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CHAPTER 11

Firm Productivity, Globalization and Global Product Sharing: Lesson from Thai Manufacturing*

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This paper examines productivity determinants across firms in Thai manufacturing, using the 2006 industrial census. The main focus is to gain better understanding two-industry-specific variables highly policy relevant, trade policy and global production networks. Our key finding is that while firm-specific variables such as years of operation, R&D activities, a number of skill workers employed have positive effect on productivity, modes in which firms are integrated into the global economy like market orientation and foreign partnership positively attribute to their productivity. Firms operating in more restrictive trade policy register lower productivity than those in more liberal environment. The negative effect much higher for large firms perhaps due to presence of water-in-tariff occurring among small and medium firms. Different types of production network might have different effect. It is producer-driven network that have positive effect on productivity only the small firm sample. When firm size exceeds 110 and 125 workers, the effect on productivity is not different from zero. By contrast, firms participating in buyer-driven networks tend to have lower productivity, regardless their size.

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1. Issue

While persistence of productivity difference across firms is well recognized in the literature[1], the reasons for the persistent pattern remains largely unknown. Some studies and Fox and Smeets (2011) in particular point to the role of unobserved firm-specific fixed effects but they seem unsatisfactory. Importantly, the policy inference from them is rather weak. This becomes increasingly important in the context of developing countries where policy reforms remain unfinished business.

There are at least two challenges in trade and development policy reform. The first is unfinished business in trade liberalization and its escalation structure (Michalopoulos, 2000; IMF 2002; Nicita et al. 2013). Policy reluctance to move forward is often found, driven by the concern that there are yet productive firms that could be out of business because of trade liberalization. This reluctance is even more when there are a large number of indigenous small enterprises involved. Since the new millennium a format of trade policy reform in many developing countries including Thailand has shifted toward preferential trade arrangement (often referred to as free trade agreements or FTAs), the policy reluctance remains. Sectors that are still under the heavily cross-border protection are likely to be sensitive in FTA negotiation where trade liberalization takes place with long transition.

The second challenge is how to materialize potential benefits from the growing importance of global production network of multinational enterprises (MNEs). Global production network (GPN) refers to a circumstance where a whole production process is broken up into geographically separated stages. The network's leading firms, which can be either buyers or manufacturers, specify the characteristics of the goods to be produced, qualified inputs to be used, and the processes to be followed (Gereffi, 1999; Bair and Gereffi, 2001; Bair, 2005; Humphrey and Schmitz, 2002; Ponte, 2002).

While participating into GPN provides ample business opportunity for firms to grow and be internationally competitive, the opportunity seems uneven available. There is general belief that some enterprises often large in size and/or multinational can

[1] For example, Baily et al. (1992), Fukao and Kwon (2006), Fox and Smeets (2011), Holzner and Peci (2011) and Katsuya (2011)

benefit from the globalization and grow more than the others and small and indigenous ones in particular. In many cases, expansion of the former comes at the latter's expense. Hence, productivity difference can be observed in both between small and large firms. Whether such belief is true is a subject to be empirically tested.

While trade policy and global production networks are the key globalization drivers and highly policy relevant, they are yet included in productivity difference analysis in the previous studies. Most of potential industry-specific factors in previous studies are captured by industry-dummies. Introducing policy-relevant industry-specific factors like trade policy and global production network seems beneficial to policymakers in managing ongoing economic globalization. Against this backdrop, this paper is to examine productivity determinants across firms with emphasis on the effect of these two industry-specific factors over and above firm-specific ones. Thailand is chosen for this issue. First, Thailand's industrialization is most broad-based developed in Southeast Asia, ranging from processed foods, garment to automotives, electronics and electrical appliances. This allows us to examine the core hypothesis set above. Second, trade policy reform remains challenge to policymakers as there are sizable tariff lines whose tariff exceeds 20 per cent (the unweighted and weighted average tariff rates are 2 and 9 per cent by 2010). Policymakers are reluctant to further liberalize with concern on its adverse effect on yet productive firm.

2. Analytical Framework

A number of empirical studies point to the persistence of productivity difference across firms such as Baily et al., 1992: Fukao and Kwon, 2006; Fox and Smeets, 2011; Katsuya, 2011). Unobserved firm-specifics could be an explanation for the observed persistence in productivity difference but clearly unsatisfactory (Fox and Smeets, 2011). More importantly, the firm specific provides little clues for policy reform in economic development. This becomes increasingly important in the context of developing countries where policy reforms remain unfinished business.

As mentioned earlier, there are at least two challenges in trade and development policy, how to continue trade policy reform and how to materialize potential gains from global production network (GPN), one facet of ongoing economic globalization.

Trade policy reform deserves special attention. From Tokyo round in General Agreement of Trade and Tariff (GATT), the average tariff in developing countries successively and significantly declined from 7.2 to 4.9 per cent observed between pre and post Tokyo round thought tariff reduction mainly occurred in raw materials (GATT, 1979: 120).[2] This links developing countries to globe through expansion of international trade and direct investment.

Nonetheless, it has been undertaken unevenly, as reflected in the observed widen gap between the declining average tariff and tariff peak. In some sector, tariff and other forms of cross-border protection remain restrictive. Policymakers are reluctance to move forward on the ground that there are yet productive firms that could be out of business because of trade liberalization. This is especially true when the industry contains lots of indigenous and small enterprises. An implicit assumption used here is that some capable entrepreneurs are in the middle of upgrading. Maintaining cross-border protection a little while could buy them more time to gain dynamic efficiency and become productive later.

The restrictive trade policy entices enterprises to produce for local markets regardless sizes and nationality. Given the limited size of domestic market, competition between firms within an industry tends to be intense. SMEs might not want to have direct competition with large and/or multinational ones. The observed difference in productivity at the firm level could be observed as a result of two groups of firms within a same sector produce products that do not directly compete to each other and use different production technology. This is in line with findings in the FDI spillover literature where MNEs operate in an enclave and are not directly interacting with indigenous local firms (e.g. Kokko, 1994; Kohpaiboon, 2006).

Another challenge is the increasing importance of global production network (GPN), the breakup of the production process into geographically separated stages. While participating into GPN provides ample business opportunity for firms to grow

[2] Figures were the weighted average tariff of total industrial products.

and be internationally competitive, the opportunity could be uneven available and usually in favor of large and/or multinational enterprises. In many cases, growth opportunity to these enterprises comes at expense of small and medium enterprises. Hence, participating in GPN could result even more productivity difference across firms.

In fact, co-operation among firms in the network is information-intensive manner. The network's leading firms specify the characteristics of the goods to be produced, qualified inputs to be used, and the processes to be followed. All of them are essential for business success. Note that obtaining all the needed information incurs fixed costs so that smaller and/or indigenous firms would be at disadvantageous comparing with large and/or multinational affiliates.

In recent years, works in a global value chain literature re-highlight noticeable different behavior of MNEs in governing their production network across industries. For complex product industries like automotives and hard disk drives, MNEs in these industries prefer direct investment modes of involvement to govern their production network both offshoring and outsourcing activities. These MNE affiliates tend to deal with larger firms as a result of the increasing importance of modular production network, an emergent American model of industrial organization where lead firms in the network concentrate on the creation, penetration and defense of markets for end products—and increasingly the provision of services to go with them—while manufacturing capacity is shifted out-of-house to globally operating *turn-key suppliers*. The modular production network relies on codified inter-firm links and the *generic manufacturing capacity* residing in turn-key suppliers to reduce transaction costs, build large external economies of scale and reduce risk for network actors (Strugen 2014). Therefore, disadvantage of being small firm size against the larger one is even larger. What remains to be empirically examined is whether business opportunity for small firms is shut down completely.

Interestingly, when traditional labor intensive products and/or processed foods are concerned, MNEs prefer other form of involvement to direct investment (Richardson 1972; Oman, 1984; Kohpaiboon,2006). In these industries, production technology *per se* is mature and there is long supply chain taking place locally. While MNEs can have a full control on branding and product design, they might not be in better position run

production facilities themselves. This is especially true in these industries where it involves numerous local workers and the production cost competitiveness is sensitive to principal-agent problem. Hence, MNEs usually present in a form of buyers. Even though their presence is assemble to arm's length transaction, their involvement as indicated in the previous studies is intense, including detailed product characteristics to be produced, qualified inputs to be used, and the processes to be followed. This is referred as the buyer-driven production network.

Nonetheless, the effect of firm size on productivity for those participating in this network is unclear. In these circumstances, advantage of being small enterprises tends to compensate and sometimes outweigh its disadvantage of being small. Small firms have higher degree of flexibility so that they can respond quickly to any changes in customer demand. Perhaps this is an area where smaller/indigenous firms are in a better position to compete internationally.

