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## *Multi-Product Firms and Exporting: A Developing Country Perspective*

**by**

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# Multi-Product Firms and Exporting: A Developing Country Perspective

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**Abstract**

In this paper, we shed additional light on the complex relationship between multinational enterprises (MNEs), exporting and economic development by making a distinction between single and multi-product firms. As far as we are aware, the export behavior of foreign firms in a multi-product setting has not previously been considered for a developing country. Using firm-level data for Thailand we show that the number of goods produced causes a much larger variation in exports volumes than in total production. Whilst the number of products exported and the total volume exported is positively correlated we find, in contrast to US studies, a surprising negative correlation between the number of products produced and the volume of production. We then go on to investigate for the first time the characteristics of multi-product firms and the number of products they produce and find the distinction between foreign owned and domestic firms as well as between foreign exporters and foreign non-exporters is important. 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 behavior of foreign firms in developing countries and emphasises that a foreign presence may not be as beneficial as policy makers are led to believe.

**JEL classification:** F21, F23 F10, F14, L11

**Keywords:** Multinationals, Firm characteristics, Multi-product, Exports

**Outline**

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3. *Descriptives and Data*
4. *Multi-Product Firms' Intensive and Extensive Margins*
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## Non-Technical Summary

In recent years, the number of firms that produce more than one product has risen dramatically. In the US multi-product firms account for 91% of total output while multi-product exporters account for more than 95% of total export sales. Explaining these stylised facts led initially to a renewed interest in the differentiated products and trade literature. However, the literature focusing directly on multi-product firms is more limited and almost exclusively concerned with developed countries. The traditional approach in international trade is to assume single products with intra-firm adjustment taking place in the scale of production. This paper examines the role of multiproduct firms in a developing country, in this case Thailand. Although the magnitude of the output and export figures are similar to the US the reversal in size of the output and export percentages for Thailand hints at subtle differences in the behavior of firms in developed and developing countries that we investigate in this paper.

The behavior of foreign firms in developing countries is a crucial part of the development story with governments becoming increasingly aggressive in their attempts to attract FDI. Certainly one motivation for domestic governments is to attract firms to benefit from technology and knowledge spillovers. An examination of the structure of foreign firms and the products they produce can provide additional insights in the role of MNEs in developing countries under the assumption that governments prefer foreign firms that produce multiple products for export rather than, for example, foreign firms that produce a single product for the domestic market. The former are likely to have great potential for spillovers of all types and a greater likelihood of increases domestic employment whilst the latter may result in a displacement of domestic firms and little or even a negative employment effect. It is therefore useful to understand the characteristics associated with the export product profile of firms.

In this paper, we examine two specific aspects of the multi-product and development question. First, 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) and how this contributes to the distribution in firm size assuming that globalization leads to intra-firm adjustment along firms' extensive and intensive margins. In addition, we examine the correlation between firms' extensive and intensive margins. Second, we examine the characteristics associated with firms' decision to produce multiple products making a distinction between domestic and foreign firms. We extend this analysis to estimate the characteristics associated with the number of products produced and the number of products exported by multi-product firms.

Our first stage results show that there is little variance between Thai firms' intensive and extensive margins and total output or total export sales. Our second stage results show that becoming a multiproduct firm and the number products produced is explained by various firm characteristics including export status, TFP and R&D status. Comparing domestic and foreign firms, we observe some systematic differences in the factors that affect the probability of becoming a multi-product firm and the number of products produced. A complex picture of the behavior of MNEs emerges where foreign owned firms that export are more likely to be multi-product but foreign firms that only serve the domestic market are considerably less likely to be multi-product or to engage in R&D. These factors might explain, in part, why evidence for knowledge diffusion and productivity spillovers is less widespread that one might have imagined. This paper presents an interesting empirical anomaly not previously highlighted in the literature, which is that of a large body of foreign owned firms that supply only the domestic market and produce just a single product.

# 1. Introduction

In recent years, the number of firms that produce more than one product has risen dramatically. Estimates for the US by Bernard *et al.*, (2005) and (2006a) show that multi-product firms account for 91% of total output while multi-product exporters account for more than 95% of total export sales. 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, direct studies of multi-product firms and trade are more limited and almost exclusively concerned with developed countries. In international trade the traditional approach has been to assume single products with intra-firm adjustment taking place in the scale of production with no role for multi-product production although Eckel and Neary (2006) represents a recent exception. On the other hand, the industrial organisation literature 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).

In this paper, we provide for the first time an examination of the role of multi-product firms in a developing country, in this case Thailand. A first pass of the data suggests that there are similarities with the US. For Thailand, we observe that 94% of output is produced by multi-product firms and 93% of total exports are from firms that export multiple products. Although the magnitudes are similar to the US the larger output percentage for Thailand hints at the subtle differences in the behavior of firms in developed and developing countries.

