*
Keywords: Efficiency, Stochastic frontier approach, Joint venture, FDI

1. **Introduction.** Due to legal restriction as well as profit consideration, Taiwanese firms invested abroad would select different forms of international joint ventures to process productive activities. Different forms of joint venture might affect the productivity and efficiency of production in a guest country. Even for the same organization form, the technical efficiency of production might be different due to diverse transaction costs and behavior codes in different countries. Since 1990, China has been becoming the largest country which attracts Taiwan's FDI. However, China is still not a free-market country and governmental regulations exist everywhere. Owing to insecure property right system and high transaction costs, making a joint venture with China's local partner is always with a high risk. Although Taiwan's FDI has been very successful in China, many Taiwan's firms' joint venture with China's enterprises (mostly are a kind of stated-owned enterprises) collapsed due to popular rent-seeking activities and partner's pirates. The purpose of this paper is to build an econometric model to examine (1) whether different forms of international joint ventures will affect the technical efficiency of production abroad; (2) whether the technical efficiency of FDI production in China is different from the one in other countries and (3) for Taiwanese enterprises, which form is the best way to make a joint venture to invest abroad?

Anderson and Gatignon [1] proposed that entrance for overseas market will help a corporation to have an improvement on its business functions. Lee et al. [2] found that ownership advantages, location advantages and internalization advantages increase the probability for Taiwanese firms to choose a wholly-owned subsidiary mode as their entry

in China. Furthermore, Chang et al. [3] illustrated that governance quality of the host country also has the positive impact to the decision of choosing wholly-owned subsidiary of Taiwanese firms. Niu et al. [4] indicated that there are several dimensions of market entry barriers. Among them, business executives in China perceive advertising effects play the most important role. Following this research, some questions, which relate to the influence of firm' strategy, structure and context on its proficiency have been arising in overcoming the market entry barriers [5].

According to China's investment law, foreigner enterprises can enter the Chinese market as the following types: Sino-foreign joint ventures, Chinese-foreign joint management and foreign sole proprietor. In order to use market to exchange technology, Chinese government prefers international firms to exploit the modes of Sino-foreign joint ventures and Chinese-foreign joint management. However, after 1990, foreigners prefer foreign sole proprietor and the rate for foreign sole proprietor is already higher than the rate of choosing Sino-foreign joint ventures. Therefore, investigating of entry barriers in China market has been arising as one of the most popular research topics.

Rent-seeking exists in every society, and the more a government regulates, the more rent-seeking activities are. This behavior is obvious in the transition of China's economy since using relationship network to process the power-money exchanging transaction is everywhere in China. Using the sample of Chinese coal industry, Chen et al. [6] indicated that although rent-seeking has the negative impact on average level of mental productivity, it does not significantly influence the average level of material productivity. The rent-seeking activities are always associated with the modes of Sino-foreign joint ventures and Chinese-foreign joint management. For example, ⌜China's Investment Atmosphere & Risk Investigation⌟ surveyed by Taiwan Electronic Mechanical Union in 2006 listed more than 25 disputes annually since 2002-2005. Among them, some firms involved are Taiwan's most famous enterprises.[1] Indeed, similar situation also happened for Hong-Kong's and Singapore's firms which invest in China.[2]

The rest of paper is organized as follows. Section 2 is the literature review of some deterministic researches of efficiency and our model specification as well as variables' definitions. Section 3 highlights the empirical results of stochastic production function and the impact of environmental variables toward technical efficiency. Finally, we make the conclusion in Section 4.

2. Efficiency Theory and Empirical Model.

Aigner et al. [7] provided the stochastic frontier production for efficiency measurement. The model allows us to estimate time-varying efficiency levels. Furthermore, many researchers try to evaluate the exogenous factors that affect the technical inefficiency. Yang et al. [8] concluded that technical efficiency of Taiwanese manufacturing firms increased over the period of time from 1987 to 2000. Furthermore, the result shows a positive correlation between technical efficiency and outward foreign direct investment activity. Based on the stochastic frontier method of Battese and Coelli [9], this study sets a stochastic Translog production function as well as an inefficiency model to simultaneously estimate the production frontier and the impacts of different forms of international joint venture on technical inefficiency.

The data consists of 1665 manufacturing firms and the total sample size is 3051. It is from the "Questionnaire of the Foreign Direct Investment (FDI) of Taiwan's Manufacture

[1]For example, in year 2007, Taiwan's largest department store, Shin Kong Group, has a terrible dispute with Beijing Shin Kong New Tiandi. In 2007, world famous bicycle brand Giant also has a serious conflict with its Chinese partner. In 2003, Wang Wenyang's Hongren Group cooperates with Jiang Zeming's son Jiang Mianheng on semi-conductor. After half a year, Jiang enforced a withdrawal on Taiwanese businessmen, which made Wang left.

