Multi-Product Firms and Exporting: A Developing Country Perspective

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Abstract

In this paper we make the distinction between single and multi-product firms to shed additional light on the complex relationship between multinational enterprises (MNEs), exporting and economic development. Using firm-level data for Thailand we show that the number of goods produced causes a larger variation in exports volumes than production volumes. Whilst the number of products and the total volume of exports are positively correlated we find, in contrast to US studies, a negative correlation between the number of products produced and the volume of production per product. We then investigate the characteristics associated with multi-product firms and find a distinction between foreign owned and domestic firms as well as between foreign exporters and foreign non-exporters. The presence of foreign firms producing single products solely for the domestic market as well as those producing many products for export demonstrates the diversity of behaviour of foreign firms in developing countries. Therefore, attracting foreign firms at all costs may not be as beneficial as policy makers believe.

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1. Introduction

The study of international trade has been transformed by the modelling of firm heterogeneity, productivity and exporting (see e.g. Hopenhayen 1992, Melitz 2003 and Bernard *et al.* 2007b)[1]. What the early literature failed to take into account was that world production and trade is dominated by multi-product firms which has led to recent developments in both the theoretical and empirical literature (Bernard *et al.* 2006a and Bernard *et al.* 2006b) The importance of multi-product firms was initially pointed out for the US by Bernard *et al.* (2005) and (2006a) who show that 41 percent of firms produce more than one product but that multi-product firms account for 91 percent of total output while multi-product exporters account for more than 95 percent of total exports. These stylised facts have led to a renewed interest in the differentiated products and trade literature (see e.g. Linder 1961, Falvey 1981, Falvey and Kierzowski 1987, Flam and Helpman 1987 and Shaked and Sutton 1987) as evidenced by recent empirical papers by Hummels and Klenow (2005), Hallak (2006) and Schott (2007).

However, detailed investigations of the multi-product firm phenomenon are limited and almost exclusively concentrated on developed countries. Yet, the role of foreign firms in developing countries is considered a crucial part of the development story with developing countries becoming increasingly aggressive in their approach to attracting foreign direct investment (FDI).[2] In this paper, we examine the role of multi-product firms in a developing country, in this case Thailand. A first pass of the data suggests that there are both similarities and dissimilarities with the US. For Thailand, 43 percent of firms produce more than one product (compared to the 41 percent figure for the US). However, 57 percent of output is produced by multi-product firms and 52 percent of total exports are from firms that export

[1] For a recent survey of the exporting and productivity literature see Greenway and Kneller (2007).
[2] Indeed, a growing literature examines the impact of FDI on developing countries and increasingly whether such policies are worthwhile (see e.g., Bergsman and Shen 1996, Blömstrom and Kokko, 1998, Aitkin and Harrison 1999 and Lall and Narula 2004).

multiple products (compared to the US figures of 91 and 95% respectively). The headline figures for the production and exporting share are clearly of a different magnitude to the figures that Bernard *et al* (2006) find for the US. The smaller output percentage for Thailand hints at the differences in the behaviour of firms in developed and developing countries certainly in terms of the size distribution of firms.[3]

In the trade literature the traditional approach to modelling the impact of trade liberalisation on an economy is to assume single product firms with any intra-firm adjustment taking place in the scale of production with no role for multi-product production. The industrial organisation literature on the other hand has been quicker to embrace the study of multi-product firms (see e.g. Brander and Eaton 1984, Baldwin and Ottaviano 2001, Johnson and Myatt 2003, and Allanson and Montagna 2005). However, the IO literature does not examine the export behaviour of firms and more specifically the export profile of firms.

So if we want to understand the dynamics of a newly industrialised country such as Thailand why is it important to make the distinction between single and multi-product firms? First, one of the arguments put forward to justify FDI subsidies and tax breaks for foreign firms is to enable governments of developing countries to attract firms and to subsequently benefit from technology and knowledge spillovers to local firm and workers. From a spillover perspective, multi-product firms are likely to be more attractive as it is logical that the greater the number of products produced, the wider the range of technologies employed and thus the more likely that domestic firms will benefit from technology and knowledge spillovers. The process of a firm becoming multi-product is also associated with process and product R&D as firms seek to

[3] However, we must be careful when making comparisons between our results and Bernard *et al.* (2005, 2006a) as the definition of multiple product depends crucially on how we define what constitutes an individual product. The greater the level of disaggregation, the larger the number of multi-product firms. This is synonymous with the categorical aggregation problem that has plagued the intra-industry trade (IIT) literature (Caves 1981). In this paper we use the equivalent of 5-digit Standard Industrial Classification (SIC) compared to Bernard *et al.* (2006a) who use a 5-digit SIC and Bernard *et al.* (2005) who use a 10-digit Harmonised System (HS) classification to measure their output and export statistics respectively and is probably one explanation for a at least some of the difference in our headline figures. Indeed, given these numbers come from different aggregation levels one should not draw conclusions from their relative magnitudes.

develop new products and methods of production. R&D is also strongly associated with positive spillovers from FDI. Second, the growth through exporting route has proved to be particularly successful in the past as experienced by many East Asian countries over the last two decades. Thus, governments, if given a choice, are likely to prefer investment from foreign firms that produce more than one product, ideally for export. Finally, multi-product firms may be more attractive to host governments given their potentially less susceptibility to demand shocks as the risk from, for example, changes in fashion or advances in product specific technology, is spread over a variety of exports and possibly export markets. Thus, domestic employment may benefit from less volatility. Therefore, an analysis of the structure of foreign firms and the products they produce will provide a useful insight into the actual role played by MNEs in developing countries.

One result from the existing firms and exporting literature is that size matters with large firms more likely to export. It is therefore important for a developing country to attract firms of a certain size. Thus, in this paper, we examine two specific aspects of the multi-product and development question. In the first stage we examine the relationship between multi-product firms' extensive margins (number of products produced or exported) and intensive margins (output or export sales per product). Given that globalization or changes in trade barriers or trade costs will lead to intra-firm adjustment along firms' extensive and intensive margins we examine how this relationship affects the distribution in firm size. In addition, we examine the correlation between firms' extensive and intensive margins. Our first stage results show, in contrast to Bernard *et al.* (2006b), that there is little variance between Thai firms' extensive margins and total output or total export sales. In addition, the relationship between the intensive and extensive margins are mixed when different definitions of the two variables are used. We find that they are negatively correlated in production but positively correlated in exports.

In the second stage of the paper, we examine the characteristics associated with firms' decisions to produce multiple products making a distinction between domestic and foreign owned firms. Our second stage results show that becoming a multi-product firm and the number products produced is associated with various firm characteristics including export status, total factor productivity (TFP) and research and development (R&D) status. Comparing domestic and foreign firms, we observe some systematic differences in both the factors that are related to being a multi-product firm and the number of products produced. Overall, a complex picture of the behaviour of MNEs in developing countries emerges where foreign owned firms that export are strongly associated with being multi-product but foreign firms that only serve the domestic market show a strong negative partial correlation with being multi-product. These factors might explain, in part, why evidence for knowledge diffusion and productivity spillovers is less widespread that one might have imagined. Thus, our finding that a significant proportion of foreign owned firms supply only the domestic market and produce just a single product is an interesting new stylised fact not previously highlighted in the literature.

The structure of the remainder of this paper is organised as the follows. Section 2 presents an overview of the theoretical and empirical literature. Section 3 describes the data. In section 4, we discuss our empirical model and present the results of our intensive and extensive margin analysis while section 5 presents our results examining the characteristics of those firms that decide to produce multiple products and the factors related to the number of goods produced. Section 6 concludes.

