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Trade Protection and Firm Productivity: Evidence from Thai Manufacturing

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Trade Protection and Firm Productivity: Evidence from Thai Manufacturing[*]

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Abstract: The paper examines the effect of trade protection on firm productivity, using the Thai manufacturing sector as a case study. While our main finding is in favor of a liberal trade policy environment, we argue input and output tariffs should be treated separately in examining their impact on productivity. *Ceteris paribus,* lowering input tariffs potentially has at least two opposite effects. It allows firms to benefit in several ways enhancing their productivity, while also discouraging their efforts to improve productivity due to the increased level of effective protection. This necessitates caution when pursuing trade policy reform in not lopsidedly focusing on input tariffs while leaving output tariffs untouched. Even though input and output tariffs work differently in promoting firms' productivity, any trade policy reform process should take both input and output tariffs into consideration in ensuring trade is actually liberalized.

Keywords: Protection, Thai Manufacturing, Trade Policy, Productivity and developing countries

JEL: F14, F13, O24, O53

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1. Issues

While the volume of tariffs in general went down substantially over the past two decades after the establishment of World Trade Organization (WTO) in 1995, much remains to be done in developing countries. Exceptions in liberalization schedules (i.e. tariff peaks) are often found. In particular, efforts concerning tariff liberalization are often lopsided, emphasizing tariff cuts on raw materials and intermediates, whereas tariffs on outputs remain untouched. This is reflected by a mounting tariff structure wherein tariff rates escalate from raw materials to finished products. This leads to nominal protection underestimating the actual/effective protection levels. It is done with the hope that maintaining such cross-border measures will give more time for firms to improve their international competitiveness and survive in an increasingly intense competitive environment.

Until the 1990s such a hope received little empirical support. In particular, the kind of quantitative/econometric-based analysis is based on the statistical relationship between economic growth and aggregate trade openness across countries with a standard growth regression analysis being performed.[3] Nonetheless, such a relationship is unable to provide a better understanding of the mechanism dictating how trade openness affects firms' productivity. As argued in Levine and Renelt (1992) and Sala-i-Martin (1997), cross-country econometric analyses are tenuous at best.

From the late 1990s, a proliferation of plant-level data became available in many countries allowing researchers to re-visit and mitigate the above shortcomings. Where the effect of trade policy on firms' performance is concerned, there are at least two aspects of relevance in the policy circles of developing countries. The first is related to a self-selection hypothesis wherein firms entering export markets are already more productive.[4] The key inference for further studies from such a self-selection hypothesis is that the nature of trade policy and firms' market orientation must be treated as two separate explanatory variables within the analysis. While both could be on a par in terms of their important influence on productivity, they remain two different entities. The former relates to the policy environment, whereas the latter concerns firms' decision-making processes.

[3] One noteworthy consideration is that there was another group which examined the effects of trade liberalization/restriction on productivity through case studies. Two influential works include the Bhagwati-Krueger project for the NBER in the 1970s and the Papageorgious-Michalely-Choksi study for the World Bank in the 1980s. While there were policy insights suggested, their case studies include only a handful of countries and their analytical tools vary significantly from one case to the other. This makes caution a prerequisite when any generalizations from the findings are made.

[4] See the literature review in Lopez (2005)

The second aspect concerns examining the possible different favorable effects of input and output tariff reductions on firms' productivity. Relevant studies include Amiti and Konings (2007), who used an Indonesian dataset, Goldberg et al. (2010) and Topalova and Khandelwal (2011), both of which employed Indian datasets and found that the favorable effect of the former is much larger than that of the latter. By contrast, Yu (2015) used Chinese plant-level data and revealed more considerable effects of output tariff reduction. The difference in their findings perhaps suggests that how tariff reduction affects firms' productivity potentially varies from country to country, leaving a need for further indepth country-specific analysis.

Against this backdrop, the paper aims to examine the determinants of firm productivity with particular emphasis on the effects of trade policy. Our proposed study has at least three contributions to make to the existing literature. Firstly, we carefully delineate the possible effects between trade (export and import) and trade policy (e.g. cross-border protection) on productivity. Secondly, we examine whether the effects of trade policy vary across types of firm by introducing an interaction term between firm specific and trade policy variables. Two firm specific factors are emphasized in this paper, market orientation (whether firms participate in the global market) and input sourcing (whether firms import raw materials or intermediates from abroad). Thirdly, the effects of output and input tariffs are re-examined, as opposed to cases using ERP (both input and output tariffs combined). Whether the effect of output is actually different than that of input remains an open question with immense policy implications. In developing countries, the impact of policy preference is lopsided, emphasizing input tariff reduction, but expressing reluctancy to tariff cuts on outputs.

Thailand is chosen in order to investigate this issue as trade policy reform remains a challenging issue for policymakers. In particular, the effort to streamline the range of tariff rates to three rates only (0-1 per cent for raw materials, 5 per cent for intermediates, and 10 per cent for finished products) is at best far from complete. Almost one fifth of tariff lines remain subject to a 20 per cent tariff rate or more. By design, the tariff structure follows a cascading pattern, so that nominal protection tends to underestimate effective one. Hence, effective protection seems to vary across industries. This allows us to test the effect of protection on firms' rates of productivity.

The paper's structure is as follows; the next section presents our analytical framework (Section 2). In Section 3, trade policy challenges are discussed, together with a brief statistical analysis of certain characteristics of Thai manufacturing firms. The research model is discussed in the following section (Section 4), followed by details of our econometric procedures and results (Sections 5 & 6). Conclusion and policy inferences are presented in the final section.

2. Analytical Framework

The gains arising from trade in terms of output growth/productivity have been studied for several decades. Research initiatives began with the standard neoclassical trade model, Ricardian comparative advantage model and/or Hecksher-Ohlin-based comparative advantage paradigms. In this model, gains from trade are derived from resource reallocation from sectors in which the country has a comparative disadvantage to those in which it holds a comparative advantage. This reallocation leads to productivity improvement at the aggregate level, despite the fact that individual firms' productivity remains unchanged. The country's comparative advantage is driven by either technology, resource endowment, or both. Hence, trade liberalization tends to generate a favorable impact on productivity.

In the 1980s, the introduction of the monopolistic competition theory of international trade, Krugman (1979) and Helpman and Krugman (1985) highlighted the fact that the origins of gains from trade had shifted more to intra-industry trade. Different from the Ricardian model, this theory stressed that not all firms would benefit from productivity gains arising from trade liberalization. For some firms, the liberalization increases sales and expands the scale of production scale. This leads to a riding down of the cost curve so that productivity improvement is observed. In the meantime, some firms potentially exit. Nonetheless, in this model, the analysis is based on a representative (homogenous) firm. Hence, the selection (i.e. some gain and the others lose) takes place on a purely random basis. This cannot explain satisfactorily why in a given industry only some firms export, not all (Greenaway and Kneller 2004).

Pioneered in Melitz (2003), the assumption of representative firms is relaxed with research focus being on firm heterogeneity. Even within a narrowly-defined industry, some firms are much larger in size, more productive and more profitable than others (Melitz and Trefler, 2012). International trade drives better-performing firms to expand their products into larger markets, while resources are re-allocated from less productive firms into productive ones. This, therefore, leads to productivity improvement, despite the fact that individual firms' productivity remains unchanged.[5]

As plant/firm-level panel data has become increasingly available in many countries, researchers have re-visited the trade liberalization-productivity nexus, under the firm heterogeneity framework. Using a micro data set, a new hypothesis is formulated, related to the impacts of trade liberalization on firms' performance. The positive relationship discovered is explained by two competing theses. One is self-selection thesis wherein firms entering export markets are already more productive than non-exporters. As a result, any positive relationship would not be directly related to trade liberalization. The key inference is that the nature of trade policy and firms' market orientation are different and must be treated as two separate explanatory variables in any analysis. The former refers to policy environment, whereas the latter concerns a firm's decision-making process.[6]

The second premise concerns the learning-by-exporting thesis wherein firms participating in foreign markets are more likely to experience productivity gains when compared to non-exporters. The former are able to receive new information about technological progress, product designs and quality of goods arising from their foreign exposure (Grossman and Helpman, 1991; Aw and Hwang, 1995; Bernard and Wagner, 1997).[7] Given the learning-by-exporting thesis, trade liberalization could further improve firms' productivity. Lowering output tariff can increase productivity by inducing tougher competition. This results in the re-allocation (selection) effect wherein the more competitive firms experience gains in their market share, while less competitive organizations are forced to exit (Trefler, 2004; Lileeva and Trefler, 2010). For firms producing multiple products, tougher competition potentially drives them to streamline their operations in order to remain globally competitive (Amiti and Konings, 2007). This might induce firms to introduce advance production technology and/or R&D

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[5] Later works such as Melitz and Ottaviano (2008) or Bernard et al. (2011) propose different mechanisms of the selection effect. The former focuses on the fact that liberalization increases demand elasticity and lower mark-ups. This forces unproductive firms to exit. In the latter, the selection effect takes place between ex-ante endowment-driven comparative advantage and disadvantage industries.

