Firm Heterogeneity and Export Participation:

A New Asian Tiger Perspective

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Abstract

This paper investigates the relationship between firm heterogeneity and a firm's decision to export, using the annual survey of Thai manufacturing firms from 2001 to 2004. We find that entry sunk costs and firm characteristics are important factors in explaining a firm's decision to participate in the export market. Another important determinant is the ownership structure of the firm, with foreign owned firms having a higher probability of exporting than domestically owned firms. Using three measures of total factor productivity, we also find that highly productive firms self-select into the export market. Other firm characteristics such as size and average wage also matter.

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Key words: FDI, exports, firm heterogeneity, development.

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1. Introduction

As the world economy becomes more closely integrated as a result of the pervasive forces of globalisation, there is continued interest from both academics and policymakers in the growth strategies of developing and newly industrialised countries (NICs). Development through exporting has been a recognised method by which small open economies, and especially the so-called Asian Tigers, have managed to grow rapidly. Edward (1993 and 1998) discusses the positive relationship between exports and growth; the more open a country, the faster its productivity growth.

Although exports are generally perceived to be beneficial to the exporting country, it is well recognised that not all firms export and the decision to enter the export market is determined by a range of different factors. To date, the majority of studies have examined the export decision of firms from developed countries (Bernard and Jenson 1999, 2004, Girma *et al*. 2004, Greenaway and Kneller 2004, Greenaway *et al*. 2005, Greenaway *et al*. 2007 and Kimura and Kiyota 2006) with only a few studies looking at the developing country experience (Roberts and Tybout 1997, Clerides *et al*. 1998, Van Biesebroeck 2005 and Alvarez and Lopez 2005).

To the best of our knowledge there have been little or no studies of the export decision of firms from one of the new Asian Tigers (Malaysia, Thailand, the Philippines, and Indonesia).[1] This is rather surprising given the nature of the export driven and foreign direct investment (FDI) competing development strategy of this region. Such strategies led to rapid growth rates as a result of successful export performances, with multinationals from the developed world, Japan in particular, using these countries as an export platform to sell their products. Moreover, the manufacturing sectors of the majority of NICs still constitute a large proportion of national output in contrast to countries such as the UK and US where the manufacturing sector now accounts for less that 20% of GDP.

In this paper we employ a detailed firm level dataset for Thailand between 2001 and 2004 to investigate the determinants of Thai firms' decision to participate in the export market. We

[1] Traditionally, the Asian tigers were thought to consist of the countries of South Korea, Hong-Kong, Singapore and Taiwan. Together, the "new" and "old" Asian tigers are characterised by export-driven economic development and industrial policies aimed at encouraging inward foreign direct investment.

show that a firm's decision to export is determined by the level of sunk entry costs, productivity, wages, and firm size. Our results are broadly consistent with those of developed countries and other developing countries although, as we might have expected given the nature of Thailand's economy, past export performance, foreign ownership and product quality generally have stronger effects for Thailand than the US, UK and other developing countries.

The remainder of this paper is organised as follows: In Section 2, we provide an overview of Thailand's export performance and the importance of manufacturing exports to the Thai economy. In Section 3 we review of theoretical and empirical literature. Section 4 describes our econometric specification and discusses our estimation techniques. Our results are presented in Section 5 while Section 6 concludes.

2. Thailand's Export Performance

Thailand has been the third largest exporter from the Southeast Asian region throughout the last 10 years (ASEAN Statistical Yearbook, 2005). As a member of ASEAN, Thailand shares in the benefits of the ASEAN Free Trade Area, established in 1992, which aims to eliminate tariff and non-tariff barriers in both manufacturing and agricultural sectors among member countries.[2] Consequently, the ASEAN region remains a major export market for Thailand. From Table 1 observe that the share of Thai exports to ASEAN in 2006 is about 20.8 percent of total exports with 15 percent and 13 percent being exported to the US and EU15 respectively.

When we consider exports by country we see that the main export destinations are concentrated in East and Southeast Asia. According to Table 2, the US, Japan, China, Singapore and Hong Kong are the top-five export destinations in both 2003 and 2006, receiving an average of 52 percent of total Thai exports.

[2] Attempts at organised regional co-operation between South-East Asian countries dates back to August 1967 when the ASEAN was established with original members Indonesia, Malaysia, the Philippines, Singapore and Thailand. Expansions to the membership of ASEAN were Brunei in 1984, Vietnam in 1995, Myanmar and Laos in 1997 and Cambodia in 1999.

Since 1999, the total export value of trade has increased dramatically reaching US$ 129,744.1 millions in 2006. From Figure 1, the top two lines show that the trend of total exports closely follows the increases in the export of manufacturing products with the Manufacturing sector being the most significant export sector for Thailand. Figure 2 confirms the importance of the manufacturing sector; the share of total exports from the manufacturing sector was 78 percent in 2006 whilst the share of agriculture products and mining and fuel products were 10 percent and 5 percent, respectively.

Table 3 shows which industries Thai exporters are most prominent in - mainly high-technology products such as computers, parts, and accessories, automobiles and parts, integrated circuits and so on. The production of computers and their parts has been Thailand's leading industrial export for many years. The export value in 1999 was US$ 8,121.6 millions that had nearly doubled to US$ 14,876.30 millions by 2006. In 2006 computers and parts accounts for 11.47 percent of the country's total exports.

The second leading export industry is the automotive industry. Numerous foreign automotive manufacturers from Japan, the US and Europe are based in Thailand and use Thailand as an export platform to sell their products to the rest of the world. Table 3 also shows the significant expansion in the export of automobiles and parts with a growth rate of 40.94 percent in 2005.

Other products that are included in Thailand's top-ten exports include labour-intensive products such as gems, jewellery, and garments. The expansion of the gem and jewellery market is mainly from fine jewelleries and articles of jewellery made from gold alloy with an export growth in 2006 of about 13 percent. After 2004, the growth of exports from the textile industry fell as a result of the elimination of the quota restriction in early 2005 and increased competition in the garment sector from China, Vietnam and India (Bank of Thailand, 2006).

Given the importance of the export sector for the Thai economy and the continued export driven development polices it is important to have a good understanding of the factors that influence a firm's decision to participate in the export market. More specifically, it is important to investigate whether there are any significant differences in the behaviour and determinants of the decision to export of Thai firms compared to the experience of firms from more and less developed countries.

Table 1: Major Export Markets

Export Markets	Value : US$ million							
	1999	2000	2001	2002	2003	2004	2005	2006 (Jan-Dec)*
ASEAN	10,871.60	13,482.20	12,599.10	13,568.90	16,486.00	21,241.00	24,397.70	27,040.00
EU-15	9,828.70	11,001.30	10,551.90	10,214.60	11,747.70	13,815.80	14,294.30	16,873.80
Japan	8,261.30	10,232.40	9,945.40	9,950.00	11,356.20	13,498.50	15,096.80	16,430.60
USA	12,654.30	14,870.10	13,199.60	13,509.40	13,596.20	15,508.50	16,996.80	19,454.00
Others	41,615.90	49,586.00	46,296.00	47,242.90	53,186.10	64,063.80	70,785.60	79,798.40
World	58,463.40	69,624.20	65,183.20	68,156.30	80,040.00	96,531.00	110,953.30	129,744.10

Note: * Preliminary Figures.

Source: Department of Trade Negotiations, Ministry of Commerce

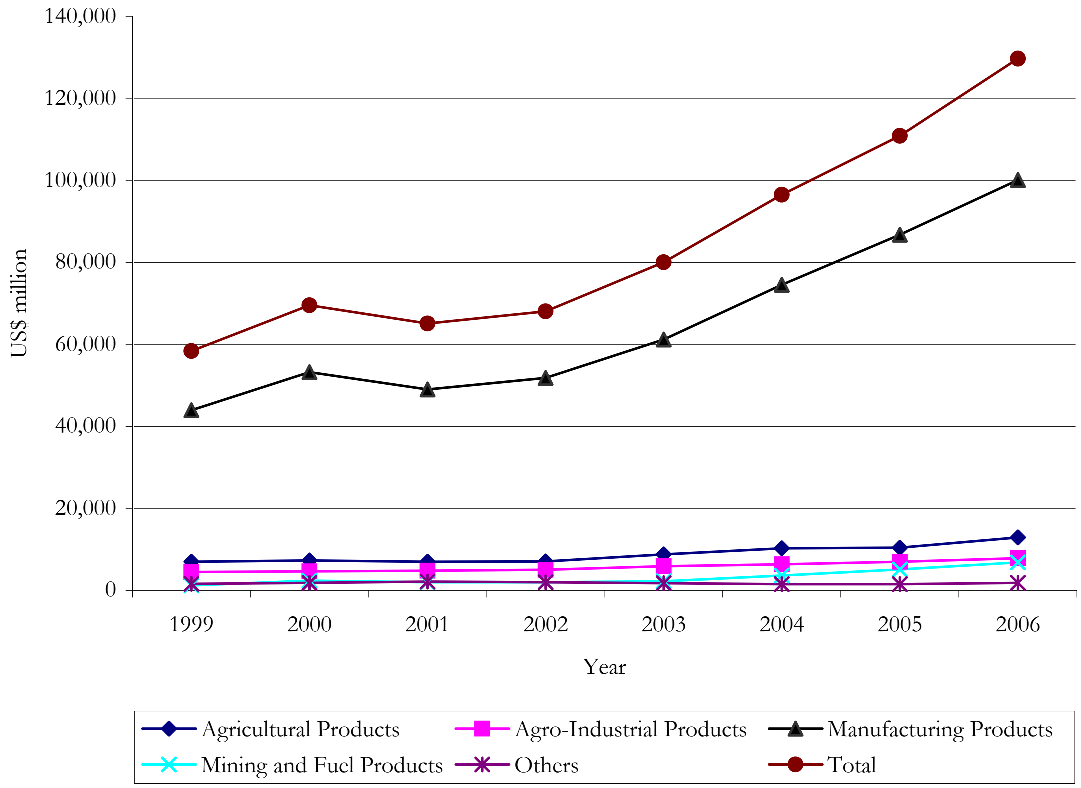
Table 2: Fifteen Major Export Destinations by Countries during 1999-2006.

Rank		Country	Value : US$ million							
2006	2003		1999	2000	2001	2002	2003	2004	2005	2006 (Jan-Dec)*
1	1	USA	12,654.30	14,870.10	13,199.60	13,509.40	13,596.20	15,508.50	16,996.80	19,454.00
2	2	Japan	8,261.30	10,232.40	9,945.40	9,950.00	11,356.20	13,498.50	15,096.80	16,430.60
3	4	China	1,860.90	2,836.50	2,873.40	3,555.00	5,688.90	7,115.10	9,167.60	11,708.90
4	3	Singapore	5,073.10	6,066.00	5,261.40	5,552.70	5,850.20	7,027.30	7,690.90	8,358.90
5	5	Hong Kong	2,981.30	3,517.90	3,306.80	3,687.90	4,315.20	4,940.40	6,165.60	7,166.90
6	6	Malaysia	2,124.20	2,832.10	2,733.40	2,835.30	3,872.00	5,312.80	5,822.00	6,616.40
7	11	Australia	1,316.30	1,636.10	1,361.70	1,641.70	2,160.00	2,468.10	3,174.60	4,351.50
8	8	UK	2,089.70	2,385.00	2,336.80	2,393.10	2,577.50	3,031.10	2,804.60	3,402.50
9	7	Taiwan	2,043.60	2,429.00	1,925.30	1,969.40	2,581.50	2,608.40	2,721.90	3,367.10
10	10	Indonesia	968.40	1,354.50	1,369.80	1,680.20	2,265.70	3,216.20	3,982.90	3,311.40
11	9	Netherlands	2,198.60	2,271.00	2,037.10	1,891.70	2,364.80	2,597.30	2,774.50	3,238.00
12	15	Vietnam	572.80	847.40	801.20	948.00	1,262.10	1,877.10	2,363.70	3,075.80
13	14	South Korea	909.60	1,277.50	1,234.00	1,398.20	1,583.00	1,859.10	2,258.60	2,643.80
14	13	Philippines	929.20	1,095.40	1,157.70	1,275.10	1,616.30	1,835.30	2,062.50	2,580.30
15	12	Germany	1,459.60	1,658.90	1,574.30	1,534.80	1,793.10	1,803.90	2,007.70	2,325.30
		Total Top 15	45,442.90	55,309.80	51,117.90	53,822.50	62,882.50	74,699.10	85,090.80	98,031.40
		Total Others	13,020.50	14,314.40	14,065.30	14,333.80	17,157.50	21,831.90	25,862.50	31,712.70
		Total	58,463.40	69,624.20	65,183.20	68,156.30	80,040.00	96,531.00	110,953.30	129,744.10

Note: * Preliminary Figures.