3. Global Integration of Thai Firms and Their Productivity

Over the past 50 years, Thai economy is increasingly integrated to the global economy. It began since the early 1960s that Thailand has always pursued a 'market-friendly' approach towards foreign investors in manufacturing. There have not been major discriminatory policies and foreign investors have been able to be involved in almost any business (Kohpaiboon, 2006). Similarly, the investment promotion regime in Thailand generally treats domestic and foreign investors equally. Investment promotion privileges, except import surcharges and input tariffs exemption, are used in order to influence decisions to allocate resources to promoted targets though effectiveness is still unclear.

It is trade policy playing a critical role in resource allocation across industries. Historically, there has been greater reliance on tariffs rather than QRs (World Bank, 1988; Kohpaiboon, 2006). This is especially true for the manufacturing sector where tariffs were the main trade policy instrument to influence the country's resource

allocation, with a few exceptions.[3] An escalating tariff structure is the key theme in designing trade policy.

The most important tariff restructuring in Thailand took place in the mid-1990s as part of its commitments under the WTO. Nonetheless, it was done as an essential part of overall economic reforms aimed at strengthening efficiency and competitiveness (see Warr 2000; WTO, 1999 with the ultimate target of 3 tariff rates (0, 5 and 10 per cent, respectively, covering raw materials, intermediates, and final goods). Nonetheless, there were sizable exemptions whose tariff rates are still above 30 per cent.

From 2000, there has not been any major unilateral tariff liberalization. All of tariff liberalization took place through free trade agreements (WTO, 2011).[4] Nonetheless, the net effect of FTA-led tariff liberalization seems highly concentrated in few product items. In addition, there was a high proportion of sensitive items which Thailand are yet ready to undertake tariff cuts for major trading partners like China and Japan (Jongwanich and Kohpaiboon, 2014). All in all, trade policy reform remains unfinished business in Thailand.

In theory, presence of cascading tariff structure means that nominal protection tends to be underestimated the effective one. This discourages firms operating domestically to export as they would be in disadvantageous to global competition because of tariff on inputs and intermediates. This would constraint their global integration. Nonetheless, Thailand like other Southeast Asia economies introduced various tariff rebates/exemption schemes. There are at least three options available; tariff exemptions/drawbacks (Section 19 of the Custom Laws) given by the Department of Customs, and tax rebate schemes given by Fiscal Policy Offices (FPO) and tariff exemptions by the BOI on imported raw materials. These schemes especially BOI tariff exemption one are highly utilized, reflected by a huge difference between incident tariff

[3] One exception was the automotive industry where the government has used both tariff and non-tariff measures i.e. LCRs, to encourage auto parts localization

[4] There was a tariff reduction plan implemented between 2004 and 2008 but it was minor and covered only 900 items most of which are intermediates such as rubber and articles thereof (HS40), glass and glassware (HS70), knitted fabrics (HS60), other base metals (HS81), woven fabrics (HS58), articles of stone (HS68), man-made staple fiber (HS55), wadding yarns (HS56), cotton (HS52), and miscellaneous vegetable preparations (HS21). The magnitude of tariff reduction is moderate within the range of 0 to 8.9 per cent (Jongwanich & Kohpaiboon, 2007: Table 1).

(the ratio between tariff revenue to total imports) and the average MFN tariff rate. For instance the 2008 incident tariff was less than 2 per cent as opposed to 10.7 and 4.5 per cent for the unweight and weighted average MFN rates.

In this setting, domestic firms have two choices; first to operate under the cascading tariff structure by producing goods for the highly protected domestic market or, second, to export, by making use of the country's comparative advantage. Hence, for a given industry as well as these schemes highly utilized, it is possible to observe the co-existence of two firm types, i.e. one for highly protected domestic market and another highly export oriented. This would result in firm heterogeneity in terms of productivity.

This is what has observed in Thai manufacturing. Even though a progress of tariff restructuring and reform was limited and the average tariff in Thailand is relative high as opposed to other upper middle income countries, the country is one of the important export hubs in the region. Thailand is at the top-10 global exporters in several manufacturing products including processed foods (canned tuna, canned pineapple, processed chicken and processed shrimp), garment, footwear, electronics, and electrical appliances (Table 1).

Table 1: Manufacturing Export of Thailand 2000-2011

	(%) Share of total export				World Market Share
	2000-7	2008-9	2010	2011	2009-11
Manufacturing Products	77,4	77,1	61,9	69,4	
- Processed Shrimp (HS 160520)	0,9	0,8	0,7	0,8	35.1 (1)
- Canned Tuna(HS 160414)	0,8	1	0,8	1	43.5 (1)
- Hard Disk Drive (HS 847170)	13,9	14,8	5,3	4,6	17.3 (2)
- Vehicles (HS 8701-4)	5,4	8,3	9,7	10,5	n.a.
- Textiles and Clothing (HS51-62)	4,8	3,4	3,2	3,5	1,3
- Television set (HS 852812)	1,4	1	0,4	0,5	1.2 (12)
- Washing Machines (HS 845011)	0,1	0,3	0,1	0,1	2.1 (6)
- Microwaves (HS 851650)	0,3	0,2	0,2	0,2	9.5 (2)
- Air Conditioning (HS 841510)	0,6	0,8	0,8	0,9	16.4 (2)

More importantly, in a process of global integration, multinational enterprises (MNEs) play a crucial role. Their presence takes place through both buyer- and producer-driven network. It began with the buyer-driven network in the late 1970s

where there were representatives of multinational trading companies seeking for reliable suppliers in developing countries including Thailand. These companies did not set up their affiliates but sent these representatives to work with these suppliers to manufacture tailor-made finished products for export. Evidence from firm interview in Thailand points the crucial role of these representatives for export success (Kohpaiboon, 2006). From the mid-1980s, process of global integration has speeded up partly due to the introduction of effective BOI tariff exemption scheme in 1983. This was more or less in line with changes in the global environment when many East Asian manufacturers started losing their international competitiveness in labor-intensive products. As a result, there have been massive FDI inflows into Thai manufacturing with the ultimate target for export to the third country. All of them attributed to Thai firms be integrated into the global economy.

Figure 1 presents kernel density estimation of labor productivity (in natural log) across firm groups in 2006. There are four groups, large, medium, small and micro enterprises. In this study, we follow the definition used in Small and Medium Enterprises Promotion Bill of Thailand. That is, large firms are defined as enterprises having more than 200 workers; medium ones are those employing between 50 and 200 workers; small ones are between 10 and 50 workers; and micro enterprises are those employing less than 10 workers. Clearly, Figure 1 shows that labor productivity is an increasing function of size. The average labor productivity is the highest in the large firm group and the lowest in the micro enterprise group. Medium and small firm groups are in the middle respectively. In the small and micro enterprise groups, labor productivity varies vastly across firms. Interestingly, these four firm groups are different from each other in these characteristics, some of which such R&D activities, a proportion of skill to total operation workers, and market orientation do matter to firm's productivity (Table 2).