[6] Interestingly, Yu (2015) makes uses of uniquely rich information utilizing transaction-level custom data and constructs input and output tariffs at the firm level. In particular, they employ weighted averages of input and output tariffs at the industry, using actual firms' import and export transaction records as weights.

[7] See a possible explanation of self-selection, for example sunk costs; imported technology; increase R&D in Keesing and Lall (1992); Bernard and Jensen (2004); Lopez (2005).

investment in order to enhance their competitiveness (Fernandes, 2007; Bustos, 2011). Similarly, cutting input tariffs induces firms to use cheaper imported inputs and benefit from the technology embodied within them stimulating their productivity. They also benefit from the variety and quality effects inherent in imported inputs (Helpern et al. 2010).

Recently, a number of researchers take another step by examining the possibility that altering either input or output tariffs have different effects on firms' productivity. The results remain mixed. For example, Amiti and Konings (2007), using an Indonesian dataset, and Goldberg et al. (2010) and Topalova and Khandelwal (2011), both using Indian datasets, found that the favorable effect of input tariffs is much larger than that of output tariffs. By contrast, Yu (2015), found a contradictory result using Chinese plant-level data. The different effects found in these empirical research projects point to the important role of country-specific factors. For example, in Yu (2015) the special treatment afforded to imported inputs for export-oriented firms constitutes an explanation making the effect of output tariff reduction greater than that of input tariff reduction. In addition, firms might respond to changes in trade policy environments differently. All in all, findings point to the need for in-depth country-level analyses in order to be able to generate definitive generalizations from such theses.

Interestingly, the main mechanism through which input and output tariff reductions affect productivity in these studies is price elasticity. When an input tariff is lowered, firms tend to import more foreign inputs. Similarly, a lower output tariff induces more imported goods. Irrefutably, this could potentially enhance firms' productivity. Nonetheless, such a conclusion exists under the assumption that the effect of (input, output or both) tariff reduction on productivity takes place in a frictionless manner. This seems a restrictive assumption. As argued in in a number of case studies[8], and East Asian literature in particular, the productivity improvement process involves a prolonged, circuitous evolution of learning and mastery. Such a process takes time and requires a concerted investment of effort and resources to result in productivity gains. In these circumstances, therefore, competitive pressure influenced by trade policy is needed to force firms to commit to such a long developmental and transformational process.

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[8] For example, Kessing (1983), Kessing and Lall (1992), Westphal et al. (1979, 1984), Aw and Batra (1998), Wortzel and Wortzel (1981), Hobday (1995), Pietrobelli (1998), Pack and Saggi, (1997) and Nelson and Pack (1999)

The influence of trade policy on competitive pressure was reflected in the well-developed concept known as effective rate of protection (ERP) pioneered by Corden (1966) and Balassa (1965). Under ERP, it does not matter whether any effective protection granted comes from either lowering input tariffs, raising output tariffs, or both. This raises two important implications for the empirical research. The first concerns whether decomposing input and output tariffs is justified. This represents an empirical question to be addressed. The second issue involves the possibly ambiguous effect of input tariffs. In line with the ERP concept, solely lowering an input tariff while leaving an output tariff unchanged, would, in turn, lead to an increase in the ERP granted to firms. This could limit competitive pressures and lower any incentives for firms to commit resources to productivity improvement processes. Hence, the net effect on productivity of input tariff cuts would be ambiguous.

3. Trade Policy and Firm Productivity in Thai Manufacturing

In Thailand, tariffs represent a core tool in conducting trade policy. Non-tariff measures (NTMs) have been used occasionally in a narrow range of products, mainly in certain sensitive agricultural products, such as soybean, palm seed, silk and milk. Like other developing countries, the high tariff levels associated with an escalating tariff structure were used to promote industrialization between the 1960s and the mid-1980s. From 1983 to 1995, tariff levels remained virtually unchanged with few exceptions, whereas efforts to promote Thailand as an export platform for multinationals were undertaken through the introduction of various tariff exemptions schemes (Kohpaiboon, 2006; Kohpaiboon and Jongwanich, 2007).

As part of its commitments under the World Trade Organization (WTO), a comprehensive plan for tariff reduction and rationalization was proposed in 1990 and implemented in 1995 and 1997. Maximum tariff levels were reduced from 100 to 30 per cent. Tariffs were significantly lowered on some 4,000 items (at the six–digit HS level) or 75 per cent of total tariff lines. By the end of the 1990s, the number of tariff bands was reduced from 39 to six (0, 1, 5, 10, 20 and 30 per cent). Nonetheless, there were numerous exceptions wherein tariff rates exceeded 30 per cent. Tariff restructuring has received a renewed emphasis as an essential part of the overall economic reform strategy aimed at strengthening efficiency and competitiveness (WTO, 1999). The Thai government introduced tariff cuts, commencing in June 2003 (implemented in October 2003), followed by a four-year period of tariff reduction from 2004 to 2008. In 2010, there were around 900 items involved in the tariff reduction process, covering a wide range of manufacturing 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) (Kohpaiboon and Jongwanich, 2007).

Table 1 presents the average of most-favored-nation (MFN) tariffs of Thailand and selected Asian economies in 2010. It is clear that the average Thai tariff rate was relatively high as opposed to other middle income countries in the region. The weighted average was lower than the unweighted, implying that tariffs imposed on certain products are redundant. Generally agricultural products are subject to higher tariffs than manufacturing products.

Table 2 illustrates the distribution of tariff lines in Thailand over the past two decades. Clearly this distribution changed as a result of the comprehensive tariff reforms of the mid-1990s. During the pre-1997 period, more than a quarter of the total of HS6 tariff lines had tariff rates in of more than 20 per cent (Table 2). After 1997, there was a dramatic shift of tariff lines to lower brackets. For example, more than 75 per cent of tariff lines are in the 0-10 per cent bracket, followed by 6.3 and 11.9 per cent in the 10-20 and 20-30 per cent brackets, respectively. The share of the more than 30 per cent classification dropped sharply to around 15 per cent in 2010.

INSERT TABLES 1 & 2 ABOUT HERE

Relatively high tariffs levels together with a cascading tariff structure tend to alter relative prices in favor producing goods for the domestic market, instead of targeting exports. This seems to be in contradiction with the export-orientation of Thailand, reflected by the increasing share of export to GDP over the past two decades. A possible explanation involves the presence of effective tariff exemption schemes in Thailand. In this setting, domestic firms can be export-oriented and apply available tariff exemption schemes in order to mitigate for any of the adverse effects of input tariffs on their international competitiveness. In Thailand, imports subject to all tariff exemption schemes accounted for 45 per cent of total imports in 2012 (Kohpaiboon & Jongwanich, 2015).