The role of foreign firms in developing countries is understood to be a crucial part of the development story with developing countries becoming increasingly aggressive in their approach to attracting foreign direct investment (FDI). A growing literature examines the impact of FDI on developing countries and increasingly whether such policies are worthwhile (see e.g. Aitkin and Harrison, 1999, Bergsman and Shen, 1996, Blömstrom and Kokko, 1998 and Lall and Narula 2004). However, these papers do not examine the export

behavior of firms and more specifically the export profile of firms. Certainly one motivation for domestic governments is to attract firms and to subsequently benefit from technology and knowledge spillovers. Under the assumption that governments have a preference for foreign firms that produce multiple products for export rather than, for example, foreign firms that produce a single product for the domestic market, an examination of the structure of foreign firms and the products they produce can provide useful additional insights into the role of MNEs in developing countries. The former are likely to have greater potential for spillovers of all types and are more likely to lead to increases in domestic employment whilst the latter may result in the displacement of domestic firms with little or even a negative employment effect. It is therefore useful to investigate the characteristics associated with the export product profile of firms.

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) and how this contributes to the distribution in firm size assuming that globalization leads to intra-firm adjustment along firms' extensive and intensive margins. 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' intensive and extensive margins and total output or total export sales.

In the second stage, we examine the characteristics associated with firms' decision to produce multiple products making a distinction between domestic and foreign firms. We extend this analysis to consider the characteristics related to the number of products produced and the number of products exported by multi-product 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 behavior of MNEs in developing countries emerges where foreign owned firms that export are strongly associated with being multi-product but that foreign firms that only serve the domestic market show a strong negative partial correlation with being multi-product or

engaging in R&D. These factors might explain, in part, why evidence for knowledge diffusion and productivity spillovers is less widespread that one might have imagined. Thus, this paper presents an interesting empirical anomaly not been previously highlighted in the literature, which is that of a large body of foreign owned firms that supply only the domestic market and produce just a single product.

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

From an international trade perspective, Eckel and Neary (2006) in a general equilibrium model of multi-product firms with oligopolist behavior, address the role of the adjustment processes within multi-product firms and linkages with factor and goods markets. Specifically, they analyze how firms react to shocks and the affect of these shocks not only on wages and labor demand but also on the number of products a firm produces highlighting the role of flexible manufacturing in modern economies. Their results suggest that instead of, in the traditional trade literature that only allows entry and exit in response to shocks, in a multi-product framework firms may adjust their scale of output and number of varieties produced. 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.

In the industrial organisation literature, that tends to be partial equilibrium in nature, the early theoretical models of multi-product firms tend to concentrate on firm behavior in the domestic market. Panzar and Willig (1977) develop a multi-output production cost

function in order to explain scale economies in multi-output firms defined in terms of multi-output technologies. The profitability of marginal cost pricing is therefore characterised by multi-output scale economies.

Shaked and Sutton (1990) model multi-product firms by focusing on the relationship between horizontal product differentiation and market structure and find that different varieties of a product come from the balance between expansion and competition effects. The former describes an increase in the profit of monopoly firms that induces them to launch new varieties of the product. In contrast, the competition effect states that an obstacle to the introduction of a new variety is that market competition decreases the price of any new offering.

In contrast, in Johnson and Myatt (2003) firms produce multiple quality-differentiated products because of market competition. In a highly competitive market for low-quality products, with increasing marginal revenues, multi-product firms find it is profitable to compete with others by launching low quality product lines. However when marginal revenues are decreasing, multi-product firms choose to cut their low-quality products first.

In terms of the determinants of multi-product production, a study on multi-product firms' selection of product lines by Brander and Eaton (1984) finds that R&D activities within firms are important in order to launch new products. For example, a firm with a degree of monopoly power may seek to develop products that are far-off substitutes to its current product range. However, products that are close substitutes to their current offering are more likely to be developed by firms in a competitive market.

More recently, various models have been developed to explain trade at the firm level. Baldwin and Ottaviano (2001) develop a model to explain the behavior 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 between them. 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 productive firms with low-productivity firms exiting the market.

Firm heterogeneity is also emphasised by Melitz (2003) who extends Krugman (1980). Melitz (2003) 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. Melitz (2003) also finds that firms enter export markets by paying the exporting variable and sunk entry costs. Firms continue to export as long as their drawing productivity level is higher than the export productivity cut-off. Similarly, the least productive exporters exit the market if their drawing productivity level falls below the export productivity cut-off. The model 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.

In contrast, Bernard *et al.* (2006b) assumes 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 in 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 shows a positive correlation between firms' intensive (the output per product) and extensive (the number of products) margins which indicate 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. Using a comparative advantage framework, Bernard *et al.* (2007b) point out that resource re-allocation 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.

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 as compared to non-exporters (Bernard *et al.*, 2007a). For example, Bernard *et al.* (2006b and 2007a) 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 as they attempt to examine the relationship between bilateral distance and firms' extensive or intensive margin. Again, 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. For GDP, importer income increases the number of exporting firms and the number of exported products but decreases the average export value.

In Bernard *et al.* (2006a), adjustments to firms' extensive margins suggests that the number of products can be switched in the production of multiple products through resource reallocation. The concept of adding and dropping particular products is based on productivity 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 are.