2. Literature Review

Various models have been developed to explain trade at the firm level. A widely cited paper is Melitz (2003) who uses productivity differences across firms to develop a firm level model of

intra-industry trade and exporting where firms produce horizontally differentiated goods. The model assumes that the production function has a single factor of production and shows that trade liberalisation through a reduction in trade barriers would reduce the export productivity cut-off, increase benefits to exporting and persuade more productive firms to enter the market. Using a comparative advantage framework, Bernard *et al.* (2007b) point out that resource reallocation within and across industries leads to increases in industry productivity and sector outputs of the comparative advantage industries compared to industries with a comparative disadvantage because the former are more likely to become exporters. These two models however, says nothing about the role of multi-product firms.

One of the first papers to consider such a role was Baldwin and Ottaviano (2001) who develop a model to explain the behaviour of multi-product firms in intra-industry FDI and intra-industry trade. Because of trade costs, multi-product firms engage in FDI by producing some products abroad in order to reduce inter-variety competition. Although FDI and exports are substitutes they may also generate some reverse imports of those varieties manufactured abroad. In the heterogeneous firm model by Bernard *et al.* (2003) which is essentially an extension of the Ricardian model, a reduction in trade barriers or trade cost induces an increase in productivity because of an expansion of high productivity firms with low-productivity firms exiting the market.

In contrast, Bernard *et al.* (2006b) present a general equilibrium model of firm dynamics with heterogeneous firms and endogenous entry and exit of firms. They assume the productivity of the firm for each single product to be fixed. When trade is liberalised, a reduction in trade costs leads to a reallocation of resources and therefore increases firm-level and industry-level productivity. Firms produce and export the most successful products (high-expertise products) rather than low-productivity products. The model predicts a positive correlation between firms' intensive (the output per product) and extensive (the number of products)

margins which indicates that the production for the export market is enlarged not only through an increase in the number of varieties sold abroad but also through an increase in exports per product. This result is driven by the interaction between general competencies (ability) and product specific abilities (expertise). Thus, following trade liberalisation, exporting firms expand the range of the products to be exported whilst simultaneously contracting the range of products that they choose to produce.

In a recent paper, Eckel and Neary (2006) present a general equilibrium model of multi-product firms with oligopolist behaviour and address the role of the adjustment processes within multi-product firms and the relationship with factor and goods markets. Specifically, they analyze how firms react to shocks and the affect of these shocks not only on wages and labour demand but also on the number of products a firm produces highlighting the role of flexible manufacturing. Their results suggest that in a multi-product framework firms may adjust their scale of output and number of varieties produced instead of in the traditional trade literature which only allows entry and exit in response to shocks. One distinguishing feature of Eckel and Neary (2006) is the emphasis on "core competences" with one variety being able to be produced more efficiently than varieties that lie outside this core competency. This means firms are free to expand their production lines but that this process is subject to diseconomies of scope and cost heterogeneities. Such costs differences allow cannibalisation to occur in response to shocks.

Similarly, Nocke and Yeaple (2006) develop a theoretical model with multi-product firms in order to analyse the effect of globalisation through trade liberalisation on firm scope assuming that the relationship between marginal costs of each product variety and the number of variety of each firm are positively correlated. They find that globalisation and trade liberalisation affect firms' productivity because the marginal costs are endogenously determined. If new product lines are added, less goods will be produced therefore firms face higher marginal costs

of production that causes a reduction in the TFP of existing product lines. Crucially, in contrast to Bernard *et al.* (2006b) their model predicts a negative correlation between firms' intensive and extensive margins.

Feenstra and Ma (2007) develop a monopolistic competition model that emphasises the optimal choice of product scope for multiproduct firms. Each firm has to choose their product scope and, at the same time, has to be concerned about cannibalization effects of their own sales. The model shows that when a country opens to trade, the less efficient firms exit the market while large and high productive firms remain and produce a greater variety of products.

In the majority of cases, models attempt to explain the stylised facts of the US international trade and to address the difference between exporters and non-exporters where exporters are assumed to have higher employment, output, value added per worker and productivity compared to non-exporters (Bernard *et al.,* 2007a). Thus, empirically one of the first papers was Bernard *et al.* (2006b) who investigate the relationship between multi-product firms and exporting by testing firms' intensive and extensive margins using the US 1997 Manufacturing Census data. The empirical results show that exporters produce a greater variety of products than non-exporters. In addition, a positive and significant relationship between the intensive margin and an export dummy indicates that exporters produce more output per product more than non-exporters.

In Bernard *et al.* (2007a), a gravity equation framework is employed to examine the relationship between bilateral distance and firms' extensive or intensive margins. Using US data, the results show that distance to trading partner decreases both the number of exporting firms and number of exported products but increases the average export value.

In Bernard *et al.* (2006a), adjustment to firms' extensive margins suggests that the number of products can be changed through resource reallocation. The concept of adding and dropping particular products is based on productivity differences across products. Bernard *et al.* (2006a) find a positive relationship between a firm's productivity and the number of products. Productive firms self-select to produce additional products whereas firms are likely to drop later-birth products and the less-productive products, compared to other firms that produce similar products. In addition, they also find that multiple product firms are larger and more productive than single product firms.

For developing countries there are two studies of interest, First, Brambilla (2006) presents a model of multi-product firms using a production function of the number of product varieties, a cost function of production technology and the maximisation of expected profits in order to explain how many varieties each firm decides to produce. The relationship between the structure of ownership and the number of product varieties among multiproduct firms in China's manufacturing sector is then examined. Because foreign and domestic owned firms face different costs of product development and have different technology and product efficiencies they show that the majority-owned foreign firms introduce more new varieties compared to private domestic firms.

Second, Eaton *et al.* (2007) investigate the variation in a country's exports using Colombian data. Total exports are a composition of the varieties sold (extensive margin) and average sales (intensive margin). They find that an increase in the total export value of Colombia affects over 50 percent more firms. They also examine the export dynamics of continuing firms, entrants and those that exit. Total export sales of new exporters are relatively small with most of the export revenue coming from a small number of very large stable exporters.

3. Descriptives and Data

Thailand has been the third largest exporter from the Southeast Asian region over the last 10 years (ASEAN Statistical Yearbook, 2005). As a member of ASEAN, Thailand shares in the benefits of the ASEAN Free Trade Area.[4] Not surprisingly, the ASEAN region remains a major export market for Thailand. The share of Thai exports to ASEAN in 2007 was about 21.3 percent of total exports with 12.6 percent and 12.8 percent exported to the US and EU15 respectively. Since 1999, the total export value of trade has increased dramatically reaching US$ 152,477.58 million in 2007. In contrast to many developed countries, the manufacturing sector still dominates, accounting for 78 percent of total exports in 2007.

Table 1 illustrates the level of exports for a range of Thai industries. Sectors with a large volume of exports tend to be high-technology products such as computers, parts, and accessories, automobiles and parts, and integrated circuits. The production of computers and parts has been Thailand's leading industrial export sector for many years, accounting for 11.35 percent of the country's total exports in 2007. 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 the country as an export platform to sell their products to the rest of the world. Other prominent export sectors include labour-intensive products such as gems, jewellery, and garments.[5]

[Table 1 about here]

For the empirical analysis in this paper we use the Annual Survey of Thailand's manufacturing industries by the Office of Industrial Economics (OIE), Ministry of Industry, Thailand. In 2001 a questionnaire was sent out to 6,735 firms. The response rate was around 60%. The

[4] 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. The ASEAN free trade area was finally established in 1992 and aims to eliminate tariff and non-tariff barriers in both manufacturing and agricultural sectors among member countries.