Table 3 reveals statistical indicators denoting how firms engage in globalization, i.e. export-sale ratios and ratios of raw material imports to total materials used, both measured in percentages. They are reported in terms of average, maximum and minimum rates. Results are classified into five categories across ERP figures. Patterns observed in Table 3 tend to be in line with the theoretical postulations of the firm heterogeneity literature. Engaging exports incurs fixed and sunk costs. Therefore, in a given industry, regardless of the ERP figure, only some firms export. There is a vast difference between the maximum and minimum values in all ERP categories. Secondly, in theory, industries subject to high and positive ERP tend to sell their products locally in order to reap the economic rents induced by protection. This pattern to a certain extent is found in Table 3. The mean value of the export-sale ratio of firms located in industries with around zero ERP and negative ERP is higher than those experiencing positive ERP. Interestingly, such a pattern is not clearly observed when considering the raw material import criterion. The mean value of the percentage of raw material imports to total used goods swings up and down across ERP categories. Industries subject to around zero ERP exhibit the highest raw material import ratios, followed by those in highly positive ERP conditions. Firms in highly negative ERP and moderate positive ERP environments have the same figure of raw material import ratios. The unclear pattern is likely due to the fact that the extent to which domestic and imported raw materials are substituted varies across industries rather than due to any protection-related considerations.

INSERT TABLE 3 ABOUT HERE

4. The Model

The model used here starts with the trans-log production function of the firm. The plant's value added is a function of two primary inputs (i.e. labor and capital), their squared terms and their interaction patterns. Labor is further disaggregated into production and nonproduction workers to capture their difference in contributing to firm productivity. Blue-collar workers are regarded as the former and white-collar the latter. Over and above these considerations, a set of firm- and industry-specifics as well as trade policy variables are included as controlling variables, as expressed in Equation 1:

$$\begin{aligned}\ln VA_{ij} &= \beta_0 + \beta_1 \ln K_{ij} + \beta_2 \left(\ln K_{ij}\right)^2 + \beta_3 \ln PL_{ij} + \beta_4 \ln NL_{ij} + \beta_5 \left(\ln PL_{ij}\right)^2 + \beta_6 \left(\ln NL_{ij}\right)^2 \\ &+ \beta_7 \ln PL_{ij} * \ln K_{ij} + \beta_8 \ln NL_{ij} * \ln K_{ij} + \gamma_1 FS_{ij} + \gamma_2 IS_j + \gamma_3 tradepolicy_j + \varepsilon_{ij} \qquad (1)\end{aligned}$$

where VA_{ij} = value added of firm *i* in industry *j*.

K_{ij} = capital used by firm *i* in industry *j*.

PL_{ij} = production workers employed by firm *i* in industry *j*.

NL_{ij} = non-production workers employed by firm *i* in industry *j*

FS_{ij} = a set of firm-specific characteristics of firm *i* in industry *j*

IS_j = a set of industry-specific characteristics of industry *j*

$tradepolicy_j$ = the nature of trade policy of industry *j*

There are four firm-specific constituents of firm *i* in industry $j\left(FS_{ij}\right)$. The first two constitutes of firm *i* in industry *j* concern market orientation measured by two proxies. One involves the export-sale ratio (mkt_{ij}) introduced in the model. Firms whose output is intended for export tend to be alert to any productivity improvement opportunities and eventually enhance firms' productivity. Hence, the coefficient associated with mkt_{ij} is expected to be positive. The second aspect of market orientation is the extent to which imported raw materials are used as a percentage of total raw materials$\left(rawm_{ij}\right)$. Firms which import raw materials benefit from the technology embodied in such materials, thus improving their productivity. The coefficient associated with $rawm_{ij}$ is also expected to be positive.

The other three comprise FS_{ij} ownership$\left(own_{ij}\right)$, R&D investment$\left(RD_{ij}\right)$, and $\left(FS_{ij}\right)$ promoted status by Thailand's Board of Investment$\left(BOI_{ij}\right)$. Firm ownership is introduced in the model due to the consensus in the foreign direct investment (FDI) literature (e.g. Caves, 2009) that foreign firms are generally more productive than indigenous counterparts. So, own_{ij} is expected to be positive. own_{ij} is measured by firms' foreign equity (per cent) share. RD_{ij}, measured here by the firm's research, planning and development expenditure to total sales would positively affect firms' productivity, so that the coefficient associated is expected to be positive. BOI_{ij} is a zero-one binary dummy variable which is equals to one when a firm is BOI–promoted, and zero otherwise. This is intended to control for the possible effect of BOI tariff exemption schemes on the relationship between productivity and input tariffs.

Three industry-specific factors are introduced in the model. The first concerns the extent to which an industry engages in global production networks. This is important for many economies in

East Asia, such as Thailand, which has been long integrated into the global production network of multinationals (Athukorala, and Kohpaiboon, 2015). Ideally, details at the firm level (e.g. whether firms are actually engaged in MNEs' production sharing, whether they import tailor-made raw materials for specific customers, etc.) are needed. Unfortunately, such details at the firm level are not available within the Thai dataset. To overcome the unavailability of perfect measures of global production sharing, two alternative proxies at the industry level are used in this study. The first two proxies involve shares of parts and component in total imports $\left(GPN1_j\right)$ and total trade $\left(GPN2_j\right)$, respectively, as reflected in Equations 2 and 3:

$$GPN1_j = \frac{\text{P\&C Imports}_j}{\text{Total Imports}_j} \qquad (2)$$

$$GPN2_j = \frac{\text{P\&C trade (import+export)}_j}{\text{Total Trade}_j} \qquad (3)$$

The higher the share, the more important the global production sharing involved is to the industry. The parts list is the result of a careful disaggregation of trade data based on Revision 3 of the Standard International Trade Classification (SITC, Rev 3) extracted from the United Nations trade data reporting system (UN Comtrade Database). It is important to note that the Comtrade database does not provide for the construction of data series covering the entire range of fragmentation-based trade. The parts list used here is from that developed in Athukorala & Kohpaiboon (2009).[9] To convert SITC to ISIC, standard concordance is applied.

The second industry specific variable concerns producer concentration (CR_j). Industries with high barriers to entry are likely to be concentrated and are often capital and/or skills intensive. This could make firms less responsive to any technological improvement, so it negatively affects productivity (negative sign). On the other hand, as argued in the well-known creative destruction thesis

[9] The use of lists of parts in the Board Economics Classification (BEC) 42 and 53 is a point of departure. Note that the parts in BEC 211 are not included as they are primary products which are usually classified as traditional, rather than fragmented-intermediates.[9] The additional lists of parts are included based on firm interviews reported in Kohpaiboon (2010). Data on trade in parts are separately listed under the commodity classes of machinery and transport equipment (SITC7) and miscellaneous manufacturing (SITC8). This was based on firm interviews elaborated in Kohpaiboon (2010). The list of parts and components is available on request.

by Schumpeter, a highly concentrated industry would give firms greater incentive to innovate. If so, the coefficient associated with producer concentration could be positive. Producer concentration is measured by the sum of the sales share of the top-four firms in total.

$tradepolicy_j$ is introduced to examine the study's main hypothesis. Two alternatives of trade policy are used in this study. The first is effective rate of protection (ERP_j) measured according to Equation 4. As argued in previous studies, input and output tariff cuts could have different effects on productivity, so they are introduced together as alternative measures of trade policy.

$$ERP_j = \frac{t_j - \sum_{k=1}^{n} a_{kj} t_k}{1 - \sum_{k=1}^{n} a_{kj}} \qquad (4)$$

where t_j = tariff on outputs on industry j

t_k = tariff on inputs k

a_{kj} = a value share of inputs k used in finished products on industry *j*

To examine whether the effect of trade policy varies across firms, an interaction term between firms' specific and trade policy variable is introduced. That is, $ERP_j * mkt_{ij}$ and $ERP_j * rawn_{ij}$ are activated. The former implies that once protection is given to an industry, the effects potentially vary according to the extent to which firms export their products to world markets. Similarly, in the latter case, the effect of protection on firms' productivity could depend on how much such firms are integrated globally through importing raw materials and intermediates. In addition, the interaction term between ERP and ownership $(ERP_j * own_{ij})$ is introduced in view of the fact that foreign firms might behave differently in different trade policy environments (known as Bhagwati's hypothesis).[10] Trade liberalization could provide an incentive for foreign firms to behave productively. By contrast, the rent-seeking behavior of foreign firms is more likely under trade restriction. This could hinder overall productivity improvement.

