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A New Approach for Quantifying the Costs of Utilizing Regional Trade Agreements†

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Abstract: This study proposes a new approach for quantifying two kinds of costs related to the utilization of regional trade agreements (RTAs). The first, which we call the "procurement adjustment cost," represents the cost involved in meeting rules of origin through the adjustment of procurement sources. The second is the additional fixed costs required to utilize RTAs, including document preparation costs for the certification of origin. The proposed approach makes it possible to compute these two costs separately using product-level data. It is built on a model of international trade where heterogeneous exporters decide which tariff scheme to use. Applying our approach to Thailand's imports from China, our estimates suggest that procurement adjustment costs to comply with RTA rules of origin at the median are equivalent to 4% of per-unit production costs. In addition, RTA utilization requires an additional 27% of fixed costs. Furthermore, simulation analysis shows that a reduction of the additional fixed costs by half would raise the RTA utilization rate by 13 percentage points, while the complete elimination of procurement adjustment costs would raise the RTA utilization rate by 32 percentage points.

Keywords: Regional trade agreement; Preference utilization; Cost estimation
JEL Classification: F15; F53

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1. Introduction

The number of regional trade agreements (RTAs) has grown steadily over the years. According to the World Trade Organization (WTO), as of 1 September 2019, there were 302 RTAs in force.[1] Yet, firms do not always utilize preferential tariff rates, so that a significant part of the trade between RTA member countries does not take advantage of RTA rules. For example, Keck and Lendle (2012, Table 4) report that the share of imports under RTA schemes out of the total imports of RTA eligible products of several developed economies (Australia, Canada, the European Union (EU), and the United States) from their respective RTA partner countries is only around 80%. Examining RTA preference utilization at the product-level in Japan's imports, Hayakawa et al. (2019) find that although the average share is similar to the figure reported by Keck and Lendle (2012), there are many products for which the share is extremely low or even zero. A similar pattern can be found in Thailand's imports from China in 2015, as indicated in Figure 1, which depicts the distribution of the RTA preference utilization rate at the product-level. The figure shows a U-shaped distribution: for most products, the utilization rate is less than one, and there are many products with a zero utilization rate.[2] These observations indicate that not all firms utilize RTA schemes when exporting to RTA partner countries. In other words, some firms keep utilizing general tariff rates such as most favored nation (MFN) rates even after RTAs come into force.

=== Figure 1 ===

Why do some firms not take advantage of RTA tariff rates even though they are lower than general tariff rates? The major reason is that firms generally have to conduct two additional processes to utilize an RTA scheme: firms must comply with rules of origin (RoOs) and obtain certificates of origin (CoOs). RoOs are used to prevent indirect exports from countries that do not qualify for preferential status, i.e., trade deflection.[3] Compliance with RoOs may require exporters to change their procurement sources. For example, to comply with RoOs, exporters may be forced to switch from intermediate inputs sourced from a country outside the RTA to more expensive local inputs.[4] Such switching costs, which we refer to as the "procurement adjustment cost" (PAC) in this

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1 See https://www.wto.org/english/tratop_e/region_e/region_e.htm.

2 Details about the data used to construct Figure 1 and employed in the rest of the study are provided in Section 3.

3 Felbermayr et al. (2019) show that trade deflection is not profitable for 86% of all country-product pairs in their global dataset and observe that this is "because external tariffs are rather similar and transportation costs are non-negligible" (Felbermayr et al., 2019, p.1).

4 For instance, Conconi et al. (2018) found that in the North American Free Trade Agreement (NAFTA), RoOs on final goods reduced imports of intermediate goods from non-member countries by around 30 percentage points.

study, are proportionate to the value of a product.[5] In addition, to obtain CoOs, exporters must submit various documents, such as a list of inputs, a production flow chart, production instructions, invoices for each input, and contract documents. Since exporters are required to provide these documents for each transaction regardless of the value of exports, such documentation requirements represent substantial fixed costs for firms wishing to utilize preferential tariff schemes.[6] Only firms for which the gains from lower preferential tariffs exceed these two types of costs – the PAC and the fixed costs - will utilize a preference scheme.[7]