Figure 1: Kernel Density Estimate of Labor Productivity Across Firm Size Group

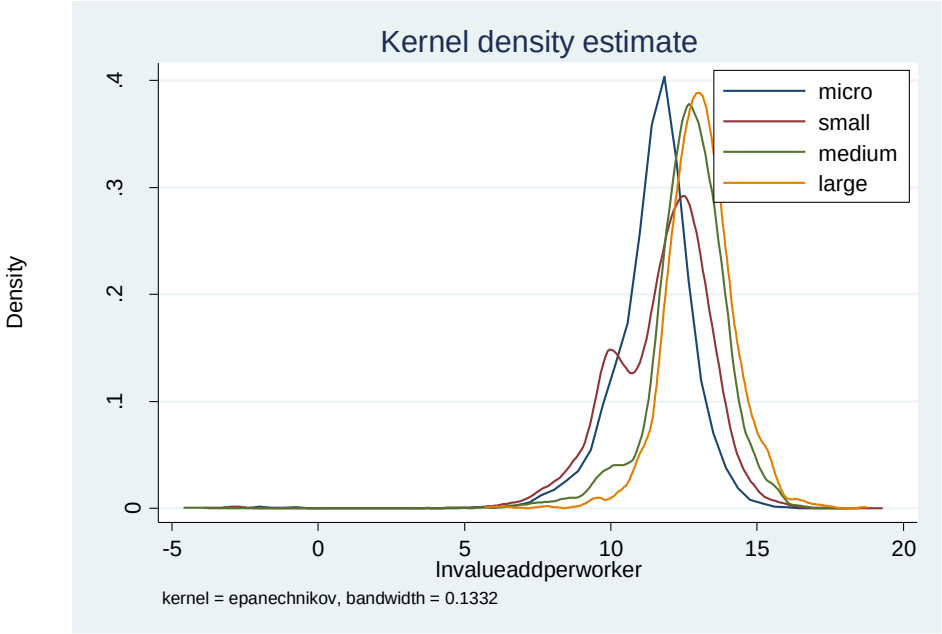


Table 2: Selected Firm Characteristics in 2006

Variables	Census 2006			
	Micro-enterprises	Small	medium	large
Registred capital	4.590.932	82.577.613	98.068.945	483.675.239
No. of irms	39.192	18.961	5.241	2.809
MNEs share (%)	0,1	1,6	8,7	19,8
Percent of exports (%)	0,1	2,8	15,6	35,5
Import materials (%)	0,3	3,7	12,5	23,5
Capacity utilization	74,8	76,4	78,4	80,8
Male (% of total pay)				
- unpaid	33,9	3,8	1	0,2
- Operative	19,3	37,1	44,3	41,2
- Skilled	16,5	28	30,9	28,3
- Unskilled	2,8	9,1	13,4	12,9
- Other employees	0,5	3,4	6,7	6,6
Female (% of total pay)				
- unpaid	32,3	8,6	1,4	0,1
- Operative	13,2	41,9	38,6	44,7
- Skilled	10,6	26,6	25,1	28,9
- Unskilled	2,6	15,4	13,5	15,8
- Other employees	0,8	5,1	8	7,2
Wage (Baht/year)				
- Operatives	88.539	1.041.578	6.281.206	47.341.036
- Other employees	7.132	264.040	2.276.928	14.725.817
Sales (Baht)	954.601	18.089.125	165.862.857	1.589.942.845
Value added (Baht)	307.375	2.579.103	64.712.365	645.478.850
R&D (% of sales)	0,01	0,1	0,38	0,6

Source: Authors' Calculation from Census 2006.

Whether firms are globally integrated as well as what modes of global integration also have a significant effect on firm's productivity. Figure 2.a, 2.b and 2.C present kernel density estimation of labor productivity (in natural log) according to how firms integrate to the globe. These kernel density estimation in Figure 2 suggest that firms integrated into the global economy either through trade (export their products or import intermediates) and/or having foreign partners exhibit higher than those that did not.

Figure 2:Kernel Density Estimate of Labor Productivity Across Modes of Global Integration

Figure 2a: Foreign Direct Investment

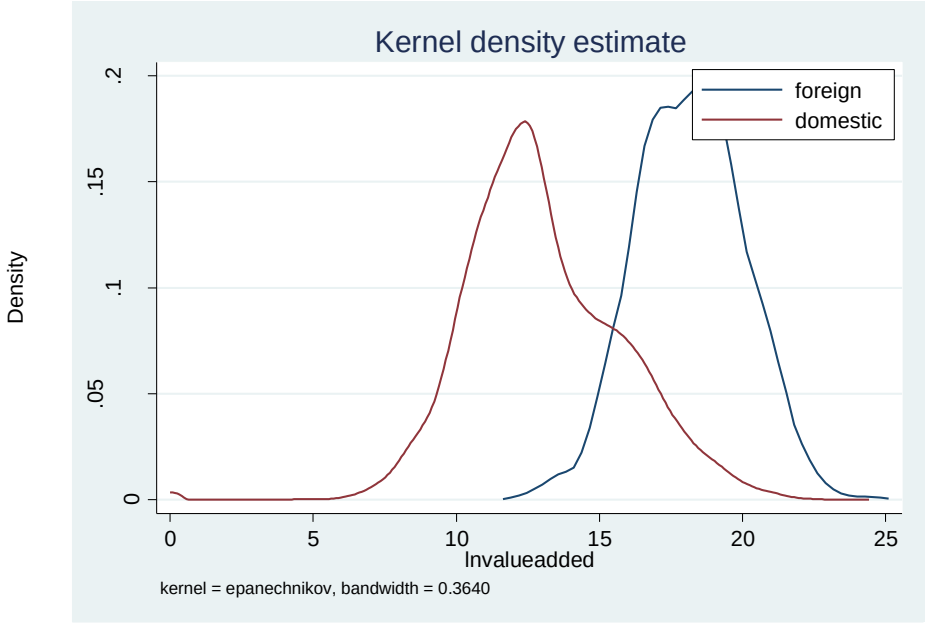


Figure 2b: Export

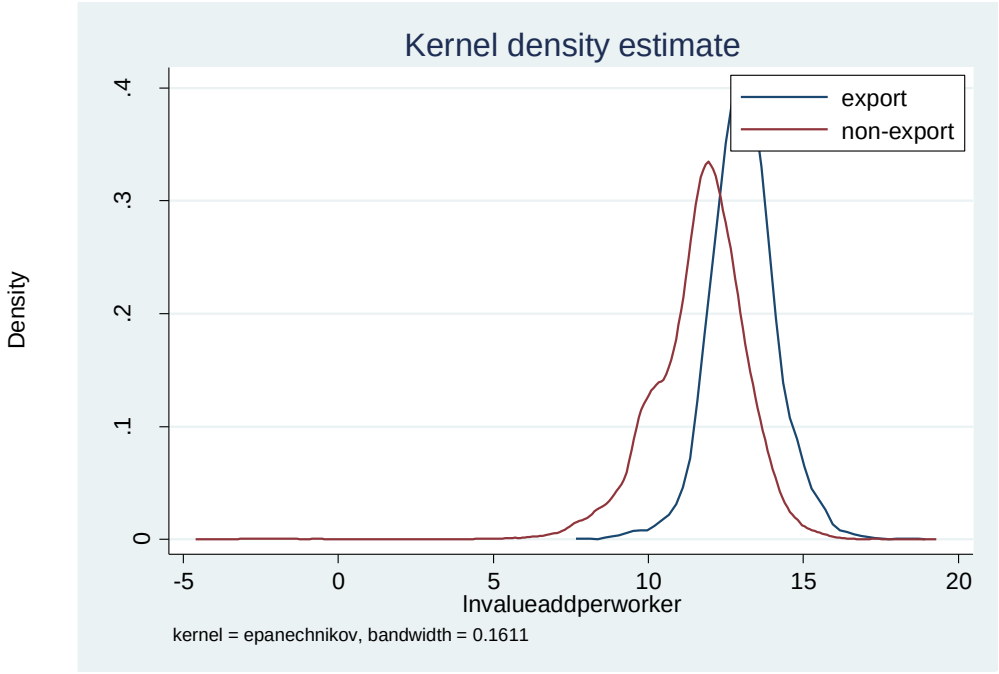
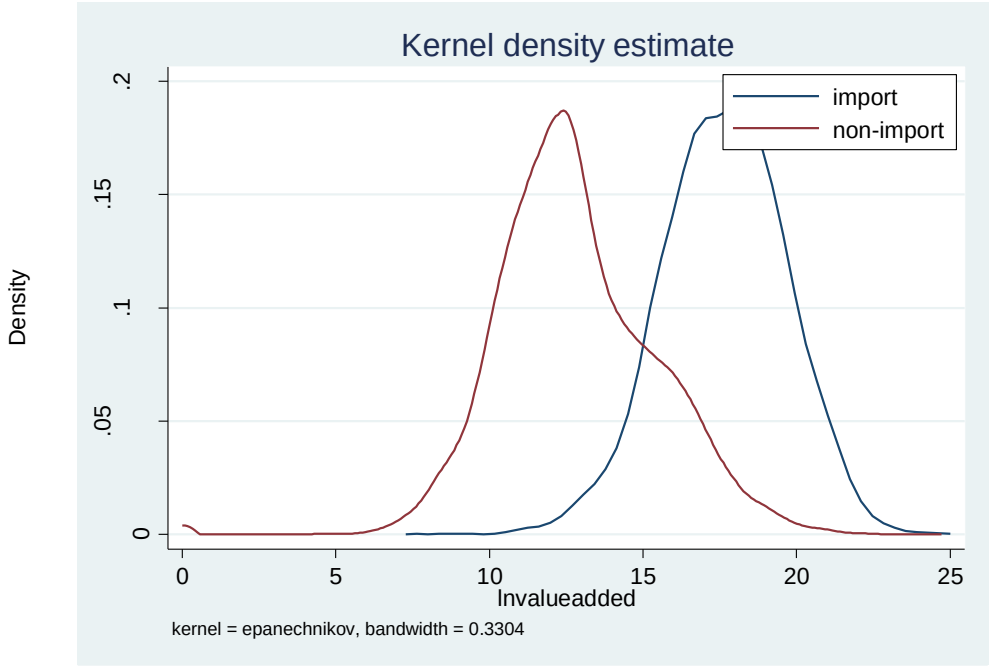


Figure 2c: Intermediate Import



Source: Authors' calculation, using 2006 industrial census.