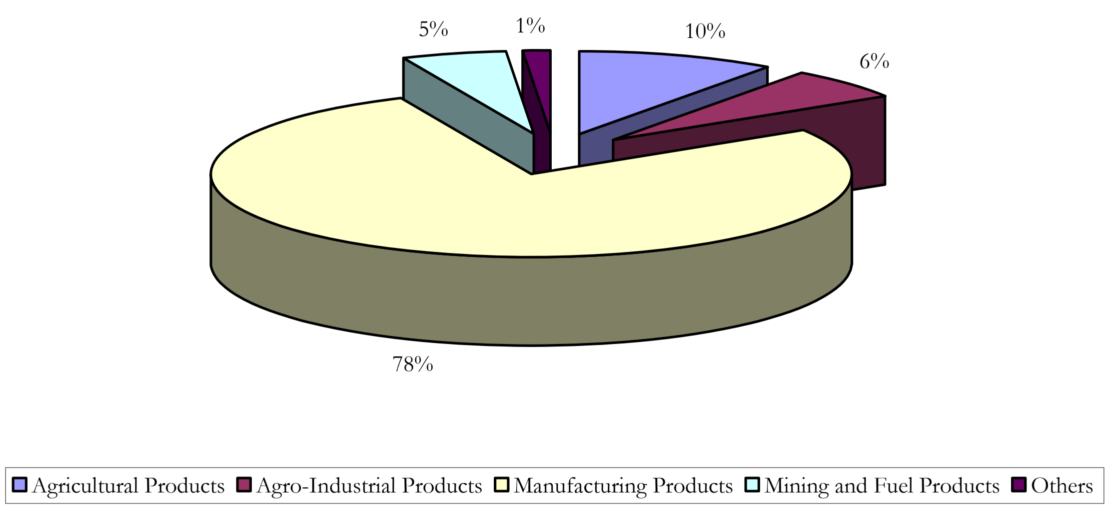
Source: Department of Trade Negotiations, Ministry of Commerce

Figure 1: Export Structure of Thailand during 1999-2006



Source: Department of Trade Negotiations, Ministry of Commerce

Figure 2: Share of Thailand Exporting Products in 2006



Source: Department of Trade Negotiations, Ministry of Commerce

Table 3: Fifteen Major Export Commodities in Thai Manufacturing Sector during 1999-2006.

Rank		Product	Value : US$ million							
2006	2003		1999	2000	2001	2002	2003	2004	2005	2006 (Jan-Dec)*
1	1	Computer machinery, parts and accessories	8,121.60	8,739.50	7,947.50	7,430.30	8,189.60	9,185.70	11,848.00	14,876.30
2	3	Automobile, parts and accessories	1,902.30	2,419.40	2,655.00	2,919.70	3,965.50	5,495.60	7,745.50	9,540.80
3	2	Integrated circuits	2,944.60	4,484.00	3,512.20	3,308.00	4,624.60	4,902.80	5,950.60	7,028.70
4	7	Plastic pellets	1,215.30	1,865.60	1,615.00	1,775.20	2,148.40	3,105.20	4,198.50	4,500.70
5	5	Gems and Jewellery	1,766.30	1,741.80	1,837.20	2,169.30	2,514.50	2,645.60	3,232.70	3,644.30
6	8	Iron and steel products	954.30	1,399.20	1,091.40	1,249.70	1,687.20	2,478.10	2,898.00	3,527.10
7	6	Radio, television and parts	1,346.50	1,964.90	1,692.80	2,094.60	2,501.80	3,225.10	3,141.80	3,462.50
8	9	Chemicals	908.00	1,248.10	1,015.10	1,193.00	1,581.40	2,059.20	2,646.80	3,443.20
9	4	Garments	2,915.60	3,132.70	2,914.40	2,721.50	2,760.20	3,092.60	3,150.60	3,204.70
10	10	Rubber products	875.00	1,060.40	1,095.10	1,260.30	1,556.40	1,944.60	2,351.20	3,090.00
11	15	Electrical appliances	545.10	901.10	873.60	957.90	1,080.00	1,935.40	2,301.80	2,746.00
12	13	Machinery and components	613.90	801.40	861.00	930.30	1,245.10	1,672.00	2,113.90	2,659.10
13	11	Air Conditioning machine and parts	895.50	1,079.60	1,160.50	1,108.30	1,430.30	1,997.80	2,201.40	2,289.30
14	14	Plastic products	758.10	894.20	860.30	954.40	1,236.20	1,410.90	1,774.70	1,886.50
15	29	Reciprocating internal combustion engine and components	187.70	327.40	287.00	346.00	547.80	1,245.40	1,380.00	1,569.10
		Total Top 15	25,949.80	32,059.30	29,418.10	30,418.50	37,068.90	46,395.80	56,935.60	67,468.20
		Total Others	32,513.60	37,564.90	35,765.10	37,737.80	42,971.10	50,135.20	54,017.80	62,275.90
		Total	58,463.40	69,624.20	65,183.20	68,156.30	80,040.00	96,531.00	110,953.30	129,744.10

Note: * Preliminary Figures.

Source: Department of Trade Negotiations, Ministry of Commerce

3. Literature Review

3.1 Entry Sunk Costs and the Decision to Export

The costs to a firm of becoming and remaining an exporter are composed of two components, sunk costs and fixed costs. The former refer to the costs that arise before a firm enters the export market; the latter occur as long as a firm remains in the export market, i.e. transport and service costs, marketing costs, and so on.

More specifically, sunk costs are defined as an initial large and one-off investment faced by a firm in order to enter the export market. Such a cost can be considered as a combination between R&D spending to improve product quality in order, for example, to conform to standards and safety regulations of a target country, and the setting up of business and marketing connections in foreign countries. Baldwin (1988) describes sunk costs as the costs of establishing a distribution and service network, and the costs of launching product or brand advertising.

Each individual firm faces a different sunk entry cost which will depend upon firm specific characteristics including geographical location. For new firms entering into an export market, a firm has to make an initial investment, known as a sunk entry cost, and an ongoing costs for as long as they remain in the export market. However, when a firm who has previously exited a market wants to re-enter it will still face a sunk cost which will vary depending on how long it has been absent from the market. In this paper, we follow the theoretical explanation of the entry and exit with the sunk cost as described by Robert and Tybout (1997).

For a given firm, the export status of firm i is given by Y_{it} where Y_{it} equals 1 if firm i exports at time t, and 0 otherwise. The export experience of firm i through period t is given by $Y_{i(t-j)} \mid j \geq 0$. In the current period, a firm chooses the infinite sequence of values of $Y_{i(t+j)} \mid j \geq 0$ that maximises the expected present value of revenue. The function of the maximised revenue can be written as:

$$V_{it}(\Omega_{it}) = \max_{Y_{i(t+j)} \mid j \geq 0} E_t\left(\sum_{j=t}^{\infty} \delta^{j-t} R_{ij} \mid \Omega_{it}\right) \qquad (1)$$

Where $j = t$, $R_{ij} = R_{it}$, and thus R_{it} is the current revenue of firm i . Ω_{it} is the current specific information set of firm i . E_t represents the expected value in the current period which is conditional on the firm specific information set of firm i available in period t and δ is the discount rate. By applying Bellman's equation with the export decision, the current export status of firm i written as Y_{it} satisfies:

$$V_{it}(\Omega_{it}) = \max_{Y_{it}}(R_{it}(Y_{i(t-j)|j\geq 0}) + \delta E_t \left(V_{i(t+1)}(\Omega_{i(t+1)}) \mid Y_{i(t-j)|j\geq 0}\right) \qquad (2)$$

From the maximisation of the revenue equation (2), we can define the current profit function $(\hat{\pi}_{it})$ as current revenue plus the difference in the expected value of the maximised revenue of firm i, conditional on the firm's export status. Thus, $\hat{\pi}_{it}$ can be written as:

$$\hat{\pi}_{it} \equiv R_{it} + \delta\left[[E_t(V_{i(t+1)}(\Omega_{i(t+1)}) \mid Y_{it} = 1] - \delta[E_t(V_{i(t+1)}(\Omega_{i(t+1)}) \mid Y_{it} = 0]\right] \qquad (3)$$

where $\Omega_{i(t+1)}$ is the information set of firm i in period $t+1$.

Each period, firm i has to decide whether to export or not. Firm i exports at period t if the expected gross profit and revenue of firm i at time t $(\hat{\pi}_{it})$ exceeds the current period cost (c_{it}) including the sunk entry cost (S_i). Otherwise, firm i chooses not to export. The export decision by firm i is therefore represented as:

$$Y_{it} = \begin{cases} 1 \text{ if } \hat{\pi}_{it} > c_{it} + S_i * (1 - Y_{i(t-1)}) \\ 0 \text{ otherwise} \end{cases} \qquad (4)$$

Sunk entry costs (S_i) are varied across firms, so previous experience including the characteristics of each particular firm affect a firms' decision to export.

Since the main aim of this paper is to examine the factors that influence the export decision of a firm, firm characteristics are included in the empirical model in order to identify the probability of exporting. We therefore specify the export decision model as:

$$Y_{it} = \begin{cases} 1 \text{ if } \beta Z_{it} - S_i * (1 - Y_{i(t-1)}) + \varepsilon_{it} \\ 0 \text{ otherwise} \end{cases} \quad (5)$$

where Z_{it} represents a vector of firm specific characteristics. Details on the variables we include in vector Z are discussed in the next section.

3.2 Empirical Analysis on Firm Heterogeneity, Sunk Entry Costs and the Decision to Export

A number of studies have examined the factors that affect a firm's decision to export. The increased availability of firm level data has led to a number of empirical studies that examine a country's exports from a firm level perspective. To date, such studies have tended to concentrate on developed countries although there are a limited number that have examined developing country firms. The lack of developing country studies is a result of limited data availability.

The primary question that these studies have attempted to answer is whether good firms become exporters or whether exporters become good firms. López (2005), and Greenaway and Kneller (2005) provide detailed surveys of the firm heterogeneity and international market participation literature. We begin with a brief review of the developed country literature.

Developed Countries

In the US, Bernard and Jensen (1999) investigate the factors that effect a firm's export decision using plant level characteristics and lagged endogenous variables as independent regressors. All plant characteristics such as firm size, productivity, wage etc. are lagged by one year in order to alleviate any simultaneity problems. A linear probability model in the first differences is then estimated. Bernard and Jensen (1999) find evidence to confirm that good firms become exporters. The statistical significance of entry sunk costs indicates that firms who have had previous export experience (either one or two years ago) seem to renter and remain exporters in the following year. Firm size, wage, productivity and product change by plant, all significantly increase the probability of exporting. Bernard and Jensen (2004) extend their 1999 model by including additional explanatory variables; foreign ownership, spillovers and subsidies, and apply alternative estimation techniques: linear probability model without plant effects, linear probability model with fixed effects and GMM in first differences. Sunk entry costs are generally positive and significant. The results from the spillover variables are negligible. Equally, expenditure on state level export promotion appears to have no effect on the probability of exporting. For the plant characteristics, the size of the firm is a significant indicator and is consistent across all three estimation techniques.

For the UK, Greenaway and Kneller (2004) find a positive and significant effect for lagged exports confirming the importance of sunk costs where past export experience increases the probability of a firm exporting. Firm size and wage are also positive and significant determinants. They also find that more productive firms are more likely to enter the export market. One additional result of interest is that both industrial and geographical agglomerations are determinants of the entry into export markets.

In a more recent paper Greenaway *et al.* (2007) look at a firm's export decision but instead of using lagged export status they instead use firm-level financial indicators to explain the significance of the sunk entry cost. The hypothesis is that the stronger the financial health of the firm, the more likely a firm is to enter the export market. Consistent with the results of other studies, they also find that small and domestic firms are less likely to export rather than large and foreign firms. However, inconsistent with other UK studies, total factor productivity (TFP) is insignificant and the sign on wage is negative.

In a further study for the UK, Kneller and Pisu (2004) examine the relationship between exports and FDI linked to the export behaviour of foreign firms. The results show that foreign firms appear to export more than domestic firms. Other results reveal a positive relationship between firm size, the proportion of the workforce that is skilled and productivity on the decision to export. One interesting result is that the origin of ownership of the firm is examined. The significance of several country groupings is consistent with the export-platform FDI hypothesis with firms, for example from the US, Canada and other countries, being more likely to export rather than those from Australia.

To test more accurately the self-selection and learning-by-exporting hypotheses, Girma *et al.* (2004) and Greenaway *et al.* (2005) use matching techniques to examine the export performance of UK and Sweden, respectively[3]. The predicted current probability of

[3] A single index identifying the probability of entry that captures all information about the characteristics of the firm pre-entry is based on the use of matching techniques.

exporting is determined by size, age and productivity. Young firms are also more likely to become exporters. In the case of the UK, the results show that more productive firms export, and once firms enter the market their productivity tends to be further increased. However, the results for Sweden differ from the UK. In the Swedish case there is no evidence of differences in productivity between exporters and non-exporters affecting pre- or post-export market entry.

In a study of Japan, Kimura and Kiyota (2006) investigate the dynamic indicators of exports and FDI in Japan from 1994 to 2000 using a random effects probit model. In this paper the significance of the firm characteristic variables in the decision to engage in the export market model indicates that good firms become exporters but also that productive firms are more likely to enter the export market. Furthermore, sunk entry costs, firm size, age and foreign ownership increase the probability of exporting.