[5] After 2004, the growth of exports from the textile industry fell as a result of the elimination of quota restrictions in early 2005 and increased competition in the garment sector from China, Vietnam and India (Bank of Thailand, 2006).

survey covers 79 types of manufacturing activity at the 4-digit ISIC level that consists of 23 2-digit ISIC industries and in 2001 included small (35 percent), medium (32 percent), and large (33 percent) firms. The sample can be considered representative of Thai manufacturing industries with the value added of firms included in the survey accounting for 95% of total manufacturing GDP (OIE, 2001). The questionnaire includes twenty-five questions that cover different aspects of a firm's characteristics and performance including balance sheet information. We control for possible outliers by excluding 0.5 pecent tails of all the regression variables except for binary dummies. Our final unbalanced panel comprises 15,115 observations for the period 2001 to 2004.[6]

The data contain detailed information on standard firm level variables such as structure of ownership, employment, region, wage, productivity, R&D, output and exports. One significant advantage of this data is that we are able to identify the number of products a firm produces. Our product classification is based loosely on ISIC and HS classifications of what constitutes a product and are based on the question in the survey that asks the firms to "list the products that you produce". We believe this approximates to a 5-digit product classification.[7]

Table 2 provides a summary of our 2-digit ISIC data for the four years of our sample 2001 to 2004. The sectors that export more than 70 percent of output are ISIC 18 (Wearing Apparel; dressing and dying of fur), ISIC 32 (Radio, television and communication equipment) and ISIC 36 (Furniture). In 17 out of 22 2-digit ISIC sectors we observe an increase in the proportion of firms that export with ISIC 34 (Motor vehicles, trailers & semi-trailers) showing the largest increase in exports during this period.

[Table 2 about here]

[6] Each year, some firms do not respond or even shut down which causes our data set to have an unbalanced structure. To compensate for the closure or none response of some firms, in 2004 the sampling was extended and data collected for additional plants (OIE, 2004). Unfortunately we do not have specific data on firm deaths.
[7] Our method of product identification was to match the product lists with the HS product classification list by visual inspection.

In Table 3 we present the share of output and the share of firms that produce single and multiple products across various groupings. When we consider all firms, we see that the majority of firms produce only one product (57.12 percent) with 17.81 percent producing two products and only 9.15 percent producing five or more products. However, those 57.12 percent of firms only produce around 43 percent of total output with the 9.15 percent of firms producing five or more products producing 15 percent of total output. If we compare foreign and domestic firms we observe that a larger proportion of domestic firms produce just one product. Thus, consistent with Bernard *et al.* (2006b) we find that foreign firms have a higher likelihood of being multi-product and a higher share of output with 17.25 percent of firms producing five or more products. Comparing exporters and non-exporters is also illuminating where we find an even greater difference with 61.16 percent of non-exporters and only 53.15 percent of exporters producing a single product.

Finally, we introduce a final complication by making a distinction between foreign owned exporters and non-exporters. We find that 68 percent of foreign non-exporters produce a single product. The fact that approximately one fifth of foreign firms do not export is a stylised fact that we believe has not been previously highlighted in the literature where foreign firms are almost considered to be exporters almost by definition. This insight adds a layer of complexity to our analysis and hints at a more subtle relationship between foreign firms and the benefits accrued to the host country.

[Table 3 about here]

4. Multi-Product Firms' Intensive and Extensive Margins

As previously noted, multi-product firms in Thailand produce 57 percent of total output while firms that export multiple products account for over 52 percent of total export sales. Bernard *et al.* (2006b) investigate this phenomenon for US multi-product firms by examining the

contribution of firms' extensive margins to firm-size distribution. In this section we follow the methodology of Bernard *et al.* (2006b) to test whether their conclusions also hold for a newly industrialising country where the importance of attracting large MNEs is often part of government industrial policy.

Bernard *et al.* (2006b) begins with a cross-section estimation. The basic framework for firm-size distribution is to identify firm' extensive (number of products) and intensive (output per product) margins. In this paper, we have a panel estimation so the relationship is presented in equation (1),

$$Y_{it} = n_{it}\bar{y}_{it} \tag{1}$$

where Y_i is firm size measured by total output of each individual firm.

n_i is the number of products produced by firm.

$\bar{y}_i$ is the average output per product that is defined as $\bar{y}_{it} \equiv \frac{1}{n_{it}} \sum_{p} y_{pit}$.

The subscripts i, t and p denote firm, time and product respectively. The relationship between firm size and multiple product firms requires a knowledge of how firm size varies. By taking the log of equation (1), the model can be separated into two regressions for firms' intensive and extensive margins as a function of the log of total output,

$$\ln n_{it} = \delta_1 + \beta_1 \ln Y_{it} + \mu_{it} \tag{2}$$

$$\ln \bar{y}_{it} = \delta_2 + \beta_2 \ln Y_{it} + \varepsilon_{it} \tag{3}$$

where μ_{it} and ε_{it} denote stochastic errors. By using OLS estimation techniques it can be assumed that $\beta_1 + \beta_2 = 1$. Thus the coefficient of β_1 captures the partial correlation between

total output and the extensive margin and β_2 captures the partial correlation between total output and the intensive margin (Bernard *et al.*, 2006b).

In addition, we examine the relationship between exporting and firms' intensive and extensive margins. In the case of an exporting firm, total exports is the number of products exported (n_i^e) multiplied by average exports per product ($\overline{y}_i^e$). Thus, the estimated regression decompositions for exporting are presented as,

$$\ln n_{it}^e = \delta_3 + \beta_3 \ln Y_{it}^e + \mu_{it} \tag{4}$$

$$\ln \overline{y}_{it}^e = \delta_4 + \beta_4 \ln Y_{it}^e + \varepsilon_{it} \tag{5}$$

Since a firm's extensive and intensive margins are correlated, where $\beta_2 = 1 - \beta_1$ and $\beta_4 = 1 - \beta_3$ we simply report the estimated results of a firm's extensive margin (β_1 and β_3). A robust variance estimation corrects for the problem of heteroscedastic errors. The results from OLS estimations with and without region, industry and time fixed effects are presented in Table 4 and are based on a sample of multi-product firms only.

In Columns (1) and (2), we find that the number of products produced accounts for approximately one percent of the variation in total firm output. This means that an increase in the number of products (extensive margin) accounts for only one percent of the increase in total output. On the other hand, this result indicates that the variation of total firm output in Thailand is mainly due to changes in average output per product (intensive margin).

A slightly higher variation is observed if we consider the number of products exported and total export sales (Columns 3 and 4). The coefficient shows that the number of products exported causes a variation in total export sales of 7.4 percent. This means that the number of

products exported raises total export sales by 7.4 percent by keeping average export sales per product constant.

[Table 4 about here]

Next we examine the relationship between intensive and extensive margins by regressing firms' output or exports per product on the number of products produced or exported by firm. The estimated regressions are presented as follows,

$$\ln \bar{y}_{it} = \sigma_1 + \gamma_1 \ln n_{i(t-1)} + \xi_{it} \tag{6}$$

$$\ln \bar{y}^{e}_{it} = \sigma_2 + \gamma_2 \ln n^{e}_{i(t-1)} + \omega_{it} \tag{7}$$

In Table 5 we observe a positive correlation between the extensive and intensive margin in Columns (3) and (4) only. This positive relationship indicates that the number of products exported increases export sales per product by between 50.1 percent and 58.4 percent. We can conclude therefore that multi-product firms only marginally increase the number of products exported but for each product, multi-product firms export a larger volume of each. However, in contrast to Bernard *et al.* (2006b), we find a negative and significant correlation for firms' extensive and intensive margins when we consider production data. Thus, in Columns (1) and (2), we find that an increase in the number of products produced decreases the amount of output per product by between 64.1 percent and 69.2 percent. This suggests that in Thailand, the more products a firm develops, the less of each one produced. One explanation is that there may be advantages associated with the production of a number of products and that by using the same production unit, distributing products through the same channels and managing production within the same organisation there is no discernible difference in cost. A second explanation is that multi-product firms in Thailand may be trying to expand their

market potential by increasing the number of products produced rather than merely increasing sales of existing products. If firms produce a greater number of products it may help to reduce future risk resulting from the product life cycle at any given period. More importantly, it suggests that the behaviour of MNEs differs by location between developed and developing countries. It will be interesting to see whether these results hold for other developing countries.