4. Empirical Model

In line with the standard practice in the literature of productivity determinants, (Griliches, 1992; Javorcik, 2004; Crespo & Fontoura, 2007; Blalock & Gertler, 2008) The empirical model used in this study begins with a production function. A translog functional form is chosen to avoid the restriction imposed in the Cobb Douglas forms that were popular in the previous empirical studies of Thai manufacturing (e.g. Khanthachai *et al.*, 1987; Tambunlertchai & Ramstetter, 1991), i.e. unity of elasticity of substitution and log-linear relationship between inputs and outputs. The translog function form also controls for input levels and scale effects on value added. It is specified as equation (1);

$$\ln Y_{ij} = \lambda_{ij} + \alpha_1 \ln K_{ij} + \alpha_2 \ln L_{ij} + \alpha_3 \ln K_{ij}^2 + \alpha_4 \ln L_{ij}^2 + \alpha_5 \ln K_{ij} * \ln L_{ij} + \gamma_{1*n} X_{n*1} + \varepsilon_{ij} \quad (1)$$

where Y_{ij} = value added of firm ith in industry jth

K_{ij} = capital stock of firm ith in industry jth

L_{ij} = workers employed by firm ith in industry jth

X_{n*1} = column vector of controlling variables of firm ith in industry jth

In line with the endogenous growth theory, there are a set of firms-and industry-specific factors. In this study, six firm-specific factors are introduced, i.e. market orientation (mkt_{ij}), import intermeidates (imp_{ij}), ownership (own_{ij}), age (age_{ij}), a number of skill workers in operation ($skill_{ij}$) and R&D activities (RD_{ij}). mkt_{ij} is, a zero-one binary dummy which takes value '1' for firms involving export market and '0' otherwise. Alternatively, a share of export to total sales is also used as a robustness test. Similar to , imp_{ij} is measured by a zero-one binary dummy which takes value '1' for firms importing intermediates from abroad and '0' otherwise. As a robustness checking, a share of intermediate imports to total import is also used. Coefficients corresponding to these two firm-specific variables are expected to be positive. As postulated in the

firm heterogeneity literature, international trade incurs sunk costs to firms so that their productivity must be adequately high to cover the cost and enter the world market.

own_{ij} is measured by a zero-one binary dummy which equals to one when firms have involved with MNEs and '0' otherwise. The share of foreign partners of firm i^{th} in industry j^{th} is also used as alternative for robust checking purpose. As also guided in the FDI literature, MNE affiliates are usually more productive than their indigenous counterparts. Nonetheless, empirical result examining the productive difference between MNE affiliates and indigenous firms is at best mixed.[5]

Another firm the model is firm age (age_{ij}), years in operations. The sign of age_{ij} is inconclusive since older firms, on the one hand, may be more traditional than younger firms and therefore less inclined to change the operating process and adopt new technologies. Hence, the older firm's productivity might be lower than that of the younger. On the other hand, older firms have more experience in production process and register higher productivity higher than the younger firms.

$skill_{ij}$, measured as a proportion of skill to total operational workers (a sum of skill and unskill operational workers) is introduced to measure how active firms improve their productivity. The higher the number of employed skill operational workers, the higher the productivity the firm. The positive sign is expected. RD_{ij} is another firm specific factor influencing on productivity. The higher the effort of R&D investment, the higher the productivity observed. Hence, the coefficient associated with RD_{ij} is expected to be positive.

Four industry-specific factors are included in the empirical model. The first industry-specific factor is producer concentration. A link between producer concentration and productivity was firstly proposed by Schumpeter (1942) with the well-known 'creative destruction' proposition. Specifically, productivity-enhancing activities typically involve large fixed and irrecoverable upon exit and are subject a large degree of risk and uncertainty, to scale and scope economies. Hence, the expectation of some forms of transient *ex post* market power is required for firms to have the incentive to invest in such activities. In a circumstance where capital markets

[5] For example, studies of productivity differentials between MNEs and non-MNEs in the manufacturing industries of Malaysia (Menon, 1988; Oguchi et al 2002) and Thailand (Ramstetter 2006) suggest that differentials tended to be relatively small and were often statistically insignificant.

are imperfect, economic rents in relatively less competitive environment also provide firms with the internal financial resources for innovative activities.[6]

However, a broad consensus emerged in previous empirical studies does not support the expected positive relation between producer concentration and productivity-enhancing activities.[7] There are several sensible explanations for the statistical insignificance of the relation above. Firstly, Schumpeter's proposition had never claimed a continuous relationship between productivity and firm size. What Schumpeter focused on is said to be the qualitative differences between small, entrepreneurial enterprises and large, modern corporations in their innovative activities. Secondly, when productivity enhancing activities occur in step-by-step manner, competition between firms is needed for them to continue such activities (Aghion and Howitt, 1998, Aghion *et al.* 1999).[8] In addition, the competition could also mitigate principal-agent problems occurring in the organization (Nickel *et al.* 1997). Thirdly, productivity-enhancing activities undertaken in a large firm can be affected by presence of scale diseconomies referred to as the bureaucratization of inventive activity by Cohen & Levin (1989), in which benefits derived from these activities could be undermined through loss of managerial control. In addition, the incentives of individual scientists and entrepreneurs become weaken as their ability to capture the benefits from their effort diminishes.[9]

The second industry-level factor is growth prospect of an industry. Its rationale relates to the nature of productivity improving activities which incur considerable fixed costs, most of which are irrecoverable, i.e. sunk costs. A large volume of sales over which to spread the fixed cost of innovation are needed. Hence, in this study, the

[6] This link between producer concentration and productivity can be related to the Structure-Conduct-Performance Paradigm in the field of industrial organization (IO) as indicated by the relation between producer concentration and firm's profitability. Despite unclear whether to interpret high accounting profits as a sign of good or bad performance of a market, to a large extent, high accounting profit is often regarded as a sign of market power and could also be a result of high efficiency of firms.

[7] See Symeonidis (1996) and Ahn (2002) and works cited therein.

[8] In a simple model of creative destruction, the incumbent firms unlike new entrants have no incentives to innovate.

[9] The effect of producer concentration on firm productivity could be conditioned by trade protection so that the interaction between producer concentration and protection variables is needed to be included in the empirical model. Nonetheless, our experiment runs point to counter-intuitive results. Therefore, our preferred empirical model excludes the interaction term.

industry's growth prospect is proxied by annual growth of gross output. The higher the annual growth the more the likelihood firms commit resources to productivity enhancing activities.

The other three industry-level factors, all of which are related to the extent to which an industry participates economic globalization, are export-output ratio, import penetration ratio and presence of multinational enterprises (MNEs), both of which would have an impact of firm productivity. Both of them are crucial in the current context. As mentioned in Section 3, Thailand introduced various tariff exemption/rebate schemes to bypass the cascading tariff structure and its impact. Even in a highly protected industry, there could be firms exporting. Similarly, in presence of tariff, tariff exemption scheme might allow firms to bypass its adverse effect. Hence, both factors work over and above the measure of cross-border protection so that they must be included in the empirical model.

Nonetheless their net impact could be either positive or negative. When export-output ratio is concerned, exporting firms could be a demonstration case of any advance technologies learning elsewhere to others to follow suit so that this could positively affect the latter's productivity. This is referred to as export spillover (Aitken et al. 1997). Hence, the positive sign is expected. On the other hand, export could adversely affect others' productivity. As postulated in the firm heterogeneity literature (e.g. Melitz (2003), Melitz and Ottaviano (2008), export could lead to the expansion of exporting firms so that demand for input especially non-traded ones like labor would increase prices. This could inflate costs and eventually negatively affect productivity of non-exporting firms.

Imports create competitive pressures to firms. This could either positively or negatively affect firms' productivity. On the one hand, imports could create market disciplinary effect on domestic prices. This could negatively affect firms' productivity. On the other hand, imports could force firms to be alert to productivity enhancing activities in order to survive in the market. Hence, the positive sign could be observed.

Theoretically it is expected that MNE affiliates should be more productive than locally non-affiliated firms (Caves, 2007).[10] Hence, an industry where there are a

[10] In empirical studies it is not always true as mentioned earlier in Footnote 5.

number of MNE affiliates, chance for firms within to benefit from them is greater. Hence, the estimated coefficient is expected to be positive.