[2]Singapore's president Lee Guanyao was supposed to hold 65% of the shares in Soochow Scientific Park, but the dispute finally made him only holding 35% of the shares.

Sector" from 2001 to 2005, surveyed by the Statistical Bureau, the Ministry of Economic Affairs of Taiwan. The production frontier function is specified as a Translog form:

$$\begin{aligned} LnY_{it} = \beta_0 + \beta_1 \ln L_{it} + \beta_2 \ln K_{it} + \frac{1}{2}\beta_3 (\ln L_{it})^2 + \frac{1}{2}\beta_4 (\ln K_{it})^2 \\ + \beta_5 (\ln L_{it} \times \ln K_{it}) + v_{it} - u_{it} \end{aligned} \tag{1}$$

where Y_i, K_i, L_i are output, labor, and capital, respectively, of firm i. The non-negative random variables u_i (≥ 0) represent output-oriented technical inefficiency of firm i which follows a truncated normal distribution, $u_{it} \sim N^+(\delta z_{it}, \sigma^2)$. v_i is the error term of firm i which follows a normal distribution, $v_i \sim N\ (0, \sigma_v^2)$. u_i is independent of v_i.

The technical inefficiency model is specified as:

$$u_{it} = \delta_0 + \delta_1 z_{1it} + \delta_2 z_{2it} + \delta_3 z_{3it} + \delta_4 z_{4it} + \delta_5 z_{5it} + \delta_6 z_{6it} + \delta_7 z_{7it} + \delta_8 z_{8it} \tag{2}$$

where z_{it} represents either environment variables or control variables which might influence the technical efficiency. The variables in the preceding two equations can be classified into 4 groups: outputs (sales), inputs (number of employee and fixed asset), forms of joint venture (see Table 1), and control variables (R&D expenditure, industrial heterogeneity, and location difference). Based on practical situation, we set four forms of international joint ventures – independent firms, jointed with Taiwan's firms, jointed with foreign firms (mainly from developed countries), and jointed with local enterprises. The definitions of each form of joint venture are shown in Table 1.

Table 1. Definitions of 4 types of joint venture

Type	Definition	The types chosen in Questionnaire
Jointed with Taiwan's firms (INV0)	Cooperated with Taiwan's firms or Individual Taiwanese	(2) Cooperated with Taiwan's firms and invest abroad together (3) Cooperated with Taiwan's firms which have invested abroad (7) Cooperated with individual Taiwanese
Independent (INV1)	Independent	(1) Independent
Jointed with local firms (INV2)	Cooperated with local firms, or government, or individual	(4) Cooperated with local firms (5) Cooperated with local governments (8) Cooperated with local individuals
Jointed with foreign firms (INV3)	Cooperated with international firms or other cases	(6) Cooperated with international firms (9) Others

3. Empirical Results Analysis.

3.1. **The empirical results of stochastic production function.** Table 2 shows the empirical results of two groups of data: the first one consists of all sample firms which invest worldwide, including those firms in China; the second one is the data of the firms who only invest in China. The estimated sigma-squared ($\sigma^2 = \sigma_v^2 + \sigma_u^2$) and Gamma value ($\gamma = \sigma_u^2/\sigma^2$) are both significantly positive which show that the variance of residual and variance of inefficiency are significant. Therefore, setting an inefficiency term in our model is adequate. Moreover, the estimated parameters of the production frontier are all fitting the good properties of a typical production function. That is, the marginal returns of all input are positive as well as the diminishing returns of inputs holding.

Since the Translog production function is the second degree approximation of a real production function, the marginal impact of each input on output must be inspected

TABLE 2. The empirical results of stochastic production frontier model

	Global			China		
Variable	**Coefficient**	**Std.error**	**t-ratio**	**Coefficient**	**Std.error**	**t-ratio**
Intercept	0.6406***	0.1657	3.8660	0.8713***	0.1992	4.3749
$\ln L$	0.7044***	0.0666	10.5800	0.5466***	0.0740	7.3834
$\ln K$	0.4060***	0.0427	9.5128	0.4554***	0.0479	9.5102
$1/2(\ln L)^2$	−0.1078**	0.0161	−6.7026	−0.0676***	0.0177	−3.8209
$1/2(\ln K)^2$	−0.0149**	0.0082	−1.8299	−0.0065	0.0094	−0.6942
$(\ln L)(\ln K)$	0.0519***	0.0086	6.0429	0.0378***	0.0099	3.8034
$(\sigma^2 = \sigma_v^2 + \sigma_u^2)$	9.9682***	1.6465	6.0541	21.9833***	1.7683	12.4316
$(\gamma = \sigma_u^2/\sigma^2)$	0.9202***	0.0138	66.7156	0.9669***	0.0031	311.2645