[10] See the discussion in Kohpaiboon (2006)

When input and output tariffs, represented by $inputtariff_j$ and $outputtariff_j$, are separately introduced, interactions are incorporated according to Equation 5:

$$\begin{aligned}
&ERP_j + ERP_j * \text{mkt}_{ij} + ERP_j * rawm_{ij};\\
&\left(t_j - \sum_{k=1}^{n} a_{kj}t_k\right) + \left(t_j - \sum_{k=1}^{n} a_{kj}t_k\right) * \text{mkt}_{ij} + \left(t_j - \sum_{k=1}^{n} a_{kj}t_k\right) * rawm_{ij}\\
&outputtariff_j - inputtariff_j + outputtariff_j * \text{mkt}_{ij} - inputtariff_j * \text{mkt}_{ij}\\
&\qquad + outputtariff_j * rawm_{ij} - inputtariff_j * rawm_{ij}
\end{aligned} \tag{5}$$

where $outputtariff_j$ = tariff on outputs of industry *j* $\left(t_j\right)$

$inputtariff_j$ = the weighted average of input tariff from k=1,…, n, $\left(\sum_{k=1}^{n} a_{kj}t_k\right)$

Note that to mitigate for any possible endogeneity problem from these industry-specific factors, they are all in lag.

All in all, the empirical model to be estimated is as follows:

$$\begin{aligned}
\ln VA_{ij} = {} & \beta_0 + \beta_1 \ln K_{ij} + \beta_2 \left(\ln K_{ij}\right)^2 + \beta_3 \ln PL_{ij} + \beta_4 \ln NL_{ij} + \beta_5 \left(\ln PL_{ij}\right)^2\\
& + \beta_6 \left(\ln NL_{ij}\right)^2 + \beta_7 \ln PL_{ij} * \ln K_{ij} + \beta_8 \ln NL_{ij} * \ln K_{ij} + \gamma_1 own_{ij} + \gamma_2 RD_{ij}\\
& + \gamma_3 rawm_{ij} + \gamma_4 mkt_{ij} + \gamma_5 BOI_{ij} + \lambda_1 CR_{j,t-j} + \lambda_2 GPN_{j,t-j} + \lambda_4 tradepolicy_{j,t-1}\\
& + \phi_1 tradepolicy_{j,t-1} * mkt_{ij} + \phi_2 tradepolicy_{j,t-1} * rawm_{ij} + \varepsilon_{ij}
\end{aligned} \tag{6}$$

where $\ln VA_{ij}$ = Value added of firm *i* in industry *j* (in natural log).

$\ln K_{ij}$ = Capital used by firm *i* in industry *j* (in natural log).

PL_{ij} = Productive Workers employed by firm *i* in industry *j*.

NL_{ij} = Non-productive workers employed by firm *i* in industry *j*

$tradepolicy_{j,t-1}$ = lag variable of trade policy measured alternatively by

1. Effective rate of protection $\left(ERP_j\right)$
2. $outputtariff_j$ $\left(t_j\right)$ and $inputtariff_j$ $\left(\sum_{k=1}^{n} a_{kj}t_k\right)$

mkt_{ij} = market orientation of firm *i* of industry *j* measured by the percentage of exports to total sales.

$rawm_{ij}$ = input sourcing of firm *i* of industry *j* measured by the percentage of imported raw materials and intermediates to total inputs.

own_{ij} = ownership of firm *i* of industry *j* measured by the share of foreign owners in total capital

RD_{ij} = The share of R&D expenditure as a percentage of the total sales of firm *i* of industry *j*

BOI_{ij} = A binary dummy variable which is equal to one when firm *i* of industry *j* is BOI Promoted, and zero otherwise.

$CR_{j,t-j}$ = Producer concentration ratio of industry *j* at time *t-j* , i.e. $CR_{j,2006}$ is used.

$GPN_{j,t-1}$ = The degree of industry involvement in the global production networks of industry *j* at time *t-1*, measured by two alternatives;

1) $GPN1_{j,t-1}$ = the share of parts and component imports to total imports at the 4 digit ISIC level

2) $GPN2_{j,t-1}$ = the share of parts and components trade (exports + imports) to total trade at the 4 digit ISIC level

5. Data Set and Cleaning Procedure

The data set best-suited for our current purposes would comprise long-panel data derived from establishments in Thai manufacturing, covering both before and after major trade reform measurements. Unfortunately, such a data set is not available in Thailand. So far, Thailand has had three industrial censuses, 1996, 2006 and 2011, all of which are cross-sectional in nature. These three censuses are not able to be formulated for use as a panel data set as the identification numbers (ID Nos.) used in each census are assigned differently. In particular, a given ID No. of two different censuses does not necessarily denote the same firm.

The latest census (2011) contains 98,482 observations. Out of the total, 71,387 observations refer to self-employed workers (zero record of paid workers) or micro enterprises (entailing less than or equal to ten workers). Given the current research focus, we exclude self-employed and micro-enterprise figures. Hence, the remaining observations comprise 27,095. As occurred in the censuses of 1996 and 2006, there are many duplicate samples in which at least two observations report the same values for most of the variables. To identify duplicated observations, we employ the criterion wherein if samples report identical values of seven key variables, they are treated as duplicated samples. The seven key variables include total workers, female workers, initial fixed assets, ending fixed assets, registered capital, sales value and input values. Following this criterion, 4,418 duplicated samples had to be removed. The remaining observations comprise 22,677 cases.

Next, we decided to discount observations reporting unrealistic values of key variables. They include negative value added, low value added (less than 10,000 baht), and low fixed assets (less than 10,000 baht). Finally, eight industries that either serve minority niches in the domestic market (e.g. processing of nuclear fuel, manufacture of weapons and ammunition), in the service sector (e.g. building and repair of ships, manufacture of aircraft and spacecraft, and recycling) or are explicitly preserved for local enterprises (e.g. manufacture of ovens, furnaces and furnace burners, manufacture of coke oven products) are excluded. All in all 13,593 observations remain. Please see the summarization and correlation of variables in Tables 4 and 5 for a more definitive picture.

INSERT TABLES 4 &5 ABOUT HERE

6. Results

Initially the equations are estimated using the ordinary least squares (OLS) method, while paying attention to the possible presence of heterogeneity and outliers. Due to the nature of cross-sectional data, it is likely that outliers could impact on and mislead the estimated parameters and, therefore, careful treatment of outliers is needed. Cook's Distance is used to identify suspected outliers. The intra-class correlation or the clustered data, based on industry level, is tested (Table 6) and the results show a low level of correlation (0.267).

INSERT TABLE 6 ABOUT HERE

Tables 7 and 8 present estimation results wherein trade policy is measured by ERP and the tariffs of output and inputs separately introduced, respectively. Column A in both tables is based on

$GPN1_{j,t-1}$, whereas Column B is based on $GPN2_{j,t-1}$. The overall results from both tables are largely similar. The estimation results are not sensitive to choice of GPN. Hence, the following result interpretation will be discussed, based on these two tables. The coefficients corresponding to the interaction terms between nonproduction workers and capital, as well as the squared terms of two types of workers, are statistically significant, suggesting the trans-log production function fits well with the data as opposed to the more restrictive Cobb-Douglas measure. The statistical difference of coefficients associated with production and nonproduction workers supports the hypothesis that quality of labor matters in determining firm productivity. The higher the incidence of white collar workers employed by firms, the higher their productivity, all other things remaining constant.