Finally, Eaton *et al*. (2007) investigate the variation in a country's exports using Colombian data. Total exports are a composition of the number of firms selling (extensive margin) and average sales for each firm (intensive margin). They find that an increase in the total export value of Colombia affects over 50% more firms. They also examine the export dynamics of continuing firms, entrants and those that exit. Total export sales of new exporters is relatively small while most of export revenue comes 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 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 that was established in 1992 and

which aims to eliminate tariff and non-tariff barriers in both manufacturing and agricultural sectors among member countries.[1] Consequently, the ASEAN region remains a major export market for Thailand. The share of Thai exports to ASEAN in 2006 is about 20.8% of total exports with 15% and 13% exported to the US and EU15 respectively. Since 1999, the total export value of trade has increased dramatically reaching US$ 129,744.1 million in 2006. The manufacturing sector still dominates, accounting for 77% of total exports in 2006.

Table 1 illustrates the level of exports for a selection of Thai industries. Sectors with large volumes of exports have tended to be high-technology products such as computers, parts, and accessories, automobiles and parts, and integrated circuits. The production of computers and their parts has been Thailand's leading industrial export sector for many years, accounting for 11.47 percent of the country's total exports in 2006. 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 labor-intensive products such as gems, jewellery, and garments.[2]

[Table 1 about here]

In this paper, we use the Annual Survey of Thailand's manufacturing industries by the Office of Industrial Economics (OIE), Ministry of Industry, Thailand. The survey covers 79 types of manufacturing activity at the 4-digit ISIC level that consist of 23 2-digit ISIC industries and includes small, medium, and large firms.[3] 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 major questions that cover different aspects of a firm's characteristics and performance including balance sheet information. We exclude a small number of firms

[1] 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.

[2] 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).

[3] In 2001 a questionnaire was sent out to 6,735 firms. The response rate was around 60%. Approximately 35% of firms were small, 32% medium and 33% large.

for which their mean of total sales exceeds US$ 1 billion. Our final unbalanced panel comprises 15,115 observations for the period 2001 to 2004.[4]

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 also 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 are based on the question in the survey that asks the firms to "list the products that you produce". This approximates to a 6-digit product classification, which helps to minimise categorical aggregation issues. Our variables are defined and descriptive statistics are presented in Table A1 and A2 of the appendix respectively.

Table 2 provides a summary of our 2-digit ISIC data for the four years of our sample 2001 to 2004. A number of those 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 percentage of firms that export with ISIC 34 (Motor vehicles, trailers & semi-trailers) showing the largest increase in exports during this period. Table 2 demonstrates Thailand has continued engagement with the global development of trade.

[Table 2 about here]

In Table 3 we present the share of output and the share of firms that produce single and multiple products by various groupings. When we consider all firms, we see that a majority of firms produce only one product (57.12%) with 17.81% producing two products and only 9.15% producing five or more products. However, those 57.12% of firms only produce about 12% of total output with the 9.15% of firms producing five or more products producing over 26% of total output. Comparing foreign and domestic firms note that a higher percentage of domestic firms produce one product. Foreign firms have a higher percentage of multi-product firms and a higher share of output (28.72%) for firms producing five or more products. Comparing exporters and non-exporters is equally

[4] Each year, there are some firms that 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.

illuminating where we find a greater difference with 61.16% of non-exporters and only 53.15% of exporters producing a single product.[5]

Finally, the issue is complicated further when we examine the split between foreign owned non-exporters and exporters. We find that 68% of foreign non-exporters produce a single product. The fact that there are so many foreign owned firms that do not export is a stylised fact that we believe has not been previously highlighted in the literature where traditionally foreign firms are considered to be exporters almost by definition. This insight adds a layer of complexity to our analysis. As this is the first study of its kind for a developing country we have no other points of reference but suspect that this might be a factor for other developing countries.

[Table 3 about here]

# 4. Multi-Product Firms' Intensive and Extensive Margins

As mentioned previously, multi-product firms in Thailand produce 94% of total output while firms that export multiple products account for about 93% 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.

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),

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

[5] The figures presented in Table 3 differ slightly from the headline figures provided in the introduction due to the exclusion of the small number of $1billion plus companies that were present in the raw data. The headline figures for our sample of firms is that 88% of output is produced by multi-product firms and 89% of total exports are from firms that export multiple products.

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

$n_i$ is the number of products produced.

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

The subscripts $i$, $t$ and $p$ denote firm, time and product respectively. The relationship between firm size and multiple product firms requires 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,

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

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

where $\mu_{it}$ and $\varepsilon_{it}$ denote stochastic errors. By using OLS estimation techniques it can be assumed that $\beta_1 + \beta_2 = 1$ and means that the coefficient of $\beta_1$ captures the partial correlation between total output and the extensive margin whereas $\beta_2$ 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 ($\beta_1$ and $\beta_3$). 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 1% of the variation in total firm output. This means that an increase in output results from an increase in number of products (extensive margin) by keeping average output per product (intensive margin) relatively constant.