Developing countries

In an early study, Robert and Tybout (1997) investigate the factors that affect the export decision of Colombian firms using firm level data from 1981 to 1989. They build a dynamic discrete-choice model as a theoretical explanation of a firm's behaviour in entering and exiting export markets where firms are prone to enter an export market if current net operating profit exceeds sunk costs. In determining the export decision, sunk costs and a vector of firm specific characteristics are included in the dynamic model. The empirical analysis confirms the existence of sunk entry costs. It indicates that firms who incur sunk cost in the previous period are expected to export in the current period. Importantly, unobserved plant heterogeneity is used to determine the probability of exporting.

Clerides *et al* (1998) study the export participation and the importance of learning-by-exporting in three countries: Colombia, Mexico, and Morocco. They investigate the link between export participation and marginal cost; whether marginal cost affects the export decision of the firm and whether the export experience has an affect on cost reductions for the firm. To determine export participation, not only the marginal cost but also exchange rate, plant characteristics and lagged endogenous variables are included in the model. Capital stock is also significant for all industries and all countries except for Mexico. The results can be interpreted as saying that plants with low marginal costs and a large capital stock are more likely to export. Moreover, past export experience also appears to determine current export participation. The exchange rate variable is significant for Colombia except for the chemical industry. There is also some evidence of geographic spillovers for Colombian plants.

There are two studies that examine Chilean manufacturing plants from 1990 to 1996, López (2004) and Alvarez and López (2005) who investigate whether firms self-select into export markets or whether firms learn by exporting. The positive and significant total factor productivity variable indicates that firms learn to export and suggests that firms invest in technology in order to be able to produce high quality export goods which lead to productivity upgrading in the pre-entry period. As productivity improves, firms are then able to enter the export market. In addition, Alvarez and López (2005) find some evidence of learning-by-exporting by which productivity increases after the firm becomes an exporter.

Finally, Van Biesebroeck (2005) focuses on nine sub-Saharan African countries in order to observe the export performance of firms from low-income countries. [4] The analysis reveals significant evidence to support both the self-selection and learning-by-exporting hypotheses. For self-selection, high productivity firms are more likely to become exporters. The significance of sunk entry costs is another important indicator of the decision to participate in the export market. Furthermore, after firms became exporters, their productivity improvements tend to increase which is further support for the learning-by-exporting hypothesis.

In summary, there is existing evidence to suggest that both good firms become exporters and those exporters become good firms. In this paper, we focus on the question of whether good firms become exporters and what determines whether a firm will self-select into the export market? The theoretical and empirical literature suggests that sunk entry costs and firm specific characteristics are important determinants of a firm's decision to export.

[4] The sub-Saharan countries include Burundi, Cameroon, Cote d'Ivoire, Ethiopia, Ghana, Kenya, Tanzania, Zambia, and Zimbabwe.

4. Model Specification and Data

4.1 Model

In this section we identify those factors that are believed to affect a firm's export decision building on best practice from the existing theoretical and empirical literature for both developed and developing countries. Differences in firms' characteristics determine the individual performance and the capacity of a firm to export. In addition, sunk entry costs are included to investigate the link between sunk costs and exporting. The model we test specifies the relationship between the export decision and various factors given by:

$$EX = f(Z) \tag{6}$$

All independent variables are lagged by one year to control for potential endogeneity problems whereby previous characteristics of the firm determine the export decision in the current period. We include the lagged dependent variable to capture the effect of sunk entry costs:

$$EX_{it} = \alpha + \delta EX_{i(t-1)} + \beta_X \ln(Z_{i(t-1)}) + \varepsilon_{it} \tag{7}$$

where EX is the export decision of the firm.

Z is a vector of firm characteristics.

ε is the error term

Our vector of firm characteristics is based on the previous literature. Our final specification is therefore:

$$\begin{aligned} EX_{it} = {} & \beta_0 + \beta_1 EX_{i(t-1)} + \beta_2 FOREIGN_{i(t-1)} + \beta_3 TFP_{i(t-1)} + \beta_4 SMALL_{i(t-1)} \\ & + \beta_5 LARGE_{i(t-1)} + \beta_6 VLARGE_{i(t-1)} + \beta_7 wage_{i(t-1)} + \beta_8 SKILL_{i(t-1)} \\ & + \beta_9 TRAIN_{i(t-1)} + \beta_{10} RDPRODUCT_{i(t-1)} + \beta_{11} RDPROCESS_{i(t-1)} + \varepsilon_{it} \end{aligned} \tag{8}$$

where EX is the export dummy of firm i.

$FOREIGN$ is a dummy to indicate the structure of foreign ownership where a dummy equals 1 if the firm is at least 10% are foreign owned.

TFP is total factor productivity of the firm.

$SMALL$ is a dummy variable to represent a small firm.

$LARGE$ is a dummy variable to indicate whether the firm is large.

$VLARGE$ is a dummy variable to represent a very large firm.

$wage$ is measured from the log of wages per employee.

$SKILL$ is the ratio of skilled labour to total labour.

$TRAIN$ represents the training dummy.

$RDPRODUCT$ is a dummy variable to indicate whether firm engages in product development R&D.

$RDPROCESS$ is a dummy variable to indicate whether firm engages in product process R&D.

4.2 Variables

The dependent variable is the export dummy (EX_{it}) where export dummy equals 1 if there is positive export with in the firm, and 0 otherwise. Our independent variables are as follows:

Sunk entry cost $(EX_{i(t-1)})$ is the lagged dependent variable and represents a barrier to a firm entering the export market. Some firms do not export as their profit fails to cover the sunk cost. The lagged dependent variable can also be used to capture the previous export experience of a firm. Firms that have learned from their past experiences and exported in the previous year tend to also export in the current year. We expect a positive relationship between sunk entry cost and the decision to export.

Foreign ownership $(FOREIGN_{i(t-1)})$ captures the structure of a firm's ownership. A firm is defined as foreign if at least 10% of its shares are foreign owned. In this case, we generate a dummy equal to 1 if a firm is foreign owned and 0 otherwise. In our sensitivity analysis we define our foreign ownership dummy at 25% and 50% levels. Foreign firm investment can be for numerous reasons, low cost production, export-platform FDI, market seeking etc. On the whole, it is assumed that foreign owned firms have a higher proportion of skilled labour and have more advanced technologies than domestic firms. As a result we expect foreign ownership to have a positive affect on the export decision.

In this paper we measure total factor productivity $(TFP_{i(t-1)})$ using three different methods. The first technique employs the semi-parametric approach of Levinsohn and Peterin (2003) by taking unobserved firm-specific productivity shocks in to account where the unobserved shock is measured by the use of intermediate inputs. The estimation procedure is provided in Appendix III. The second method is the estimation of a semi-parametric and nonlinear least square regression of Buettner (2003) which also considers endogenous R&D (see Appendix IV). Finally, we measure productivity using a simple labour productivity measure which is calculated from the log of value added over total labour. TFP is an indicator of plant success and is based on the argument that good firms become exporters (Bernard and Jensen, 2004). Assuming firms with high TFP export, we expect a positive relationship between the two variables.

Firm size is another important determinant of exporting as it is an indication of a firm's capacity to export. Large firms tend to have higher productivity and are therefore more likely to engage in export activity. In this paper we categorise firm size into small, medium, large and very large. Small firm $(SMALL_{i(t-1)})$ is a dummy variable equal to 1 if the total number of workers in firm i at time $t-1$ is in the first quartile distribution of the total workforce for all firms operating in the same two-digit International Industrial Standard Industrial Classification (ISIC) level (Revision 3) as firm i at time $t-1$. Medium $(MEDIUM_{i(t-1)})$, large $(LARGE_{i(t-1)})$ and very large firm $(VLARGE_{i(t-1)})$ are grouped using the same method of which total worker of firm i in period $t-1$ fall in the second, third and forth quartile of the total worker distribution respectively. MEDIUM is the omitted category.

Wage $(wage_{i(t-1)})$ is the log of wages per employee where wages per employee are calculated from the ratio of total wage payments to total workers less owners who do not receive a wage. Wage is employed as an indicator of labour quality. An increase in wages follows an increase in the quality of labour. Firms which pay high wages are expected to have a higher probability of exporting.

Skilled labour $(SKILL_{i(t-1)})$ is the ratio of professional and skilled worker to total worker and is another proxy for workforce quality within a firm. In general, export goods are assumed to have a higher quality than domestically produced goods (to meet the standard qualifications of import countries). The higher the quality of workers, therefore the better the quality of goods can be produced. Thus, we expect the ratio of skilled worker and the export decision to be positive.

Training $(TRAIN_{i(t-1)})$ represents a training dummy equal to 1 if the workforce within a firm received formal training either in-house training or outside training or both at least one time, and 0 otherwise. Workers who are trained tend to increase their workplace skills are and thus more efficient.

R&D is known as an improvement for enhanced product quality as well as cost saving in production process. Firms that perform R&D are assumed to improve product quality standards and are thus more likely to enter the export market. R&D is categorised into two groups: R&D in product development and R&D in process development. The former, R&D in product $(RDPRODUCT_{i(t-1)})$, is a dummy variable for product improvement; it equals 1 if firm conducts R&D in the product and 0 otherwise. The latter, R&D in process $(RDPROCESS_{i(t-1)})$, is an indicator for cost saving in the production process where a dummy variable equals 1 if firm carries out R&D in production processes and 0 otherwise.

Table 4 summarises our prior expectations for the decision to export:

Table 4: The expected sign of the coefficients on export decision

Explanatory Variables	Expected signs
Sunk entry cost	+
Foreign ownership	+
Total factor productivity	+
Small firm	-
Large firm	+
Very large firm	+
Wage	+
Skilled labour	+
Training	+
R&D in product	+
R&D in process	+

4.3 Data

Our data consists of a four year unbalanced firm level panel from the Annual Survey of Thailand's manufacturing industries by the Office of Industrial Economics, Ministry of Industry for the period between 2001 and 2004.

All monetary variables are converted into US dollars using the market exchange rate from International Financial Statistics (IFS). In addition, the monetary variables are deflated by setting the year 2001 equal to 100. The inflation rate data is taken from IFS (2005) CD-ROM.

We control for possible outliers by excluding firms for which their mean of total sales exceeds US$ 1 billions. Our panel consists of a total of 15,115 observations over our four-year period. However, all regressors in the model are lagged by one year to minimise possible simultaneity problems; the data in the estimated sample finally includes 9,322 observations which cover the three-year period from 2002 to 2004.

Descriptive statistics for all three years are provided in Table II-1 of Appendix II. A correlation matrix is provided in Table II-2 of Appendix II. The raw correlations tend to match the expected signs from Table 4 except for the relationship between the export dummy and the ratio of skilled to total worker.

4.4 Econometric Methodology

In our model, the dependent variable is a binary response dummy variable for export status. The explanation for the binary choice model can be written in the form of latent variables as:

$$EX_{it}^{*} = \alpha + \beta^{'} Z_{i(t-1)} + \varepsilon_{it} \qquad (9)$$

where Z is a $K \times 1$ vector of firm characteristic parameters and ε_{it} is the error term. Rather than observing the latent variable (EX_{it}^{*}) in equation (9), we only observe a binary response (EX_{it}) which then indicates the sign of EX_{it}^* where $EX_{it} = 1$ if $EX_{it}^* > 0$ and $EX_{it} = 0$ if $EX_{it}^* \leq 0$.

Because of the discrete dummy variable for export status, a probit model is used for our estimation methodology in this part of the paper. With certain assumptions, the error term (ε_{it}) follows normal cumulative distribution function.

The literature suggests a number of alternatives to deal with the characteristics of a binary choice model such as GMM in first differences and the linear probability model (LPM). However, the GMM first difference estimator for dynamic panel data by Arellano and Bond (1991) requires two or more lags of all the right-hand-side variables as an instrument. Because of our relatively short panel we can not use GMM in first differences. For LPM, the relationship between the occurring probability and the independent variables is assumed to be linear. However, LPM seems not to be an appropriate method of estimation for a binary choice framework because of several defects with the model[5]. Firstly, the value of the disturbance comprises of only two specific values. Therefore, LPM failed to fulfil the requirement under OLS assumption for normality distribution of the disturbances. Secondly, LPM appears to have a problem of heteroscedastic variances of disturbances because the variances of disturbances follow the change in the dependent variables. Finally, there is the possibility that the predicted probability of LPM lies outside the range of 0 to 1, so the estimated coefficients are likely to be biased. Although, the problem of heteroscedastic standard errors can be corrected by using a robust variance estimator the first and third problems persist.

Within our available firm-level data, we have unobserved firm hetegerogeneity. For each specification, unobserved firm hetegerogeneity should be modelled as fixed effects or random effects depending on which is the more appropriate. The error tem (ε_{it}) from the latent variable model in equation (9) comprises of two components where $\varepsilon_{it} = \mu_i + \eta_{it}$. μ_i is the individual unobserved heterogeneity error and η_{it} is the idiosyncratic error or time-varying error. It is assumed that (η_{it}) follows

[5] For further detail discussions, see Gujarati (1995) pp. 542-546.

