Technical Efficiency and Location Choice of Small and Medium-Sized Enterprises

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ABSTRACT. We establish a theoretical model to explain the relationship between the regional technical efficiencies and production location choice. A higher regional technical efficiency level attracts foreign direct investment (FDI) and offsets the adverse effects of a high wage rate and setup cost. Data from Taiwan's SMEs during the period 1989–1996 are collected. Observations are classified into three exclusive and exhaustive groups: SMEs without FDI, SMEs with FDI in mainland China, and SMEs with FDI in other countries. We then apply the multi-logit model to test the relationship between the technical efficiency and FDI location choice. Taiwan's SMEs with higher technical efficiencies are less likely to invest in mainland China. Technical efficiencies do not significantly influence the location choice between Taiwan and other countries. The wage rate is a significant motive for SMEs to invest internationally, while the setup cost is not an important factor to affect firms' location choices.

1. Introduction

The conventional theory of FDI location choice focuses on the location advantages, which maximize the value of firm-specific assets net of setup costs (Hymer, 1960; Vernon, 1970; Horst, 1972; Dunning, 1980, 1981; Caves, 1982; Chen, 1992; Fujita, 1997). Local factors, which can minimize transaction costs or coordination costs of markets, also matter in the FDI location decision (Dunning, 1995, 1997). These factors include firm own-specific advantage, natural resources, labor quality, wage rates, tax and tariff policy, infrastructure, market size, internal management, political stability, culture and customs, legal system, climate, and so on. However, the regional technical efficiency of production has never been introduced into the theoretical and empirical analysis of FDI behavior. However, regional technical efficiencies do affect FDI profits drastically. Due to imperfections in the real world, firms usually produce at an inefficient level (Farrell, 1957; Afriat, 1972; Aigner et al., 1977; Meeusen and Van den Broeck, 1977). That is, the firms are usually not producing at the efficient production frontier. The regional technical efficiency is affected by many economic and non-economic factors, such as the labor quality, internal control, network linkage, local government regulation, local climate, etc. A firm can produce more with the same inputs if the regional technical efficiency is higher and thus can make a higher profit with the benefit of a higher regional technical efficiency. Therefore, introducing the factor of regional technical efficiencies may reinforce or offset the FDI attraction effects of those factors considered in the existing literature.

Although some earlier empirical literature showed that FDI is mainly an activity of large firms (Vernon, 1970; Horst, 1972; Caves, 1982), new evidence suggests that small and medium-sized enterprises (SMEs) also play an important role in FDI in globally. For example, SMEs accounted for 50 percent of all U.S. FDI in 1982 (Kohn, 1997). In the United Kingdom, SMEs accounted for 66 percent of the total number of FDI in 1981 (Fujita, 1997). Because of resource

Final version accepted on June 21, 2001

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Small Business Economics **19**: 1–12, 2002.

constraints, SMEs when compared to large firms are more sensitive to location condition in undertaking FDI. Empirical studies found that low-wage labor and a sizable local market are key factors in the recipient countries to attract FDI from Japanese SMEs (Fujita, 1995a, b; Urata and Kawai, 2000). Johanson and Mattson (1987) argue that getting established in a local network requires adaptation and that SMEs are generally more adaptable than large firms. Gemunden and Heydebreck (1995) indicate that the network relationship between SMEs is a very valuable asset of firms. Chen and Chen (1998) find that network linkage significantly influences the location choices of FDI for Taiwan's SMEs. However, none of them considers the effect of regional technical efficiencies on SMEs' FDI location choice.

Since this paper is the first in economic literature to explicitly link the regional technical efficiencies with FDI location choice, we will first establish a theoretical model to show how the regional technical efficiency affects a firm's location choice decision. Second, we will use data of Taiwan's SMEs to test how robust our theoretical framework is and to show how such a new viewpoint can help understand more about the FDI behavior.

Taiwan is a small open economy with a small domestic market and few natural resources. Her development must therefore depend heavily on international trade. For instance, the value of exports accounted for 48.3 percent of GNP and that of exports plus imports was 94.4 percent of GNP in 1995. It is well known that Taiwan's economy has been growing at a rapid pace with per capita income growing from US$196 in 1952 to US$13,303 in 1996.[1] Lucas (1993) argues that the economic miracle of Taiwan comes from the rapid accumulation of human capital to push economic growth, which results from learning-by-doing through a huge volume of exports. Taiwan's FDI took off in 1986 and most FDI in recent years have been undertaken by export-oriented firms (Chen, 1992). These firms ventured abroad ever since the value of Taiwan's currency (NT$) and the domestic wage rate skyrocketed simultaneously, both undermining their competitiveness (Van Hoesel, 1996). According to information published by the Investment Commission in the Ministry of Economic Affairs, Taiwan's government approved only US$374.58 million in overseas investment in 1987, while it surged to US$12.04 billion by the end of 1996.