[Table 5 about here]

From the decomposition of the firm-size distribution and firms' extensive margins, we found that intra-firm adjustment on the number of products produced and exported by multi-product firms positively and significantly affects the variation in firm size. The effect on the variation in firm size is mainly due to changes in output and export sales per product. When we consider the relationship between firms' extensive and intensive margins, our results show that extensive and intensive margins are negatively correlated in production but positively correlated in exporting.

We now know that multi-product firms also play a significant but complex role in Thailand's economy. Although there are a larger number of single product firms, approximately 57 percent of total output is accounted for by multi-product firms. Given the importance of multi-product firms we now investigate which factors, in addition to size, are associated with a firm's decision to produce multiple products. By identifying these characteristics the results may enable policymakers to refine the selection criteria for targeting FDI attraction policies to encourage those firms that are most likely to benefit the domestic economy.

5. The Characteristics of Multi-Product Firms

5.1 The decision to become a multi-product firm

Recent stylised facts have shown that, in both domestic and international markets, multi-product firms have become increasingly important. We now investigate the characteristics of those firm's that decide to produce multiple products.

We estimate a pooled probit model for the binary dependent variable, which indicates the status of a firm.[8] All independent variables are lagged by one year in order to control for any possible endogeneity problems. Unfortunately the data does not provide a set of instruments to control for possible exogeneity between multi-product production and our dependent variables. For example, being multi-product may cause TFP to rise or make it more likely that a firm will export. We believe this is less of a problem than with the traditional determinants of exporting regressions. However, we acknowledge that lagging by one year is not ideal and hence in our results section we refer to associations and partial correlations instead of determinants and effects. Thus, our probit model is as follows,

$$\Pr(MULTIDUM_{it} = 1 \,|\, Z_{i(t-1)}) = \Phi(\beta' Z_{i(t-1)}) \tag{8}$$

where, $MULTIDUM_{it}$ is a dummy variable that is 1 if the firm is multi-product and 0 otherwise.

Z is a vector of firm characteristics.

Φ is the cumulative distribution function of the normal distribution function.

We include five region dummies, twenty-three two-digit industry and two year-dummies in order to control for unobserved effects.[9] In addition, we allow for robust clustering at the two-digit industry level (clustering at the regional level made little difference to the results).

[8] Since our data has a short panel structure we are not able to use alternative estimation methods (e.g. a fixed effects estimator or a GMM first difference estimator). Arellano and Bond (1991) explain that the GMM first difference estimator requires two or more lags of all the right-hand-side variables as instruments.

[9] Our region dummies are Bangkok and Metropolitan area, Central, East, North and South (see Table A1 of the Appendix).

This relaxes the independence assumption and requires only that the observations are independent across sectors.

In equation (8), the vector of firm characteristics (Z) includes the following,

EX is an export dummy which equals 1 if the firm has positive export sales and 0 otherwise.

$FOREIGN$ is a dummy, which equals 1 if at least 10% of shares are foreign owned, and 0 otherwise. Cut-offs of 25% and 50% were used in a sensitivity analysis.

*EX*FOREIGN* is an interaction term that measures the effect of being both foreign and an exporter over and above the individual effects.

TFP^{LP} is a measure of total factor productivity. The calculation of the parameter is obtained from the semi-parametric approach of Levinsohn and Petrin (2003) which takes account of unobserved firm-specific productivity shocks. In a sensitivity analysis, we use two alternative measures of TFP. The R&D estimator of TFP ($TFP^{BUETTNER}$) is obtained from a semi-parametric and nonlinear least square regression of Buettner (2003) that allows for endogenous R&D. The standard labour productivity ($TFP^{LABPROD}$) is calculated from the log of value added over total labour.[10]

$size$ is measured as the log of total employment. As a robustness check we also categorise firm size into small ($SMALL$), medium ($MEDIUM$), large ($LARGE$) and very large ($VLARGE$) by following the quartile distribution of the total employment for all firms operating in the same 2-digit ISIC (Rev.3).

[10] Due to limitations of space we do not include the methodology underlying our Levinsohn and Petrin (2003) and Buettner (2003) TFP calculations but this information is available from the authors upon request.

wage is the log of wage per employee. Wage is an indicator of labour quality. It is expected that the higher the wages, the more superior the quality of labour and the more likely that a firm will be able to produce multiple products.

RDPRODUCT and *RDPROCESS* are dummy variables for R&D to capture those firms that undertake R&D in product development and production processes respectively. R&D activity is an important mechanism for firms to introduce new products (Brander and Eaton, 1984). R&D is also an important procedure for enhancing the quality of existing products and for developing new products as well as highlighting cost savings in the production process. It is expected that firms that carry out R&D especially product R&D are more likely to be a multi-product firms.

The results reported in Tables 6 and 7 are marginal effect estimations that are calculated at the mean of the independent variables except for dummy variables. Each coefficient indicates the change in the probability of the outcome. Our variables are defined and descriptive statistics presented in Tables A1 and A2 of the appendix respectively.

In Table 6, the results of our preferred specification in column (6) show a complex relationship between export status and the propensity of a firm to be a multi-product producer. The results suggest that it is not whether you are an exporter that is important but the export status of the firm combined with our ownership variable. For example, being foreign and an exporter has a large positive partial correlation with being a multi-product producer. In contrast, being an exporter *per se* is insignificant. This suggests a difference in behaviour between domestic and foreign exporters.

Foreign ownership appears therefore to have an important association with multi-product production although it is not a straightforward relationship. The individual partial correlation for foreign ownership is negative and significant for all specifications. This suggests that

foreign owned firms *per se* are negatively associated with multiple product production. This is a surprising result. One explanation might be overseas firms setting up single product assembly plants that specialise in the production of one single product for sale either domestically in Thailand or for export (possibly to Thailand's ASEAN neighbours). This would also fit with the Baldwin and Ottaviano (2001) hypothesis that MNEs locate the production of different varieties in different countries. However, as noted earlier, foreign owned firms that also export are positively and significantly correlated with firms that produce multiple products. Thus it is clear that foreign firms cannot be considered one homogenous group.

For TFP, as expected we observe that more productive firms are positively associated with multi-product firms. The positive and significant coefficients for product R&D and process R&D suggests that firms that carry out R&D in either product development or production processes, or both, are positively related to the probability that a firm will be a multiple product producer. When we examine our proxy for the quality of labour we see that the coefficient on wage is positive but generally insignificant.

As expected, the relationship between size and being a multi-product firm is positive and significant at the one percent level. A one-unit increase in size is associated with an increase in the probability of producing multiple products of approximately six percentage points. If we categorise firm size into small, large and very large firms, the coefficients are also significant at the one percent level with small firms being negatively correlated with being multi-product. As firm sizes increases, we observe increasingly positive results so that the larger the size, the greater the probability of producing multiple products.

To further investigate the negative foreign ownership and exporter results from Table 6 we split the sample into domestic firms and foreign firms. Approximately one quarter of our firm sample are foreign owned firms. We retain the 10 percent foreign owned definition.[11]

The results are presented in Table 7. The insignificant coefficient for export status in Table 6 is now explained. Observe that the export status of domestic firms has no relationship with the probability of a firm producing multiple products. In contrast exporting has a significant and positive partial correlation with the propensity of a foreign firm being a multi-product producer and is picked up in Table 6 by the positive and significant interaction term. This suggests a systemic difference between the behaviour of foreign and domestic firms with foreign exporters producing more than one product and domestic exporters tending to concentrate on the export of a single product. The larger number of domestic firms explains why the overall figure in Table 6 is insignificant (6878 domestic against 2043 foreign firms).