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 %. This means that the number of products exported raises total export sales by 7.4 % by keeping average export sales per product constant.

[Table 4 about here]

We also 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 a firm. The estimated regressions are presented as follows,

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

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

In Table 5 we observe a positive correlation between extensive and intensive margins only in Columns (3) and (4). This positive relationship indicates that the number of products exported increases export sales per product by between 50.1% and 58.4%. We can conclude therefore that multi-product firms marginally increase the number of products exported but for each product, multi-product firms export a larger volume. However, in contrast to Bernard *et al.* (2006b), we find a negative and significant correlation for firms' extensive and intensive margins using 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% and 69.2%. This suggests that in Thailand, multi-product firms tend to produce a large range of products but only in small volumes. Most importantly, it suggests that the behavior of MNEs differs by location between developed and developing countries. As this is the first study for a developing country we only have the US for comparison. However, in terms of development the range of products could be considered

more important than the volume as variety of product will require a variety of production techniques and potentially different technologies. Volume may be considered more important for job creation. The problem is that too few foreign firms are multi-product firms.

[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 affects the variation in firm size. 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 play a significant role in Thailand's economy. Although there are a larger number of single product firms, over 94% of total output is accounted for by multi-product firms. To investigate why the behavior of MNEs in Thailand might differ from those in the US we investigate which factors, in addition to size, determine a firm's decision to produce multiple products.

# 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. In section 5.1 we 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.[6] All independent variables are lagged by one year in order to control for

[6] 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

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,

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

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.

$\Phi$ 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.[7] In addition, we allow for robust clustering at the two-digit industry level (clustering at the regional level made little difference to the results). 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.

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GMM first difference estimator requires two or more lags of all the right-hand-side variables as instruments.

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

$TFP^{LP}$ 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 the 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 labor productivity ($TFP^{LABPROD}$) is calculated from the log of value added over total labor.

*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).

*wage* is the log of wage per employee. Wage is an indicator of labor quality. It is expected that the higher the wages, the more superior the quality of labor 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 to 8 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.

In Table 6, the results of our preferred specification in column (6) shows 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 or not 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 behavior between domestic and foreign exporters that we investigate later. The positive coefficient on $EX_{i(t-1)}$ in columns (1) and (2) is when we do not include size, which has a strong partial correlation with export status (see the correlation matrix in Table A3 of the appendix for details).

Foreign ownership appears therefore to be one of the more important associations 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 we noted earlier, foreign owned firms that also export are positively and significantly correlated with firms that produce multiple products. Thus it is evident 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 labor 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 1% level. A one-unit increase in size is associated with an increase in the probability of producing multiple products of approximately 6 percentage points. If we categorise firm size into small, large and very large firms, the coefficients are also significant at the 1% level with small firms being negatively correlated with being multi-product. As firm sizes increase, we observe increasingly positive results so that the larger the size, the greater the probability of producing multiple products.

To investigate the negative foreign ownership and exporter results further we split the sample into domestic firms and foreign firms in order to investigate the differences between

these groups. Approximately one quarter of our sample are foreign firms. We retain the 10% foreign owned definition.[8]

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 to be a multi-product producer and is picked up in Table 6 by the positive and significant interaction term. This suggests a structural difference between the behavior 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.

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 indicates 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 or 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% and 5% level for foreign firms only. Firm size for both domestic and foreign firms is positive and significant.

Table 8 represents a final attempt to disentangle the foreign ownership and exporting issue by changing our dependent variable from a dummy representing the production of multiple products to a dummy that captures the export of multiple products. Reassuringly, there is a positive correlation between being an exporter and being more likely to export multiple products. However, neither the foreign owned firms or interaction terms are significant. This suggests that foreign owned and domestic firms are equally likely to export multiple products once they have crossed the threshold and achieved export status.

For TFP we now observe that it is an insignificant association with the propensity to export multiple products. The other variables such as R&D, wages and size are generally

[8] As part of a sensitivity analysis we tested 25% and 50% cut-off points with broadly similar results available upon request.

consistent with Table 6. In sum, the relationship between ownership and multiple product production is complex. First, we observe that foreign owned firms and exporters have a negative partial correlation with the likelihood of being a multi-product producer in general but that being foreign and an exporter means a firm is has a positive partial correlation with both the production and export of multiple products. Finally, we show that once a firm achieves export status, that ownership is less important. Evidently, the behavior of foreign firms in developing countries is not as straightforward as one might have expected.

### 5.2 Multi-Product Firms and the Number of Products

In sub-section 5.1 we examined the characteristics of being a multi-product firm. In this section we investigate the characteristics associated with the number of products produced by multi-product firms. Thus, our sample now includes multi-product firms only. The dependent variable is a count of the number of products produced. We judge this to be the appropriate specification as we suspect that there is a threshold effect where it is the decision to be multi-product that is important with potentially different variables associated with being multi-product and the number of products produced. We also estimated a simple Poisson count model that includes single product and multi-product firms. Tables A4 and A5 of the appendix provides the results for the simple Poisson count model for all firms and a domestic foreign split respectively. Our simple Poisson regression results in Tables A4 and A5 are almost identical to those presented in Tables 6 and 7.