After the two sides across the Taiwan Strait started to exchange visits in the 1980s, direct investment by Taiwan businessmen began to rise rapidly. Mainland China has an advantage in attracting FDI from Taiwan since the two economies share a very close cultural background in spite of different economic and political systems. According to official statistics of the PRC Ministry of Foreign Trade and Economic Cooperation, from 1979 through to April 1999 the accumulated contractual agreement and actual investment were 4.160 and 2.165 billions U.S. dollars, respectively. Until 1995, investment in mainland China had counted for 35.5 percent of Taiwan's outward FDI.

Due to the political and military tensions across the Taiwan Strait, especially mainland China's three rounds of missile tests around the island of Taiwan in 1996, Taiwan's government has implemented a slowdown policy[2] against FDI in mainland China. At the same time, Taiwan's government tried to encourage Taiwanese businessmen to invest in South East Asia. There are many policy debates on whether outward FDI from Taiwan should go west (mainland China) or south (South East Asia). Of course, there are many aspects to cover for Taiwan's outward FDI. However, in this paper we are interested in the relationships between the technical efficiencies and FDI location choice of Taiwan's SMEs.

Taiwan's SMEs have the competitive advantage of flexibility and adaptability to confront capital shortages, energy crises, and depressions. After rapid economic growth since the 1960s, the SMEs still constitute 98 percent of all businesses in Taiwan as of 1997. In 1995, the share of sales by SMEs was only 35.97 percent, but they accounted for 50.65 percent of exports and even 79.75 percent of employment.[3] Therefore, we apply the FDI data of the SMEs in Taiwan to test our theoretical propositions and to find the relationships between FDI location choice and the technical efficiencies.

The structure of this study is as follows. In Section 2 we establish a theoretical model and derive the theoretical propositions on the relationships between regional technical efficiencies

and the FDI location choice. Section 3 is the empirical analysis, where we investigate the relationship between the technical efficiency and FDI location choice of Taiwan SMEs during the period from 1989 to 1996. Section 4 concludes this paper.

2. The theoretical model

In order to explain the relationships between the regional technical efficiencies and location choice, we establish a theoretical model. There are M countries (locations) in the world: the home country (denoted country 1) and $M - 1$ foreign countries. The home country has N firms in an industry, producing the same product. Firms input two factors, capital (K) and labor (L), to produce the product. The product is perfectly mobile across countries and the world price of the product is P. Capital is also perfectly mobile across countries and the world interest rate is $r > 0$. Labor is not allowed to move across the countries and the wage rates in the M countries are $w_m > 0$, $m = 1, \ldots, M$, respectively. An investment project lasts for T periods with $T \geq 1$. Revenues, costs, and all other variables in this model are calculated by the present value at time zero. All firms make their location choices at time zero.

Due to an asset constraint, each firm can choose only one location, either the home country or a foreign country, to produce the product. The setup cost to undertake production in the home country is zero ($S_{n1} = 0$). If firm n chooses country m, a setup cost of $S_{nm} > 0$ is incurred, with $n = 1, \ldots, N$, $m = 2, \ldots, M$. Because individual firms have different internal management systems and regional network linkages, they may incur different setup costs to go to the foreign country. Moreover, all the N firms have the same production technology in the home and foreign countries. However, the technical efficiencies among countries are different for the same firm, because the M countries are different in economic environments, e.g., economic system, legal system, infrastructure, customs and culture, crime rate, climate, etc. Moreover, technical efficiencies can also be different for firms producing the product in the same country, because of the differences in a firm's own-specific advantage, internal management systems, regional network linkages, etc.

We assume that the frontier production function for firm n to undertake production in country m is a Cobb-Douglas function:

$$Y_{nm} = AK_{nm}^{\alpha} L_{nm}^{\beta} - U_{nm}, \quad n = 1, \ldots, N, \; m = 1, \ldots, M. \tag{1}$$

The notation Y_{nm} is the output for firm n to produce in country m. All the N firms in this industry have the same production technology level $A > 0$. The parameters are $\alpha > 0$, $\beta > 0$, and $0 < \alpha + \beta < 1$; that is, the production function has the property of decreasing returns of scale. The technical efficiency level U_{nm} is a random variable, with $U_{nm} \geq 0$, and the expected value $\bar{U}_{nm}$. A higher U_{nm} implies a lower technical efficiency level for firm n to produce the product in country m, for $m = 1, \ldots, M$. That is, the expected value of technical efficiencies in the home and foreign countries are different for the same firm. Here we allow a difference in both regional and individual firms' technical efficiency levels. We allow the output level in the production possibilities set to be negative and this assumption is the same as those in most of the microeconomic textbooks, e.g., Debreu (1959), Varian (1992), Mas-Colell et al. (1995), etc.