For productivity, the coefficients for both domestic and foreign firms are positive and significant for only two of our six specifications. For process R&D, the positive significant coefficients for the domestic sample indicate that for domestic firms, R&D in production processes is associated with a higher probability of a firm becoming multi-product. In contrast, the insignificant coefficient for our foreign firm sample suggests that neither R&D process development nor wages are associated with an increase in the probability of being a multi-product producer. However, R&D product development is positive and significant at the 10 percent and five percent level for foreign firms only. Firm size for both domestic and foreign firms is positive and significant.

Our results suggest therefore that the relationship between ownership and multiple product production is complex. We observe that individually foreign owned firms and exporters have a

[11] In a sensitivity analysis we tested 25% and 50% cut-off points with broadly similar results available upon request.

negative partial correlation with the likelihood of being a multi-product producer but that being foreign and an exporter means a firm is has a positive partial correlation with the production of multiple products.

5.2 The Number of Products Produced

In the previous section we examined the characteristics of being a multi-product firm. In this section we aim to identify a firm's performance by investigate the characteristics associated with the number of products produced. Thus, our dependent variable is now a count of the number of products produced.

Since count data is used as our dependent variable, there are two alternative regression models for counts which are poisson regression model and negative binomial regression model.[12] In this paper, we estimate count data using a negative binomial regression model. Additionally, we also estimated a simple poisson count model for a sensitivity check.[13] We lag all independent variables by one year to control for possible endogeneity problems. As this is not ideal we continue to avoid direct causal language in discussing our results. Our negative binomial regression model can be specified as follows,

$$\Pr(NPRODUCT|Z) = \frac{\Gamma(NPRODUCT + \alpha^{-1})}{NPRODUCT!\Gamma(\alpha^{-1})}\left(\frac{\alpha^{-1}}{\alpha^{-1}+\mu}\right)\left(\frac{\mu}{\alpha^{-1}+\mu}\right)^{NPRODUCT} \quad (9)$$

where $NPRODUCT$ is a count for the number of products produced by each firm.

Z is a vector of firm level characteristics.

$\Gamma()$ is the gamma function.

[12] Poisson regression estimation assumes that the observed count is drawn from a poisson distribution of which the mean and variance are equal. In practice, the poisson regression model maybe inappropriate due to overdispersion. Therefore, the negative binomial regression model which is an extension of poisson regression alleviate an overdispersion problem by including a parameter that captures unobserved heterogeneity amongst observations.

[13] The estimated results from Poisson regression are identical to the negative binomial regression and are available from the authors upon request. This indicates that we do not experience an overdispersion problem in our data set.

α is the degree of overdispersion which equals to zero when negative binomial and poisson has the same distribution.

μ is known as the observed heterogeneity and is estimated from the observed firm characteristic where $\mu = \exp(\beta' Z + \varepsilon)$.[14]

In equation (9), the independent variables included in a vector of firm level characteristics (Z) are the same as before. Five region, two-digit ISIC industry and two year-dummies are included in order to control for unobserved effects. A robust variance estimation corrects for possible heteroscedasticity in the error term and we allow for clustering at the 2-digit industry level. Tables 8 and 9 present the coefficients obtained from the estimation of marginal effects for our negative binomial regressions calculated at the mean of the independent variables except for the dummy variables.

In general, the sign and significant level of results in Tables 8 and 9 are consistent with those presented in Tables 6 and 7. Table 8 shows that being an exporter does not have any significant association with the number of products produced. For ownership status, the relationship of foreign ownership and the product count is not so simple. The negative and significant coefficient indicates that being a foreign owned firm is negatively associated with the number of products produced. However, being foreign owned and an exporter leads to a proportional increase in the expected change in the number of products produced of approximately 0.4.

TFP has a significant positive impact on the number of products produced in three of the six columns. For example, the TFP coefficient in Column (1) indicates that one percent change in TFP is associated with 11.6 percent increase in the expected change in the product count.

[14] According to Long (1997) and Cameron and Trivedi (1998), $\exp(\varepsilon)$ is unknown but it can be drawn from a gamma distribution of which mean equals 1 and variance equals α.

Other variables such as R&D of both product and production process, wage, size have positive and significant effect on the number of products produced as expected.

In Table 9, we split the sample into domestic and foreign firms. The insignificant results for export status in Table 8 are now explained. This is also picked up by the positive and significant results for the interaction term reported in Table 8. The export status of domestic firms has no significant association with the product count. In contrast, the export status of foreign firms has a positive and significant impact on the number of products produced. If foreign firms export, the expected change in the number of products produced tends to increase by approximately 30 percent.

When we consider the productivity of domestic firms, the coefficient is positive and significant when size is excluded from the model. In the foreign firms sample, the coefficients of TFP are generally positive and significantly associated with the number of products produced. In both samples, product R&D has a positive coefficient but is only significant in two of the specifications. Production process R&D and the wage of only domestic owned firms are associated with an increase in the expected change in the number of products produced. As expected, firm size of both domestic and foreign firms is positive and significant. A one percent change in firm size leads to a proportional increase in the expected change in the number of products produced by 15.9 percent for domestic firms and 17.6 percent for foreign firms.

Finally, it is worth pointing out that we performed a series of sensitivity checks. For ownership structure, we tested 25% and 50% foreign owned as the cut-off point. For productivity, the Buettner (2003) approach and standard labour productivity were employed

instead of our Levinsohn and Petrin (2003) approach.[15] The results are broadly consistent with results shown in Tables 6 to 9 but are not included for reasons of space.

6. Conclusions

In this paper, we investigate different aspects of multi-product firms in international trade using the Thailand Annual Manufacturing Industries survey from 2001 to 2004. The empirical analysis comprises two sections. First, we examine the relationship between multi-product firm's extensive margin (number of products) on output or exporting. Second, we investigate the characteristics associated with being a multi-product firm using binary data and the number of product produced using count data. The use of the former allowed us to analyse the characteristics of those firms that become multi-product while the latter is used to explain factors that affect the number of products produced by firms. We also examine the systematic differences in the between domestic and foreign firms by estimating each sample separately.

Our results show little variation is observed for firms' extensive margins in both total output and export sales. However, firms' extensive margins seem to have a higher variation in export sales than in total output. We suspect a partial explanation for these low variations, at least relative to the findings in Bernard *et al.* (2006b), is because of the level of aggregation we use when we classify the number of products.[16] Another explanation arises from the fact that multi-product firms in Thailand do not dominate domestic production and exporting. As this is the first such study for a developing country we have no other reference point.

Various factors such as export status, foreign ownership, TFP, R&D both in product and in the production processes and firm size are important correlates with both multi-product firms

[15] With the Buettner (2003) measure of TFP we lose approximately four percent of our observations.
[16] Bernard *et al.* (2006b) use two different sources of data. Both of them define a product at a disaggregate level of classification; ten-digit Harmonized System (HS) category and five-digit SIC category.

and the number of products produced. Productive and large firms and those that carry out R&D also have a strong association with being a multiple product firm. Similarly, the effects of different factors on the expected number of product produced by firms are generally consistent with the factors that affect the probability of becoming a multi-product firm.

We did however find that there are systematic differences in the factors correlated with multi-product production between different groups in our sample. The differences in the significance and sign of factors indicate that domestic firms perform differently to foreign firms and foreign non-exporting firms perform differently to foreign exporting firms. Perhaps more importantly from a development policy perspective is that R&D has a weak association with the propensity of a foreign firm to be multi-product or the number of products produced. Assuming that potential benefits from spillovers increase with the number of varieties this may partially explain the lack of evidence for spillovers found in many studies of developing countries.