Since count data is used as our dependent variable, we estimate count data using a truncated Poisson regression model.[9] We lag all independent variables by one year to control for possible endogeneity problems as before. As before, this is not ideal and so we continue to avoid direct causal language in discussing our results. Our truncated Poisson model can be specified as follows,

$$\Pr(NPRODUCT_{it} \mid NPRODUCT_{it} \geq 2, Z_{i(t-1)}) = \frac{\Pr(NPRODUCT_{it} \mid Z_{i(t-1)})}{\Pr(NPRODUCT_{it} \geq 2 \mid Z_{i(t-1)})} \qquad (9)$$

[9] The computation of the count data truncated at two is the probability for each positive outcome given that we know that outcome is greater than one. An alternative estimation procedure is to employ a negative binomial model which is preferable when the dependent variable is small relative to the standard deviation. This is not a concern with our data.

where $NPRODUCT_{it}$ is a count for the number of products produced by each multi-product firm.

$Z$ is a vector of firm level characteristics.

In equation (9), the probability of a truncated count is $\Pr(NPRODUCT_{it} \geq 2 | Z_{i(t-1)}) = 1 - \exp(-\mu)$ and $\mu = \exp(\beta' Z_{i(t-1)})$. Independent variables included in a vector of firm level characteristics $(Z)$ are the same as in the previous sub-section. 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. Again, we allow for robust clustering at the two-digit industry level.

Table 9 reveals a number of similarities and differences to Table 6. The main difference is that being an exporter is negatively and significantly partially correlated with the number of products produced while the interaction term remains positive and significant and being foreign owned remains negative and significant. For the other independent variables, the coefficient on TFP is now generally negative when firm size variables are included and the R&D variables are generally insignificant. It is reassuring that the results for wage and size are generally consistent with the results in Table 6.

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 labor productivity were employed instead of our Levinsohn and Petrin (2003) approach.[10] 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 attempt to explain different aspects of multi-product firms in international trade using the Thailand Annual Manufacturing Industries survey from 2001 to 2004. The

[10] Using the Buettner (2003) measure of TFP means we lose approximately four percent of our observations.

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 two different type of dependent variables, binary and 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 multi-product firms. We also examine the systematic differences in the characteristics of multi-product firms between domestic and foreign firms by estimating each sample separately.

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 that the explanation for these low variations, at least relative to the findings in Bernard *et al.* (2006b), is partially as a result of the level of aggregation we use when we classify the number of products.[11] 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 and the number of products produced. Productive and large firms and those that carry out R&D also have a strong association the probability of being a multiple product firm. Similarly, the effects of different factors on the expected number of product produced by multi-product firms are fairly consistent with the factors that affect the probability of becoming a multi-product firm. There is some evidence to show that productivity may be associated with a lower number of products suggesting that some countries follow the route of producing a greater volume rather than produce a greater larger number of varieties. There is no clear relationship between productivity and the number of products produced.

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 important from a development policy perspective is that R&D has a broadly insignificant association with the propensity of a foreign firm to be multi-product or the

[11] 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.

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. The results from empirical analysis also confirm that export status to be one of the important characteristics associated with the emergence of multi-product firms and number of products produced by multi-product firms. There appears however to be differences in the behavior of foreign firms in developing and developed countries. In future research it would be useful to break down foreign ownership into different country groupings to see whether there is a difference between the behavior of firms from developing and developed countries. A further extension that would require a longer time period would be to examine the behavior 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 1999-2006.**