For firm n, the expected output in country m is

$$\mathrm{E}(Y_{nm}) = AK_{nm}^{\alpha} L_{nm}^{\beta} - \bar{U}_{nm}. \tag{1}$$

The expected profit maximization problem when firm n chooses country m is

$$\underset{K_{nm},\, L_{nm}}{\mathrm{Max}} \; \mathrm{E}(\pi_{nm}) = P(K_{nm}^{\alpha} L_{nm}^{\beta} - \bar{U}_{nm}) - rK_{nm} - w_m L_{nm} - S_{nm}. \tag{2}$$

Solving the maximization problem depicted by Equation (2), we now have the equilibrium factors' input if the firm n chooses country m:

$$(K_{nm}^{*}, L_{nm}^{*}) = [(PA\alpha^{1-\beta}\beta^{\beta} r^{\beta-1} w_m^{-\beta})^{\frac{1}{1-\alpha-\beta}}, (PA\alpha^{\alpha}\beta^{1-\alpha} r^{-\alpha} w_m^{-(1-\alpha)})^{\frac{1}{1-\alpha-\beta}}]. \tag{3}$$

The present value of equilibrium profit if firm n chooses country m is

$$\pi_{nm}^{*}, = M(PAr^{-\alpha} w_m^{-\beta})^{\frac{1}{1-\alpha-\beta}} - P\,\bar{U}_{nm} - S_{nm}. \tag{4}$$

Therefore, the rationality constraint for firm n to produce in foreign country m is

$$\pi^{*}_{nm}, = M(PAr^{-\alpha}w_m^{-\beta})^{\frac{1}{1-\alpha-\beta}} - P\,\bar{U}_{nm} - S_{nm} \geq 0 \quad (5)$$

That is, a necessary (not sufficient) condition for firm n to choose country m is that the expected profit should be non-negative. The incentive constraint for firm n to produce in country m is

$$\pi^{*}_{nm} \geq \pi^{*}_{nm'},\ m, m' \in \{1, \ldots, M\},\ m \neq m', \quad (6)$$

This implies that the expected profit of choosing country m must be no less than that of any other country in the world. Rearranging Equation (6), we obtain

$$M(PAr^{-\alpha})^{\frac{1}{1-\alpha-\beta}}(w_m^{\frac{-\beta}{1-\alpha-\beta}} - w_{m'}^{\frac{-\beta}{1-\alpha-\beta}}) - P(\bar{U}_{nm} - \bar{U}_{nm'}) \geq S_{nm} - S_{nm'},$$
$$m, m' \in \{1, \ldots, M\},\ m \neq m', \quad (6')$$

where $M = [(\alpha^{\alpha}\beta^{\beta})^{\frac{1}{1-\alpha-\beta}} - (\alpha^{1-\beta}\beta^{\beta})^{\frac{1}{1-\alpha-\beta}} - (\alpha^{\alpha}\beta^{1-\alpha})^{\frac{1}{1-\alpha-\beta}}]$; $M > 0$ if $\alpha > 0$, $\beta > 0$ and $0 < \alpha + \beta < 1$. Firm n will choose country m if and only if the rationality constraint (Equation (5)) and the incentive constraint (Equation (6′)) both hold.

According to Equations (5) and (6′), we find that when an enterprise chooses the location of production, it will take technical efficiencies as well as wage rates and setup costs into account. We can now come up with the following theoretical propositions from Equations (5) and (6′):

[PROPOSITION 1] *Other things being equal, firm n is more likely to choose country m for production as the expected technical efficiency in country m gets higher, for n = 1, . . . , N, m = 1, . . . , M.*

[PROPOSITION 2] *Other things being equal, firm n is more likely to choose country m as the wage rate in country m gets lower, for n = 1, . . . , N, m = 1, . . . , M.*

[PROPOSITION 3] *Other things being equal, firm n is more likely to choose country m as its setup cost in country m gets lower, for n = 1, . . . , N, m = 1, . . . , M.*

[PROPOSITION 4] *Even when the wage rate in a foreign country is higher than that of the home country, if the expected technical efficiency in the foreign country is sufficiently high, then firm n will still go to the foreign country and bear the setup cost, for n = 1, . . . , N.*

[PROPOSITION 5] *Even when the expected technical efficiency of going to a foreign country is lower than that of staying in the home country, as long as the wage rate in the foreign country is sufficiently low, then firm n will still go to the foreign country and bear the setup cost, for n = 1, . . . , N.*

[PROPOSITION 6] *After the N firms choose their locations to produce their products, there are three possible equilibrium outcomes: (1) all firms stay in the home country; (2) some of the firms go to foreign countries; (3) all the firms go to foreign countries.*

Proposition 1 tells us that the firms can choose their locations in order to change the economic environment of production and thus increase the technical efficiencies, making their profits increase. A higher regional technical efficiency attracts foreign direct investment and offsets the adverse effects of a high wage rate and setup cost. Therefore, after the enterprises engage in FDI, their technical efficiency levels may be higher. Propositions 2 and 3 are the same as the conclusions in the traditional FDI literature. In order to minimize production costs, employing cheaper local factors is a key factor in the FDI location decision (Dunning, 1995, 1997). For example, cheaper labor is a primary concern for Japanese SMEs when choosing their locations (Fujita, 1995a, 1995b; Urata and Kawai, 2000).