A number of previous studies have attempted to quantify the costs associated with utilizing RTAs. However, typically they do not distinguish between the PAC and fixed costs. For example, applying the threshold regression approach to the utilization rate of preferences under the Cotonou Agreement, Francois et al. (2006) find that the tariff-equivalent costs of using the preferences ranged between 4% and 4.5%. Further, some studies have estimated absolute values for the fixed costs required for RTA utilization. Using data on RTA utilization for exports from Chile to the United States, Ulloa and Wagner-Brizzi (2013) find that the 75th percentile was around US$3,000 in the year the RTA came into force (the median was around US$200). Similarly, using firm-level data on the utilization of the generalized system of preferences (GSP) for exports of apparel products to the EU from Bangladesh, Cherkashin et al. (2015) estimate that the fixed costs

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[5] Such costs will affect the behavior of exporting firms. For example, the revised version of NAFTA, known as the US-Mexico-Canada Agreement (USMCA), includes higher RoO requirements. According to the North American Economic Alliance, there is a concern that a tightening of RoOs in the automotive sector will discourage manufacturers from utilizing the revised NAFTA and lead them to pay MFN rates instead. See the article by John G. Murphy entitled "Offshoring American Jobs? The Risk Posed by Tighter Rules of Origin in NAFTA," which is available at https://www.naeconomicalliance.com/offshoring-american-jobs-the-risk-posed-by-tighter-rules-of-origin-in-nafta/.

[6] Firms have to pay fees to obtain a CoO. The fees vary across countries. For example, they are around US$30 when exporting one product from Japan. The fixed costs that we estimate in this study include the direct and indirect costs involved in preparing the various documents. Firms may need to ask their counterparts to provide documents on transactions. The prices of imports in terms of the home currency may need to be updated for every transaction due to changes in exchange rates. Therefore, firms may need to set up a division and assign staff to handle all these procedures. Our fixed costs include these communication costs and labor expenses incurred in preparing necessary documents. Note that firms have to incur these indirect costs not only in the third-party system but also in the self-certification system.

[7] According to a survey conducted by the Japan External Trade Organization (JETRO, 2012), many affiliates of Japanese firms in China that export goods abroad complain about the costs and complexity of RoOs. Among the 911 respondents to the survey (out of 1,445 surveyed affiliates in mainland China), 227 affiliates (25%) are exporters. Among those exporters, only 27% of affiliates (62 affiliates) answered that there were no problems in utilizing RTA schemes. Major problems highlighted by respondents include the costs of obtaining CoOs, the long time required for obtaining CoOs, the complexity of obtaining CoOs, and complications due to differences in RoOs across RTAs. Among the 227 exporters, 124 affiliates (55%) export to ASEAN countries, but only 27% of them (33 affiliates) had utilized RTA schemes.

of documentation are US$4,240. Meanwhile, using detailed customs data for Thailand and a modified version of Ulloa and Wagner-Brizzi's (2013) method, Hayakawa et al. (2016) find that the median costs for exports from China were approximately US$2,000. In sum, these studies suggest that the fixed costs of preference utilization are substantial.

To increase RTA utilization rates, it is necessary to reduce the associated costs. As highlighted above, these can be divided into the PAC and fixed costs. It is important to quantify these costs separately because concrete policy prescriptions to reduce these costs differ. For example, policy makers could reduce PACs by setting more business friendly RoOs such as co-equal rules where firms can choose between two (or more) alternative rules such as a change-in-heading rule or a regional value content rule. On the other hand, to reduce the fixed costs of RTA utilization, policy makers could introduce more concise and transparent procedures for certifying the origin of goods. However, to the best of our knowledge, no studies so far have proposed a method for quantifying these two costs separately. In addition, the methods that have been used in the literature cannot necessarily be employed for other countries. In this study, we try to fill this gap by proposing a new tractable method for separately quantifying the two costs associated with the utilization of RTAs. Our method is potentially applicable to many countries, particularly developing countries.

Our approach relies on the model of tariff scheme choice developed by Demidova and Krishna (2008), which incorporates the exporter's tariff scheme choice into the heterogeneous firm model of Melitz (2003). In Demidova and Krishna's (2008) model, when exporters use an RTA scheme, they incur PACs and fixed costs to obtain CoOs. The model theoretically demonstrated that more productive exporters choose a preference scheme while less productive exporters choose the MFN scheme. In our approach, we compute the ratio of fixed costs of preference utilization to the fixed costs associated with exports in general rather than the absolute size of preference utilization fixed costs. We call this ratio the "fixed cost ratio" (FCR), which represents the additional fixed costs required to export under a preference scheme compared with the MFN scheme. We then employ our approach to compute the PAC and the FCR.