INSERT TABLES 7&8 ABOUT HERE

In both tables, the coefficients corresponding to own_{ij}, mkt_{ij} and $rawm_{ij}$ turn out to be positive and significantly different from zero at the 5 per cent. This finding is in line with previous studies,in that foreign firms tend to be more productive than their indigenous counterparts, all things being equal. Meanwhile, firms, either domestic or foreign, engaging in international business dealings (either exporting their products, importing raw materials, or both), tend to be more productive than those strictly engaged in local markets. Similarly, the positive sign of RD_{ij} suggests firms spending more on R&D tend to have higher value added incorporated, *ceteris paribus.* The positive and statistically significant coefficient associated with BOI_{ij} is likely to reflect the positive effect of BOI privileges on firms' value added, including that of BOI tariff exemption schemes.

With respect to industry-specific factors, our study found a negative statistical significance of $CR_{j,2006}$ at the 1 per cent level. Such a negative sign suggests that industries that are highly concentrated or entail high barriers to entry tend to include firms which are less responsive to any technological improvement. Both $GPN1_{j,t-1}$ and $GPN2_{j,t-1}$ are positive and significant at one per cent, confirming the robustness of the fact that participating in global production networks potentially results in higher productivity improvements among firms. This finding is consistent with Kohpaiboon and Jongwanich (2014) who revealed that participation in the global production network of Thai firms is beyond simple assembly and wage premiums in the industries engaged in the network being statistically found.

Regarding the effects of trade policy, the coefficient corresponding to ERP_j turns out to be negative and significant statistically (Table 7). All other things being equal, firms under higher cross-border protection have lower productivity. In other words, protection can hinder the process of productivity improvement. This finding reconfirms the conclusions in previous studies in favor of trade liberalization. Interestingly, the negative effect of ERP_j on productivity is higher for exporting firms, as suggested by the statistical significance of the interaction term between ERP_j and mkt_{ij}.

Table 8 presents estimate results when ERP_j is deconstructed into output and input tariffs. The coefficient associated with $outputtariff_j$ attains the theoretically expected sign, but is not statistically significant. The coefficient corresponding to the interaction term between $outputtariff_j$ and mkt_{ij} is negative and statistically significant. That is, negative effects would occur only with exporting firms. There is no significant effect on non-exporting firms.

This finding seems intuitive for a country like Thailand. In such circumstances where output is subject to higher tariff rates than input and various tariff exemption schemes are available, firms choose either to export or sell domestically. It would be costly for a firm to sell in both domestic and foreign markets simultaneously as they must deal with administrative complications, such as how much output to sell locally, how to refund the portion of input tariff paid, as well as any cumbersome technicalities tariff exemption schemes might entail. This is especially true for small and medium sized firms. The histogram showing the export-sales ratios of exporting firms presented in Figure 1 confirms such behavior. In particular, firms selling in both domestic and foreign markets (i.e. their export-sales ratio is between 25 and 80 per cent) account for less than 30 per cent of the total sample. The majority of these firms export either more than 80 per cent of their products, or less than 20 per cent.

While export-oriented firms pay less attention to any protection granted to the domestic market, such protection certainly does matter for domestic-oriented organizations in order to remain in business. Keeping domestic-oriented firms in business inflates wages to a certain extent as they compete with export-oriented to attract the local workforce. Inflated wages would have an uneven and negative effect on these two groups of firms. The adverse effect tends to be greater on exporting firms as their output price is driven by worldwide forces. All other things being equal, inflated wages could not be passed onto output price, thereby squeezing mark-ups. On the other hand, domestic-oriented firms would be in a better position to pass inflated wages onto output prices to a certain extent due to the presence of their trade protection. A reduction in output tariffs could generate a tougher competitive environment in the domestic market. Less productive firms, which are likely to be purely domestic-oriented, would potentially be forced out of business. For exporting firms, such a reduction would not have any direct effect as they sell at world price levels. Instead, the reduction in output tariffs would lower pressure on domestic wages and lead to a situation wherein some workers relocate from less productive and more domestically-oriented firms to more productive and export-oriented operations (i.e. resource reallocation).

The positive and statistical significance of $inputtariff_j$ is in line with findings in Table 7, i.e. a negative effect of protection on productivity was revealed, as discussed above.[11] This suggests that for a given level of output tariff, lowering input tariffs would simply increase the protection effectively granted to output producers. Note that the net effect of input tariff reduction on productivity remains ambiguous as the interaction term between $inputtariff_j$ and $rawm_{ij}$ turns out to be negative and statistically significant. When firms rely substantially on imported raw materials (defined as imported raw materials accounting for more than 33.6 per cent of their total raw material expenses), input tariff reduction could have a net positive effect on productivity, all other things being equal. The positive effects derived from technology being embodied tends to overshadow the negative effects from increased effective protection. Operations relying less on imported raw materials are less likely to benefit from the embedded technology and, consequently, any net effects they experience would be negative.[12] One finding we reveal that is different from Amiti and Kornings (2007) concerns highlighting the role of country-specific factors, such as economic development and the extent to which firms are engaged in the global economy, in explaining the relationship between tariffs and productivity. The analysis in Amiti and Kornings (2007) covers the period of 1991 and 2001 where input tariffs in Indonesia remained substantially high. By contrast, our analysis involves 2006 where major tariff reform undertaken in the late 1990s had focused on input tariff cuts.

[11] Considering ERP formula expressed in Equation 6 above, the negative coefficient associated with ERP will result in negative and positive coefficients on output and input tariffs, respectively.

[12] Note that the cutting point found in this study seems high as opposed to the average figure of six per cent when all firms are included. In fact, the firms which rely substantially on imported raw materials are exporting firms. The corresponding average in these exporting firms is 24.2 per cent, so that the cutting point is reasonable.

Another interesting finding is that the interaction term between ownership and trade policy (both ERP_j and the disaggregated function) is statistically insignificant (Tables 9 and 10, respectively). This potentially reflects the dominant role of export-oriented and efficiency-seeking FDI which is motivated by strengthening global competitiveness. These foreign firms tend to be eligible for tariff exemption schemes, so their behavior would not be altered by being granted protection.

INSERT TABLES 9 & 10 ABOUT HERE

As a robustness check, the empirical model (Equation 8) is re-estimated, using the previous industrial census (2006). Tables 10-12 correspond to Tables 7-9, respectively, but use the 2006 census. To a certain extent, the results are in line with findings in the more recent census with a few exceptions of statistical insignificance concerning some coefficients. The main finding of Tables 10-12 supports the crucial role of trade liberalization in productivity improvement. Despite being smaller in magnitude, the coefficient associated with ERP is negative and statistically significant (Table 10). The difference lies in the fact that the coefficient corresponding to the interaction term ERP_j*mkt_{ij} in Table 10 is not statistically significant. However, it is when the 2011 census is applied. Another difference is that all the interaction terms with input and output tariffs turn out to be statistically insignificant, although their corresponding coefficients attain their theoretical expected sign. The divergence in these results between 2006 and 2011 industrial censuses are potentially due to the differences in labor market conditions. As mentioned above, the channel through which lowering output tariffs affects the productivity of exporting firms is via competing workforces. The extent to which the labor market is tightening is significantly different between these two periods.

INSERT TABLES 10-12 ABOUT HERE

7. Conclusion and Policy Recommendations

The paper examines the effect of protection on firm productivity, using the Thai manufacturing sector as a case study. In our analysis, trade policy and global participation are treated as two different variables in our analysis. Our key finding is that foreign firms tend to be more productive than indigenous, all other things remaining constant. Firms, either domestic or foreign, engaging in global market participation tended to be more productive than those strictly operating in local markets. As expected, firms spending more on R&D are inclined to have higher productivity. Participating in global production networks could result in higher rates when considering a firm's productivity improvement.

While controlling for firms' global participation, defined as export-sales ratio, and the extent to which raw materials are imported, our study highlights the important role of trade policy. Trade liberalization measured by lowering the effective rate of protection (ERP) could potentially encourage firms to commit to productivity improvement activities. When ERP is decomposed, the effects of input and output tariffs on productivity are different, in line with the findings from previous studies.