Proposition 4 indicates that even when the foreign country has a higher wage rate and a positive setup cost, a firm may still conduct FDI to pursue a higher technical efficiency level. This result can explain why firms from low wage rate countries perform FDI in high wage rate countries. If a high wage rate country has a better economic environment (a higher technical efficiency level), then it is still possible for firms from countries with lower wage rates to undergo FDI in the high wage rate country. Proposition 5 says that firms bear the lower technical efficiency levels and setup costs for FDI, if the wage rate in a foreign country is sufficiently low. Summing up from Propositions

4 and 5, we find that the effects of wage rate differences and setup costs on FDI will be offset or reinforced by regional technical efficiencies. However, we need to undergo more empirical studies to find which is the major concern for firms before undertaking FDI.

Proposition 6 implies that the firms' location choices may not be the same since firms are not identical. Their location choices depend on their own technical efficiency levels and setup costs in different countries. Therefore, some firms will choose to go abroad for production while some firms will choose to stay in the home country. Our theoretical model thus can explain why, for firms in the same industry, some will stay in the home country while some will leave for foreign countries.

3. Empirical analysis

3.1. *Data source*

This study consists of an empirical investigation of FDI location choices for Taiwan SMEs, which have capital less than NT$60 million[4] or have fewer than 200 employees, during the period from 1989 to 1996. We employ a questionnaire survey to collect data. The sample firms are selected at random in the book *Registry of Approved Firms in the Center-Satellite Factory System* issued by the Corporate Synergy Development Center. Questionnaires are mailed to all 510 selected firms (including 103 automotive firms, 97 machinery firms, and 310 electronics firms). Of the 510 company questionnaires sent out in this study, 114 were returned, making the effective return 22.4%.

3.2. *Stochastic frontier model*

After Farrell (1957) introduced the frontier production function for efficiency measurement, many scholars applied the concept of frontier functions to measure efficiency. Afriat (1972), Richmond (1974), and Schmidt (1976) all apply the deterministic frontier model. However, the corresponding maximum likelihood estimators (MLE), in general, do not have their usual desirable asymptotic properties, because for any one-sided error distribution the range of the random variable usually depends on the unknown parameters (Greene, 1980). Ainger et al. (1977) and Meeusen and van den Broeck (1977) provide the stochastic frontier production for efficiency measurement. Pitt and Lee (1981) and Schmidt and Sickles (1984) extend the stochastic frontier model to panel data, but they assume that technical efficiency is invariant for individual firms. The advanced model allows us to estimate time-varying efficiency levels and was proposed by Cornwell et al. (1990) and Battese and Coelli (1992, 1995). Furthermore, Coelli (1996) provides a computer program, called Frontier 4.1, to estimate the MLE of the models proposed by Battese and Coelli in 1992 and 1995.

This study applies the model of Battese and Coelli (1992) to measure the technical efficiency. The computer program Frontier 4.1 is used to estimate the corresponding MLE and technical efficiency levels. The production function is specified as the Cobb-Douglas production function. We further add dummy variables to control the heterogeneity across industries. Hence, the model can be written as:

$$\begin{aligned} \ln Q_{nt} = {} & \alpha_0 + \alpha_1 \ln L_{nt} + \alpha_2 \ln K_{nt} + \\ & \alpha_3 D_{n1} + \alpha_4 D_{n2} + (V_{nt} - U_{nt}), \\ & n = 1, \ldots, N, \; t = 1, \ldots, T, \end{aligned} \tag{7}$$

where Q_{nt}, L_{nt}, K_{nt} are the real sales (NT$10 million), the number of employees, and the real fixed assets (NT$10 million),[5,6] respectively, of firm n in period t. The dummy variable $D_{nt} = 1$ if firm n belongs to industry i; while $D_{ni} = 0$, otherwise.

We treat the automotive industry as the reference industry; $i = 1$ is the machinery industry; and $i = 2$ is the electronics industry. The random variables $V_{nt} \overset{iid}{\sim} N(0, \sigma_V^2)$; $U_{nt} = (U_n \exp(-\eta(t - T))$ where U_n are non-negative random variables which account for technical inefficiency in production and are assumed to be *iid* as truncations at zero of the $N(\mu, \sigma_U^2)$ distribution. Moreover, V_{nt} and U_n are assumed to be independent; μ and η are unknown parameters. The coefficient η captures the time-varying effect. If $\eta = 0$, then the non-negative random variable U_{nt} becomes a time-invariant non-negative random variable U_n. Otherwise, U_{nt} will represent time-varying technical inefficiencies; that is, $U_{nt} = (U_n \exp(-\eta(t-T))$