Our approach for computing the PAC and the FCR can be summarized as follows. First, our approach consists of solving the two key equations obtained from our theoretical setup for the PAC and the FCR. The first equation expresses the FCR as a function of the PAC and the trade value and tariff rates by tariff scheme (i.e., the MFN and the RTA scheme). For a number of countries, data on trade classified by tariff scheme (e.g., RTA or MFN) are publicly available or at least available for academic research.[8] Detailed tariff data are also available from databases managed by international organizations (e.g., World Integrated Trade Solution by the World Bank or Tariff Analysis Online by the WTO). Thus, if we obtain estimates of the PAC, we can compute the FCR by using the first equation.

[8] Such data are publicly available, for example, in the United States, the EU, and Japan.

The second equation, which is derived by adding the assumption that the FCR is time-invariant to the first equation, describes the relationship among the PAC and the trade values and tariffs by tariff scheme in two periods of time. Using the detailed trade and tariff data, we can numerically solve this equation for the PAC. Then, applying the PAC estimates to the first equation, we can compute the FCR.

To demonstrate how our new approach works in practice, we apply it to Thailand's imports from China during the period 2007–2015. The RTA that firms can take advantage of in this case is the ASEAN-China Free Trade Area (ACFTA). The Agreement on Trade in Goods under ACFTA was signed in 2004 and implemented on 1 July 2005 by the 10 ASEAN countries and 20 July 2005 by China. According to the World Trade Atlas, China is the largest source of imports for Thailand in terms of trade value. For example, in 2015, imports from China accounted for 20% of Thailand's total imports. There are two reasons why we focus on Thai imports from China. The first is that there remain many products with positive rates of MFN tariffs in Thailand, implying that for many products there remains considerable margin for RTAs to reduce the tariff rates. The second is that ACFTA is an RTA under the Enabling Clause. In this type of RTAs, preferential tariff rates tend to be reduced *gradually* rather than eliminated *immediately*. Given that our approach can be applied only for products that have *two* different RTA tariff rate levels below the MFN rate during the observation period, our method becomes feasible for more products when examining tariff reductions through an RTA under the Enabling Clause than when examining the case of an RTA under GATT Article XXIV.

Using the data on Thailand's imports from China under each tariff scheme, we quantify PACs and FCRs at the product-level. Products are defined at the eight-digit level of the Harmonized System (HS). Our findings can be summarized as follows. The magnitude of PACs is 4% at the median, meaning that exporters complying with RoOs incur additional costs equivalent to 4% of per-unit production costs. On the other hand, the median of FCRs is found to be 0.27, meaning that RTA utilization in exporting requires an additional 27% of fixed costs. Further, we also find some quantitative differences across industries in both PACs and FCRs. For example, in the machinery and transport equipment industry, PACs are relatively low, while the FCR is relatively high. Further, our estimates imply that although RTA tariff rates are 6.7% lower than MFN rates, due to the existence of PACs, the use of ACFTA lowers export prices only by 2.8% (at the median) compared with the use of MFN rates.

Using these estimates, we simulate how much the RTA utilization rate, defined as imports under the RTA scheme over total imports, would rise if the FCR decreased by half. This analysis shows that the utilization rate would rise by 13 percentage points at the median. We also simulate the impact of the elimination of PACs and find that the RTA utilization rate would rise by 32 percentage points at the median. We further examine the empirical validity of our assumption that the FCR is time-invariant, which is necessary to compute the PACs in our second key equation above. For this, we first show theoretically that, under certain conditions, if the FCR is time-invariant, the ratio of imports under the MFN scheme to imports under the RTA scheme should not change over time. We then empirically show that the null hypothesis that this ratio does not change over time cannot be rejected. This result provides indirect support for the time-invariability of the FCR.

This study contributes to at least three strands of literature. The first strand is the literature that quantifies the fixed costs incurred in preference utilization. We listed a number of studies in this literature above. A clear advantage of our approach is that computing the FCR is much easier than in other studies such as Cherkashin et al. (2015). We simply solve the two key equations for the PAC and the FCR, as mentioned above. In addition, unlike the approaches by Cherkashin et al. (2015) and Hayakawa et al. (2016), our approach does not require detailed data such as firm/transaction-level trade data by tariff scheme. In addition to two parameters (the elasticity of substitution and the shape parameter of the Pareto distribution in firms' productivity) obtained from existing studies, we employ product-level data on trade values and tariff rates by tariff scheme in our approach.[9] As mentioned, data on trade by tariff scheme are becoming widely available in many countries. Tariff rates can be drawn from public databases provided by international organizations. Therefore, our approach is more likely to be feasible in terms of data requirements than the approaches proposed in previous studies.[10]