However, this study differs from previous research projects in finding an ambiguous effect of lowering input tariffs on productivity as there are two distinct effects running opposite to each other. Lowering input tariffs potentially allows firms to access higher quality foreign inputs, benefit from the learning effects from the foreign technology embedded in such inputs and the increased variety they represent, all of which lead to improvements in firms' productivity. What is novel in this study, on the other hand, is the emphasis on the fact that lowering input tariffs could also lead to an increase in the effective rate of protection granted to the finished products of firms. This could discourage them from being active in productivity improvement activities and, thus, hamper their productivity. This represents a highly pertinent consideration for policymakers in developing countries whose trade policy reform process is lopsided. Their policymakers put great effort into lowering input tariffs, while being reluctant to alter output tariffs. Such a lopsided reform process is risky. The policy lessons learnt by many Latin American/African economies during the 1950s-1970s in their pursuit of import substitution industrialization strategies (i.e. maintaining high tariffs on output to nurture domestic firms, but lowering input tariffs) represent pertinent reference cases in this context. Focusing solely on lowering input tariffs, while leaving output tariffs untouched, may well significantly obstruct overall productivity improvement.

Two policy inferences can be made from our study. Firstly, our study supports global integration (e.g. exporting products, importing raw materials) as it potentially promotes productivity enhancement. With respect to policymaking, what matters is the prevailing policy environment. Conditions must be conducive for firms to enthusiastically engage with globalization. Such an environment represents the second priority concerning channels that will potentially reap benefits. Some might prefer to enter into a joint venture with a leading foreign firm, while the others may derive benefits from the advance technology embodied in imported machinery and/or raw materials. Secondly, our findings raises policy awareness issues regarding overemphasizing input tariffs solely in performing trade policy reform. Input and output tariffs are able to work differently in promoting firms' productivity. Where the trade policy reform process is concerned, both input and output tariffs must be taken into consideration together. This ensures that the economic incentives between selling in domestic and foreign markets are neutralized and trade is actually liberalized. Otherwise, this could potentially act as a barrier to productivity improvement.

Table 1

Weighted Average of Most-Favored Nation Tariff Rate of Selected Countries during 2010-2012

Country (year)	Unweighted	Weighted	Agricultural Products	Non-Agricultural Products
Thailand (2011)	8.7	5.0	9.0	4.9
Viet Nam (2010)	9.8	12.2	24.4	10.7
Singapore (2011)	0	0	0	0
Philippines (2011)	6.2	12.2	23.2	10.4
Myanmar (2011)	5.6	6.6	12.6	4.9
Malaysia (2012)	5.3	6.7	8.7	6.5
Indonesia (2012)	6.6	9.8	1.8	11.1
Laos (2008)	9.7	13.6	19.3	12.6
Brunei (2011)	2.5	1.7	0	2.6
Cambodia (2012)	10.9	12.0	14.7	11.1
Australia (2011)	2.8	3.8	1.6	3.9
New Zealand (2011)	2.0	2.7	1.9	2.8
China (2010)	9.9	8.6	21.5	7.4
India (2012)	13.3	9.4	48.6	7.7
Japan (2011)	3.0	2.1	7.0	1.3
South Korea (2011)	11.2	9.6	34.1	5.6

Source: Author's calculation using MFN tariff rates from the World Trade Organization

Table 2
Share of 4–Digit HS Categories of Applied Tariff Rates in Thailand, 1989–2008

Tariff bands	1989	1995	2002	2003	2004–08
0	2.5	2.6	5.6	5.7	6.0
0.1–5	14.4	17.3	33.3	37.7	48.8
5.1–10	14.2	17.6	14.1	14.2	14.8
10.1–15	12.7	3.2	3.9	4.5	3.6
15.1–20	15.4	16.4	21.4	17.9	8.4
20.1–30	15.8	16	13.8	14.3	12.7
30–100	25	26.8	7.8	5.8	5.7

Source: Data for 1989 and 1995 is from WTO (1990) and (1995), respectively. Data for 2002–08 is from authors' compilation from official documents provided by the Ministry of Finance

Table 3

Market Orientation and Raw Material Sourcing Behavior of Thai Manufacturing Firms in 2011

Export-sale ratios (per cent of total sales)	Mean	Max	Min
Highly Negative ERP (<-10%)	9.1	88.8	0.0
Moderately Negative ERP (-2%-10%)	8.3	85.5	0.0
Around Zero ERP (-2%-2%)	9.0	81.3	0.0
Moderate Positive ERP (2%-10%)	7.1	79.6	0.0
Highly Positive ERP (>10%)	8.8	85.9	0.0
Raw material imports as a per cent of total raw materials used			
Highly Negative ERP (<-10%)	8.6	90.3	0.0
Moderately Negative ERP (-2%-10%)	6.8	81.3	0.0
Around Zero ERP (-2%-2%)	9.5	87.9	0.0
Moderate Positive ERP (2%-10%)	8.6	86.4	0.0
Highly Positive ERP (>10%)	9.3	83.6	0.3

Source: Authors' compilation from the 2011 Industrial census

Table 4: Data Summary

Variables	Mean	Std.Dev.	Min	Max
VA$_{ij}$	15.88	2.40	9.21	25.26
PL_{ij}	0.99	1.39	0	8.88
NL_{ij}	3.67	1.13	0	9.50
K_{ij}	15.84	2.32	9.21	26.32
own_{ij}	4.19	17.21	0	100
mkt_{ij}	7.430	21.90	0	100
$rawm_{ij}$	6.27	18.53	0	100
RD_{ij}	-11.87	6.85	-13.82	20.51
BOI_{ij}	0.07	0.253	0	1
ERP_j	0.05	0.17	-0.58	0.60
$cr4_{j,t-j}$	0.45	0.09	0.32	0.65
$GPN1_{j,t-j}$	0.04	0.12	0	1
$GPN2_{j,t-j}$	0.03	0.11	0	1

Note: All variables are in logarithms, with the exception of ownership; market-oriented; imported raw materials; trade policy; concentration ratios; and production networks.
Source: Authors' calculation

Table 5 Correlation Matrix of Variables used in the Regression Analysis

Variables	VA*ij*	PL_{ij}	NL_{ij}	K_{ij}	own_{ij}	mkt_{ij}	$rawm_{ij}$	RD_{ij}	*ERP*j	$outputtariff_j$	$inputtariff_j$	$cr4_{j,t-j}$	$GPN1_{j,t-1}$	$GPN2_{j,t-1}$
VA*ij*	1.00													
PL_{ij}	0.61	1.00												
NL_{ij}	0.54	0.46	1.00											
K_{ij}	0.81	0.57	0.49	1.00										
own_{ij}	0.23	0.22	0.23	0.21	1.00									
mkt_{ij}	0.29	0.33	0.24	0.25	0.37	1.00								
$rawm_{ij}$	0.25	0.22	0.23	0.23	0.34	0.36	1.00							
RD_{ij}	0.23	0.20	0.19	0.21	0.05	0.11	0.11	1.00						
*ERP*j	-0.01	0.003	0.01	-0.01	0.08	0.02	0.05	-0.02	1.00					
$outputtariff_j$	0.08	0.06	0.07	0.08	0.07	0.09	0.04	0.02	0.73	1.00				
$inputtariff_j$	0.14	0.10	0.10	0.12	0.04	0.06	0.00	0.03	-0.19	0.32	1.00			
$cr4_{j,t-j}$	0.02	-0.01	0.01	0.06	-0.004	0.02	0.02	-0.02	0.06	0.04	-0.05	1.00		
$GPN1_{j,t-1}$	0.14	0.12	0.10	0.10	0.11	0.08	0.07	0.03	0.14	0.17	0.24	0.13	1.00	
$GPN2_{j,t-j}$	0.13	0.13	0.09	0.10	0.11	0.05	0.08	0.03	0.20	0.21	0.24	0.14	0.92	1.00

Source: Authors' calculation

Table 6: Intra-group Correlation

Number of obs. = 13593
R-squared = 0.26

Source	SS	df	MS	F	Prob>F
Between isic_obs	22120.752	60	368.679	80.13	0.000
Within isic_obs	62257.048	13532	4.601		
Total	84377.8	13592	6.21		