(Battese and Coelli, 1992; Coelli, 1996). The measures of technical efficiency are defined as:

$$TEF_{nt} = E(\exp(-U_{nt})|(V_{nt} - U_{nt})). \quad (8)$$

The empirical results of the stochastic frontier production for the panel data are listed in Table I. The estimated $\gamma = 0.95$ is significantly greater than zero, suggesting that the model should include U_{nt}. Moreover, the time-varying model is better than the time-invariant model since the estimated $\eta = 0.01$ is significantly differently from zero. Furthermore, the sum of the estimated coefficients of labor and capital is less than one, which implies decreasing returns to scale.[7]

3.3. *Empirical analysis of location choices*

This study applies the multi-logit model to analyze how technical efficiencies influence firms' location choices. Observations are classified into three exclusive and exhaustive groups. The first group, the reference group, consists of those Taiwanese SMEs who did not invest abroad during the period from 1989 to 1996. The second group includes observations that invested in mainland China. The last group contains those that invested in other countries.[8]

Since the middle of the 1980s, the value of Taiwan's currency and its domestic wage rate have skyrocketed simultaneously, both undermining the competitiveness of Taiwan's firms. Van Hoesel (1996) argues that the increase in the value of Taiwan's currency and the domestic wage rate are the major factors that have influenced Taiwan's FDI during the past decade. Chen (1992) also finds that after 1986 Taiwan's FDI has mainly been motivated by cheaper labor. Firms with lower technical efficiencies hence wish to eliminate their weaknesses by taking advantage of cheaper foreign resources. Therefore, we expect that those Taiwan SMEs with a lower technical efficiency are more likely to take the risk to invest internationally. Furthermore, the rise in wage rates has an especially great impact on labor-intensive firms; as a result, the greater the degree is of labor intensities, the greater the intention firms will have to undergo FDI.

TABLE I
The empirical results of the stochastic frontier production

Variables	Coefficients	Standard error	*t*-ratio
Constant	1.07712	0.31204	3.45177
ln L_{nt}	0.33719	0.01145	29.44800
ln K_{nt}	0.64395	0.03994	16.12399
D_{n1}	–0.07401	0.16128	–0.45886
D_{n2}	0.86607	0.15159	5.71341
$\sigma^2 = \sigma_V^2 + \sigma_U^2$	1.36121	0.11590	11.74475
γ	0.95178	0.00418	227.53064
μ	2.27646	0.16260	14.00084
η	0.01009	0.00178	5.66097
Number of Cross-sections (Observations)			114 (902)

1. The dependent variable is real sales. The computer program Frontier 4.1 is used to estimate the corresponding MLE and technical efficiency levels.
2. ***P-value ≤ 0.01.
3. $\gamma = \sigma_U^2/(\sigma_V^2 + \sigma_U^2)$. Setting γ to be 0 implies that the U_{nt} term should be removed.
4. Setting η to be 0 suggests the time-invariant model.

Large enterprises have more resources than smaller enterprises (including labor, financial, and management resources). They hence should have a greater ability to globalize and conduct FDI. Empirical studies also show that the incidence of FDI positively relates to firm sizes (Horst, 1972; Wolf, 1977; Lall, 1980; Yu and Ito, 1988). We therefore expect firm sizes to be positively related to the tendency to invest abroad.

FDI can reduce market uncertainties as well as decrease transportation and tariff costs. Erramilli and Souza (1995) find that U.S. multinational enterprises (MNEs) prefer to invest in more uncertain countries. They argue that MNEs investing in foreign countries can respond to the change in these countries more efficiently. On one hand, the greater a firm's export ratios are, the more likely the firm will directly produce in the host country in order to reduce transportation costs and/or avoid trade barriers. On the other hand, the greater a firm's dependence on foreign markets is, the more likely the firm will reduce the uncertain nature of sales in foreign markets by replacing exports with FDI. Therefore, the greater a firm's export ratios are, the more likely the firm will invest abroad.

The eclectic FDI theory (Dunning, 1988) suggests that product innovation ability belongs to the asset advantage of a firm's ownership-specific advantages. Firms that are technological leaders in their industry have advantages in competing internationally. Fujita (1997) argues that innovative activities are unrelated to firm sizes, and

product innovation or replacement usually requires considerable R&D expenditures. Kohn (1997) indicates that most SMEs investing abroad rely on R&D-based technology, while large firms may rely on either advertising or R&D-based advantages. Kohn also finds that SMEs in the U.S. with investment abroad have greater R&D intensities than those SMEs only operating domestically. Therefore, we expect that R&D intensities will increase the likelihood of FDI.

Taiwan's FDI took off in 1986 and most FDI in recent years have been undertaken by export-oriented firms (Chen, 1992). These firms ventured abroad since the increases in both Taiwan's currency and the domestic wage rate undermined their international competitiveness (van Hoesel, 1996). The affected firms tried to utilize foreign resources to offset these impacts. The motivation for Taiwan's FDI was mainly motivated by employing cheaper labor after 1986 (Chen, 1992). Griffin and Pustay (1996) point out that reducing production costs is one of the factors influencing firms' decisions to undertake FDI. Urata and Kawai (2000) indicate that low-wage labor and a well-developed infrastructure are key factors in the recipient countries to attract FDI from Japanese SMEs. Hence, we expect that 'cheaper labor' and 'cheap land' are important motives for Taiwan SMEs who invest abroad.