To address two key hypotheses in this study, protection and global production network variables are introduced. Firstly, trade protection is introduced to control a possible industry's specific factor. The role of protection on productivity has been long recognized in numerous previous studies (e.g. Corden, 1974: Hart, 1983). While protection can create economic rents that potentially can be used for productivity improving activities, in practice this could run the opposite. By insulting firms from foreign competition, high protection tends to induce producers to become 'unresponsive' to improved technological capability as well as requests for improvement in the quality and price of what they offer (de Melo and Urata, 1986; Moran, 2001). This in turn results in a general deterioration of technological and management skills. Hence, the sign of trade protection is theoretically ambiguous. In this study, effective rate of protection (ERP_j) is used to measure the restrictiveness of cross-border protection granted to an industry j^{th}.[11] Our hypothesis is the greater the protection (the higher the ERP_j), the lower the productivity

Ideally, to capture the role of global production network on productivity, firm specific information (whether output is traded in MNE global network) is needed. Such information is not available for Thai industrial census. While in the previous studies (Kohpaiboon & Jongwanich, 2014), a share of parts and component trade (or export) was used, it cannot be used here due to one main purpose of this study is to examine types of production network and its effect on firm productivity. Hence, to do so that two zero-one binary dummy variables are used; they are $PGPN_j$ = Producer-driven GPN and $BGPN_j$ = Buyer-driven GPN.

The former refers to electronics, electrical appliances, and automotives whereas the latter consists of traditional labor intensives and processed foods. See detail about industries classified as producer- and buyer-driven production network in Appendix 1.

[11] Even though, there is no consensus between *ERP* and nominal rate of protection (*NRP*) amongst economists as to choice of one over the other (Corden, 1966; Cheh, 1974), Jongwanich & Kohpaiboon (2007) argue that political bargains in Thai manufacturing are struck over *ERP* rather than *NRP*.

The coefficients corresponding to both dummy variables are expected to be different. In the former ($PGPN_j$), the positive sign is expected. That is, firms involved in the network tend to be more productive as there is increasing pressure from the leading firm in the network. As mentioned earlier, MNEs play a key role from product innovation, production and marketing. Products themselves are rather complex. Leading MNEs adopt modular production system where suppliers in the network must take a full responsibility at the product module level. This even makes scale and scope economies more essential. Hence for firms to survive in the network, extra productivity is needed. This is especially true for smaller firms which are disadvantage in covering the incurred fixed cost. Therefore, the positive sign is expected to be larger in smaller firms whereas the sign for the larger firm group could be either positive or zero.

By contrast, the coefficient corresponding to $BGPN_j$ is expected to be negative. For traditional labor intensive products and/or processed foods, production technology *per se* is mature and there is long supply chain taking place locally. Specialization in the whole production process is clear. While MNEs can have a full control on branding and product design, indigenous firms take a full control in manufacturing process under a close supervision by MNEs. In addition these products are usually the starting point for relatively newcomers to into the world economy. Pressures on value added tend to more intense in the buyer-driven network. As mentioned earlier, production process in these industries in the buyer-driven network involves numerous local workers and the production cost competitiveness is sensitive to principal-agent problem. Advantage of being large enterprises over smaller ones would be limited. Hence, the negative sign tends to be more or less the same regardless firm size.

All in all, the proposed empirical model is summarized as follows;

$$\ln Y_{ij} = \lambda_{ij} + \alpha_1 \ln K_{ij} + \alpha_2 \ln L_{ij} + \alpha_3 \ln K_{ij}^2 + \alpha_4 \ln L_{ij}^2 + \alpha_5 \ln K_{ij} * \ln L_{ij} + \gamma_1 mkt_{ij} + \gamma_2 own_{ij} + \gamma_3 age_{ij} + \gamma_4 skill_{ij} + \gamma_5 RD_{ij} + \gamma_6 CR4_j + \gamma_7 OGROWTH_j + \gamma_8 XOR + \gamma_9 MPR + \gamma_{10} ERP_j + \gamma_{11} PGPN_j + \gamma_{12} BGPN_j + \varepsilon_{ij}$$

(2)

Dependent variable

$\ln Y_{ij}$ = Value added per workers of firm *i* in industry *j* (in natural log)

Explanatory variables;

$\ln K_{ij}$ = capital stock of firm ith in industry jth

$\ln L_{ij}$ = workers employed by firm ith in industry jth

mkt_{ij} (+) = market orientation of firm *i* in industry *j* measured by two alternatives;

1. A zero-one binary dummy variable; 1 = engaging export and 0 otherwise (mkt1)
2. Export share to total sales of firm i in industry j (mkt2)

imp_{ij} (+) = intermediate imports of firm *i* in industry *j* measured by two alternatives;

1. A zero-one binary dummy variable; 1 = importing intermediates and 0 otherwise (imp1)
2. Intermediate import to total import of firm i in industry j (imp2)

own_{ij} (+) = foreign ownership of firm *i* in industry *j* measured by two alternatives;

1. Foreign ownership of firm *i* in industry *j* (own1)
2. A zero-one binary dummy variable; 1 = foreign ownership engaging export and 0 otherwise (own2)

age_{ij} (+/-) = years in operation of firm *i* in industry *j*

$skill_{ij}$ (+) = the ratio of skill to total operational workers of firm *i* in industry *j*

RD_{ij} (+) = R&D activities of firm *i* in industry *j* measured by a binary-dummy variable; it equals to 1 if a firm committed R&D regardless whether it is in-house or outsourced and 0 otherwises.

ERP_j (-) = effective rate of protection of industry *j*

$CR4_j$ (+/-) = the cumulative share of top-4 firms of industry *j*

$OGROWTH_j$(+) = the annual output growth between 2000 and 2006.

XORj (+/-) = the export-output ratio of industry *j*

MPRj (+/-) = the import-penetration ratio of industry *j,* measured as the ratio of imports to domestic outputs (summation between import and gross output)

MNEj (+/-) = the share of multinational enterprises sales to total sale of industry j

$PGPN_j$ (+/?) = producer-driven network dummy variable; it equals to 1 if they are traditional electronics, electrical appliances, and automotives and 0 otherwises.

$BGPN_j$ (-) = buyer-driven network dummy variable; it equals to 1 if they are traditional labor intensives and processed foods and 0 otherwises.

ε_{ij} = disturbance terms

5. Data

Data for the study are compiled from unpublished returns to the Industrial Census 2006, the latest industrial census available, conducted by the National Statistics Office (NSO). A well-known limitation of the cross-sectional data set with each industry representing a single data point is that they make it difficult to control for unobserved industry specific differences. Long-term averages tend to ignore changes that may have occurred over time in the same country. These limitations can be avoided by using the panel data set compiled by pooling cross-industry and time-series data. Particularly, in the nature of technology spillover that involves a time-consuming process, panel data is more appropriate. Unfortunately, given the nature of data availability in this case, this preferred data choice is not possible. So far there are two industrial census sets, i.e. 1996 and 2006, both are establishment-level data. Even though both of them provide establishment identification number, the number is not assigned systematically. For a given ID No., an establishment in 1996 is not necessarily the same as that in 2006.

The census covers 73,931 plants, classified according to four-digit industries of International Standard of Industrial Classification (ISIC). The census was cleaned up by firstly checking duplicated samples. As occurred in the 1996 industrial census, there are some duplicated records in survey return, presumably because plants belonging to the same firm filled the questionnaire using the same records. The procedure followed in dealing with this problem was to treat the records that report the same value of the eight key variables of interest in this study, are counted as one record. The eight variables are registered capital, number of male workers, number of female workers, sale value, values of (initial and ending periods) capital stocks, value of intermediates

and initial stock of raw materials. There are 8,645 such cases so that the final sample drops to 65,286 plants. In addition, we delete establishments which had not responded to one or more the key questions such as sale value, output and which had provided seemingly unrealistic information such as negative output value or the initial capital stock of less than 5,000 baht (less than $200).[12]

The 2006 census contains a large number of micro-enterprises defined as the plants with less than 10 workers. There are 37,042 samples which employ less than 10 workers (henceforth referred to micro enterprises), out of which 52 per cent of which are micro enterprises which do not hire paid workers (zero paid workers). Since our main interest here is to examine firm behavior across size, our analysis will include these micro enterprises. Nonetheless, analysis on these enterprises must be undertaken with care. 7 industries that are either to serve niches in the domestic market (e.g. processing of nuclear fuel, manufacture of weapons and ammunition), in the service sector (e.g. building and repairing of ships, manufacture of aircraft and spacecraft, and recycling) or explicitly preserved for local enterprises (e.g. manufacture of ovens, furnaces and furnace burners, manufacture of coke oven products) are excluded. All in all, these remained establishment plants accounted for 75% of the Thailand's manufacturing gross output and 62% of manufacturing value added in 2006.