$\eta_{it} \sim IN(0,\sigma_{\eta}^{2})$ and unobserved firm effects (μ_i) have zero mean and constant variance, $\mu_i \sim IN(0,\sigma_{\mu}^{2})$.

The random effects estimator treats unobserved heterogeneity as a random variable by the assumption that the unobserved firm heterogeneity errors are uncorrelated with the observed explanatory variables. On the other hand, the fixed effects estimator captures firm specific effects where its assumption requires the unobserved firm effects to be correlated with the idiosyncratic error.

The random effects estimator does not appear to suit our model due to the fact that the required assumption for independent variables to be strictly exogenous conditional on μ_i is likely to be violated as we include a lagged dependent variable as a measure of sunk entry cost in the model. Plant characteristics are also correlated with the unobserved firm heterogeneity such as technology within the firm, managerial capability, etc. Regarding the lagged dependent and independent variable, fixed effects estimator would produce biased and inconsistent results (Bernard and Jensen, 2004).

Consequently by choosing among the models and available specifications, we employ a pooled probit model to estimate the decision of firm to engage in export market. The response probability for the probit model can be written as:

$$P(EX_{it}=1 \mid Z_{i(t-1)}) = \Phi(\beta' Z_{i(t-1)}) \qquad (10)$$

where P stands for outcome probability. $Z_{i(t-1)}$ is a vector of firm characteristics including sunk entry cost. $\Phi(.)$ is a normal cumulative distribution function of the error term which is assumed to lie between the range of 0 and 1, $0 < \Phi(.) < 1$.

We add industry dummies and time dummies to control for unobserved industry fixed effects and time varying effects. The former $(INDUS_j)$ are categorised according to the three-digit ISIC level (Revision 3); there are 51 industries in total. We omit one industry dummy, so we left 50 industry dummies in the model. For the time dummies (T_t), only two-year dummies are included to the model as we lag all the independent variables by one year.

We also correct for the problem of heteroscedastic of the error by using a robust variance estimate. Thus, the estimate model for export decision becomes:

$$\begin{aligned} P(EX_{it}=1|Z_{i(t-1)}) = \Phi[&\beta_0+\beta_1 EX_{i(t-1)}+\beta_2 FOREIGN_{i(t-1)}+\beta_3 TFP_{i(t-1)} \\ &+\beta_4 SMALL_{i(t-1)}+\beta_5 LARGE_{i(t-1)}+\beta_6 VLARGE_{i(t-1)} \\ &+\beta_7 wage_{i(t-1)}+\beta_8 SKILL_{i(t-1)}+\beta_9 TRAIN_{i(t-1)} \\ &+\beta_{10} RDPRODUCT_{i(t-1)}+\beta_{11} RDPROCESS_{i(t-1)} \\ &+\sum_{j=1}^{50}\beta_j INDUS_j+\sum_{t=1}^{2}\beta_t T_t+\varepsilon_{it}] \end{aligned} \tag{11}$$

In our estimated results, the coefficients which are obtained from the probit estimation are the predicted probabilities of belonging to one of the categories on the dependent variable. In order to provide an interpretation of the coefficients, we calculate marginal effect to indicate the slope of the expected change in the probability of the outcome when the independent variables are changed one at a time. In general, marginal effects are calculated at the mean of particular variable while keeping all other variables constant. The marginal effect of pooled probit model is given by:

$$\frac{\partial[P(EX_{it}=1|Z_{i(t-1)})]}{\partial Z_{ki(t-1)}}=\frac{\partial[E(EX_{it})]}{\partial Z_{ki(t-1)}}=\frac{\partial[\Phi(\beta' Z_{i(t-1)})]}{\partial Z_{ki(t-1)}}=\Phi(\beta' Z_{i(t-1)})\beta_k \tag{12}$$

where Φ is the probability density function for a standard normal variables.

Z_k is a coefficient of a particular continuous variables from the probit regression where $k=1,2,3,...,n$.

5. Empirical Results

The results shown in Table 5 are from the marginal effect estimation, calculated at the mean of the independent variables except for dummy variables. Three different TFP calculation techniques are performed for the purpose of sensitivity analysis. Column (1) includes TFP^{LP} obtained from the estimation procedure of Levinsohn and Petrin (2003). Columns (2) and (3) are our alternative TFP measures: denoted $TFP^{BUETTNER}$ and $TFP^{LABPROD}$ from Buettner's (2003) method and the log of labour productivity, respectively. If each particular calculation measures the correct value of TFP, all three measures should provide similar and consistent results.

The results show that the past experience of a firm or sunk entry cost has a positive effect on export decision. Exporting in the previous period has a large impact on the export in the present period. The coefficient of past export experience is identical and consistent across all three columns. This indicates that export experience in the previous period increases the probability of the current period exporting by 0.913.

For foreign ownership, it is clear seen that foreign ownership is positively correlated with the probability of exporting. Hence, foreign firms are more likely to become exporters; the probability to export is increased by an average value of 0.058.

The results for all three TFP variables are similar and are a positive and significant determinant of the decision to export. The coefficients in Column (1) to Column (3) can be interpreted as the increase in TFP by one unit raises the probability of export by 3.2, 2.9 and 3.4 percentage points, respectively. These marginal effects are reassuringly close.

As expected, firm size is another important determinant of the export decision. The three size groupings provide different results. The negative and significant coefficient on small firms indicates that small firms are less likely to become exporters. As firm sizes increases, we observe increasingly positive and significant results. The coefficients of large and very large firm indicate that the larger the size, the more likely the firm is to enter the export market.

The quality of the workforce is also a factor that determines the probability of exporting. We assume that the labour quality is proxied by the average wage. Table 5 shows that wage has positive coefficients but only Column (1) and Column (2) are significant at the 10% level. By one unit, wage raises the probability of exporting by 5.2 and 5.1 percentage points, respectively.

Other firm characteristics such as ratio of skilled labour[6], training, R&D in the product, and production process have a positive effect on the probability of exporting. However, such variables appear to be insignificant in all three columns.

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[6] We have some concerns about the quality of our skilled labour variable from the raw data as some firms may not specify the quantity of labour skill differences correctly. When we exclude this variable there are

Table 5: Pooled Probit Model for a Firm's Decision to Export

Variable	(1)	(2)	(3)
$EX_{i(t-1)}$	0.913*** (169.88)	0.913*** (168.06)	0.913*** (168.39)
$FOREIGN_{i(t-1)}$	0.059** (2.14)	0.058** (2.11)	0.057** (2.08)
$TFP^{LP}_{i(t-1)}$	0.032** (2.36)		
$TFP^{BUETTNER}_{i(t-1)}$		0.029* (1.87)	
$TFP^{LABPROD}_{i(t-1)}$			0.034** (2.40)
$SMALL_{i(t-1)}$	-0.102*** (3.34)	-0.101*** (3.24)	-0.111*** (3.67)
$LARGE_{i(t-1)}$	0.102*** (3.51)	0.101*** (3.45)	0.109*** (3.82)
$VLARGE_{i(t-1)}$	0.149*** (4.93)	0.147*** (4.62)	0.165*** (5.71)
$wage_{i(t-1)}$	0.052* (1.81)	0.051* (1.67)	0.045 (1.52)
$SKILL_{i(t-1)}$	0.023 (0.68)	0.025 (0.73)	0.024 (0.70)
$TRAIN_{i(t-1)}$	0.013 (0.38)	0.012 (0.35)	0.013 (0.37)
$RDPRODUCT_{i(t-1)}$	0.050 (0.84)	0.047 (0.80)	0.050 (0.85)
$RDPROCESS_{i(t-1)}$	0.048 (0.72)	0.048 (0.72)	0.047 (0.70)
Observations	9074	9074	9074

Note: Robust z statistics in parentheses. Time dummies and three digit industry dummies are included. All the dependent variables are lagged one year. * significant at 1%; ** significant at 5%; *** significant at 10%.

As a further sensitivity check we investigate the effect of the sunk-entry cost and firm characteristics on the probability of exporting when using different definitions of foreign ownership. Rather than define a firm as foreign when only 10% is foreign owned, we use 25% and 50% as alternative cut-off points. The marginal effect results are reported in Table 6. It turns out that the higher the percentage of shares used to classify foreign ownership, the more significant foreign ownership dummies become. $FOREIGN25_{i(t-1)}$ and $FOREIGN50_{i(t-1)}$ are now significant at the 1% level whereas all the other variables are almost identical to those in Table 5.

no differences in the results for the other regressors. The sign, the significant or insignificant of all other variables in the model are the same. The results for excluding the ratio of skilled labour are available from authors upon request.

Table 6: Sensitivity Analysis on Foreign Ownership in the Pooled Probit Model

Variable	(1)	(2)	(3)	(4)	(5)	(6)
$EX_{i(t-1)}$	0.913*** (168.97)	0.913*** (167.31)	0.913*** (167.39)	0.913*** (169.91)	0.913*** (167.69)	0.913*** (168.46)
$FOREIGN25_{i(t-1)}$	0.077*** (2.73)	0.077*** (2.70)	0.076*** (2.66)			
$FOREIGN50_{i(t-1)}$				0.119*** (3.23)	0.119*** (3.22)	0.117*** (3.18)
$TFP^{LP}_{i(t-1)}$	0.032** (2.39)			0.034** (2.48)		
$TFP^{BUETTNER}_{i(t-1)}$		0.029* (1.90)			0.031** (2.01)	
$TFP^{LABPROD}_{i(t-1)}$			0.035** (2.40)			0.036** (2.49)
$SMALL_{i(t-1)}$	-0.103*** (3.35)	-0.101*** (3.24)	-0.111*** (3.67)	-0.101*** (3.32)	-0.099*** (3.21)	-0.110*** (3.66)
$LARGE_{i(t-1)}$	0.103*** (3.52)	0.101*** (3.46)	0.110*** (3.84)	0.100*** (3.44)	0.099*** (3.38)	0.108*** (3.78)
$VLARGE_{i(t-1)}$	0.149*** (4.93)	0.147*** (4.61)	0.165*** (5.71)	0.146*** (4.81)	0.143*** (4.51)	0.163*** (5.61)
$wage_{i(t-1)}$	0.048* (1.67)	0.047 (1.54)	0.041 (1.38)	0.048* (1.69)	0.046 (1.54)	0.040 (1.38)
$SKILL_{i(t-1)}$	0.024 (0.70)	0.025 (0.74)	0.024 (0.71)	0.024 (0.71)	0.026 (0.75)	0.024 (0.72)
$TRAIN_{i(t-1)}$	0.013 (0.37)	0.012 (0.35)	0.012 (0.37)	0.013 (0.40)	0.012 (0.37)	0.013 (0.39)
$RDPRODUCT_{i(t-1)}$	0.049 (0.84)	0.047 (0.79)	0.049 (0.84)	0.051 (0.88)	0.048 (0.83)	0.051 (0.88)
$RDPROCESS_{i(t-1)}$	0.047 (0.71)	0.047 (0.71)	0.046 (0.70)	0.052 (0.78)	0.052 (0.78)	0.051 (0.77)
Observations	9074	9074	9074	9074	9074	9074

Note: Robust z statistics in parentheses. Time dummies and three digit industry dummies are included. All the dependent variables are lagged one year. * significant at 1%; ** significant at 5%; *** significant at 10%.

We also performed a range of other sensitivity checks on our other variables. For example we re-estimated the model classifying size according to total fixed assets instead of employment. The results are fairly consistent. Further discussions of the results are presented in Table II-3 of Appendix II.

The estimated marginal effect results for our alternatives estimation techniques which we discuss in Section 4.4 can be found in Appendix V.

6. Conclusions

This paper examines the export decision of firms using a manufacturing firm level data of Thailand between 2001 and 2004. Consistent with both the theoretical and past empirical explanations, sunk entry cost is the most important determinant with the strongest impact on the probability of exporting. Firms enter the export market if the expected profit of the current period is greater than sunk entry cost. Once firms export, they are likely to gain experience of being exporters. Consequently, the past export experience of the firm significantly determines the current export decision.

For productivity, we employ three different estimation techniques for our TFP variables; a standard labour productivity measure; a semi-parametric approach that takes account of unobserved firm-specific productivity shocks and a system estimation which allows for endogenous R&D. The estimated results are robust with positive and significant coefficients implying that firms with high productivity have a higher probability of exporting.

For our other independent variables, the results show a positive and significant relationship between foreign ownership and export status. Firms with high wages are likely to enter export markets and firm size is also important, small firms are less likely to export where the bigger a firm becomes the more likely it is to export.

In summary our results show that the determinants of a firm's export decision from the perspective of Thailand are consistent with those findings from other developed and developing countries. The significance of the factors supports the premise that good firms become exporters whereas firms self-select into the export market based on differences in their export experience, productivity and other firm specific characteristics.

Moreover, the effects of sunk entry costs, wages and foreign ownership appear to be more pronounced for Thai firms than those of other studies. We believe that this reflects the importance of exporting to the previous, current and future development strategy of the new Asian Tigers. An analysis that until now has not be undertaken.