| 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

**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 | 43.15 | 42.52 | 44.19 |

| | | | | | |
|---|---|---|---|---|---|
| | | (65) | (63) | (54) | (57) |
| 32 | Radio, television & communication equipment & apparatus | 75.95 | 79.08 | 78.08 | 74.26 |
| | | (120) | (121) | (114) | (101) |
| 33 | Medical, precision and optical instruments, watches & | 47.76 | 50.85 | 47.27 | 50.00 |
| | clocks | (32) | (30) | (26) | (22) |
| 34 | Motor vehicles, trailers & semi-trailers | 46.53 | 49.48 | 59.09 | 65.60 |
| | | (47) | (48) | (78) | (82) |
| 35 | Other transport equipment | 48.84 | 51.22 | 54.05 | 41.38 |
| | | (21) | (21) | (20) | (12) |
| 36 | Furniture; manufacturing n.e.c. | 74.43 | 73.43 | 77.83 | 77.27 |
| | | (163) | (152) | (158) | (136) |
| 37 | Recycling | 25.00 | 30.77 | 33.33 | 28.57 |
| | | (4) | (4) | (4) | (4) |
| | **Total industry** | 48.10 | 49.16 | 51.10 | 51.78 |
| | | (1,936) | (1,854) | (1,791) | (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 | 11.95 | 58.17 | 11.46 | 54.37 | 13.05 | 61.16 | 15.38 | 53.15 | 12.51 | 68.29 | 9.94 | 50.85 | 14.59 |
| | (5,438) | | (4,001) | | (1,437) | | (2,883) | | (2,555) | | (364) | | (1,073) | |
| 2 | 17.81 | 17.78 | 16.89 | 18.75 | 20.20 | 16.08 | 16.31 | 22.87 | 19.28 | 16.71 | 16.70 | 19.03 | 21.09 | 16.06 |
| | (1,696) | | (1,162) | | (534) | | (769) | | (927) | | (89) | | (445) | |
| 3 | 9.16 | 23.88 | 9.57 | 27.76 | 8.10 | 23.10 | 8.59 | 35.76 | 9.71 | 21.68 | 6.38 | 48.18 | 8.53 | 20.81 |
| | (872) | | (658) | | (241) | | (405) | | (467) | | (34) | | (180) | |
| 4 | 6.76 | 20.31 | 6.54 | 21.25 | 7.34 | 19.05 | 5.11 | 16.11 | 8.38 | 18.77 | 3.75 | 13.09 | 8.25 | 19.15 |
| | (644) | | (450) | | (194) | | (241) | | (403) | | (20) | | (174) | |
| 5+ | 9.15 | 26.08 | 8.83 | 20.78 | 9.99 | 28.72 | 8.82 | 9.88 | 9.47 | 30.33 | 4.88 | 9.76 | 11.28 | 29.39 |
| | (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 $(\ln \overline{y}^{e}_{it})$. 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 a Firm's Decision to Export Multiple Products (Dep. Var. is $MULTIEXDUM_{it}$)**

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| $EX_{i(t-1)}$ | 0.110*** | 0.109*** | 0.076* | 0.076* | 0.077** | 0.077** |
| | (2.91) | (2.88) | (1.91) | (1.91) | (1.98) | (1.99) |
| $FOREIGN_{i(t-1)}$ | -0.103 | -0.093 | -0.104 | -0.103 | -0.109 | -0.107 |
| | (1.17) | (1.10) | (1.18) | (1.20) | (1.24) | (1.24) |
| $(EX * FOREIGN)_{i(t-1)}$ | 0.134 | 0.132 | 0.137 | 0.137 | 0.146 | 0.145 |
| | (1.51) | (1.50) | (1.56) | (1.56) | (1.63) | (1.64) |
| $TFP^{LP}_{i(t-1)}$ | 0.041*** | 0.055*** | -0.001 | 0.001 | 0.006 | 0.010 |
| | (3.27) | (3.95) | (0.06) | (0.05) | (0.46) | (0.62) |
| $RDPRODUCT_{i(t-1)}$ | 0.086*** | 0.084*** | 0.058 | 0.058 | 0.069** | 0.069** |
| | (2.64) | (2.64) | (1.58) | (1.58) | (2.13) | (2.13) |
| $RDPROCESS_{i(t-1)}$ | 0.056 | 0.057 | 0.052 | 0.052 | 0.049 | 0.050 |
| | (1.34) | (1.35) | (1.15) | (1.15) | (1.10) | (1.11) |
| $wage_{i(t-1)}$ | | -0.052* | | -0.004 | | -0.012 |
| | | (1.79) | | (0.14) | | (0.39) |
| $size_{i(t-1)}$ | | | 0.073*** | 0.073*** | | |
| | | | (7.21) | (6.76) | | |
| $SMALL_{i(t-1)}$ | | | | | -0.083** | -0.083** |
| | | | | | (2.34) | (2.33) |
| $LARGE_{i(t-1)}$ | | | | | 0.099*** | 0.098*** |
| | | | | | (3.62) | (3.53) |
| $VLARGE_{i(t-1)}$ | | | | | 0.173*** | 0.171*** |
| | | | | | (8.12) | (7.56) |
| Observations | 4835 | 4835 | 4835 | 4835 | 4835 | 4835 |

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 Multi-Product Firms (Dep. Var. is $NPRODUCT_{it}$)**