Concentration ratio (*CR4*), which is used as an instrument variable for exports, is obtained from Kophaiboon and Ramstetter (2008) in which the concentration is measured at the more aggregate level (e.g. many measured at the 4-digit whereas some at the 3-digit ISIC classification) to guard against possible problems arising from the fact that two reasonably substitutable goods are treated as two different industries according to the conventional industrial classification at high level of disaggregation. Tables 3 and 4 provide a statistical summary as well as a correlation matrix of all relevant variables in this analysis. Gross output and its corresponding price deflators are from National Economics and Social Development Board (NESDB). The annual growth rate is based on gross output at constant price (1988).

[12] If we alter to 10,000 baht the number to be dropped increased to 1,289 samples (another 500 samples dropped).

Table 3: Statistical Summary of Variables used in Regression Analysis

Variable	Obs	Mean	Std. Dev.	Min	Max
lnvalueadded	62334	13,20777	2,865902	0	24,72803
lnk	66203	13,50282	2,915696	0	24,56993
lnlabor	44453	2,592941	1,580975	0	9,262174
lnage	66203	2,031822	0,871148	0	4,59512
RD	66203	0,011993	0,108857	0	1
skillshare	44198	0,75269	0,380363	0	1
foreign_fi~y	66203	1,033956	0,181118	1	2
foreign_sh~e	66203	2,035225	12,32081	0	100
export_dummy	66203	1,071764	0,258099	1	2
export_share	66203	3,626225	16,2944	0	100
import_mat~y	66203	1,077036	0,26665	1	2
import_share	66203	3,246333	14,16749	0	100
cr4	66040	0,458451	.093988 .	3220835	0,693147
outgrowth~06	65758	0,061647	.0622808 -.	1765142	0,30588
erp1	66040	0,067698	.338837 -1	0,532832	0,465767
dummypro~cer	66203	0,054106	0,226229	0	1
dummybuyer	66203	0,425751	0,49446	0	1
xor	63548	0,535286	0,369604	0	1
imp	63548	0,250397	0,302973	0	1
mnes	65692	0,176331	0,14759	0	0,8476

Source: Authors' Calculation from Census 2006

Table 4: Correlation Coefficient Matrix

	$ln\ Y_{ij}$	$ln\ K_{ij}$	$ln\ L_{ij}$	age_{ij}	RD_{ij}	$skill_{ij}$	$own1_{ij}$	$own2_{ij}$	$mkt1_{ij}$	$mkt2_{ij}$	$imp1ij$	$Imp2ij$	$CR4_j$	OG	ERP_j	PG	BG	$XORj$	$MPRj$	$MNEj$
$ln\ K_{ij}$	0,7	1																		
$ln\ L_{ij}$	0,79	0,56	1																	
age_{ij}	0,34	0,32	0,25	1																
RD_{ij}	0,21	0,17	0,2	0,09	1															
$skill_{ij}$	-0,08	-0,02	-0,18	0,02	-0,01	1														
$own1_{ij}$	0,35	0,29	0,34	0,08	0,1	-0,01	1													
$own2_{ij}$	0,33	0,27	0,31	0,06	0,08	-0,02	0,88	1												
$mkt1_{ij}$	0,5	0,4	0,51	0,18	0,18	-0,03	0,42	0,4	1											
$mkt2_{ij}$	0,4	0,32	0,43	0,13	0,11	-0,02	0,38	0,39	0,8	1										
$imp1ij$	0,47	0,38	0,45	0,18	0,17	-0,04	0,41	0,4	0,55	0,44	1									
$Imp2ij$	0,37	0,3	0,35	0,13	0,12	-0,03	0,37	0,39	0,43	0,4	0,79	1								
$CR4_j$	0	0,03	-0,06	0,04	0	0,03	0	-0,01	-0,03	-0,01	-0,01	0	1							
OG	0,08	0,12	-0,04	0,06	0,02	0,06	0,07	0,08	0,01	-0,02	0,04	0,03	0,12	1						
ERP_j	-0,06	-0,07	-0,03	-0,05	0	0,06	0	0	0,02	0,02	0,02	0,01	-0,11	-0,05	1					

Table 4: Correlation Coefficient Matrix (cont.)

	$ln\ Y_{ij}$	$ln\ K_{ij}$	$ln\ L_{ij}$	age_{ij}	RD_{ij}	$skill_{ij}$	$own1_{ij}$	$own2_{ij}$	$mkt1_{ij}$	$mkt2_{ij}$	$imp1ij$	$Imp2ij$	$CR4_j$	OG	ERP_j	PG	BG	$XORj$	$MPRj$	$MNEj$
ERP_j	-0,06	-0,07	-0,03	-0,05	0	0,06	0	0	0,02	0,02	0,02	0,01	-0,11	-0,05	1					
$PGPN_j$	0,18	0,12	0,16	0,04	0,04	0,03	0,21	0,22	0,16	0,16	0,18	0,18	0,16	0,18	0	1				
$BGPN_j$	-0,13	-0,14	-0,01	-0,04	-0,03	-0,06	-0,08	-0,08	-0,03	0,02	-0,1	-0,09	-0,22	-0,39	-0,08	-0,05	1			
XORj	0,07	0,03	0,07	0	0,03	0	0,09	0,1	0,11	0,09	0,11	0,1	-0,18	0,07	0,05	0,15	-0,16	1		
MPRj	0,14	0,1	0,11	0,03	0,04	0	0,12	0,13	0,1	0,05	0,16	0,15	0,04	0,09	0,07	0,2	-0,36	0,64	1	
MNEj	0,17	0,11	0,12	0,03	0,05	0,02	0,2	0,21	0,14	0,11	0,2	0,18	-0,05	0,18	0,09	0,48	-0,18	0,4	0,43	1

Source: Authors' Calculation from Census 2006.

6. Results

Table 5 reports estimations of Equation 2 using the ordinary least squares (OLS) method. T-statistics in the table are based on the robust standard error. Columns 5.1 and 5.2 in Table 5 are the samples with and without outliers detected by Cook's Distance, respectively. Regression results with and without outliers are resilient on the controlling variables in interest. The main difference is on the coefficients associated with primary inputs like capital and labor. In the regression with outliers, these coefficients in some cases turn out to be counter intuitive, e.g. negative sign on capital (in natural log). Therefore, the following discussion will emphasize that without outliers.

Table 5: Econometric Results: Productivity Determinants in 2006 (OLS estimation)

	5.1 All Samples	Samples without outliers				
		5,2	5.3	5,4	5,5	5,6
		All size	Totalworker>10	Large firm	Medium Firm	Small Firm
$\ln K_{ij}$	-0.272 (-20.28)	0.139 (8.91)	0.231 (10.11)	0.342 (2.51)	0.421 (4.06)	-0.272 (6.77)
$\ln K_{ij}^2$	0.028 (48.17)	0.009 (14.24)	0.014 (9.72)	0.01 (2.56)	0.007 (3.72)	0.028 (13.01)
$\ln L_{ij}$	1.183 (46.14)	0.886 (33.03)	1.759 (24.67)	1.135 (3.37)	2.36 (2.92)	1.183 (5.25)
$\ln L_{ij}^2$	0.003 (1.09)	0 (0.13)	0.014 (1.76)	0.049 (2.01)	-0.077 (-0.86)	0.003 (1.85)
$\ln K_{ij}$ * $\ln L_{ij}$	-0.033 (-14.54)	-0.007 (-2.87)	-0.067 (-8.94)	-0.052 (-3.26)	-0.056 (-2.72)	-0.033 (-9.04)
age_{ij}	0.179 (21.94)	0.153 (23.18)	0.178 (19.54)	0.101 (4.58)	0.171 (9.28)	0.179 (16.3)
RD_{ij}	0.202 (5.36)	0.143 (4.44)	0.149 (4.71)	0.183 (4.11)	0.108 (2)	0.202 (2.23)
$skill_{ij}$	0.086 (4.97)	0.081 (5.66)	0.095 (5.32)	0.121 (3.18)	-0.004 (-0.11)	0.086 (5.24)
$own1_{ij}$	0.08 (2.99)	0.121 (5.58)	0.135 (6.29)	0.12 (3.53)	0.175 (4.97)	0.08 (4.66)
$mkt1_{ij}$	0.232 (10.52)	0.201 (10.72)	0.2 (10.59)	0.146 (4.39)	0.179 (6.15)	0.232 (8.17)