Second, to our best knowledge, this study is the first to provide estimates of the PAC. Although several studies quantify the fixed costs of preference utilization, no studies have estimated PACs. However, it is essential to differentiate PACs from the fixed costs of RTA utilization, since these two costs are qualitatively different. Although Cherkashin et al. (2015) incorporate the PACs of GSP utilization in the export of woven apparel products, they set the magnitude of these costs simply based on market prices and cost structures. Specifically, as domestic cloth is about 20% more expensive than imported cloth and roughly 75% of the production cost of woven apparel products is accounted for by the cloth, they assume that meeting RoOs generates a cost increase of 15%. However, they do

[9] Some studies employ trade data differentiated by tariff scheme. For example, a number of studies examine what determines the use of preference schemes (e.g., Cadot et al., 2006; Francois et al., 2006; Manchin, 2006; Hakobyan, 2015). They find that preference margins (i.e., MFN rates minus preferential rates) and the restrictiveness of RoOs play a significant role. Another strand of literature examines the benefits to exporters arising from preference utilization (Cadot et al., 2005; Olarreaga and Ozden, 2005; Ozden and Sharma, 2006; Cirera, 2014). Specifically, these studies quantify how much export prices rise with the use of preference schemes.

[10] The fixed costs associated with exports have been quantified in several studies (e.g., Das et al., 2007; Morales et al., 2019; Albornoz et al., 2016). Many of these studies examine the relationship between the sunk and fixed costs associated with exports. For example, using plant-level data for Colombia, Das et al. (2007) find that sunk costs amount to about US$400,000, while annual fixed costs are almost zero. Using firm-level export data for Chile, Morales et al. (2019) obtain similar results in that sunk costs are much larger than annual fixed costs. However, using firm-level export data for Argentina, Albornoz et al. (2016) find the opposite relationship, namely, that the fixed costs associated with exports are higher than the sunk costs. In addition, using Swiss export data, Kropf and Sauré (2014) compute fixed costs per export shipment rather than those for annual total exports.

not include the costs related to the adjustment of production facilities and product specificity. Meanwhile, the approach for measuring the fixed costs of RTA utilization employed by Ulloa and Wagner-Brizzi (2013) and Hayakawa et al. (2016) can be used only when it is assumed that there are no costs for procurement adjustment. This study therefore presents the first estimates of PACs.

Third and finally, our simulation analysis is related to several studies that quantify the effects of tariff reductions through RTAs on trade and welfare (e.g., Karemera and Ojah, 1998; Clausing, 2001; Romalis, 2007; Caliendo and Parro, 2015).[11] A critical difference between these studies and ours is that we take into account the costs of RTA utilization.[12] As mentioned, due to the presence of such costs, not all exporters use RTA tariff rates. We therefore believe that it is essential to consider the presence of these costs when evaluating the performance of RTAs. Furthermore, as we differentiate between the two types of costs of RTA utilization (i.e., the PAC and the FCR), we can simulate the impact of changes in these costs separately. We examine how much a reduction or elimination of each type of costs of RTA utilization would raise the RTA utilization rate. Such simulation analyses have not been conducted in the literature.

The rest of this study is organized as follows. Section 2 presents the theoretical setup for our approach to quantify the costs of RTA utilization. Section 3 provides an overview of ACFTA utilization in Thailand for imports from China and shows that not all exporters use ACFTA tariff rates. Section 4 provides our estimates of the two costs in Thailand's ACFTA imports from China as well as additional analyses including a simulation of the effects of a reduction in these costs. Finally, Section 5 provides concluding remarks.

2. Theoretical Setup

In this section, we present the theoretical setup for our approach to quantify the costs of RTA utilization. Our approach is based on the model developed by Demidova and Krishna (2008), which we use to quantify the PAC and the FCR. Their model includes two types of tariff schemes, the MFN scheme and the RTA scheme. Exporters choose one of the two to maximize their export profits. The model shows that some exporters choose not to use the RTA scheme when exporting to RTA partner countries. To make the structure of the model consistent with our data, we assume that there are multiple products. A continuum of monopolistically competitive firms engage in the production of each product.

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[11] There is also a growing number of studies that quantify the effects of trade liberalization on welfare (Arkolakis et al., 2012; Ossa, 2015; Felbermayr et al., 2015; Edmond et al., 2015; Federico and Tena-Junguito, 2017). This literature focuses on a special pattern of trade liberalization, namely, the change from autarky to free trade, and does not explicitly consider the costs associated with RTA utilization that this study focuses on.