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| $EX_{i(t-1)}$ | | | - | - | | |
| | -0.023 | -0.024 | 0.074*** | 0.076*** | -0.059** | -0.061** |
| | (0.97) | (0.96) | (2.89) | (2.96) | (2.29) | (2.32) |
| $FOREIGN_{i(t-1)}$ | - | - | - | - | - | - |
| | 0.137*** | 0.143*** | 0.153*** | 0.164*** | 0.148*** | 0.158*** |
| | (2.59) | (2.69) | (2.90) | (3.10) | (2.76) | (2.91) |
| $(EX * FOREIGN)_{i(t-1)}$ | 0.139** | 0.141*** | 0.153*** | 0.157*** | 0.151*** | 0.154*** |
| | (2.57) | (2.63) | (2.84) | (3.00) | (2.73) | (2.84) |
| $TFP^{LP}_{i(t-1)}$ | | | | - | | |
| | 0.011 | 0.006 | -0.018* | 0.029*** | -0.009 | -0.018* |
| | (1.12) | (0.57) | (1.70) | (2.76) | (0.98) | (1.82) |
| $RDPRODUCT_{i(t-1)}$ | 0.054** | 0.056** | 0.030 | 0.031 | 0.042 | 0.043* |
| | (2.21) | (2.23) | (1.16) | (1.23) | (1.63) | (1.69) |
| $RDPROCESS_{i(t-1)}$ | 0.032 | 0.031 | 0.034 | 0.033 | 0.032 | 0.031 |
| | (1.05) | (1.03) | (1.07) | (1.04) | (1.03) | (0.99) |
| $wage_{i(t-1)}$ | | 0.020 | | 0.040* | | 0.033 |
| | | (0.86) | | (1.77) | | (1.40) |
| $size_{i(t-1)}$ | | | 0.051*** | 0.053*** | | |
| | | | (5.35) | (5.52) | | |
| $SMALL_{i(t-1)}$ | | | | | -0.056* | -0.056* |
| | | | | | (1.69) | (1.72) |
| $LARGE_{i(t-1)}$ | | | | | 0.056* | 0.058* |
| | | | | | (1.80) | (1.85) |
| $VLARGE_{i(t-1)}$ | | | | | 0.092*** | 0.097*** |
| | | | | | (2.83) | (2.93) |
| Observations | 4083 | 4083 | 4083 | 4083 | 4083 | 4083 |

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 I: Variables**

**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 that is calculated from the aggregation of output of individual products divides by the number of product exported. |
| $MULTIDUM_{it}$ | A dummy variable for multi-product firm which equals 1 if firm produces multiple products and 0 if firm produces single product. |
| $MULTIEXDUM_{it}$ | A dummy variable for multi-product exporter which equals 1 if firm exports multiple products and 0 if 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 that is obtained from a system estimation (a |

| | |
|---|---|
| | semi-parametric and nonlinear least square regression) of Buettner (2003). |
| $TFP^{LABPROD}_{i(t-1)}$ | Labor productivity that is calculated from the log of value added divided by total labor. |
| $size_{i(t-1)}$ | The log of total employees. |
| $SMALL_{i(t-1)}$ | For a small firm variable, a dummy variable is equal to 1 if the total labor of the firm $i$ at time $t-1$ is in the first quartile of the distribution of the total labor 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 labor of the firm $i$ at time $t-1$ is in the third quartile of the distribution of the total labor 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 labor of the firm $i$ at time $t-1$ is in the forth quartile of the distribution of the total labor 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 labor payments over total labor less owners. |
| $RDPRODUCT_{i(t-1)}$ | 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 |
| $\ln \bar{y}_{it}$ | 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 |
| $\ln \bar{y}_{it}^{e}$ | 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 |
| $MULTIEXDUM_{it}$ | 4835 | 0.38 | 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 |

**Table A3: Correlation Matrix**

| | *MULTIDUM* | *EX* | *FOREIGN* | *FOREIGN25* | *FOREIGN50* | $TFP^{LP}$ | $TFP^{BUETTNER}$ | $TFP^{LABPROD}$ | *RDPRODUCT* | *RDPROCESS* | *wage* | *size* | *SMALL* | *LARGE* | *VLARGE* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $MULTIDUM_{it}$ | 1.00 | | | | | | | | | | | | | | |
| *EX* | 0.08 | 1.00 | | | | | | | | | | | | | |
| *FOREIGN* | 0.03 | 0.36 | 1.00 | | | | | | | | | | | | |
| *FOREIGN*25 | 0.04 | 0.36 | 0.92 | 1.00 | | | | | | | | | | | |
| *FOREIGN*50 | 0.04 | 0.32 | 0.66 | 0.72 | 1.00 | | | | | | | | | | |
| $TFP^{LP}$ | 0.08 | 0.20 | 0.15 | 0.13 | 0.08 | 1.00 | | | | | | | | | |
| $TFP^{BUETTNER}$ | 0.15 | 0.39 | 0.38 | 0.36 | 0.31 | 0.63 | 1.00 | | | | | | | | |
| $TFP^{LABPROD}$ | 0.11 | 0.25 | 0.34 | 0.33 | 0.27 | 0.62 | 0.93 | 1.00 | | | | | | | |
| *RDPRODUCT* | 0.09 | 0.13 | 0.05 | 0.05 | 0.03 | 0.07 | 0.15 | 0.09 | 1.00 | | | | | | |
| *RDPROCESS* | 0.07 | 0.11 | 0.04 | 0.04 | 0.02 | 0.06 | 0.13 | 0.08 | 0.57 | 1.00 | | | | | |
| *wage* | 0.08 | 0.26 | 0.40 | 0.40 | 0.34 | 0.42 | 0.66 | 0.69 | 0.06 | 0.06 | 1.00 | | | | |
| *size* | 0.16 | 0.53 | 0.29 | 0.27 | 0.27 | 0.34 | 0.60 | 0.30 | 0.18 | 0.13 | 0.28 | 1.00 | | | |
| *SMALL* | -0.13 | -0.36 | -0.18 | -0.17 | -0.17 | -0.26 | -0.45 | -0.25 | -0.10 | -0.08 | -0.23 | -0.70 | 1.00 | | |
| *LARGE* | 0.04 | 0.13 | 0.02 | 0.02 | 0.02 | 0.08 | 0.13 | 0.08 | 0.01 | 0.02 | 0.08 | 0.18 | -0.34 | 1.00 | |
| *VLARGE* | 0.13 | 0.35 | 0.22 | 0.20 | 0.21 | 0.25 | 0.43 | 0.21 | 0.15 | 0.11 | 0.18 | 0.72 | -0.34 | -0.33 | 1.00 |