imp1ij	0.299 (14.51)	0.259 (14.31)	0.208 (11.05)	0.03 (0.92)	0.199 (6.7)	0.299 (9.91)
$CR4_j$	-0.104 (-1.58)	-0.316 (-5.63)	-0.269 (-3.65)	0.445 (2.86)	-0.019 (-0.14)	-0.104 (-5.29)
$OGROWTH_j$	0.52 (4.79)	0.591 (6.52)	0.562 (4.98)	0.439 (2.26)	0.255 (1.33)	0.52 (4.9)
ERP_j	-0.121 (-3.67)	-0.231 (-14.06)	-0.247 (-11.02)	-0.345 (-4.13)	-0.244 (-5.97)	-0.121 (-9.87)
$PGPN_j$	0.185 (7.11)	0.192 (8.91)	0.09 (3.35)	-0.012 (-0.26)	-0.011 (-0.24)	0.185 (5.04)
$BGPN_j$	-0.222 (-14.69)	-0.224 (-17.42)	-0.258 (-14.98)	-0.129 (-3.48)	-0.111 (-3.37)	-0.222 (-14.06)
XORj	-0.099 (-4.23)	-0.113 (-5.62)	-0.161 (-5.88)	0.004 (0.07)	-0.178 (-3.28)	-0.099 (-5.69)
MPRj	0.089 (2.99)	0.128 (5.01)	0.159 (4.71)	0.206 (2.73)	0.242 (3.76)	0.089 (3.3)
MNEj	0.003 (7.08)	0.003 (7.62)	0.004 (6.58)	0.001 (0.5)	0.003 (2.63)	0.003 (6.01)
Intercept	9.547 (82.28)	7.487 (62.64)	5.096 (29.18)	5.355 (3.11)	2.312 (1.07)	9.547 (8.21)
#obs.	40034	38198	20650	2371	4485	13794
F-stat	8900,22	13016,26	5737,98	349,89	265,34	1171,56
R^2	0,7658	0,826	0,8096	0,7076	0,5748	0,6153

Note: The number in the parenthesis is the corresponding t-stat.
Source: Authors' Estimation.

As mentioned earlier, there are numerous microenterprises in the dataset, many of which seem to be self-employed. Including these samples might have impact on the estimation so that Equation 2 is re-estimated by excluding enterprises employing less than 10 workers (Column 5.3). Including these enterprises seems to have limited effect on the overall regression analysis.

Note that regression results on Columns 5.1-5.3 are under the implicit assumption that all firms share the common production function regardless their size. In reality such an assumption could be restrictive. To guard against any effect of such an assumption on regression estimates, Equation 2 is re-estimated into 3 subsamples, i.e. large firm group (equal to or more than 200 workers), medium firm group (between 50 and 200 workers), and small firm group (between 10 and 50 workers). This is done after removing the detected outliers. Their regression results are reported in Columns 5.4-5.6, respectively. Clearly, pooling all firm sizes together in regression analysis seems inappropriate as several coefficients are different across firm groups. This is especially

true for one of the key interest in this study, $PGPN_j$ where statistical significance is found only in small firm group only. Hence, our preferred choice here is to run regression by sub samples.

Another important methodological note is related to possible simultaneity problem that is often raised in the cross-sectional regressions. In particular, firm productivity could have a significant effect on the observed producer concentration. To address equation 5.3-5.6 above is re-estimated using the instrumental variable estimation (IV) method. IV involves applying OLS in two stages. The first stage involves regressing each of the explanatory endogenous variables on all the pre-determined variables. In the second stage, the fitted values of the explanatory endogenous variables, obtained from the first regression, are used in place of their observed values to estimate the structural form coefficients. This two-stage procedure avoids the simple one-stage least square bias and inconsistency in the estimates by eliminating from the explanatory endogenous variables that part of the variation is due to the disturbance.

IV estimating results are reported in Table 6. Generally, results between IV and OLS estimations are rather resilient except the coefficient corresponding to producer concentration where the sign turns from negative in OLS estimation to positive in IV one. Given the methodological superiority, our results of IV estimation are discussed. Two alternative measures of market orientation (mkt_{ij}), intermediate imports (imp_{ij}) and foreign ownership (own_{ij}) do not have any impact on the regression analysis. Given the better performance in the overall fit test, $mkt1_{ij}$ $imp1_{ij}$ and $own1_{ij}$ and are used (Columns 6.1-6.3).

Table 6: Econometric Results: Productivity Determinants in 2006 (IV estimation)

	Foreign and export dummy			Foreign and export share		
	6.1 Large firm	6.2 Medium Firm	6.3 Small Firm	6.4 Large firm	6.5 Medium Firm	6.6 Small Firm
$\ln K_{it}$	0.335 (2.48)	0.429 (4.13)	0.256 (6.74)	0.347 (2.61)	0.424 (4.04)	0.236 (6.23)
$\ln K_{it}^2$	0.01 (2.6)	0.006 (3.53)	0.015 (12.95)	0.01 (2.6)	0.006 (3.62)	0.016 (13.26)
$\ln L_{it}$	1.158 (3.42)	2.343 (2.89)	1.684 (5.32)	1.126 (3.35)	2.21 (2.71)	1.642 (5.18)
$\ln L_{it}^2$	0.045 (1.83)	-0.076 (-0.85)	0.086 (1.71)	0.048 (1.96)	-0.062 (-0.69)	0.084 (1.65)
$\ln K_{it}$ * $\ln L_{it}$	-0.051 (-3.19)	-0.055 (-2.66)	-0.09 (-8.87)	-0.051 (-3.22)	-0.054 (-2.59)	-0.085 (-8.4)
age_{ij}	0.1 (4.51)	0.169 (9.14)	0.182 (15.86)	0.113 (5.06)	0.181 (9.75)	0.186 (16.14)
RD_{ij}	0.18 (4.04)	0.106 (1.96)	0.15 (2.2)	0.189 (4.23)	0.134 (2.49)	0.214 (3.07)
$skill_{ij}$	0.117 (3.04)	-0.003 (-0.1)	0.118 (5.16)	0.118 (3.07)	0.008 (0.23)	0.118 (5.18)
$own1_{ij}$	0.121 (3.55)	0.179 (5.05)	0.194 (4.8)			
$own2_{ij}$				0.002 (5.58)	0.003 (5.81)	0.003 (4.35)
$mkt1_{ij}$	0.151 (4.51)	0.18 (6.13)	0.271 (8.08)			
$mkt2_{ij}$				0 (1.23)	0.002 (4.85)	0.003 (6.49)
imp1ij	0.031 (0.93)	0.199 (6.64)	0.309 (10.02)			
Imp2ij				0.001 (2.25)	0.003 (6.65)	0.005 (9.46)
$CR4_j$	0.869 (2.46)	0.528 (1.65)	0.23 (0.87)	0.766 (2.19)	0.53 (1.64)	0.265 (1)
$OGROWTH_j$	0.493 (2.45)	0.33 (1.68)	0.875 (5.07)	0.511 (2.57)	0.323 (1.64)	0.864 (4.97)
ERP_j	-0.329 (-3.93)	-0.22 (-5.18)	-0.236 (-8.16)	-0.324 (-3.85)	-0.201 (-4.72)	-0.227 (-7.85)
$PGPN_j$ $BGPN_j$	-0.035 (-0.72)	-0.06 (-1.14)	0.139 (2.9)	-0.046 (-0.97)	-0.076 (-1.45)	0.132 (2.71)

	-0.11 (-2.8)	-0.09 (-2.6)	-0.283 (-11.24)	-0.111 (-2.79)	-0.082 (-2.35)	-0.283 (-11.18)
XORj	0.018 (0.28)	-0.15 (-2.62)	-0.141 (-3.61)	0.05 (0.79)	-0.133 (-2.32)	-0.138 (-3.54)
MPRj	0.224 (2.89)	0.245 (3.79)	0.104 (2.23)	0.192 (2.49)	0.248 (3.84)	0.109 (2.34)
MNEj	0 (0.26)	0.003 (2.64)	0.005 (6.48)	0 (-0.14)	0.003 (2.94)	0.005 (6.74)
Intercept	5.145 (2.96)	2.021 (0.93)	4.511 (7.31)	5.476 (3.17)	2.828 (1.29)	5.422 (8.86)
#obs.	2371	2371	4485	4485	13794	13794
F-stat	348,26	354,29	263,14	260,12	1169,06	1151,74
R^2	0,7067	0,7063	0,5731	0,5696	0,6138	0,6117

Note: The number in the parenthesis is the corresponding t-stat.

Source: Authors' Estimation.