[12] A study taking some of the costs of RTA utilization into account is that by Petri et al. (2011) focusing on the Trans-Pacific Partnership Agreement.

2.1. Representative Household and Producers

We assume there are J countries, including the home country, in the world economy. Our analysis focuses on imports and domestic consumption in the home country. The representative household is assumed to consume L types of products. The utility function of the representative household is given by

$$u = c = \prod_{l=1}^{L} [c(l)]^{\beta(l)}, \qquad \sum_{l=1}^{L} \beta(l) = 1,$$

where $c(l)$ is the consumption index for product l, and L is the number of products. $c(l)$ is defined as

$$c(l) = \left(\sum_{i=1}^{J} \int_{k \in \Omega_i(l)} [c_i(l,k)]^{\frac{v(l)-1}{v(l)}} dk \right)^{\frac{v(l)}{v(l)-1}}, \qquad 1 < v(l) < \infty,$$

where $v(l)$ represents the demand elasticity of each product. Producers are indexed by k. $\Omega_i(l)$ is the set of firms in country i that supply product l. Using the above aggregates, the optimal consumption is derived in the following manner:

$$c_i(l,k) = \left(\frac{p_i(l,k)}{p(l)} \right)^{-v(l)} c(l), \qquad c(l) = \beta(l) \left(\frac{p(l)}{P} \right)^{-1} c.$$

Price indices are defined as follows:

$$p(l) = \left(\sum_{i=1}^{J} \int_{k \in \Omega_i(l)} [p_i(l,k)]^{1-v(l)} dk \right)^{\frac{1}{1-v(l)}}, \quad P = \sum_{l=1}^{L} \left[\frac{p(l)}{\beta(l)} \right]^{\beta_l}.$$

Employing the domestic labor force, producers produce output and sell it in the domestic and foreign markets. We assume that the production function of each producer k of product l in country i is a simple linear function of the labor force:

$$y_i(l,k) = \varphi(k) n_i(l,k),$$

where $\varphi(k)$ represents firm-specific productivity and $n_i(l,k)$ is the labor input. Firms' productivity $\varphi(k)$ follows the cumulative distribution function $G_l(\varphi)$. Profit maximization leads to the following free on-board price:

$$\tilde{p}_i(l,k) = \frac{v(l)}{v(l)-1} \frac{w_i}{\varphi(k)},$$

where w_i is the wage rate in country i.

2.2. Choice of Tariff Scheme

Producers decide whether to export and which tariff scheme to use. For simplicity, we assume, without any loss of generality, that supplying the domestic market does not involve any fixed costs. Further, we assume that destination markets are segmented and that producers decide whether to export to a particular destination and the tariff scheme for each destination market separately. This setting allows us to examine the trade between each pair of countries independent of other country pairs. In addition, each exporter is assumed to be so small that the effect of their behavior on macroeconomic variables such as the price index in destination markets can be ignored. To examine the FCR and PAC, we focus on a pair of exporting and importing countries that are members of the same RTA. Firms exporting to the other country in the pair can choose whether to do so based on the MFN scheme (M) or the RTA scheme (R).[13] In either case, they need to pay the fixed costs associated with exporting, which are denoted by $f_i(l)$. Furthermore, when exporting under the RTA scheme, firms incur *additional* fixed costs such as document preparation costs, which are denoted by $f_i^R(l)$.[14] These two types of fixed costs are assumed to be specific to the country of origin and the product exported and to be paid in units of labor in the exporter's country. Producers do not face a choice of tariff schemes when they sell in their home country.

When we focus on exports, the respective export prices under the MFN and RTA schemes are given by[15]

$$p_i^M(l,k) = T(l)\tau_i(l)\tilde{p}_i(l,k), \qquad p_i^R(l,k) = \theta_i(l)\mu_i(l)T(l)\tau_i(l)\tilde{p}_i(l,k),$$

where τ_i is the iceberg transport costs ($\tau_i > 1$) for exports from country i. $T(l)$ is the (one plus) per-unit MFN tariff rate ($T(l) > 1$) and $\mu_i(l)$ is the "tariff ratio," defined as

$$\mu_i(l) \equiv \frac{T_i^R(l)}{T(l)},$$

where $T_i^R(l)$ is the (one plus) per-unit RTA tariff rate ($T(l) > T_i^R(l) > 1$). $\theta_i(l)$ represents what we refer to as the PAC in this study and is the cost of adjusting procurement sources

[13] While we use the term "MFN scheme" here, the countries we focus on in our empirical analysis are China and Thailand, both of which are WTO members.