We aim to further this analysis by investigating the source of firm ownership on the decision of a firm to export to examine whether certain regions are more strongly reliant on Thailand as an export platform. We are also able to measure exports continuously to examine whether exports as a percentage of output differs across ownership structure and ownership origin.

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Appendix I: Variables

Dependent Variable:

EX_{it}: A dummy variable for export status where EX_{it} equals 1 if firm i exports and 0 otherwise.

Independent variables:

$EX_{i(t-1)}$: Sunk entry cost or export experience. A dummy variable for export status where EX_{it} equals 1 if firm i exports and 0 otherwise.

$FOREIGN_{i(t-1)}$: A dummy variable that indicates the structure of foreign ownership where a dummy equals 1 if shares of at least 10% are foreign owned.

$FOREIGN25_{i(t-1)}$: A dummy variable that indicates the structure of foreign ownership where a dummy equals 1 if shares of at least 25% are foreign owned.

$FOREIGN50_{i(t-1)}$: A dummy variable that indicates the structure of foreign ownership where a dummy equals 1 if shares of at least 50% are foreign owned.

$TFP_{i(t-1)}^{LP}$: Total factor productivity which is obtained from the estimation of the semi-parametric approach of Levinsohn and Peterin (2003).

$TFP_{i(t-1)}^{BUETTNER}$: Total factor production which is obtained from a system estimation of Buettner (2003).

$TFP_{i(t-1)}^{LABPROD}$: Labour productivity which is calculated from the log of value added divided by total labour.

$SMALL_{i(t-1)}$: For a small firm variable, a dummy variable is equal to 1 if the total labour of the firm i at time $t-1$ is in the first quartile of the distribution of the total labour of all firms operating in the same two-digit ISIC level (Revision 3) as firm i at time $t-1$.

$LARGE_{i(t-1)}$: For a large firm variable, a dummy variable equal to 1 if the total labour of the firm i at time $t-1$ is in the third quartile of the distribution of the total labour of all firms operating in the same two-digit ISIC level (Revision 3) as firm i at time $t-1$.

$VLARGE_{i(t-1)}$: A very large firm variable, a dummy variable equal to 1 if the total labour of the firm i at time $t-1$ is in the forth quartile of the distribution of the total labours of all firms operating in the same two-digit ISIC level (Revision 3) as firm i at time $t-1$.

$SMALL^{A}_{i(t-1)}$: Firm is categorised as small firm if total fixed assets of the firm i at time $t-1$ is in the first quartile of the distribution of the total fixed assets of all firms operating in the same two-digit ISIC level (Revision 3) as firm i at time $t-1$.

$LARGE^{A}_{i(t-1)}$: Firm is categorised as large firm if the total fixed assets of the firm i at time $t-1$ is in the third quartile of the distribution of the total fixed assets of all firms operating in the same two-digit ISIC level (Revision 3) as firm i at time $t-1$.

$VLARGE^{A}_{i(t-1)}$: Firm is categorised as very large firm if the total fixed assets of the firm i at time $t-1$ is in the forth quartile of the distribution of the total fixed assets of all firms operating in the same two-digit ISIC level (Revision 3) as firm i at time $t-1$.

$wage_{i(t-1)}$: The log of wage per employee where wage per employee is calculated from the ratio of total labour payments over total labour less owners.

$SKILL_{i(t-1)}$: The ratio of professional and skilled labour to total labour.

$TRAIN_{i(t-1)}$: A training dummy equals 1 if the workforce within a firm has received formal training either in-house training or outside training or both at least once, and 0 otherwise.

$RDPRODUCT_{i(t-1)}$: A dummy variable equal 1 if a firm carries out R&D in product development and 0 otherwise.

$RDPROCESS_{i(t-1)}$: A dummy variable if a firm performs R&D in the development of production processes and 0 otherwise.

Appendix II

Table II-1: Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
EX_{it}	9153	0.5044248	0.5000077	0	1
$EX_{i(t-1)}$	9322	0.5008582	0.5000261	0	1
$FOREIGN_{i(t-1)}$	9319	0.2772830	0.4476814	0	1
$FOREIGN25_{i(t-1)}$	9319	0.2462711	0.4308614	0	1
$FOREIGN50_{i(t-1)}$	9319	0.1441142	0.3512243	0	1
$SMALL_{i(t-1)}$	9322	0.2586355	0.4379084	0	1
$LARGE_{i(t-1)}$	9322	0.2460845	0.4307515	0	1
$VLARGE_{i(t-1)}$	9322	0.2506973	0.4334378	0	1
$SMALL^{A}_{i(t-1)}$	9322	0.2583137	0.4377308	0	1
$LARGE^{A}_{i(t-1)}$	9322	0.2445827	0.4298626	0	1
$VLARGE^{A}_{i(t-1)}$	9322	0.2499464	0.433005	0	1
$wage_{i(t-1)}$	9318	7.7109770	0.5391990	3.08257	10.28713
$SKILL_{i(t-1)}$	9322	0.5342507	0.3243238	0	1
$TRAIN_{i(t-1)}$	9318	0.8720756	0.3340236	0	1
$RDPRODUCT_{i(t-1)}$	9306	0.0597464	0.2370291	0	1
$RDPROCESS_{i(t-1)}$	9270	0.0407767	0.1977832	0	1
$TFP^{LP}_{i(t-1)}$	9322	9.2242060	1.8315820	.4717388	16.74690
$TFP^{BUETTNER}_{i(t-1)}$	9322	10.196180	1.2839580	1.210144	15.31219
$TFP^{LABPROD}_{i(t-1)}$	9322	8.9875570	1.0379200	1.449256	14.02708

Note: The descriptive statistics are for the 3 years sample period.

Table II-2: Correlation Marix

	EX	$EX_{i(t-1)}$	*FOREGIN*	*FOREGIN25*	*FOREGIN50*	*SMALL*	*LARGE*	*VLARGE*	$SMALL^{A}$	$LARGE^{A}$	$VLARGE^{A}$	*wage*	*SKILL*	*TRAIN*	*RDPRODUCT*	*RDPROCESS*	TFP^{LP}	$TFP^{LABPROD}$	$TFP^{LABPROD}$
EX	1.0000																		
$EX_{i(t-1)}$	0.9349	1.0000																	
FOREGIN	0.3643	0.3708	1.0000																
FOREGIN25	0.3603	0.3660	0.9221	1.0000															
FOREGIN50	0.3223	0.3257	0.6617	0.7175	1.0000														
SMALL	-0.3709	-0.3663	-0.1863	-0.1728	-0.1683	1.0000													
LARGE	0.1350	0.1290	0.0221	0.0162	0.0174	-0.3382	1.0000												
VLARGE	0.3552	0.3570	0.2217	0.2082	0.1986	-0.3429	-0.3299	1.0000											
$SMALL^{A}$	-0.3665	-0.3654	-0.2409	-0.2250	-0.2032	0.5812	-0.2611	-0.3342	1.0000										
$LARGE^{A}$	0.1358	0.1328	0.0673	0.0612	0.0511	-0.2351	0.2770	-0.0310	-0.3357	1.0000									
$VLARGE^{A}$	0.3400	0.3418	0.2687	0.2628	0.2573	-0.3372	-0.0394	0.6261	-0.3143	-0.3280	1.0000								
wage	0.2772	0.2695	0.4055	0.3989	0.3366	-0.2298	0.0828	0.1826	-0.3191	0.1076	0.3131	1.0000							
SKILL	-0.0159	-0.0176	-0.0177	-0.0121	-0.0107	0.1079	-0.0465	-0.0568	0.0633	-0.0346	-0.0218	0.0759	1.0000						
TRAIN	0.2149	0.2153	0.1349	0.1300	0.1109	-0.2779	0.1092	0.1906	-0.2487	0.0882	0.1978	0.2091	-0.0337	1.0000					
RDPRODUCT	0.1305	0.1304	0.0527	0.0509	0.0354	-0.0988	0.0116	0.1455	-0.1015	0.0389	0.1122	0.0777	-0.0352	0.0782	1.0000				
RDPROCESS	0.0997	0.0982	0.0455	0.0401	0.0212	-0.0796	0.0233	0.1058	-0.0881	0.0188	0.0997	0.0770	-0.0179	0.0670	0.5733	1.0000			
TFP^{LP}	0.2052	0.1979	0.1443	0.1327	0.0796	-0.2582	0.0728	0.2504	-0.2585	0.0541	0.2995	0.4233	-0.0395	0.1733	0.0779	0.0739	1.0000		
$TFP^{BUETTNER}$	0.4006	0.3959	0.3777	0.3574	0.3081	-0.4562	0.1328	0.4360	-0.5021	0.1209	0.5482	0.6505	-0.0316	0.2912	0.1527	0.1311	0.6251	1.0000	
$TFP^{LABPROD}$	0.2650	0.2590	0.3489	0.3327	0.2748	-0.2547	0.0808	0.2195	-0.3820	0.0956	0.4108	0.6955	0.0065	0.2175	0.1050	0.1030	0.6121	0.9267	1.0000

Note: The correlation matrix of the 3 years sample period.

Table II-3: Sensitivity Analysis of the Pooled Probit Model - Classified Size by Fixed Assets.

Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
$EX_{i(t-1)}$	0.915***	0.915***	0.916***	0.915***	0.915***	0.916***	0.915***	0.915***	0.916***
	(174.05)	(164.29)	(170.62)	(173.41)	(173.61)	(169.87)	(173.56)	(164.07)	(167.19)
$FOREIGN_{i(t-1)}$	0.053*	0.053*	0.055**						
	(1.93)	(1.93)	(2.00)						
$FOREIGN25_{i(t-1)}$				0.070**	0.070**	0.070**			
				(2.46)	(2.47)	(2.47)			
$FOREIGN50_{i(t-1)}$							0.115***	0.116***	0.113***
							(3.10)	(3.13)	(3.04)
$TFP^{LP}_{i(t-1)}$	0.046***			0.047***			0.048***		
	(3.40)			(3.44)			(3.54)		
$TFP^{BUETTNER}_{i(t-1)}$		0.038**			0.038**			0.040**	
		(2.28)			(2.33)			(2.46)	
$TFP^{LABPROD}_{i(t-1)}$			0.017			0.017			0.019
			(1.11)			(1.14)			(1.27)
$SMALL^{A}_{i(t-1)}$	-0.072**	-0.066**	-0.080***	-0.072**	-0.066**	-0.080***	-0.072**	-0.065**	-0.080***
	(2.34)	(2.10)	(2.61)	(2.36)	(2.11)	(2.63)	(2.34)	(2.08)	(2.62)
$LARGE^{A}_{i(t-1)}$	0.078***	0.076***	0.088***	0.078***	0.076***	0.088***	0.076***	0.074**	0.086***
	(2.80)	(2.67)	(3.18)	(2.77)	(2.64)	(3.16)	(2.70)	(2.56)	(3.09)
$VLARGE^{A}_{i(t-1)}$	0.126***	0.123***	0.155***	0.124***	0.121***	0.153***	0.118***	0.114***	0.148***
	(3.91)	(3.43)	(4.95)	(3.84)	(3.37)	(4.89)	(3.61)	(3.17)	(4.67)
$wage_{i(t-1)}$	0.019	0.024	0.043	0.015	0.020	0.039	0.015	0.020	0.039
	(0.68)	(0.82)	(1.45)	(0.55)	(0.69)	(1.34)	(0.56)	(0.68)	(1.34)
$SKILL_{i(t-1)}$	0.010	0.011	0.009	0.011	0.012	0.010	0.011	0.012	0.010
	(0.30)	(0.34)	(0.28)	(0.32)	(0.35)	(0.29)	(0.33)	(0.37)	(0.30)
$TRAIN_{i(t-1)}$	0.029	0.029	0.035	0.029	0.029	0.036	0.030	0.030	0.037
	(0.85)	(0.87)	(1.06)	(0.86)	(0.88)	(1.07)	(0.89)	(0.91)	(1.10)
$RDPRODUCT_{i(t-1)}$	0.054	0.051	0.055	0.054	0.051	0.055	0.056	0.054	0.058
	(0.95)	(0.91)	(0.99)	(0.94)	(0.90)	(0.99)	(1.00)	(0.95)	(1.04)
$RDPROCESS_{i(t-1)}$	0.047	0.048	0.052	0.047	0.048	0.052	0.051	0.051	0.055
	(0.73)	(0.75)	(0.82)	(0.73)	(0.75)	(0.82)	(0.78)	(0.80)	(0.87)
Observations	9074	9074	9074	9074	9074	9074	9074	9074	9074

Note: Robust z statistics in parentheses. Time dummies and three digit industry dummies are included. All the dependent variables are lagged one year. * significant at 10%; ** significant at 5%; *** significant at 1%.

Appendix III: TFP Estimation Using Levinsohn and Petrin's (2003) Method

In this paper, the estimation of total factor productivity (TFP) is accomplished using a Cobb-Douglas production function and the semi-parametric approach of Levinsohn and Petrin (2003). The approach was adapted from Olley and Pakes (1996) which considered the endogeniety problem by taking unobserved firm-specific productivity shocks into account.