The statistical significance of coefficients corresponding to the primary inputs (capital, and workers) and their interactions suggests that the assumption imposed in the Cobb-Douglas production function is not supported by data of Thai manufacturing.[13] Coefficients of all the controlling variables reach the theoretical expected sign at the 5 per cent or even better. The statistical significance of age_{ij} coefficient suggests that older firms tend to be more productive than the younger ones. Firms with foreign partners and engaging in international trade register higher productivity than those owned entitled by indigenous firms and fully domestic-oriented. Note that international trade includes both exporting their products abroad and importing intermediates. Firms employing higher skill operational workers register higher productivity. As expected, the coefficients associated with $skill_{ij}$ and RD_{ij} are both positive and statistically different from zero. All other things being equal, firms that hire more skill operational workers and/or committed R&D activities exhibit higher productivity.

The positive and statistical significance associated with CR4 are found in all sub samples. It suggests that some forms of transient *ex post* market power is required for firms to have the incentive to invest in such activities. In a circumstance where capital markets are imperfect, economic rents in relatively less competitive environment also provide firms with the internal financial resources for innovative activities.[14] The coefficient associated with $OGROWTH_j$ is positive and statistically significant at 1 per cent. This is in line with our hypothesis that due to the nature of productivity improving activities which incur considerable fixed costs, the higher the annual growth the more the likelihood firms commit resources to productivity enhancing activities.

The positive coefficient associated with the import penetration at the industry level in all firm groups suggests that importing raw materials enhances firms' productivity. This seems to be in line with the international R&D spillover literature (e.g. Coe and Helpman, 1995; Coe et al. 1997) that imports of intermediate products and capital

[13] Our estimation trial suggests that the overall fit of Cobb-Douglas production function estimate is far lower than that of trans-log production one. Results are available for Authors' request.

[14] This link between producer concentration and productivity can be related to the Structure-Conduct-Performance Paradigm in the field of industrial organization (IO) as indicated by the relation between producer concentration and firm's profitability. Despite unclear whether to interpret high accounting profits as a sign of good or bad performance of a market, to a large extent, high accounting profit is often regarded as a sign of market power and could also be a result of high efficiency of firms.

equipment are one crucial conducive channel for advance technology invented elsewhere to be transmitted. Experience from Thai firms suggests advance technology tends to be embodied in imported raw materials. Interestingly, the coefficient with export-output ratio is negative and statistically significant at the conventional level only in the medium and small firm groups. This seems consistent with the postulation in the firm heterogeneity literature. In a given industry, production expansion induced by export could negatively affect productivity of non-exporting firms. It is important to note that the estimated coefficient of *XOR* seems to be far lower than that of *mkt*, suggesting there is still net productivity gain for medium and small exporting firms. Finally, firms located in an industry where MNE share is larger tend to have higher productivity than those elsewhere. This can be either the fact that MNE affiliates are generally more productive than their indigenous counterparts, presence of MNE technology spillover or both. Further works are needed to provide a clear answer.

ERP reaches negative expected sign at the 1 per cent level of statistical significance. This suggests that all other things being equal, firms operating in more restrictive trade policy register lower productivity than those in more liberal environment. Interestingly, the negative coefficient is ascending according to firm size group. The negative coefficient for the small firm group is 0.236, about two third of that for the large firm group (0.329). For the medium firm group, the coefficient is 0.22. The coefficient of the large size firm group is statistically different from the other two groups, not between medium and small firm groups. While protection can create economic rents that potentially can be used for productivity improving activities, in practice insulting firms from foreign competition, high protection tends to induce producers to become 'unresponsive' to improved technological capability as well as requests for improvement in the quality and price of what they offer. Evidence of Thai manufacturing suggests the latter. This is more likely to occur in the large firm group as opposed to smaller size firm groups (under 200 workers).

The interesting and highly policy relevant question is the larger negative coefficient for large firm group as opposed to the others. Our interpretation is as follows; in an industry operating under highly restrictive trade policy, rents induced from the restrictive cross-border protection would be attractive for firms. When there are too many firms entering, it some might experience difficulty to reach optimal operational

scale and exit. Two groups of firms within a same industry classification (i.e. ISIC) produce products that do not directly compete to each other and use different production technology. Productivity difference, therefore, can be observed as these two groups simply because they are in different market segment. It is more likely that smaller size firms compete to each other to steal market share from each other regardless cross-border protection granted by tariff structure. The more the number of firms, the harder the firm to collude and avoid price wars. In other words, they were experiencing water in tariff. Hence, even though they are operating in the given level of protection, water in tariff causes firms act more toward free trade.

The coefficient corresponding to $PGPN_j$ is found positive and statistically different from zero only in the small firm sample. For medium and large firm groups, their coefficients turn negative but not statistically significant at the conventional level. It implies that while firm size does matter when participating in producer-driven network, it occurs to some extent. When firms surpass certain size, it no longer matters. Generally, participating in the producer-driven production network incurs fixed costs so that larger firms are in better position to overcome the costs and reach optimal operational scale. Hence, smaller firms in the network must be more productive than elsewhere to survive. Otherwise, they are unlikely to survive and so unobserved in the dataset.

By contrast, the coefficient corresponding to $BGPN_j$ is found negative in all three firm groups. Interestingly, the negative coefficient is ascending from the large firm group (-0.11) to the small firm one (-0.28). The negative size in all firm groups suggests that operating within this network is under heavily competitive pressure so that, *certaris paribus*, value added tends to be thinner than those outside the network. This result tends to be in line findings in the global value chain literature that pressure from the buyers tremendously increased due to trade liberalization after the abolishment of Agreement of Textiles and Clothing (ATC). In addition there have been a number of newcomers especially from the former centralized economies in these traditional labor intensives operating in the buyer-driven network. It seems that small firms are more difficult to survive in the network comparing to the medium and large firms.

7. Conclusion and Policy Inferences

This paper examines productivity determinants across firms in Thai manufacturing, using the 2006 industrial census. The main focus is to gain better understanding the effect of economic globalization. Two aspects of economic globalization are discussed here, trade policy and global production networks. Our paper departs from the existing literature by distinguishing global production network into producer- and buyer-driven, which are hypothesized to have different effect on firms' productivity.

Our key finding is that while firm-specific variables such as years of operation, R&D activities, a number of skill workers employed have positive effect on productivity, modes in which firms are integrated into the global economy like market orientation, intermediate imports and foreign partnership positively attribute to their productivity. Some forms of transient *ex post* market power indicated by producer concentration is required for firms to have the incentive to invest in such activities. Firms operating in industries having brighter growth prospects are more likely to commit resources to productivity enhancing activities.

Firms operating in more restrictive trade policy register lower productivity than those in more liberal environment. Insulting firms from foreign competition through cross-border protection like tariff tends to induce producers to become 'unresponsive' to improved technological capability as well as requests for improvement in the quality and price of what they offer. Interestingly, the negative coefficient is ascending according to firm size group. The negative effect seems to be much higher for large firms perhaps due to presence of water-in-tariff occurring among small and medium firms.

Different types of production network might have different effect. It is producer-driven network that have positive effect on productivity as hypothesized. Nonetheless, it is found only the small firm sample. For firms to participate in the network, there are tremendous pressures to be productive. When firm size is greater than certain sizes, there is no difference is not so significant. By contrast, firms participating in buyer-driven networks tend to have lower productivity, regardless their size. Nevertheless, the

negative coefficient tends to be absolutely bigger in small firm group comparing to medium and large firm ones.

Two policy inferences can be drawn from this study. Firstly, our study provides another evidence supporting for global integration. Global integration would force firms to stay productive and competitive. This would eventually improve resource allocation countrywide. The expected benefit in terms of productivity improvement from cross-border protection is unlikely to be materialized as productivity improvement activities are not costless. Competition pressure is crucial for firms to commit resources for these activities.

Secondly, insights into the production network suggest that both types of network are quite different. While both of them provide ample business opportunity, competition in the network is rather intense. It seems small firms tend to be in disadvantageous position to survive the ongoing globalization. Hence, social safety net is needed to go hand in hand for the ongoing economic globalization to mitigate social side-effects from the global competition. Nonetheless, opportunity for medium size firms to participate and compete into the network is fairly open.

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Appendix 1

Definition of Producer and Buyer-driven Network

ISIC	$PGPN_j$	ISIC	$BGPN_j$
3110	1	1511	1
3120	1	1512	1
3130	1	1513	1
3140	1	1514	1
3150	1	1520	1
3190	1	1531	1
3210	1	1532	1
3220	1	1533	1
3230	1	1541	1
3410	1	1542	1
3420	1	1543	1
3430	1	1544	1
3591	1	1549	1
		1711	1
		1712	1
		1721	1
		1722	1
		1723	1
		1729	1
		1810	1
		1912	1
		1920	1
		3691	1
		3694	1