One of the major strategies taken into consideration by a firm is whether the host country offers preferential tax arrangements and/or has great market potential (Urata and Kawai, 2000). Therefore, 'tax incentives' and 'market expansion' are also important motives to invest abroad.

This study utilizes two dummy variables to control heterogeneity among industries. The automotive industry is treated as the reference industry. The definition and sample mean of the variables used in the multi-logit model are presented in Table II.

The empirical results are presented in Table III. The goodness of fit (such as the *R*-squared measure for a regression equation) can be measured by the pseudo *R*-squared suggested by Maddala (1982).[9] It is 0.487 here, indicating a good fitting. Furthermore, the actual and predicted outcomes are shown in Table IV. The hit rate is 72.34%. Both measures suggest that the location choice model provides reliable empirical results.

The estimated coefficient of the technical efficiency is negative and significant in the choice of mainland China versus Taiwan, while the technical efficiency is insignificant to affect the choice between other countries and Taiwan. When we treat mainland China as the reference group, the estimated coefficients of the technical efficiency are all positive and significant.[10] These results suggest that those SMEs who have higher technical efficiencies are less likely to invest in mainland China. These findings are consistent with our theoretical predictions. Ever since the middle of the 1980s, the value of Taiwan's currency and its domestic wage rate have sky-

TABLE II
Variable definitions and sample means

Variables	Description	Sample mean
TEF	Technical efficiency levels	0.1125
SIZE[a]	Real total sales (NT$ billion)	0.4469
KL	Capital intensities, real fixed assets (NT$ billion) divided by the number of employees	0.0206
RD[a]	Real R&D expenditure (NT$ billion)	0.0168
EX	Export ratios (%): the value of exports divided by total sales.	27.6801
Labor	1 if 'cheaper labor' is a motive for FDI; 0, otherwise.	0.5248
Land	1 if 'cheaper land' is a motive for FDI; 0, otherwise.	0.3972
Market	1 if 'market expansion' is a motive for FDI; 0, otherwise.	0.5106
Tax	1 if 'tax incentives' are a motive for FDI; 0, otherwise.	0.2057
DM[b]	1 if firm *n* belongs to the machinery industry; 0, otherwise.	0.2766
DE[b]	1 if firm *n* belongs to the electronics industry; 0, otherwise.	0.1702

[a] We divide the nominal *SIZE* and *RD* terms by the GDP deflator (1991 = 1.00) to obtain the real terms.
[b] The automotive industry is treated as the reference industry.

TABLE III
Empirical results of the multi-logit model

Variables	Mainland China *vs*. Taiwan		Other countries *vs*. Taiwan	
	Coefficients	Standard error	Coefficients	Standard error
Constant	1.6093*	0.8978	–0.9867	1.0125
TEF	–13.6285**	6.6066	1.8017	6.3688
SIZE	5.1043***	1.7789	4.5509**	1.8529
KL	–85.1458****	24.8612	–48.2121**	23.2322
RD	–0.6297	24.7290	–56.0094	43.0713
EX	0.0217**	0.0092	0.0149	0.0107
Labor	2.0835***	0.7417	1.6881**	0.8564
Land	–0.5324	0.6929	–1.3388	0.8385
Market	1.0323*	0.5399	0.8972	0.6203
Tax	0.0762	0.7603	1.2172	0.7968
DM	–0.5818	0.7635	–1.5170	1.0527
DE	–2.9273***	0.7556	–1.5667**	0.7790
Pseudo *R*-squared		0.4870		
Observations		141		

1. The dependent variable is a category variable including three groups: the reference group consists of those Taiwan's SMEs who did not invest abroad; the second group includes observations that invested in mainland China; the last group contains those that invested in other countries.
2. The maximum likelihood method is used for the parameter estimation.
3. *: P-value ≤ 0.1; **: P-value ≤ 0.05; ***: P-value ≤ 0.01.

TABLE IV
Actual and predicted outcomes of the multi-logit model

Actual	Predicted			Total
	Taiwan	Mainland China	Other countries	
Taiwan	48	11	1	60
Mainland China	5	52	3	60
Other countries	9	8	4	21
Total	62	71	8	141
Hit rate	72.34%			

rocketed simultaneously, both undermining competitiveness of Taiwan's firms. The affected firms hope to eliminate their weaknesses by taking advantage of beneficial resources overseas. Furthermore, Taiwan and mainland China share a common cultural heritage and language. Both factors help reduce the learning cost and uncertainty for Taiwan's firms to invest in mainland China instead of other foreign markets. Therefore, for some firms that might not survive in other countries, mainland China provides a profitable chance for them. As a result, the lower a Taiwan SME's technical efficiency is, the stronger its motivation to invest in mainland China is.