Intra-class correlation	Asy. S.E.	95% conf.Interval	
0.267	0.056	0.16	0.37
Estimated SD of isic_obs effect			1.29
Estimated SD within isic_obs			2.14
Est. reliability of a isic_obs mean (evaluated at n=217.59)			0.98

Source: Authors' estimates

Table 7

Productivity Determinants based on ERP and the 2011 Census

Variables	Column A		Column B	
	Coefficient	t-statistics	Coefficient	t-statistics
Intercept	2.02**	3.91	1.96**	3.80
PL_{ij}	0.41**	3.53	0.41**	3.52
NL_{ij}	2.27**	23.9	2.27**	23.89
K_{ij}	0.82**	12.25	0.83**	12.33
$PL_{ij}*K_{ij}$	0.00	0.04	0.00	0.05
$NL_{ij}*K_{ij}$	-0.12**	-20.48	-0.12**	-20.44
PL_{ij}^2	0.003	0.3	0.003	0.31
NL_{ij}^2	0.04**	6.29	0.04**	6.16
K_{ij}^2	-0.004*	-1.29	-0.004*	-1.37
BOI	0.10*	2.04	0.11**	2.14
own_{ij}	0.003**	3.47	0.003**	3.55
mkt_{ij}	0.002**	3.49	0.002**	3.67
$rawm_{ij}$	0.002**	2.85	0.002**	2.76
RD_{ij}	0.01**	8.03	0.01**	8.06
$ERP_{j,\ t-j}$	-0.29**	-3.8	-0.29**	-3.74
$ERP_{j,\ t-j}*mkt_{ij}$	-0.01*	-1.97	-0.01**	-2.12
$ERP_{j,\ t-j}*rawm_{ij}$	0.003	0.85	0.004	0.90
$cr4_{j,\ t-j}$	-0.35**	-3.02	-0.32**	-2.76
$GPN1j,\ t_{-1}$	0.63	6.88		
$GPN2j,\ t_{-1}$			0.54	5.02
# obs	13593		13593	
Ad-R	0.73		0.73	
F-stat	1717 (p-value=0.00)		1711 (p-value=0.00)	

Note: ** and * indicate the level of statistical significance at 1% and 5%, respectively; an increase in ERP reflect a higher level of trade protection
Source: Authors 'estimate.

Table 8

Productivity Determinants based on ERP Decomposition and the 2011 Census

Variables	Column A		Column B	
	Coefficient	t-statistics	Coefficient	t-statistics
Intercept	2.01**	3.89	1.96**	3.79
PL_{ij}	0.42**	3.55	0.42**	3.55
NL_{ij}	2.26**	23.79	2.26**	23.79
K_{ij}	0.81**	11.94	0.81**	11.98
PL_{ij}*K_{ij}	-0.0003	-0.03	-0.0002	-0.02
NL_{ij}*K_{ij}	-0.12**	-20.40	-0.12**	-20.37
PL_{ij}^2	0.004	0.40	0.004	0.41
NL_{ij}^2	0.04**	6.32	0.04*	6.21
K_{ij}^2	-0.003	-1.09	-0.003	-1.13
BOI	0.10**	2.06	0.11*	2.14
own_{ij}	0.003**	3.50	0.003**	3.59
mkt_{ij}	0.004**	2.33	0.004**	2.41
$rawm_{ij}$	0.006**	4.08	0.01**	4
$R\&D_{ij}$	0.01**	8.12	0.01**	8.15
$outputtariff_j$	-0.27	-1.01	-0.27	-0.99
$inputtariff_j$	3.02**	4.90	3.25**	5.3
$Outputtariff_j$*mkt_{ij}	-0.02*	-2.09	-0.02*	-2.25
$Inputtariff_j$*mkt_{ij}	-0.01	-0.27	-0.01	-0.23
$Outputtariff_j$*$rawm_{ij}$	-0.004	-0.30	-0.003	-0.25
$Inputtariff_j$*$rawm_{ij}$	-0.09**	-2.81	-0.09**	-2.78
$cr4_{j,\ t-j}$	-0.32**	-2.74	-0.28**	-2.45
GPN1j, t-1	0.54**	5.71		
GPN2j, t-1			0.42**	3.83
# obs	13593		13593	
Ad-R	0.73		0.73	
F-stat	1503.3(p-value=0.00)		1500 (p-value=0.00)	

Note: ** and * indicate the level of statistical significance at 1% and 5%, respectively
Source: Authors 'estimate.

Table 9

Productivity Determinants based on ERP Decomposition, Interaction with Ownership and the 2011 Census

Variables	Column A		Column B	
	Coefficient	t-statistics	Coefficient	t-statistics
Intercept	2.01**	3.88	1.95**	3.78
PL_{ij}	0.42**	3.57	0.42**	3.57
NL_{ij}	2.26**	23.83	2.27**	23.84
K_{ij}	0.81**	11.96	0.81**	12
$PL_{ij}*K_{ij}$	-0.0005	-0.05	-0.0004	-0.04
$NL_{ij}*K_{ij}$	-0.12**	-20.43	-0.12**	-20.4
PL_{ij}^2	0.0046	0.42	0.005	0.43
NL_{ij}^2	0.042**	6.30	0.04**	6.19
K_{ij}^2	-0.003	-1.09	-0.003	-1.14
BOI	0.10*	2.02	0.11*	2.1
own_{ij}	0.001	0.29	0.0005	0.23
$own_{ij}*outputtariff_j$	-0.01	-0.51	-0.01	-0.5
$own_{ij}*inputtariff_j$	0.05*	1.51	0.06*	1.61
mkt_{ij}	0.004**	2.58	0.004**	2.69
$rawm_{ij}$	0.01**	4.27	0.01**	4.22
RD_{ij}	0.01**	8.15	0.01**	8.18
$outputtariff_j$	-0.27	-1.01	-0.27	-0.99
$inputtariff_j$	2.98**	4.83	3.21**	5.22
$Outputtariff_j*mkt_{ij}$	-0.02*	-1.94	-0.02*	-2.11
$Inputtariff_j*mkt_{ij}$	-0.02	-0.63	-0.02	-0.63
$Outputtariff_j*rawm_{ij}$	-0.003	-0.23	-0.003	-0.18
$Inputtariff_j*rawm_{ij}$	-0.10**	-3.07	-0.10**	-3.07
$cr4_{j,\ t-j}$	-0.32**	-2.79	-0.29**	-2.51
GPN1j, t-j	0.53**	5.65		
GPN2j, t-j			0.42**	3.78
# obs	13593		13593	
Ad-R	0.73		0.73	
F-stat	1389.6 (p-value=0.00)		1387.0(p-value=0.00)	

Note: ** and * indicate the level of statistical significance at 1% and 5% respectively
Source: Authors 'estimate.

Table 10

Productivity Determinants based on ERP and the 2006 Census

Variables	Column A		Column B	
	Coefficient	t-statistics	Coefficient	t-statistics
Intercept	5.88**	18.48	5.85**	18.38
PL_{ij}	1.77**	29.88	1.77**	29.93
NL_{ij}	1.69**	34.57	1.69**	34.6
K_{ij}	0.04	0.84	0.04	0.9
$PL_{ij}*K_{ij}$	-0.10**	-23.94	-0.10**	-23.97
$NL_{ij}*K_{ij}$	-0.10**	-31.52	-0.10**	-31.54
PL_{ij}^2	0.05**	14.09	0.05**	14.12
NL_{ij}^2	0.07**	18.4	0.07**	18.43
K_{ij}^2	0.03**	15.27	0.03**	15.23
BOI	0.27**	8.08	0.27**	8.11
own_{ij}	0.003**	5.62	0.003**	5.83
mkt_{ij}	0.002**	-3.17	-0.002**	-2.96
$rawm_{ij}$	0.004**	6.96	0.004**	6.93
RD_{ij}	0.01**	9.73	0.01**	9.67
$ERP_{j,\ t-j}$	-0.15*	-2.23	-0.15**	-2.27
$ERP_{j,\ t-j}*mkt_{ij}$	0.001	0.71	0.001	0.53
$ERP_{j,\ t-j}*rawm_{ij}$	-0.003	-0.95	-0.003	-0.88
$cr4_{j,\ t-j}$	0.20**	2.88	0.21**	3.07
GPN1j, t-j	0.53**	6.34		
GPN2j, t-j			0.44**	4.19
# obs	15564		15564	
Ad-R	0.76		0.76	
F-stat	2768.5 (p-value=0.00)		2776.0 (p-value=0.00)	

Note: ** and * indicate the level of statistical significance at 1% and 5% respectively; an increase in ERP reflects a higher level of trade protection

Source: Authors ‘estimate.