[14] Following Helpman et al. (2004) and Helpman et al. (2008), we assume that exporters pay fixed costs for exports to each destination and ignore the case where they deal with export processes for multiple destinations simultaneously, saving on total fixed costs. In other words, economies of scale are not considered for $f_i(l)$.

[15] We assume that tariff reductions under RTAs are fully passed through to import prices. Studies such as Cirera (2014) show that exporters and importers bargain for tariff rents, and that tariff pass-through becomes incomplete. In this case, exporters gain more from utilizing RTAs than we predict and the probability that exporters choose RTAs becomes higher. We abstract from this issue to keep our framework tractable, although it is likely that if we were to consider this issue it would probably affect our results to some extent.

to comply with RoOs ($\theta_i(l) \geq 1$). RTA tariff rates are assumed to be exporting country (i.e., country pair) and product-specific. We exclude the case where all exporters always choose the RTA scheme by assuming that:

$$0 < \theta_i(l)\mu_i(l) < 1. \quad (1)$$

As a result, export profits under the respective tariff schemes can be derived as follows:

$$\pi_i^M(l,k) = [\varphi(k)]^{\nu(l)-1}[T(l)]^{-\nu(l)}\zeta_i(l) - w_i f_i(l),$$

$$\pi_i^R(l,k) = [\varphi(k)]^{\nu(l)-1}[\theta_i(l)\mu_i(l)T(l)]^{-\nu(l)}\zeta_i(l) - w_i f_i(l) - w_i f_i^R(l),$$

where

$$\zeta_i(l) = \left(\frac{\nu(l)-1}{w_i}\right)^{\nu(l)-1}\left(\frac{1}{\tau_i(l)\nu(l)}\right)^{\nu(l)}\left(p(l)\right)^{\nu(l)-1}\beta(l)Pc.$$

Thus, export profits are increasing in $\varphi(k)$. Further, we obtain the following relation:

$$\pi_i^R(l,k) - \pi_i^M(l,k) = [\varphi(k)]^{\nu(l)-1}[T(l)]^{-\nu(l)}\zeta_i(l)\left[\left(\frac{1}{\theta_i(l)\mu_i(l)}\right)^{\nu(l)} - 1\right] - w_i f_i^R(l),$$

which implies that RTA tariffs are more beneficial than MFN tariffs for more productive producers. This follows from the assumption represented by (1), which states that variable costs are smaller under RTA rules than under MFN rules. Thus, exporters face the trade-off that variable costs are smaller (larger) but fixed costs are larger (smaller) under RTA (MFN) rules. More productive firms export more; therefore, the total variable costs under the two tariff schemes are larger for more productive exporters than for less productive exporters, since variable costs are assumed to be multiplicative. In other words, more productive exporters can save a larger amount of variable costs by utilizing RTAs. Therefore, more productive exporters prefer utilizing RTA rules to MFN rules as they can make larger variable cost savings that overcome the disadvantage of larger fixed costs under RTA rules.

Exporters' optimization with regard to their export decision is given by

$$\max\{0, \pi_i^M(l,k), \pi_i^R(l,k)\},$$

where zero profit refers to the case where the firm sells its products only domestically. We have three productivity thresholds. The first and second define the range of producers that earn positive profits by exporting under MFN rules ($\pi_i^M(l,k) \geq 0$) and RTA rules ($\pi_i^R(l,k) \geq 0$), respectively. These thresholds are obtained from solving $\pi_i^M(l,k) = 0$ and $\pi_i^R(l,k) = 0$, respectively, and are as follow:

$$\bar{\varphi}_i^M(l) = \left(\frac{w_i f_i(l)}{\zeta_i(l)}[T(l)]^{\upsilon(l)}\right)^{\frac{1}{\upsilon(l)-1}},$$

$$\bar{\varphi}_i^R(l) = \left(\frac{w_i f_i(l) + w_i f_i^R(l)}{\zeta_i(l)}[\theta_i(l)\mu_i(l)T(l)]^{\upsilon(l)}\right)^{\frac{1}{\upsilon(l)-1}}.$$

Given firms' decision to export, they will prefer exporting under RTA rules to exporting under MFN rules if $\pi_i^R(l,k) > \pi_i^M(l,k)$. Thus, the choice regarding the tariff scheme is given by the third threshold:

$$\bar{\varphi}_i^{R>M}(l) = \left(\frac{w_i f_i^R(l)}{\zeta_i(l)}\left([\theta_i(l)\mu_i(l)T(l)]^{-\upsilon(l)} - [T(l)]^{-\upsilon(l)}\right)^{-1}\right)^{\frac{1}{\upsilon(l)-1}}.$$