In sum, for Thailand we show therefore that the relationship between MNEs and development is complex. We show that multi-products firms have played a significant role in international trade especially though exporting and FDI. The results from the empirical analysis also confirm that being foreign owned and an exporter is an important characteristics associated with the emergence of multi-product firms and number of products produced. There appears however to be differences in the behaviour of foreign firms in developing and developed countries. In future research it would be useful to break down foreign ownership into country of origin to see whether there is a difference between the behaviour of firms from developing and developed countries. A further extension that would require a longer time period would be to examine the behaviour of firms in response to a shock to see whether product adjustment occurs at the intensive or extensive margin.

Table 1: Fifteen Major Export Commodities in Thai Manufacturing Sector during 1999-2007.

Rank		Product	Value : US$ million								
2007	2003		1999	2000	2001	2002	2003	2004	2005	2006	2007
1	1	Computer machinery, parts and accessories	8,121.57	8,739.55	7,947.47	7,430.35	8,189.69	9,185.45	11,848.66	14,876.39	17,305.06
2	4	Automobile, parts and accessories	1,902.26	2,419.36	2,655.03	2,919.71	3,965.53	5,495.24	7,745.44	9,524.19	12,040.69
3	2	Integrated circuits	2,944.55	4,484.03	3,512.25	3,307.99	4,624.57	4,902.78	5,950.64	7,029.98	8,053.38
4	5	Gems and Jewellery	1,766.30	1,741.85	1,837.16	2,169.28	2,514.47	2,645.59	3,232.66	3,668.29	5,382.20
5	7	Plastic pellets	1,215.31	1,865.63	1,615.02	1,775.24	2,148.43	3,104.60	4,198.45	4,498.43	5,214.07
6	8	Iron and steel products	954.29	1,399.16	1,091.43	1,249.69	1,687.20	2,477.84	2,895.63	3,528.61	4,596.01
7	22	Machinery and components	613.87	801.45	860.96	930.22	1,244.97	1,670.14	2,111.26	2,655.15	4,366.64
8	9	Chemicals	908.00	1,248.11	1,015.12	1,192.97	1,581.36	2,059.06	2,646.08	3,434.34	3,922.64
9	24	Electrical appliances	545.13	901.09	873.57	905.66	967.930	1,839.57	2,208.78	2,514.18	3,670.14
10	12	Rubber products	875.05	1,060.37	1,095.07	1,260.31	1,556.44	1,943.68	2,351.20	3,082.00	3,661.26
11	10	Air Conditioning machine and parts	895.52	1,079.62	1,160.50	1,108.35	1,430.29	1,997.74	2,201.41	2,287.50	3,191.59
12	6	Radio, television and parts	1,346.48	1,964.87	1,692.77	2,094.58	2,501.77	3,224.46	3,141.84	3,457.34	3,095.18
13	3	Garments	2,915.63	3,132.68	2,914.40	2,721.50	2,760.19	3,089.23	3,150.21	3,198.83	2,991.88
14	17	Plastic products	758.13	894.23	860.32	954.44	1,236.20	1,410.21	1,774.70	1,883.99	2,273.27
15	47	Reciprocating internal combustion engine and components	187.69	327.40	286.97	345.98	547.82	1,245.04	1,379.96	1,567.92	1,732.21
		Total 15 products	25,949.78	32,059.40	29,418.04	30,366.27	36,956.86	46,290.63	56,836.92	67,207.14	81,496.22
		Total Others	32,513.66	37,564.83	35,765.19	37,790.04	43,083.12	50,212.19	54,100.74	62,513.29	70,981.36
		Total	58,463.44	69,624.23	65,183.23	68,156.31	80,039.98	96,502.82	110,937.66	129,720.43	152,477.58

Source: Department of Trade Negotiations, Ministry of Commerce

Table 2: Share of Exporting Firms by two-digit ISIC

ISIC Rev. 3	Industry	2001	2002	2003	2004
15	Food products & beverages	49.96 (301)	48.82 (289)	51.39 (278)	54.44 (245)
16	Tobacco products	16.67 (1)	16.67 (1)	20.00 (1)	0.00 (0)
17	Textiles	34.55 (133)	35.81 (130)	38.06 (118)	38.13 (114)
18	Wearing apparel; dressing & dyeing of fur	76.33 (216)	76.63 (200)	77.73 (178)	72.82 (142)
19	Tanning & dressing of leather; manufacture of luggage, handbags, saddler, harness & footwear	64.91 (74)	63.89 (69)	67.65 (69)	65.17 (58)
20	Wood & products of wood and cork, except furniture; manufacture of articles of straw & plaiting materials	44.05 (37)	45.45 (35)	47.83 (33)	44.26 (27)
21	Paper and paper products	40.59 (41)	42.27 (41)	41.24 (40)	36.78 (32)
22	Publishing, printing & reproduction of recorded media	10.69 (14)	9.60 (12)	11.97 (14)	12.26 (13)
23	Coke, refined petroleum products & nuclear fuel	66.67 (8)	62.50 (5)	50.00 (3)	80.00 (4)
24	Chemicals & chemical products	52.87 (129)	53.78 (128)	57.14 (124)	57.92 (106)
25	Rubber & plastics products	45.92 (169)	46.94 (169)	49.26 (166)	51.68 (154)
26	Other non-metallic mineral products	32.31 (116)	33.64 (109)	32.54 (96)	37.60 (91)
27	Basic metals	34.34 (34)	33.33 (32)	33.33 (30)	40.26 (31)
28	Fabricated metal products, except machinery & equipment	42.36 (86)	43.62 (82)	44.69 (80)	43.40 (69)
29	Machinery & equipment n.e.c.	49.25 (99)	51.67 (93)	52.84 (93)	54.60 (89)
30	Office, accounting & computing machinery	63.41 (26)	62.50 (20)	60.87 (14)	52.17 (12)
31	Electrical machinery & apparatus n.e.c.	43.62 (65)	43.15 (63)	42.52 (54)	44.19 (57)
32	Radio, television & communication equipment & apparatus	75.95 (120)	79.08 (121)	78.08 (114)	74.26 (101)
33	Medical, precision and optical instruments, watches & clocks	47.76 (32)	50.85 (30)	47.27 (26)	50.00 (22)
34	Motor vehicles, trailers & semi-trailers	46.53 (47)	49.48 (48)	59.09 (78)	65.60 (82)
35	Other transport equipment	48.84 (21)	51.22 (21)	54.05 (20)	41.38 (12)
36	Furniture; manufacturing n.e.c.	74.43 (163)	73.43 (152)	77.83 (158)	77.27 (136)
37	Recycling	25.00 (4)	30.77 (4)	33.33 (4)	28.57 (4)
	Total industry	48.10 (1,936)	49.16 (1,854)	51.10 (1,791)	51.78 (1,601)

Note: Numbers of exporting observation are reported in parentheses.

Table 3: Share of Firms and Output for Different Groups by Product Distributions

Number products produced	All Firms		Domestic Firms		Foreign Firms		Non-Exporting Firms		Exporting Firms		Foreign Non-Exporting Firms		Foreign Exporting Firms	
	Share Firms	Share Output	Share Firms	Share Output	Share Firms	Share of Output	Share Firms	Share Output	Share Firms	Share of Output	Share Firms	Share of Output	Share Firms	Share of Output
1	57.12	43.02	58.17	42.49	54.37	43.31	61.16	52.63	53.15	40.54	68.29	48.34	50.85	42.75
	(5,438)		(4,001)		(1,437)		(2,883)		(2,555)		(364)		(1,073)	
2	17.81	19.79	16.89	20.19	20.20	19.58	16.31	20.79	19.28	19.57	16.70	22.76	21.09	19.21
	(1,696)		(1,162)		(534)		(769)		(927)		(89)		(445)	
3	9.16	13.74	9.57	16.91	8.10	11.42	8.59	17.14	9.71	12.95	6.38	21.99	8.53	10.25
	(872)		(658)		(241)		(405)		(467)		(34)		(180)	
4	6.76	8.66	6.54	8.87	7.34	8.44	5.11	4.59	8.38	9.60	3.75	3.51	8.25	9.01
	(644)		(450)		(194)		(241)		(403)		(20)		(174)	
5+	9.15	14.79	8.83	11.54	9.99	17.25	8.82	4.85	9.47	17.33	4.88	3.41	11.28	18.78
	(871)		(607)		(264)		(416)		(455)		(26)		(238)	
Total	100	100	100	100	100	100	100	100	100	100	100	100	100	100
	(9,521)		(6,878)		(2,643)		(4,714)		(4,807)		(533)		(2,110)	

Note: Numbers of observation are reported in parentheses.