A consequence of the endogeneity problem is that ordinary least square (OLS) yields biased and inconsistent results in productivity estimations because it fails to take unobserved productivity shock into account. Olley and Pakes (1996) resolved the endogeneity problem by using an investment proxy to control for the simultaneity problem between the correlation of input levels and unobserved productivity shocks.

Levinsohn and Petrin (2003) pointed out that such an investment proxy may not respond to the productivity shock smoothly due to adjustment costs. Additionally, such a variable is valid only among those firms who report non-zero investment. Firms with zero investment have to be dropped from the sample.

To avoid the zero investment and adjustment problems, Levinsohn and Petrin (2003) introduced, with the modification of Olley and Pakes (1996), the use of intermediate inputs to measure the correlation between input levels and productivity shocks. If intermediate inputs are less costly to adjust, it may perhaps respond smoothly and fully to productivity shocks.

TFP in the paper is separately estimated for each of the two-digit ISIC manufacturing sectors, 22[7] in total. The estimated production function can be expressed as follow:

$$y_{it} = \beta_0 + \beta_l l_{it} + \beta_k k_{it} + \omega_{it} + \eta_{it} \quad \text{(III.1)}$$

where y_{it} is the log of value added of plant i at time t defined as sales net raw material costs, l_{it} is the log of total labour[8], k_{it} is the log of plant's capital stock which is defined as

[7] Due to the insufficient observations, the manufacture of tobacco products is grouped with the manufacture of food products and beverages.

[8] We use total labour rather than the number of skilled and unskilled workers. This is because of concerns that we have previously expressed about the quality of our raw data as some firms may be mis-specifying

value of fixed assets. The error terms comprises two components, ω_{it} and η_{it}, where the former is unobserved productivity shocks which are correlated with the input choice while the latter is the error term which has no impact on the firms' decision.

The demand function for intermediate input is a function of state variables – capital and unobserved productivity shock – as given in equation (III.2)

$$\omega_{it} = \omega_{it}(m_{it}, k_{it}) \; m_{it} = m_{it}(k_{it}, \omega_{it}) \qquad \text{(III.2)}$$

The relationship between intermediate inputs and unobserved firm productivity shocks is assumed to be monotonic where firms respond to positive productivity shocks by using more intermediate inputs so as to enlarge their output. Thus, the demand function for intermediate input in equation (III.2) can be inverted. Unobserved productivity shocks can be written as a function of intermediate input and capital as follows:

$$\omega_{it} = \omega_{it}(m_{it}, k_{it}) \qquad \text{(III.3)}$$

where m_{it} denotes log of a fuel and energy cost as a proxy for intermediate inputs.

With substitution of (III.3) into (III.1)

$$y_{it} = \beta_0 + \beta_l l_{it} + \beta_k k_{it} + \omega_{it}(m_{it}, k_{it}) + \eta_{it} \qquad \text{(III.4)}$$

Since $\omega_{it}(m_{it}, k_{it})$ is an unknown function of intermediate input and capital, Levinsohn and Petrin (2003) has generated a function of $\phi_{it}(m_{it}, k_{it})$ in order to estimate the parameters.

$$\phi_{it}(m_{it}, k_{it}) = \beta_0 + \beta_k k_{it} + \omega_{it}(m_{it}, k_{it}) \qquad \text{(III.5)}$$

So,

$$\omega_{it}(m_{it}, k_{it}) = \phi_{it}(m_{it}, k_{it}) - \beta_0 - \beta_k k_{it} \qquad \text{(III.6)}$$

Substituting (III.6) into (III.4) gives us the production function as if a fuel and energy cost is used as the proxy variable.

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the number of skilled and unskilled workers. TFP estimations with labour split into skilled and unskilled labour are available from authors up on request.

$$y_{it} = \beta_l l_{it} + \phi_{it}(k_{it}, m_{it}) + \eta_{it} \qquad \text{(III.7)}$$

The estimation procedure in this paper follows the two stage estimation in the value-added case as discussed in Petrin *et al.* (2004).

In the first stage, the estimation of production function (III.7) using OLS by the substitution of $\phi_{it}(m_{it}, k_{it})$ with a third-order polynomial in m_{it} and k_{it} yields $\widehat{\beta_l}$ and $\widehat{\phi_{it}}$ (up to the intercept).

$$y_{it} = \alpha_0 + \beta_l l_{it} + \sum_{h=0}^{3}\sum_{j=0}^{3-h} \alpha_{hj} k_{it}^{h} m_{it}^{j} + \eta_{it} \qquad \text{(III.8)}$$

Once the estimated elasticity of β_l and ϕ_{it} in the first stage is achieved, the next stage is to identify the residual of the production function and the estimated $\widehat{\beta_k}$.

The relationship of the estimate residual from the production function can be written as

$$\widehat{\eta_{it} + \xi_{it}} = y_t - \widehat{\beta_l} l_{it} - \beta_k^* k_{it} - E[\widehat{\omega_{it} \mid \omega}_{it-1}] \qquad \text{(III.9)}$$

where ξ_{it} is the error term namely the productivity innovation uncorrelated to capital, β_k^* is computed from a prediction of $\widehat{\omega_{it}} = \hat{\phi}_{it} - \beta_k^* k_{it}$, while $E[\widehat{\omega_{it} \mid \omega}_{it-1}]$ is a predicted unobserved productivity shock from a nonparametric approximation regression of $\widehat{\omega_{it}} = \lambda_0 + \lambda_1 \omega_{it-1} + \lambda_2 \omega_{it-1}^2 + \lambda_3 \omega_{it-1}^3 + \mu_{it}$.

The estimate $\widehat{\beta_k}$ is defined as to minimise β_k^* the solution of

$$\min_{\beta_k^*} \sum_i \sum_t (y_{it} - \widehat{\beta_l} l_{it} - \beta_k^* k_{it} - E[\widehat{\omega_{it} \mid \omega}_{it-1}])^2 \qquad \text{(III.10)}$$

The estimated elasticities of inputs obtained from the procedure of Petrin *et al.* (2004) are eventually used to predict the level of productivity.

$$\widehat{\omega_{it}} = \exp(y_{it} - \widehat{\beta_l} l_{it} - \widehat{\beta_k} k_{it}) \qquad \text{(III.11)}$$

The number of bootstrap replications performed in this paper is 250 to estimate standard errors.

Appendix IV: TFP Estimation Using Buettner's (2003) Method

Firms normally engage in R&D activities with the aim of improving productivity within firms. Recent R&D investment would yield a direct effect on future productivity. Therefore, Buettner (2003) points out that R&D investment should be taken into account as part of the consideration for measuring the total factor productivity (TFP). The study provides the estimation framework on the distribution of the future productivity conditionally based on the R&D investment and current productivity. In addition, the structural model for firm dynamics is used to build up the estimation of the unobserved productivity state.

To begin with Cobb-Douglas's production function can be written as follows:

$$y_{it} = \beta_0 + \beta_l l_{it} + \beta_k k_{it} + \omega_{it} + \eta_{it} \qquad \text{(IV.1)}$$

Here y is the log of the value added of plant i at time t. l and k are the log of the total labour and plant's capital stock respectively. There are two components of the error terms in equation (IV.1), ω_{it} is the productivity shock which correlates with the input choice while η_{it} represents the measurement error that has no impact on the firms' decision.

Buettner (2003) explains the estimation algorithm in two stages. Stage one is indistinguishable from Olley and Pakes's (1996) technique in the estimation of factors of input(s) coefficient. However, in the second stage, Buettner (2003) had modified Olley and Pakes (1996) in the estimation of the quasi-fixed inputs by assuming that the future productivity depends on current productivity and also the current R&D investment.

Stage one: Estimation of the Coefficients of the Variable Input(s)

The nonparametric approach is used as the estimation strategy to control the unobserved productivity shock which has an impact on the firms' decisions.

The level of firm investment i at time t is a function of the state variables, current capital stock (k_{it}) and current productivity shock (ω_{it}), as given; $i_{it} = i_{it}(k_{it}, \omega_{it})$. This level of investment function has a monotonic property – a positive productivity shock influences firms to invest more. Thus, the investment function can be inverted and rewritten so the relationship of the unobserved productivity is:

$$\omega_{it} = \widetilde{\omega_{it}}(i_{it}, k_{it}) \quad (\text{IV.2})$$

[9]

Substituting (IV.2) into Cobb-Douglas's production function (IV.1) gives us:

$$y_{it} = \beta_0 + \beta_l l_{it} + \beta_k k_{it} + \widetilde{\omega_{it}}(i_{it}, k_{it}) + \eta_{it} \quad (\text{IV.3})$$

Since $\widetilde{\omega_{it}}(i_{it}, k_{it})$ has an unknown functional form, Olley and Pakes (1996) and Levinsohn and Petrin (2003) have generated another unknown function of $\phi_{it}(i_{it}, k_{it})$ which can be written as the equation (IV.4):

$$\phi_{it}(i_{it}, k_{it}) = \beta_0 + \beta_k k_{it} + \widetilde{\omega_{it}}(i_{it}, k_{it}) \quad (\text{IV.4})$$

Hence,

$$\widetilde{\omega_{it}}(i_{it}, k_{it}) = \phi_{it}(i_{it}, k_{it}) - \beta_0 - \beta_k k_{it} \quad (\text{IV.5})$$

Substitute (IV.5) into (IV.3) to obtain the production function to give:

$$y_{it} = \beta_l l_{it} + \phi_{it}(i_{it}, k_{it}) + \eta_{it} \quad (\text{IV.6})$$

Buettner (2003) estimates the semi-parametric regression model (IV.6) using OLS which yields a consistent estimation of coefficient β_l ; however, it does not identify the coefficient of β_k .

Stage two: Estimation of the Coefficients of the Quasi-fixed Input(s)

This stage aims to obtain the production function coefficient(s). Buettner (2003) applies the identical strategy in stage two as Olley and Pakes (1996), but the only difference is that Buettner (2003) controls the expected productivity restricted on the past information at time $t-1$ for the reason that it correlates with the current period's capital stock which was chosen at time $t-1$.

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[9] Similarly, Unobserved productivity can also be written as the function of next period and current capital of firm i: $\omega_{it} = \widetilde{\omega_{it}}(k_{it+1}, k_t)$ because next period capital is formed as $k_{it+1} = (1-\delta)k_{it} + i_{it}$.

Rearrange the equation (IV.3) as similarly:

$$y_{it} - \beta_l l_{it} = \beta_0 + \beta_k k_{it} + \widetilde{\omega_{it}}(i_{it}, k_{it}) + \eta_{it} \qquad \text{(IV.7)}$$

The expectation of the transformed dependent variable in equation (IV.7) is restricted on the information at time $t-1$ and survival until t, can be written as:

$$E[(y_{it} - \beta_l l_{it}) \mid I_{t-1}, \chi_{it} = 1] = \beta_0 + \beta_k k_{it} + E[\omega_{it} \mid \psi_{it}, \chi_{it} = 1] \qquad \text{(IV.8)}$$

where I_{it-1} is a the past information at time $t-1$, χ_{it} represents the survival firm, ψ_{it} denotes the current distribution choice of the productivity which is influenced by the firm decision on the R&D investment.

Regarding Markov's assumption for the productivity process, the function of productivity condition on survival can be written as:

$$\omega_{it} = E[\omega_{it} \mid \psi_{it}, \chi_{it} = 1] + \xi_{it} \qquad \text{(IV.9)}$$

where ξ_{it} is the productivity innovation which is uncorrelated with k_{it}.

Substitute (IV.9) into (IV.7) to obtain the second stage estimation equation:

$$y_{it} - \beta_l l_{it} = \beta_0 + \beta_k k_{it} + E[\omega_{it} \mid \psi_{it}, \chi_{it} = 1] + \xi_{it} + \eta_{it} \qquad \text{(IV.10)}$$

In order to obtain the consistent coefficient of β_k from the estimation of the equation (IV.10), the expected productivity condition on survival is needed to be controlled. The next step is similar to the approach in the first stage. Since the expectation $E[\omega_{it} \mid \psi_{it}, \chi_{it} = 1]$ is an unknown function, we have to generate another unknown function of g(.) and estimate g(.) using the non-parametrically approach. From the distribution choice of the policy function, $\psi_{it} = \widetilde{\psi}(\omega_{it-1}, k_{it-1})$, the expectation term of the current productivity shock becomes:

$$\begin{aligned} E[\omega_{it} \mid \psi_{it}, \chi_{it} = 1] = E[\omega_{it} \mid \psi_{it}] = \int \omega_{it+1} dF(\omega_{it+1} \mid \psi_{it}) \\ \equiv g(\psi_{it}) - \beta_0 \end{aligned} \qquad \text{(IV.11)}$$

No R&D:

In the model of Olley and Pakes (1996) by means of the absence of R&D, the productivity distribution only depends on the productivity shock at time $t-1$, $\psi_{it} = \omega_{it-1}$. The second state estimation equation, then, becomes:

$$y_{it} - \beta_l l_{it} = \beta_k k_{it} + g(\omega_{it-1}) + \xi_{it} + \eta_{it} \qquad \text{(IV.12)}$$

where $\omega_{it-1} = \phi_{it-1} - \beta_k k_{it-1} - \beta_0$. Equation (IV.12) is estimated by the nonlinear least square of which $g(\omega_{it-1})$ can be approximated by the nonparametric approach in $\phi_{it-1} - \beta_k k_{it-1}$. Consequently, the coefficient of β_k is obtained from the estimation of the linear term $\beta_k k_{it}$ and nonlinear function in $\phi_{it-1} - \beta_k k_{it-1}$.