The firm size has a strong positive correlation with SMEs' intention to invest abroad, which is consistent with previous research findings (Wolf, 1977; Lall, 1980; Grubaugh, 1987; Yu and Ito, 1988). In contrast to smaller SMEs, larger SMEs have more resources to globalize, and therefore are more likely to be interested in undertaking FDI. For a NT$1 billion change in real sales, the estimated log odds of choosing mainland China over Taiwan and choosing other countries

over Taiwan increase 5.1043 and 4.5509, respectively.

The estimated coefficients of capital intensity are negative and significant in both cases. This indicates that the higher the degree of labor intensities is, the more likely the firm is to undergo FDI. According to the factor endowment theory, the lower the degree of capital intensities is, the more harm a firm will suffer when wages rise, and the greater its likelihood to undergo FDI. Most SMEs in Taiwan are labor-intensive firms. Therefore, the rapid rise of wage rates since 1986 has had an especially great impact on these SMEs.

R&D expenditures are insignificant to influence firms' likelihood to invest abroad. This might reflect the fact that FDI originating from Taiwan focuses on the host country's comparative advantage rather than possessing some kinds of own-specific advantage. This is similar to the situation of Japanese SMEs' FDI in the 1970s (Kojima, 1978). The estimated coefficient of export ratios is significantly positive in the case of mainland China versus Taiwan. The log odds of investing in mainland China over Taiwan, on average, increase 0.0217 when export ratios increase one percent, while that of those investing in other countries over Taiwan is insignificantly different from zero. This is consistent with the previous finding that Taiwan's FDI took off in 1986 and most FDI in recent years have been undertaken by export-oriented firms (Chen, 1992). The more an SME depends on foreign markets, the more its intention is to take advantage of beneficial resources overseas.

The motive of 'cheaper labor' is significant to influence firms' location choices in both cases. SMEs that take into account this motivation have larger probability to invest internationally. The log odds ratios are 2.0835 and 1.6881 for investing in mainland China and other countries over Taiwan, respectively. This result reflects the fact that the increase in wage rates, which started from 1986, damaged the international competitiveness of most Taiwan's SMEs, which are labor-intensive. Kojima (1978) indicates that whenever domestic production conditions change (such as wage increases), possibly causing some firms to lose their international competitiveness, the affected firms seek out development overseas. By taking advantage of beneficial resources overseas, firms can hope to eliminate their weaknesses. Van Hoesel (1996) argued that the increase in the domestic wage rate is one of the major factors that have influenced Taiwan's FDI during the past decade. Chen (1992) also finds that Taiwan's FDI was mainly motivated by utilizing low-cost labor after 1986.

The estimated coefficients of the other three motives are insignificant except for 'market expansion' in the case of mainland China versus Taiwan, with a *P*-value of 0.0559. This may suggest that 'tax incentives' and/or 'cheaper land' are not significant factors in SMEs' FDI decisions. However, Taiwan's SMEs are indeed interested in mainland China's potential market. The corresponding log odds of choosing mainland China over Taiwan are 1.0323.

The estimated coefficients of the machinery industry, *DM*, are insignificant in both cases. This suggests that the log odds ratio of investment in foreign countries over Taiwan does not express significant differences between the machinery and automotive industries. However, the estimated coefficients of the electronics industry, *DE*, are statistically negative and significant at 0.01 levels of significance in both cases. In other words, the electronics industry compared to the automotive industry is less likely to invest internationally. This may reflect that Taiwan has a comparative advantage in the electronics industry, which has accounted for the largest share of Taiwan's GDP and export value in the past decade. SMEs in Taiwan's electronics industry hence have higher technical efficiencies to produce in Taiwan than in foreign countries.

The estimated coefficients of 'cheaper labor' suggest that it is a significant motivation for Taiwan's SMEs to invest internationally. This result supports Proposition 2. This may be because an increase in the wage rate hampers the international competitiveness of Taiwan's labor-intensive SMEs. These affected SMEs then wish to eliminate their weaknesses by employing foreign low-cost labor. Compared to mainland China, Taiwan in general provides higher expected technical efficiencies for these SMEs, because of local familiarity, better infrastructure, and so on. Nevertheless, the motive of employing cheaper labor significantly increases the log odds of investing in mainland China over Taiwan, since

these SMEs need low wage rates to alleviate their production inefficiency. This finding supports Proposition 5.

Empirical results also indicate that Taiwan's SMEs with lower technical efficiencies are more likely to invest in mainland China rather than in other countries. One possible reason is that mainland China shares similar cultural and linguistic environments with Taiwan, making learning and uncertainty costs decrease. Compared to other countries, mainland China thus can give Taiwan's SMEs higher expected technical efficiencies. SMEs with lower technical efficiencies employ cheaper foreign labor in order to improve their competitiveness. Among places outside Taiwan, mainland China is more attractive to these SMEs, because of higher expected technical efficiencies. This finding verifies Proposition 1.