Firms will prefer exporting under RTA rules to exporting under MFN rules if $\varphi(k) > \bar{\varphi}_i^{R>M}(l)$. A product is exported under both tariff schemes when $\bar{\varphi}_i^R(l) > \bar{\varphi}_i^M(l)$, which can be rewritten as

$$FCR_i(l) > \left[\frac{1}{\theta_i(l)\mu_i(l)}\right]^{\upsilon(l)} - 1, \tag{2}$$

where

$$FCR_i(l) \equiv \frac{f_i^R(l)}{f_i(l)}.$$

$FCR_i(l)$ stands for the "fixed cost ratio" and represents the additional fixed costs of RTA utilization. Condition (2) states that when the FCR is sufficiently large, or RTA tariff rates are not sufficiently low, less productive exporters will refrain from using the RTA scheme. Such exporters will then use the MFN scheme, while more productive exporters will choose the RTA scheme. We call this case the heterogeneous regime following Demidova and Krishna (2008). In contrast, all exporters earn larger profits through the RTA than the MFN scheme when condition (2) is violated. In this case, product l is only exported under the RTA scheme. We call this case the (RTA-)homogeneous regime.

2.3. Computation of the PAC and FCR

This subsection presents our approach to quantifying the PAC and the FCR based on the theoretical setup above. Assume that productivity $\varphi(k)$ follows a Pareto distribution whose cumulative distribution function is given by

$$G_l(\varphi) = 1 - \varphi^{-\alpha(l)} \qquad \upsilon(l) < \alpha,$$

with $\varphi \in [1, \infty)$. Focusing on the heterogeneous regime, we can derive the following equation on the relation between $FCR_i(l)$ and the ratio of MFN imports to RTA imports (hereafter, we call this ratio "MFN/RTA import ratio" or simply "import ratio" for short):[16]

$$FCR_i(l) = \left([\theta_i(l)\mu_i(l)]^{-\upsilon(l)} - 1\right)\left([\theta_i(l)\mu_i(l)]^{1-\upsilon(l)} \frac{Q_i^M(l)}{Q_i^R(l)} + 1\right)^{\frac{\upsilon(l)-1}{\alpha(l)-\upsilon(l)+1}}. \quad (3)$$

$\alpha(l)$ is the shape parameter of the Pareto distribution and is assumed to vary across products. $Q_i^M(l)$ and $Q_i^R(l)$ are the imports of product l from country i under MFN rules and RTA rules, respectively, and are defined as

$$Q_i^M(l) \equiv \int_{\overline{\varphi}_i^M(l)}^{\overline{\varphi}_i^{R>M}(l)} p_i^M(l,k) c_i^M(l,k) G_l(\varphi),$$

$$Q_i^R(l) \equiv \int_{\overline{\varphi}_i^{R>M}(l)}^{\infty} p_i^R(l,k) c_i^R(l,k) G_l(\varphi),$$

where

$$c_i^M(l,k) \equiv c_i(l,k)\big|_{p_i(l,k)=p_i^M(l,k)}, \qquad c_i^R(l,k) \equiv c_i(l,k)\big|_{p_i(l,k)=p_i^R(l,k)}.$$

Equation (3) is one of the key equations in this study and captures the theoretical relationship between the FCR and other variables, including the PAC, the tariff ratio, the import ratio, and a number of other parameters. Figure 2 depicts the link between the FCR and the import ratio based on equation (3). In the figure, we assume that RTA tariff rates are zero. The shape parameter of the Pareto distribution (α) and the demand elasticity (υ) are set to 3.09 and 2.25, respectively.[17] To focus on the relationship between the FCR and the import ratio, we set $\theta_i(l) = 1$. The figure shows two cases: one where the MFN rate is 5%, and one where it is 20%. The figure indicates that there is a positive relationship between the import ratio and the FCR. That is, a higher import ratio is associated with a higher FCR. Another interesting finding is that, at a given import ratio, the FCR is positively related to the MFN rate. That is, the model indicates that, taking the import ratio as given, the FCR will be lower when the MFN rate is lower. The reason is as follows: the lower MFN rates are, the smaller are the benefits from utilizing RTA rules (i.e., the smaller is the preference margin), and hence the lower the fixed costs of RTA utilization have to be for the same import ratio.