*Note: *represents significance at the 10% level; **represents significance at the 5% level; ***represents significance at the 1% level.*

TABLE 3. The empirical result of technical inefficiency model

	Global			China		
Variable	**Coefficient**	**Std.error**	**t-ratio**	**Coefficient**	**Std.error**	**t-ratio**
Intercept	−8.1868***	1.9750	−4.1452	−23.5075***	1.7447	−13.4739
INV1	−1.1056***	0.3084	−3.1729	−1.1287***	0.4020	−2.8078
INV2	−0.0414	0.3316	−0.1250	0.6341*	0.4411	1.4377
INV3	−4.2932***	0.8099	−5.3009	−2.5933***	1.1994	−2.1622
RD	−0.00007**	0.00005	−1.4418	−0.0002***	0.00002	−8.3876
IND1	−1.3134***	0.2554	−5.1426	−2.0754***	0.6068	−3.4200
IND2	−3.8534***	0.6859	−5.6177	−6.7754***	0.5639	−12.0161
LCA1	−7.3810***	1.4369	−5.1367			
LCA2	−1.1046***	0.03357	−3.2907			
LCA3	−1.4489***	0.6224	−2.3280			

*Note: *represents significance at the 10% level; **represents significance at the 5% level; ***represents significance at the 1% level.*

by first degree and second degree of partial derivatives of each input on output. Our empirical results of both Global case and China case are able to fit the requirements of a good production function.

3.2. **The empirical results of technical inefficiency.** Table 3 shows the empirical results of inefficiency models from both groups. In Global case, this study finds that, relative to the form of "jointed with Taiwan's firms" (**INV0**, as the reference), those firms investing abroad by adopting the forms of "independent firms" (**INV1**) and "jointed with foreign firms" (**INV3**) can significantly increase technical efficiency. However, the effect of jointed with local firms (**INV2**) is ambiguous since it is statistically insignificant.

In China case, the results show that, the effect of "independent firms" (**INV1**) and "jointed with foreign firms" (**INV3**) are the same as the case in Global case. That is, relative to the form of "jointed with Taiwan's firms" (**INV0**, as the reference), those firms investing abroad by adopting the forms of "independent firms" (**INV1**) and "jointed with foreign firms" (**INV3**) can significantly increase technical efficiency. However, the effect

of jointed with local firms (**INV2**) in this group is totally different from the one in the Global case since the estimated parameter of **INV2** is 0.6341 which indicates that to joint with China's local firms would significantly cut down the technical efficiency of Taiwanese firms' FDI.

The result is quite consistent with some researches. Regarding other control variables, the result shows that the estimate of R&D is significantly negative that is consistent with the findings of Qian [10]. It suggests that, for Taiwan's firms, the increase of R&D expenditure would raise the technical level as well as to reduce the technical inefficiency. For industrial difference, we find that in both groups, relative to traditional industry (IND0, as the reference), the basic industry (IND1) and the technical intense industry (IND2), have higher technical efficiency. Regarding the location difference, in the Global case, Table 3 shows that, relative to invest in China and Hong Kong (LAC0), all three other areas, including developed countries (LCA1), Southeast Asia countries (LAC2), and other countries (LAC3), have higher efficiency. According to traditional FDI theory, most of firms investing abroad are muti-national enterprises that carry the advantage of either intangible asset or large scale. However, due to the same cultural and language advantage, the majority of Taiwanese firms investing in China are small and median size firms who usually do not carry a significant technical advantage relative to large sized MNS. That is, most Taiwanese firms invest in China not because they want to pursue a higher production efficiency but because of the driving force of low cost, including production costs as well as transaction costs.

4. **Concluding Remark.** This study is an empirical work which sheds a light on the impact of the FDI diversification strategies on the technical efficiency of Taiwan's manufacturing firms. Based on the data of the "Questionnaire of the Foreign Direct Investment (FDI) of Taiwan's Manufacture Sector" from 2001 to 2005, this study follows the Stochastic Frontier Approach of Battese and Coelli (1995). Adopting a Translog production function and a technical inefficiency model, we explore the impact of 4 types of international joint venture on the performance of Taiwan's manufacture sector. The empirical result shows that, while the forms of "independent firms" and "jointed with foreign firms" can increase technical efficiency, the form of "jointed with China's firms" (**INV2**) will significantly decrease the technical efficiency of Taiwanese firms in China. This result suggests that, for an international producer to invest in an institutions- not-well-specified country, such as in China, the best strategy is not to make a joint venture with local enterprises. Instead, trying to build an independent business or making a joint venture with advanced international partners will raise technical efficiency of production.

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