Table 11

Productivity Determinants based on ERP Decomposition and the 2006 Census

Variables	Column A		Column B	
	Coefficient	t-statistics	Coefficient	t-statistics
Intercept	5.94**	18.64	5.91**	18.55
PL_{ij}	1.76**	29.75	1.77**	29.78
NL_{ij}	1.69**	34.47	1.69**	34.51
K_{ij}	0.02	0.32	0.02	0.34
$PL_{ij}*K_{ij}$	-0.10**	-23.85	-0.10**	-23.87
$NL_{ij}*K_{ij}$	-0.10**	-31.43	-0.10**	-31.45
PL_{ij}^2	0.05**	14.08	0.05**	14.12
NL_{ij}^2	0.07**	18.3	0.07**	18.31
K_{ij}^2	0.03**	15.53	0.03**	15.51
BOI	0.27**	8.11	0.27**	8.13
own_{ij}	0.003**	5.63	0.003**	5.83
mkt_{ij}	0.001	0.1	0.0003	0.26
$rawm_{ij}$	0.01**	4.22	0.01**	4.05
RD_{ij}	0.01**	9.55	0.01**	9.48
$outputtariff_j$	-0.28	-1.18	-0.29	-1.19
$inputtariff_j$	3.35**	5.55	3.58**	5.96
$Outputtariff_j*mkt_{ij}$	0.001	0.17	-0.0002	-0.03
$Inputtariff_j*mkt_{ij}$	-0.04*	-1.99	-0.04**	-2.01
$Outputtariff_j*rawm_{ij}$	-0.01	-0.67	-0.01	-0.58
$Inputtariff_j*rawm_{ij}$	-0.03*	-1.23	-0.03	-1.09
$cr4_{j,\ t-j}$	0.24**	3.42	0.26**	3.67
$GPN1j,\ t\text{-}1$	0.43**	5.08		
$GPN2j,\ t\text{-}1$			0.31**	2.89
# obs	15564		15564	
Ad-R	0.76		0.76	
F-stat	2415.2 (p-value=0.00)		2421.7 (p-value=0.00)	

Note: ** and * indicate the level of statistical significance at 1% and 5%, respectively
Source: Authors 'estimate.

Table 12

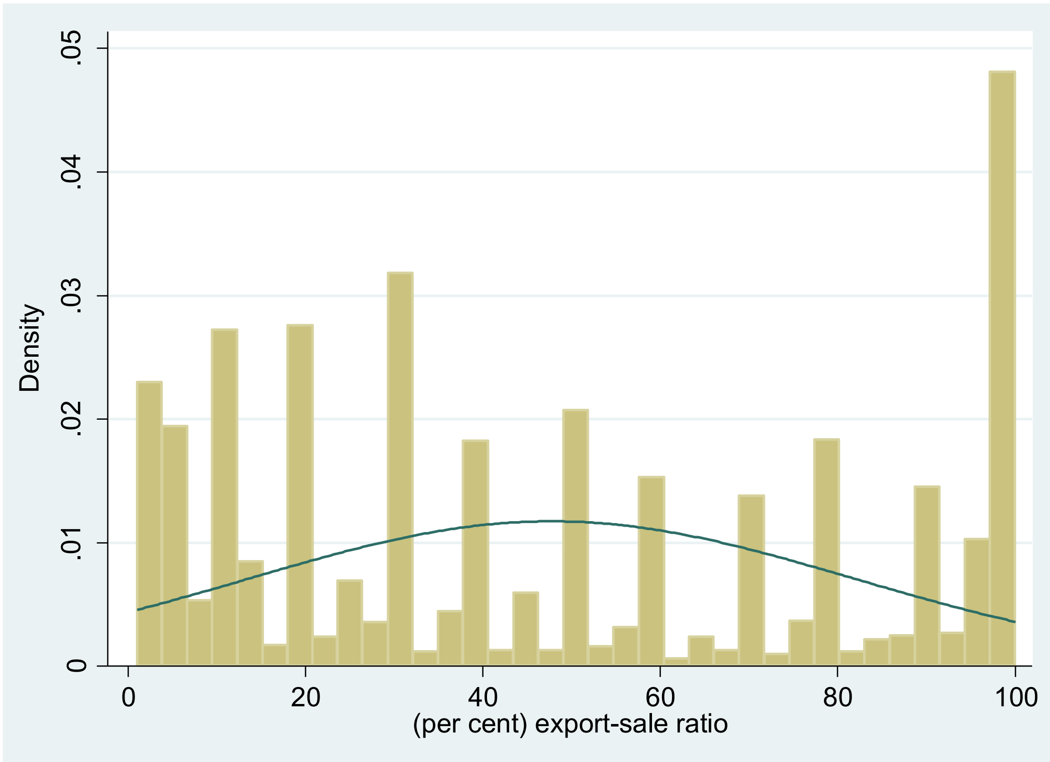
Productivity Determinants based on ERP Decomposition, Interaction with Ownership and the 2006 Census

Variables	Column A		Column B	
	Coefficient	t-statistics	Coefficient	t-statistics
Intercept	5.95**	18.65	5.92**	18.56
PL_{ij}	1.76**	29.74	1.77**	29.78
NL_{ij}	1.69**	34.47	1.69**	34.51
K_{ij}	0.01	0.29	0.02	0.32
$PL_{ij}*K_{ij}$	-0.10**	-23.83	-0.10**	-23.85
$NL_{ij}*K_{ij}$	-0.10**	-31.41	-0.10**	-31.44
PL_{ij}^2	0.05**	14.04	0.05**	14.08
NL_{ij}^2	0.07**	18.23	0.07**	18.25
K_{ij}^2	0.03**	15.54	0.03**	15.51
BOI	0.28**	8.13	0.28**	8.14
own_{ij}	0.004**	2.46	0.003**	2.38
$own_{ij}*outputtariff_j$	0.01	0.71	0.01	0.66
$own_{ij}*inputtariff_j$	-0.03	-0.99	-0.02	-0.79
mkt_{ij}	0.004	-0.01	0.0002	0.18
$rawm_{ij}$	0.01**	4.19	0.005**	4.05
RD_{ij}	0.01**	9.51	0.01**	9.45
$outputtariff_j$	-0.29	-1.19	-0.29	-1.19
$inputtariff_j$	3.36**	5.57	3.59**	5.97
$Outputtariff_j*mkt_{ij}$	0.0003	0.00	-0.0014	-0.18
$Inputtariff_j*mkt_{ij}$	-0.03*	-1.7	-0.03*	-1.77
$Outputtariff_j*rawm_{ij}$	-0.01	-0.79	-0.01	-0.69
$Inputtariff_j*rawm_{ij}$)	-0.02	-1.03	-0.02	-0.94
$cr4_{j,\ t-j}$	0.24**	3.39	0.26**	3.65
GPN1j, t-j	0.44**	5.09		
GPN2j, t-j			0.31**	2.87
# obs	15564		15564	
Ad-R	0.76		0.76	
F-stat	2224.4 (p-value=0.00)		2230.2 (p-value=0.00)	

Note: ** and * indicate the level of statistical significance at 1% and 5% respectively
Source: Authors ‘estimate.

Figure 1

Histogram of Export-Sales Ratios of Exporting Thai Manufacturing Firms in 2011



Note: Exporting firms are defined as firms whose export value is greater than zero; the line is normal density plot

Source: Authors' calculation using the database discussed in the text.

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