R&D:

For endogenous R&D, firms improve the next period productivity shock ω_{it+1} by increasing the R&D investment in the current period. Rather than having a direct effect, ω_{it+1} is affected by the R&D investment and ω_{it} the current period productivity shock through the ψ_{it+1}. The policy function indicates the current distribution choice of productivity as a function of productivity shock and capital at time $t-1, \psi_{it} = \widetilde{\psi}(\omega_{it-1}, k_{it-1})$.

The R&D investment can be written as a function of the current distribution and previous period productivity shock, $r(\psi_{it}, \omega_{it-1})$. The relationship is assumed to be monotonic with the increase in ψ_{it} for fixed ω_{it-1}, thus, the R&D function can be inverted.

$$\psi_{it} = r^{-1}(r_{it-1}, \omega_{it-1}) \qquad \text{(IV.13)}$$

where r_{it-1} is the observed R&D investment of a firm i at time $t-1$. Buettner (2003) uses the equation (IV.13) to control the current distribution choice of the productivity. Therefore, the second stage estimation equation becomes:

$$y_{it} - \beta_l l_{it} = \beta_k k_{it} + g(r^{-1}(r_{it-1}, \omega_{it-1})) + \xi_{it} + \eta_{it} \qquad \text{(IV.14)}$$

Replace $g(r^{-1}(r_{it-1}, \omega_{it-1}))$ with the nonlinear function of $\tilde{g}(.,.)$ in r_{it-1} and $\phi_{it-1} - \beta_k k_{it-1}$ and rewrite the equation (IV.14) as follows:

$$y_{it} - \beta_l l_{it} = \beta_k k_{it} + \tilde{g}(r_{it-1}, \phi_{it-1} - \beta_k k_{it-1}) + \xi_{it} + \eta_{it} \qquad \text{(IV.15)}$$

The assumption for a consistent estimation of the equation (IV.15) requires R&D to be uncorrelated with the error terms. In this paper, R&D expenses are used in the computation of value added; therefore, the estimation of the equation (IV.15) is likely to be violated.

By avoiding R&D data, the second alternative approach of the estimation in stage two develops the property of structural model by referring to the choice of distribution. The optimal choice of distribution ψ_{it} is as a function of the state variable ω_{it-1} and the optimal choice of capital k_{it}. The relationship can be written as:

$$\psi_{it} = \overline{\psi}(\omega_{it-1}, k_{it}) \qquad \text{(IV.16)}$$

There is no direct relationship of ψ_{it} on k_{it-1}. k_{it-1} affects ψ_{it} only through the link of k_{it}. For the endogenous R&D model, the stage two estimation equation becomes:

$$\begin{aligned} y_{it} - \beta_l l_{it} &= \beta_k k_{it} + g(\overline{\psi}(\omega_{it-1}, k_{it})) + \xi_{it} + \eta_{it} \\ &= \int (\phi_{it-1} - \beta_k k_{it-1}, k_{it}) + \xi_{it} + \eta_{it} \end{aligned} \qquad \text{(IV.17)}$$

Rather than a partially linear semi-parametric equation, the equation (IV.17) becomes a fully nonlinear equation. Therefore, we run the nonlinear least square regression of the equation (IV.17) on a nonparametric function in $\phi_{it-1} - \beta_k k_{it-1}$ and k_{it} to obtain a consistent estimate of β_k.

In this paper, we work with a system estimation of equation (IV.6) and (IV.17) which yields consistent estimate coefficients of β_l and β_k. As a consequence, log of TFP_{it} is measured from $y_{it} - \beta_l l_{it} - \beta_k k_{it}$.

Appendix V: Alternative Model Estimations

TableV-1: Random Effects Probit Model - Classified Size by Total Labour.

Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
$EX_{i(t-1)}$	0.918***	0.917***	0.918***	0.917***	0.917***	0.917***	0.917***	0.917***	0.917***
	(168.11)	(121.46)	(148.98)	(167.27)	(123.78)	(148.12)	(168.34)	(152.00)	(152.72)
$FOREIGN_{i(t-1)}$	0.062**	0.061**	0.060**						
	(2.07)	(2.05)	(2.01)						
$FOREIGN25_{i(t-1)}$				0.081***	0.080***	0.079**			
				(2.60)	(2.58)	(2.54)			
$FOREIGN50_{i(t-1)}$							0.123***	0.124***	0.122***
							(3.13)	(3.13)	(3.09)
$TFP^{LP}_{i(t-1)}$	0.033**			0.034**			0.035**		
	(2.11)			(2.14)			(2.22)		
$TFP^{BUETTNER}_{i(t-1)}$		0.030**			0.030**			0.032**	
		(2.15)			(2.18)			(2.28)	
$TFP^{LABPROD}_{i(t-1)}$			0.036**			0.036**			0.037**
			(2.17)			(2.19)			(2.28)
$SMALL_{i(t-1)}$	-0.105***	-0.104***	-0.114***	-0.106***	-0.104***	-0.114***	-0.104***	-0.102***	-0.113***
	(3.28)	(3.21)	(3.59)	(3.28)	(3.21)	(3.60)	(3.24)	(3.16)	(3.56)
$LARGE_{i(t-1)}$	0.105***	0.104***	0.112***	0.105***	0.104***	0.113***	0.103***	0.102***	0.111***
	(3.50)	(3.45)	(3.80)	(3.52)	(3.47)	(3.82)	(3.44)	(3.39)	(3.75)
$VLARGE_{i(t-1)}$	0.154***	0.152***	0.170***	0.153***	0.151***	0.170***	0.150***	0.148***	0.168***
	(4.57)	(4.47)	(5.37)	(4.56)	(4.45)	(5.38)	(4.45)	(4.35)	(5.29)
$wage_{i(t-1)}$	0.053*	0.052*	0.046	0.048	0.048	0.041	0.048	0.047	0.041
	(1.73)	(1.71)	(1.43)	(1.58)	(1.55)	(1.29)	(1.59)	(1.54)	(1.28)
$SKILL_{i(t-1)}$	0.023	0.025	0.024	0.024	0.025	0.024	0.024	0.026	0.024
	(0.64)	(0.69)	(0.65)	(0.66)	(0.70)	(0.67)	(0.67)	(0.71)	(0.68)
$TRAIN_{i(t-1)}$	0.013	0.012	0.013	0.013	0.012	0.013	0.014	0.013	0.014
	(0.36)	(0.34)	(0.35)	(0.36)	(0.33)	(0.35)	(0.38)	(0.35)	(0.37)
$RDPRODUCT_{i(t-1)}$	0.052	0.049	0.052	0.052	0.049	0.052	0.054	0.051	0.054
	(0.83)	(0.79)	(0.83)	(0.83)	(0.78)	(0.83)	(0.86)	(0.81)	(0.86)
$RDPROCESS_{i(t-1)}$	0.049	0.049	0.048	0.049	0.048	0.048	0.053	0.053	0.052
	(0.66)	(0.66)	(0.65)	(0.66)	(0.65)	(0.64)	(0.72)	(0.72)	(0.71)
Observations	9074	9074	9074	9074	9074	9074	9074	9074	9074

Note: Absolute value of z statistics in parentheses. Time dummies and three digit industry dummies are included. All the dependent variables are lagged one year. * significant at 10%; ** significant at 5%; *** significant at 1%.

TableV-2: Random Effects Probit Model - Classified Size by Total Fixed Assets.

Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
$EX_{i(t-1)}$	0.919***	0.919***	0.920***	0.919***	0.919***	0.920***	0.919***	0.919***	0.920***
	(145.44)	(113.22)	(135.46)	(144.83)	(151.08)	(134.70)	(138.77)	(132.32)	(123.09)
$FOREIGN_{i(t-1)}$	0.055*	0.056*	0.057*						
	(1.86)	(1.88)	(1.93)						
$FOREIGN25_{i(t-1)}$				0.073**	0.074**	0.073**			
				(2.34)	(2.36)	(2.35)			
$FOREIGN50_{i(t-1)}$							0.119***	0.120***	0.117***
							(2.99)	(3.02)	(2.93)
$TFP^{LP}_{i(t-1)}$	0.048***			0.048***			0.050***		
	(3.05)			(3.10)			(3.19)		
$TFP^{BUETTNER}_{i(t-1)}$		0.039***			0.039***			0.041***	
		(2.69)			(2.74)			(2.87)	
$TFP^{LABPROD}_{i(t-1)}$			0.017			0.018			0.020
			(1.01)			(1.05)			(1.16)
$SMALL^{A}_{i(t-1)}$	-0.075**	-0.068**	-0.083***	-0.075**	-0.068**	-0.083***	-0.074**	-0.067**	-0.083***
	(2.35)	(2.12)	(2.62)	(2.37)	(2.12)	(2.64)	(2.35)	(2.10)	(2.63)
$LARGE^{A}_{i(t-1)}$	0.081***	0.079**	0.091***	0.080***	0.078**	0.090***	0.078**	0.076**	0.088***
	(2.62)	(2.54)	(2.98)	(2.60)	(2.51)	(2.96)	(2.53)	(2.44)	(2.91)
$VLARGE^{A}_{i(t-1)}$	0.130***	0.127***	0.159***	0.128***	0.125***	0.158***	0.122***	0.118***	0.152***
	(3.61)	(3.43)	(4.64)	(3.56)	(3.37)	(4.60)	(3.36)	(3.15)	(4.40)
$wage_{i(t-1)}$	0.019	0.024	0.043	0.015	0.020	0.040	0.015	0.020	0.040
	(0.63)	(0.81)	(1.36)	(0.49)	(0.68)	(1.24)	(0.50)	(0.67)	(1.24)
$SKILL_{i(t-1)}$	0.010	0.011	0.009	0.010	0.012	0.009	0.011	0.012	0.010
	(0.28)	(0.31)	(0.25)	(0.29)	(0.32)	(0.26)	(0.31)	(0.34)	(0.27)
$TRAIN_{i(t-1)}$	0.029	0.030	0.036	0.030	0.030	0.037	0.031	0.031	0.038
	(0.81)	(0.83)	(1.01)	(0.82)	(0.84)	(1.02)	(0.84)	(0.86)	(1.04)
$RDPRODUCT_{i(t-1)}$	0.056	0.054	0.058	0.056	0.053	0.058	0.059	0.056	0.060
	(0.90)	(0.86)	(0.93)	(0.90)	(0.86)	(0.93)	(0.95)	(0.90)	(0.98)
$RDPROCESS_{i(t-1)}$	0.048	0.049	0.053	0.048	0.049	0.053	0.052	0.053	0.057
	(0.66)	(0.67)	(0.72)	(0.65)	(0.67)	(0.72)	(0.70)	(0.72)	(0.77)
Observations	9074	9074	9074	9074	9074	9074	9074	9074	9074

Note: Absolute value of z statistics in parentheses. Time dummies and three digit industry dummies are included. All the dependent variables are lagged one year. * significant at 10%; ** significant at 5%; *** significant at 1%.

TableV-3: Pooled Linear Probability Model - Classified Size by Total Labour.

Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
$EX_{i(t-1)}$	0.892***	0.892***	0.892***	0.892***	0.892***	0.892***	0.892***	0.892***	0.892***
	(131.17)	(131.39)	(131.72)	(130.54)	(130.77)	(131.11)	(132.31)	(132.59)	(132.59)
$FOREIGN_{i(t-1)}$	0.012**	0.011**	0.011**						
	(2.36)	(2.31)	(2.30)						
$FOREIGN25_{i(t-1)}$				0.014***	0.014***	0.014***			
				(2.86)	(2.82)	(2.80)			
$FOREIGN50_{i(t-1)}$							0.017***	0.017***	0.017***
							(3.11)	(3.10)	(3.10)
$TFP^{LP}_{i(t-1)}$	0.007***			0.007***					
	(2.79)			(2.81)					
$TFP^{BUETTNER}_{i(t-1)}$		0.006**			0.006**		0.006**		
		(1.97)			(1.98)		(1.99)		
$TFP^{LABPROD}_{i(t-1)}$			0.006**			0.006**		0.006**	0.006**
			(2.44)			(2.43)		(2.45)	(2.45)
$SMALL_{i(t-1)}$	-0.019***	-0.018***	-0.020***	-0.019***	-0.018***	-0.020***	-0.018***	-0.020***	-0.020***
	(3.25)	(3.16)	(3.58)	(3.26)	(3.17)	(3.59)	(3.12)	(3.55)	(3.55)
$LARGE_{i(t-1)}$	0.023***	0.022***	0.024***	0.023***	0.022***	0.024***	0.022***	0.024***	0.024***
	(3.72)	(3.66)	(3.99)	(3.74)	(3.68)	(4.01)	(3.66)	(3.99)	(3.99)
$VLARGE_{i(t-1)}$	0.030***	0.029***	0.033***	0.030***	0.029***	0.033***	0.029***	0.033***	0.033***
	(4.87)	(4.57)	(5.48)	(4.87)	(4.58)	(5.49)	(4.54)	(5.45)	(5.45)
$wage_{i(t-1)}$	0.010**	0.011*	0.010*	0.010*	0.010*	0.009*	0.011**	0.010*	0.010*
	(2.00)	(1.90)	(1.85)	(1.92)	(1.82)	(1.78)	(1.96)	(1.91)	(1.91)
$SKILL_{i(t-1)}$	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003
	(0.59)	(0.59)	(0.56)	(0.60)	(0.60)	(0.57)	(0.58)	(0.55)	(0.55)
$TRAIN_{i(t-1)}$	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.003	0.003
	(0.42)	(0.39)	(0.43)	(0.42)	(0.39)	(0.43)	(0.41)	(0.46)	(0.46)
$RDPRODUCT_{i(t-1)}$	0.006	0.006	0.007	0.006	0.006	0.006	0.006	0.007	0.007
	(0.75)	(0.72)	(0.78)	(0.74)	(0.71)	(0.77)	(0.72)	(0.78)	(0.78)
$RDPROCESS_{i(t-1)}$	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007
	(0.69)	(0.68)	(0.67)	(0.71)	(0.70)	(0.69)	(0.74)	(0.73)	(0.73)
Observations	9074	9074	9074	9074	9074	9074	9074	9074	9074

Note: Robust t statistics in parentheses. Time dummies and three digit industry dummies are included. All the dependent variables are lagged one year. * significant at 10%; ** significant at 5%; *** significant at 1%.

TableV-4: Pooled Linear Probability Model - Classified Size by Total Fixed Assets.

Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
$EX_{i(t-1)}$	0.896***	0.897***	0.898***	0.896***	0.896***	0.898***	0.896***	0.896***	0.898***
	(135.88)	(136.74)	(138.66)	(135.43)	(136.29)	(138.22)	(136.96)	(137.93)	(139.87)
$FOREIGN_{i(t-1)}$	0.010**	0.010**	0.010**						
	(2.07)	(2.06)	(2.10)						
$FOREIGN25_{i(t-1)}$				0.012**	0.012**	0.012**			
				(2.51)	(2.48)	(2.48)			
$FOREIGN50_{i(t-1)}$							0.016***	0.016***	0.016***
							(2.89)	(2.83)	(2.79)
$TFP_{i(t-1)}^{LP}$	0.009***			0.009***			0.009***		
	(3.72)			(3.75)			(3.81)		
$TFP_{i(t-1)}^{BUETTNER}$		0.007**			0.008**			0.008**	
		(2.45)			(2.48)			(2.51)	
$TFP_{i(t-1)}^{LABPROD}$			0.003			0.003			0.003
			(1.14)			(1.15)			(1.22)
$SMALL_{i(t-1)}^{A}$	-0.014**	-0.013**	-0.016***	-0.014**	-0.013**	-0.016***	-0.014**	-0.013**	-0.016***
	(2.41)	(2.19)	(2.69)	(2.43)	(2.21)	(2.71)	(2.43)	(2.20)	(2.71)
$LARGE_{i(t-1)}^{A}$	0.018***	0.017***	0.019***	0.017***	0.017***	0.019***	0.017***	0.017***	0.019***
	(3.11)	(2.96)	(3.40)	(3.10)	(2.94)	(3.38)	(3.04)	(2.89)	(3.33)
$VLARGE_{i(t-1)}^{A}$	0.024***	0.023***	0.029***	0.024***	0.023***	0.029***	0.023***	0.022***	0.028***
	(4.04)	(3.48)	(4.88)	(4.00)	(3.44)	(4.85)	(3.85)	(3.32)	(4.72)
$wage_{i(t-1)}$	0.004	0.005	0.009*	0.004	0.005	0.009*	0.004	0.005	0.009*
	(0.84)	(0.99)	(1.73)	(0.76)	(0.91)	(1.68)	(0.87)	(1.03)	(1.80)
$SKILL_{i(t-1)}$	0.001	0.001	0.000	0.001	0.001	0.000	0.001	0.001	0.000
	(0.17)	(0.16)	(0.06)	(0.18)	(0.16)	(0.06)	(0.17)	(0.15)	(0.05)
$TRAIN_{i(t-1)}$	0.006	0.006	0.007	0.006	0.006	0.007	0.006	0.006	0.007
	(1.02)	(1.03)	(1.26)	(1.03)	(1.03)	(1.27)	(1.05)	(1.05)	(1.29)
$RDPRODUCT_{i(t-1)}$	0.007	0.007	0.008	0.007	0.007	0.008	0.007	0.007	0.008
	(0.86)	(0.84)	(0.98)	(0.85)	(0.83)	(0.98)	(0.86)	(0.84)	(0.99)
$RDPROCESS_{i(t-1)}$	0.007	0.007	0.007	0.007	0.007	0.008	0.008	0.008	0.008
	(0.72)	(0.71)	(0.76)	(0.74)	(0.73)	(0.78)	(0.78)	(0.77)	(0.82)
Observations	9074	9074	9074	9074	9074	9074	9074	9074	9074

Note: Robust t statistics in parentheses. Time dummies and three digit industry dummies are included. All the dependent variables are lagged one year. * significant at 10%; ** significant at 5%; *** significant at 1%.

TableV-5: Random Effects Linear Probability Model - Classified Size by Total Labour.

Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
$EX_{i(t-1)}$	0.825***	0.825***	0.826***	0.825***	0.825***	0.825***	0.826***	0.826***	0.827***
	(82.21)	(82.35)	(82.54)	(81.84)	(81.98)	(82.18)	(82.71)	(82.90)	(83.07)
$FOREIGN_{i(t-1)}$	0.026***	0.026***	0.025***						
	(4.20)	(4.15)	(4.14)						
$FOREIGN25_{i(t-1)}$				0.029***	0.029***	0.029***			
				(4.66)	(4.59)	(4.58)			
$FOREIGN50_{i(t-1)}$							0.031***	0.031***	0.031***
							(4.41)	(4.29)	(4.29)
$TFP^{LP}_{i(t-1)}$	0.011***			0.011***			0.012***		
	(3.90)			(3.93)			(4.02)		
$TFP^{BUETTNER}_{i(t-1)}$		0.009***			0.009***			0.009***	
		(2.59)			(2.61)			(2.66)	
$TFP^{LABPROD}_{i(t-1)}$			0.010***			0.010***			0.011***
			(3.38)			(3.39)			(3.47)
$SMALL_{i(t-1)}$	-0.026***	-0.025***	-0.028***	-0.026***	-0.026***	-0.029***	-0.025***	-0.025***	-0.028***
	(3.76)	(3.66)	(4.20)	(3.77)	(3.67)	(4.22)	(3.70)	(3.60)	(4.15)
$LARGE_{i(t-1)}$	0.032***	0.032***	0.034***	0.032***	0.032***	0.035***	0.032***	0.032***	0.034***
	(4.45)	(4.39)	(4.84)	(4.48)	(4.42)	(4.87)	(4.43)	(4.38)	(4.83)
$VLARGE_{i(t-1)}$	0.047***	0.046***	0.052***	0.047***	0.046***	0.052***	0.047***	0.046***	0.052***
	(6.09)	(5.77)	(6.88)	(6.12)	(5.79)	(6.90)	(6.10)	(5.79)	(6.90)
$wage_{i(t-1)}$	0.010*	0.011*	0.010	0.010	0.011	0.009	0.011*	0.012*	0.011*
	(1.71)	(1.71)	(1.60)	(1.63)	(1.63)	(1.53)	(1.93)	(1.92)	(1.81)
$SKILL_{i(t-1)}$	0.003	0.003	0.002	0.003	0.003	0.002	0.002	0.002	0.002
	(0.37)	(0.37)	(0.33)	(0.37)	(0.37)	(0.33)	(0.32)	(0.32)	(0.28)
$TRAIN_{i(t-1)}$	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004
	(0.63)	(0.60)	(0.66)	(0.63)	(0.60)	(0.66)	(0.66)	(0.63)	(0.69)
$RDPRODUCT_{i(t-1)}$	0.010	0.010	0.011	0.010	0.010	0.010	0.010	0.010	0.010
	(1.07)	(1.04)	(1.11)	(1.05)	(1.02)	(1.09)	(1.06)	(1.03)	(1.10)
$RDPROCESS_{i(t-1)}$	0.011	0.011	0.011	0.011	0.011	0.011	0.012	0.012	0.012
	(0.99)	(0.98)	(0.97)	(1.02)	(1.02)	(1.01)	(1.07)	(1.06)	(1.05)
Observations	9074	9074	9074	9074	9074	9074	9074	9074	9074

Note: Robust z statistics in parentheses. Time dummies and three digit industry dummies are included. All the dependent variables are lagged one year. * significant at 10%; ** significant at 5%; *** significant at 1%.

TableV-6: Random Effects Linear Probability Model - Classified Size by Total Fixed Assets.

Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
$EX_{i(t-1)}$	0.830***	0.831***	0.833***	0.829***	0.830***	0.832***	0.831***	0.831***	0.834***
	(84.85)	(85.33)	(86.39)	(84.57)	(85.07)	(86.15)	(85.46)	(86.01)	(87.13)
$FOREIGN_{i(t-1)}$	0.024***	0.024***	0.024***						
	(3.90)	(3.89)	(3.95)						
$FOREIGN25_{i(t-1)}$				0.027***	0.027***	0.027***			
				(4.28)	(4.25)	(4.27)			
$FOREIGN50_{i(t-1)}$							0.029***	0.028***	0.028***
							(4.03)	(3.96)	(3.94)
$TFP^{LP}_{i(t-1)}$	0.014***			0.014***			0.014***		
	(4.73)			(4.78)			(4.86)		
$TFP^{BUETTNER}_{i(t-1)}$		0.011***			0.011***			0.011***	
		(2.88)			(2.92)			(2.98)	
$TFP^{LABPROD}_{i(t-1)}$			0.006*			0.006*			0.006*
			(1.78)			(1.81)			(1.92)
$SMALL^{A}_{i(t-1)}$	-0.021***	-0.020***	-0.023***	-0.021***	-0.020***	-0.024***	-0.021***	-0.020***	-0.024***
	(3.10)	(2.86)	(3.39)	(3.14)	(2.90)	(3.44)	(3.13)	(2.89)	(3.43)
$LARGE^{A}_{i(t-1)}$	0.027***	0.026***	0.029***	0.026***	0.026***	0.029***	0.026***	0.026***	0.029***
	(3.87)	(3.71)	(4.22)	(3.85)	(3.69)	(4.20)	(3.81)	(3.66)	(4.17)
$VLARGE^{A}_{i(t-1)}$	0.040***	0.039***	0.047***	0.039***	0.038***	0.047***	0.039***	0.038***	0.046***
	(5.27)	(4.69)	(6.20)	(5.23)	(4.65)	(6.17)	(5.12)	(4.57)	(6.08)
$wage_{i(t-1)}$	0.002	0.004	0.008	0.001	0.004	0.008	0.003	0.005	0.009
	(0.30)	(0.62)	(1.33)	(0.22)	(0.56)	(1.29)	(0.50)	(0.83)	(1.55)
$SKILL_{i(t-1)}$	-0.001	-0.001	-0.002	-0.001	-0.001	-0.002	-0.001	-0.001	-0.002
	(0.09)	(0.11)	(0.23)	(0.09)	(0.11)	(0.23)	(0.13)	(0.16)	(0.28)
$TRAIN_{i(t-1)}$	0.007	0.007	0.009	0.007	0.007	0.009	0.007	0.008	0.009
	(1.15)	(1.17)	(1.41)	(1.16)	(1.18)	(1.42)	(1.17)	(1.19)	(1.44)
$RDPRODUCT_{i(t-1)}$	0.011	0.011	0.012	0.011	0.011	0.012	0.011	0.011	0.012
	(1.18)	(1.17)	(1.32)	(1.16)	(1.15)	(1.30)	(1.17)	(1.16)	(1.31)
$RDPROCESS_{i(t-1)}$	0.011	0.011	0.012	0.012	0.012	0.012	0.012	0.012	0.013
	(1.04)	(1.04)	(1.09)	(1.07)	(1.08)	(1.12)	(1.11)	(1.12)	(1.16)
Observations	9074	9074	9074	9074	9074	9074	9074	9074	9074

Note: Robust z statistics in parentheses. Time dummies and three digit industry dummies are included. All the dependent variables are lagged one year. * significant at 10%; ** significant at 5%; *** significant at 1%.