**Table A4: The Characteristics Associated with the Number of Products Produced (Dep. Var. is $NPRODUCT_{it}$)**

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| $EX_{i(t-1)}$ | 0.017 | 0.017 | -0.073 | -0.077 | -0.061 | -0.064 |
| | (0.37) | (0.36) | (1.56) | (1.60) | (1.28) | (1.30) |
| $FOREIGN_{i(t-1)}$ | - | - | - | - | - | - |
| | 0.217*** | 0.222*** | 0.237*** | 0.252*** | 0.237*** | 0.249*** |
| | (5.63) | (5.81) | (6.19) | (6.57) | (6.21) | (6.43) |
| $(EX*FOREIGN)_{i(t-1)}$ | 0.202*** | 0.204*** | 0.223*** | 0.228*** | 0.225*** | 0.229*** |
| | (3.73) | (3.72) | (4.73) | (4.82) | (4.47) | (4.50) |
| $TFP^{LP}_{i(t-1)}$ | 0.061*** | 0.056*** | 0.014 | -0.001 | 0.021** | 0.010 |
| | (8.49) | (4.78) | (1.59) | (0.06) | (2.34) | (0.78) |
| $RDPRODUCT_{i(t-1)}$ | 0.098*** | 0.098*** | 0.061** | 0.061** | 0.077*** | 0.077*** |
| | (3.38) | (3.42) | (2.02) | (2.04) | (2.58) | (2.62) |
| $RDPROCESS_{i(t-1)}$ | 0.085** | 0.085** | 0.080** | 0.080** | 0.078* | 0.078* |
| | (2.28) | (2.28) | (2.01) | (2.01) | (1.94) | (1.94) |
| $wage_{i(t-1)}$ | | 0.019 | | 0.055** | | 0.046* |
| | | (0.69) | | (2.34) | | (1.81) |
| $size_{i(t-1)}$ | | | 0.085*** | 0.088*** | | |
| | | | (7.49) | (7.80) | | |
| $SMALL_{i(t-1)}$ | | | | | - | - |
| | | | | | 0.114*** | 0.115*** |
| | | | | | (4.29) | (4.41) |
| $LARGE_{i(t-1)}$ | | | | | 0.105*** | 0.107*** |
| | | | | | (2.83) | (2.89) |
| $VLARGE_{i(t-1)}$ | | | | | 0.180*** | 0.186*** |
| | | | | | (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 A5: 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) |
| $EX_{i(t-1)}$ | 0.015 | -0.071 | -0.065 | 0.209*** | 0.140*** | 0.163*** |
| | (0.34) | (1.59) | (1.42) | (4.27) | (2.91) | (3.27) |
| $TFP^{LP}_{i(t-1)}$ | 0.051*** | -0.004 | 0.002 | 0.086*** | 0.019 | 0.044* |
| | (2.98) | (0.26) | (0.15) | (3.70) | (0.81) | (1.93) |
| $RDPRODUCT_{i(t-1)}$ | 0.081* | 0.040 | 0.051 | 0.112* | 0.090 | 0.107 |
| | (1.71) | (0.80) | (1.03) | (1.68) | (1.31) | (1.62) |
| $RDPROCESS_{i(t-1)}$ | 0.157*** | 0.154*** | 0.152*** | -0.055 | -0.059 | -0.062 |
| | (3.30) | (3.14) | (2.98) | (0.79) | (0.87) | (0.91) |
| $wage_{i(t-1)}$ | 0.034 | 0.054** | 0.048** | -0.013 | 0.057 | 0.030 |
| | (1.18) | (2.19) | (1.96) | (0.26) | (1.05) | (0.58) |
| $size_{i(t-1)}$ | | 0.084*** | | | 0.090*** | |
| | | (8.70) | | | (5.30) | |
| $SMALL_{i(t-1)}$ | | | -0.109*** | | | -0.146* |
| | | | (3.32) | | | (1.84) |
| $LARGE_{i(t-1)}$ | | | 0.132*** | | | 0.021 |
| | | | (2.78) | | | (0.38) |
| $VLARGE_{i(t-1)}$ | | | 0.198*** | | | 0.116*** |
| | | | (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.