Table 4: OLS Regression Decomposition of Firm Size and Firms' Extensive Margins

	Production		Exporting	
	(1)	(2)	(3)	(4)
$\ln Y_{it}$	0.009***	0.012***		
	(4.17)	(5.20)		
$\ln Y_{it}^{e}$			0.074***	0.074***
			(21.87)	(20.48)
Observations	6042	6042	3331	3331
R-squared	0.003	0.057	0.118	0.189
Additional Covariates	None	Region, Industry and Time Fixed Effects	None	Region, Industry and Time Fixed Effects

Notes: Sample includes multi-product firms only. Dependent variable in Column (1) and (2) is the log of number of product produced ($\ln n_{it}$), and Column (3) and (4) is the log of number of product exported ($\ln n_{it}^{e}$). Robust *t* statistics in parentheses. *** significant at 1%.

Table 5: OLS Regression of Firms' Extensive and Intensive Margins

	Production		Exporting	
	(1)	(2)	(3)	(4)
$\ln n_{it}$	-0.692***	-0.641***		
	(9.32)	(9.22)		
$\ln n_{it}^{e}$			0.584***	0.501***
			(7.49)	(6.33)
Observations	6042	6042	3331	3331
R-squared	0.014	0.200	0.018	0.139
Additional Covariates	None	Region, Industry and Time Fixed Effects	None	Region, Industry and Time Fixed Effects

Notes: Sample includes multi-product firms only. Dependent variable in Column (1) and (2) is log of output per product ($\ln \overline{y}_{it}$), and Column (3) and (4) is the log of export sales product per product ($\ln \overline{y}_{it}^{e}$). Region, industry and time dummies are included. Robust t statistics in parentheses. *** significant at 1%.

Table 6: The Characteristics Associated with a Firm's Decision to Produce Multiple Products (Dep. Var. is $MULTIDUM_{it}$)

	(1)	(2)	(3)	(4)	(5)	(6)
$EX_{i(t-1)}$	0.030	0.030	-0.029	-0.030	-0.024	-0.025
	(0.97)	(0.97)	(0.86)	(0.88)	(0.70)	(0.71)
$FOREIGN_{i(t-1)}$	-0.139***	-0.139***	-0.154***	-0.159***	-0.154***	-0.159***
	(4.24)	(4.35)	(4.55)	(4.79)	(4.58)	(4.75)
$(EX * FOREIGN)_{i(t-1)}$	0.128***	0.128***	0.143***	0.145***	0.145***	0.146***
	(2.73)	(2.71)	(3.22)	(3.23)	(3.14)	(3.14)
$TFP^{LP}_{i(t-1)}$	0.056***	0.056***	0.025***	0.019*	0.028***	0.023**
	(7.00)	(4.86)	(3.41)	(1.83)	(3.65)	(2.13)
$RDPRODUCT_{i(t-1)}$	0.062***	0.062***	0.037*	0.037*	0.047**	0.047**
	(3.08)	(3.09)	(1.77)	(1.75)	(2.37)	(2.37)
$RDPROCESS_{i(t-1)}$	0.063**	0.063**	0.060**	0.060**	0.058**	0.058**
	(2.42)	(2.42)	(2.18)	(2.17)	(2.07)	(2.07)
$wage_{i(t-1)}$		0.000		0.023		0.019
		(0.01)		(1.19)		(0.92)
$size_{i(t-1)}$			0.057***	0.058***		
			(6.49)	(6.62)		
$SMALL_{i(t-1)}$					-0.077***	-0.077***
					(4.67)	(4.73)
$LARGE_{i(t-1)}$					0.071***	0.071***
					(2.98)	(3.00)
$VLARGE_{i(t-1)}$					0.129***	0.131***
					(4.65)	(4.69)
Observations	9521	9521	9521	9521	9521	9521

Notes: Robust z statistics in parentheses. Standard errors are adjusted for clustering at the 2-digit industry level. * significant at 10%; ** significant at 5%; *** significant at 1%. Region, 2-digit industry and time dummies are included.

Table 7: The Characteristics Associated with a Firm's Decision to Produce Multiple Products for Domestic and Foreign Firms Only (Dep. Var. is $MULTIDUM_{it}$)

	Domestic Firms Only			Foreign Firms Only		
	(1)	(2)	(3)	(4)	(5)	(6)
$EX_{i(t-1)}$	0.026	-0.029	-0.027	0.159***	0.115***	0.124***
	(0.87)	(0.88)	(0.80)	(4.33)	(3.09)	(3.22)
$TFP^{LP}_{i(t-1)}$	0.051***	0.016	0.019	0.070***	0.020	0.032
	(3.69)	(1.46)	(1.59)	(2.78)	(0.82)	(1.28)
$RDPRODUCT_{i(t-1)}$	0.051	0.023	0.030	0.073*	0.057	0.070**
	(1.49)	(0.67)	(0.87)	(1.94)	(1.53)	(1.99)
$RDPROCESS_{i(t-1)}$	0.114***	0.112***	0.110***	-0.026	-0.030	-0.034
	(3.19)	(3.08)	(2.93)	(0.50)	(0.58)	(0.67)
$wage_{i(t-1)}$	0.020	0.032*	0.029	-0.039	0.010	-0.001
	(0.90)	(1.74)	(1.58)	(0.81)	(0.21)	(0.02)
$size_{i(t-1)}$		0.054***			0.067***	
		(6.18)			(5.17)	
$SMALL_{i(t-1)}$			-0.068***			-0.121***
			(3.06)			(2.99)
$LARGE_{i(t-1)}$			0.087***			0.023
			(2.89)			(0.63)
$VLARGE_{i(t-1)}$			0.134***			0.104***
			(3.58)			(3.09)
Observations	6878	6878	6878	2643	2643	2643

Notes: Robust z statistics in parentheses. Standard errors are adjusted for clustering at the 2-digit industry level. * significant at 10%; ** significant at 5%; *** significant at 1%. Region, 2-digit industry and time dummies are included.

Table 8: The Characteristics Associated with the Number of Products Produced (Dep. Var. is $NPRODUCT_{it}$)

	(1)	(2)	(3)	(4)	(5)	(6)
$EX_{i(t-1)}$	0.032	0.032	-0.139	-0.146	-0.117	-0.122
	(0.37)	(0.36)	(1.56)	(1.60)	(1.28)	(1.30)
$FOREIGN_{i(t-1)}$	-0.397***	-0.406***	-0.430***	-0.455***	-0.430***	-0.451***
	(5.63)	(5.81)	(6.19)	(6.57)	(6.21)	(6.43)
$(EX * FOREIGN)_{i(t-1)}$	0.410***	0.414***	0.454***	0.464***	0.459***	0.467***
	(3.73)	(3.72)	(4.73)	(4.82)	(4.47)	(4.50)
$TFP^{LP}_{i(t-1)}$	0.116***	0.107***	0.027	-0.001	0.041**	0.018
	(8.49)	(4.78)	(1.59)	(0.06)	(2.34)	(0.78)
$RDPRODUCT_{i(t-1)}$	0.195***	0.196***	0.120**	0.120**	0.151***	0.152***
	(3.38)	(3.42)	(2.02)	(2.04)	(2.58)	(2.62)
$RDPROCESS_{i(t-1)}$	0.170**	0.169**	0.159**	0.158**	0.154*	0.153*
	(2.28)	(2.28)	(2.01)	(2.01)	(1.94)	(1.94)
$wage_{i(t-1)}$		0.037		0.106**		0.088*
		(0.69)		(2.34)		(1.81)
$size_{i(t-1)}$			0.162***	0.167***		
			(7.49)	(7.80)		
$SMALL_{i(t-1)}$					-0.212***	-0.213***
					(4.29)	(4.41)
$LARGE_{i(t-1)}$					0.206***	0.209***
					(2.83)	(2.89)
$VLARGE_{i(t-1)}$					0.359***	0.371***
					(5.69)	(5.99)
Observations	9521	9521	9521	9521	9521	9521

Notes: Robust z statistics in parentheses. Standard errors are adjusted for clustering at the 2-digit industry level. * significant at 10%; ** significant at 5%; *** significant at 1%. Region, 2-digit industry and time dummies are included.