'Cheaper land' is not a significant motive for SMEs' location choice. This does not contradict Proposition 3 since the setup cost for an SME to move around is much lower than a large-sized firm. SMEs do not need much capital and find it easier to set up in a new location. Setup costs compared with labor costs are relatively unimportant. Hence, it is reasonable for the setup cost to become an insignificant factor in SMEs' location choice.

4. Concluding remarks

In this study we establish a theoretical model to explain the relationship between the technical efficiencies and production location choice. The regional technical efficiency level, as well as the regional wage rate and setup cost, are crucial in determining the firm's profit. A higher regional technical efficiency attracts FDI and offsets the adverse effects of a high wage rate and setup cost. A firm from a low wage country can still go to a high wage country for higher technical efficiency.

This study applies the multi-logit model to test the relationship between the technical efficiency and FDI location choice of Taiwan's SMEs during the period from 1989 to 1996. Observations are classified into three exclusive and exhaustive groups: Taiwanese SMEs who did not invest abroad, those who invested in mainland China, and those who invested in other countries. The SMEs with higher technical efficiencies are less likely to invest in mainland China rather than in other countries, which is consistent with proposition 1. One reason may be that Taiwan and mainland China have a common culture and language. Both can reduce the learning cost and uncertainty. SMEs with lower technical efficiencies tend to improve their competitiveness by employing cheaper foreign labor. Outside of Taiwan, mainland China is a more attractive place for Taiwan's SMEs, because of higher expected technical efficiencies.

The motive of 'cheaper labor' is significant to induce Taiwan's SMEs to invest internationally. This may reflect the fact that the increase in wage rates damaged the international competitiveness of Taiwan's SMEs, because they tend to be labor-intensive. The affected firms hope to eliminate their weaknesses by utilizing low-cost foreign labor. The result supports proposition 2. Compared to mainland China, Taiwan provides higher expected technical efficiencies for these SMEs, because of local familiarity, better infrastructure, etc. The motive for employing cheaper labor significantly increases the likelihood of investing in mainland China, since these SMEs need low wage rates to alleviate their production inefficiency. This finding supports Proposition 5. The motive of "cheap land" is not significant to influence firms' location choices, which is not supported by proposition 3. In other words, setup cost does not affect the location choices of Taiwan's SMEs. One possible reason might be that a plant built by SMEs does not cost much due to the resource constraint. Hence, setup costs compared with labor costs are relatively unimportant.

There are still many extensions for this study. We can apply this framework to analyze the FDI of large firms. Second, we can apply this framework to see FDI undertaken by other countries. Third, more local institutional factors can be added to see how the regional efficiency level is determined. Fourth, a more general form of the stochastic frontier production function can be used for estimation.

Acknowledgements

We are grateful to two anonymous referees and one co-editor for their insightful suggestions, leading to substantial improvements of this paper. The authors are also indebted to Tain-Jy Chen,

Jung-Chao Liu, and Homin Chen for helpful comments on an earlier version. A financial support from Taiwan National Science Council is gratefully acknowledged (NSC 88-2415-H-260-004). The usual disclaimer applies.

Notes

[1] For details, please refer to the ROC Council for Economic Planning and Development (1996), *Taiwan Statistical Data Book*.

[2] The political slogan of the slowdown policy is 'Jieh-Jyi-Yong-Reen' in Chinese, which means, 'Abstain from the Hurry. Use the Endurance!' This is a phrase minted by President Teng-Hui Lee in Taiwan.

[3] For details, see the ROC Ministry of Economic Affairs (1997), *White Paper on Small- and Medium-sized Enterprises*.

[4] The spot exchange rate was US$1 = NT$32.51 on June 11, 1999. The definition for SMEs in this paper follows the official definition in Taiwan.

[5] Many related researchers also use sales and fixed assets to proxy output and capital, respectively, for instance, Battese and Coelli (1992, 1995), Lundvall and Battese (2000), Jones et al. (1998), and Kim et al. (1999).

[6] We divide firms' sales and fixed assets by a GDP deflator (1991 = 1.00).

[7] We apply the likelihood ratio test to test H_0: $\alpha_1 + \alpha_2 = 1$. The value of the likelihood ratio test is 109.54, which is far away from the critical value 7.8794 (= $\chi^2_{(1),\,0.005}$). Therefore, we conclude that the production function is decreasing returns to scale (and the estimated value of $\alpha_1 + \alpha_2$ is 0.98).

[8] Some firms may provide more than one observation if they invested abroad more than once during the period from 1989 to 1996. There are 60 observations in the first group, 60 observations in the second group, and 21 observations in the last group. We cannot analyze more than three categories since the category of other countries only consists of 21 observations.

[9] The pseudo R-squared is defined as $(1 - L_\omega/L_\Omega)^{2/n}/(1 - L_\Omega)^{2/n}$ where n is the sample size, and both L_ω and L_Ω are the maximum of the likelihood function when maximized with respect to only a constant and all parameters, respectively (Maddala, 1982, p 40).

[10] The P-values of Taiwan versus mainland China and other countries versus mainland China are 0.039 and 0.030, respectively.

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