Table 9: The Characteristics Associated with the Number of Products Produced by Domestic and Foreign Firms (Dep. Var. is $NPRODUCT_{it}$)

	Domestic Firms Only			Foreign Firms Only		
	(1)	(2)	(3)	(4)	(5)	(6)
$EX_{i(t-1)}$	0.028	-0.132	-0.121	0.385***	0.262***	0.304***
	(0.34)	(1.59)	(1.42)	(4.27)	(2.91)	(3.27)
$TFP^{LP}_{i(t-1)}$	0.096***	-0.007	0.004	0.168***	0.037	0.086*
	(2.98)	(0.26)	(0.15)	(3.70)	(0.81)	(1.93)
$RDPRODUCT_{i(t-1)}$	0.159*	0.076	0.098	0.230*	0.182	0.218
	(1.71)	(0.80)	(1.03)	(1.68)	(1.31)	(1.62)
$RDPROCESS_{i(t-1)}$	0.320***	0.311***	0.307***	-0.106	-0.111	-0.117
	(3.30)	(3.14)	(2.98)	(0.79)	(0.87)	(0.91)
$wage_{i(t-1)}$	0.065	0.102**	0.091**	-0.025	0.111	0.059
	(1.18)	(2.19)	(1.96)	(0.26)	(1.05)	(0.58)
$size_{i(t-1)}$		0.159***			0.176***	
		(8.70)			(5.30)	
$SMALL_{i(t-1)}$			-0.201***			-0.271*
			(3.32)			(1.84)
$LARGE_{i(t-1)}$			0.258***			0.042
			(2.78)			(0.38)
$VLARGE_{i(t-1)}$			0.397***			0.230***
			(5.71)			(2.62)
Observations	6878	6878	6878	2643	2643	2643

Notes: Robust z statistics in parentheses. Standard errors are adjusted for clustering at the 2-digit industry level. * significant at 10%; ** significant at 5%; *** significant at 1%. Region, 2-digit industry and time dummies are included.

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Appendix

Table A1: Definition of Variables

Variable	Definition
Y_{it}	Total output of the firm
Y_{it}^{e}	Total firm export sales
n_{it}	Number of products produced by firm
n_{it}^{e}	Number of products exported by firm
$\overline{y}_{it}$	Average output per product that is calculated from the aggregation of output of individual products divides by the number of product.
$\overline{y}_{it}^{e}$	Average export sales per product calculated as the aggregation of output of individual products divided by the number of products exported.
$MULTIDUM_{it}$	A dummy variable for multi-product firm which equals 1 if a firm produces multiple products and 0 if a firm produces a single product.
$MULTIEXDUM_{it}$	A dummy variable for multi-product exporter which equals 1 if a firm exports multiple products and 0 if a firm exports single product.
$NPRODUCT_{it}$	Count data for number of products that produce by each multi-product firm of which $NPRODUCT_{it} = n_{it} - 1$.
$EX_{i(t-1)}$	A dummy variable for export status where a dummy equals 1 if firm i has positive export sales 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 that is obtained from the estimation of the semi-parametric approach of Levinsohn and Petrin (2003).
$TFP_{i(t-1)}^{BUETTNER}$	Total factor productivity obtained from the system estimation (a semi-parametric and nonlinear least square regression) by Buettner (2003).
$TFP_{i(t-1)}^{LABPROD}$	Labour productivity calculated as the log of value added divided by total labour.
$size_{i(t-1)}$	Size is measured as the log of total employees.
$SMALL_{i(t-1)}$	A dummy variable equal to 1 if the total labour of 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 2-digit ISIC level (Rev. 3) as firm i at time $t-1$.
$LARGE_{i(t-1)}$	A dummy variable equal to 1 if the total labour of 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 2-digit ISIC level (Rev. 3) as firm i at time $t-1$.
$VLARGE_{i(t-1)}$	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 labour of all firms operating in the same 2-digit ISIC level (Rev. 3) as firm i at time $t-1$.
$wage_{i(t-1)}$	The log of wage per employee calculated as the ratio of total labour payments over total labour less owner's wage.

$RDPRODUCT_{i(t-1)}$	A dummy variable equals 1 if a firm carries out R&D in product development and 0 otherwise.
$RDPROCESS_{i(t-1)}$	A dummy variable equals 1 if a firm performs R&D in the development of production processes and 0 otherwise.
$BKKM$	A dummy variable identifies whether firm locates in Bangkok and Metropolitan Area or not.
$CENTRAL$	A dummy variable equals 1 if a firm locates in Central region excluding Bangkok and Metropolitan Area and 0 otherwise.
$EAST$	A dummy variable equals 1 if a firm locates in Eastern region and 0 otherwise.
$NORTH$	A dummy variable equals 1 if a firm locates in the North of Thailand and 0 otherwise.
$SOUTH$	A dummy variable equals 1 if a firm locates in the South of Thailand and 0 otherwise.

Table A2: Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
$\ln Y_{it}$	6042	14.81	2.21	6.31	20.61
$\ln \overline{y}_{it}$	6042	13.73	2.22	5.21	19.80
$\ln n_{it}$	6042	1.08	0.38	0.69	2.30
$\ln Y_{it}^{e}$	3331	14.70	2.36	3.86	20.37
$\ln \overline{y}_{it}^{e}$	3331	13.87	2.23	3.86	19.21
$\ln n_{it}^{e}$	3331	0.83	0.51	0	2.08
$MULTIDUM_{it}$	9521	0.43	0.49	0	1
$NPRODUCT_{it}$	9521	1.95	1.38	1	10.00
$EX_{i(t-1)}$	9521	0.50	0.50	0	1
$FOREIGN_{i(t-1)}$	9521	0.28	0.45	0	1
$FOREIGN25_{i(t-1)}$	9521	0.25	0.43	0	1
$FOREIGN50_{i(t-1)}$	9521	0.14	0.35	0	1
$TFP_{i(t-1)}^{LP}$	9521	9.22	1.84	0.47	16.69
$TFP_{i(t-1)}^{BUETTNER}$	9195	10.19	1.28	1.21	15.31
$TFP_{i(t-1)}^{LABPROD}$	9521	8.98	1.05	1.45	14.00
$RDPRODUCT_{i(t-1)}$	9521	0.08	0.27	0	1
$RDPROCESS_{i(t-1)}$	9521	0.06	0.24	0	1
$wage_{i(t-1)}$	9521	7.71	0.53	4.19	10.29
$size_{i(t-1)}$	9521	4.79	1.50	1.10	9.00
$SMALL_{i(t-1)}$	9521	0.26	0.44	0	1
$LARGE_{i(t-1)}$	9521	0.25	0.43	0	1
$VLARGE_{i(t-1)}$	9521	0.25	0.43	0	1