=== Figure 2 ===

[16] The derivation of equation (3) is provided in Appendix A. By assuming the Pareto distribution, the import ratio can be explicitly solved for the FCR.

[17] These values are obtained from the weighted averages among all industries in Crozet and Koenig (2010). Details are provided in the next section.

Next, Figure 3 presents the relationship between the FCR and the import ratio with alternative values for the PAC. Specifically, the figure shows the case where $\theta_i(l) = 1$ and the case where $\theta_i(l) = 1.15$. The latter level is the one assumed by Cherkashin et al. (2015). The MFN rate is fixed at 20% ($T(l) = 1.20$) for both cases, so that we can examine how ignoring the PAC generates bias in the estimation of the FCR. For other parameters, we employ the same values as in Figure 2. In the figure, the solid line for $\theta_i(l) = 1$ is always located above the dotted line for $\theta_i(l) = 1.15$, indicating that the FCR is overestimated when the PAC is ignored. For instance, if the import ratio is 1, the simulated FCR is 0.88 in the case with $\theta_i(l) = 1$ and 0.16 in the case with $\theta_i(l) = 1.15$. Therefore, the extent to which the FCR is overestimated is not negligible. In addition, the extent of the overestimation is larger when the import ratio is higher. This illustration highlights the importance of considering the PAC and the fixed costs of RTA utilization jointly.

=== Figure 3 ===

Once we have the information on the import ratio, the tariff ratio, the elasticity of substitution ($\upsilon(l)$), the shape parameter ($\alpha(l)$) and the PAC ($\theta_i(l)$), which appear on the right-hand side (RHS) of equation (3), we can infer the FCR. In fact, we can obtain the data on the tariff ratio and the import ratio from publicly available databases. Further, for the elasticity of substitution ($\upsilon(l)$) and the shape parameter ($\alpha(l)$) we can take estimates from existing studies, such as Crozet and Koenig (2010). Therefore, the only unknown variable on the right-hand side is the PAC, $\theta_i(l)$. To infer this cost as well as the FCR, we introduce a time dimension into our discussion. Specifically, we impose the assumption that the FCR is time-invariant.[18] This assumption is not very strong, since we allow proportional changes in the fixed costs of exporting and RTA utilization. For instance, the assumption holds if these fixed costs fall at a similar pace as firms gain experience in exporting and RTA utilization. In addition, we regard the PAC as time-invariant, since in our empirical analysis RoOs remain unchanged over the observation period. In fact, as the renegotiation of RoOs in NAFTA shows, it is rather difficult to change RoOs after an RTA has come into force. Moreover, the elasticity of substitution ($\upsilon(l)$) and the shape parameter ($\alpha(l)$) are assumed to be time-invariant, since our observation period is so short that these parameters are likely to be stable. On the other hand, the tariff ratio ($\mu_i(l)$) and the import ratio ($Q_i^M(l)/Q_i^R(l)$) change from year to year.

Let t refer to the year. Equation (3) can be rewritten as

$$FCR_i(l) = \left([\theta_i(l)\mu_{it}(l)]^{-\upsilon(l)} - 1\right)\left([\theta_i(l)\mu_{it}(l)]^{1-\upsilon(l)} \frac{Q_{it}^M(l)}{Q_{it}^R(l)} + 1\right)^{\frac{\upsilon(l)-1}{\alpha(l)-\upsilon(l)+1}}. \quad (4)$$

Combining equation (4) for alternative years ($t = t', t^*$) to eliminate $FCR_i(l)$ yields the

[18] We examine this assumption in Section 5.1.

following relationship:

$$\left([\theta_i(l)\mu_{it'}(l)]^{-\upsilon(l)} - 1\right)\left([\theta_i(l)\mu_{it'}(l)]^{1-\upsilon(l)}\frac{Q_{it'}^{M}(l)}{Q_{it'}^{R}(l)} + 1\right)^{\frac{\upsilon(l)-1}{\alpha(l)-\upsilon(l)+1}}$$
$$= \left([\theta_i(l)\mu_{it^*}(l)]^{-\upsilon(l)} - 1\right)\left([\theta_i(l)\mu_{it^*}(l)]^{1-\upsilon(l)}\frac{Q_{it^*}^{M}(l)}{Q_{it^*}^{R}(l)} + 1\right)^{\frac{\upsilon(l)-1}{\alpha(l)-\upsilon(l)+1}}. \quad (5)$$

Equation (5) presents a way to calculate the PAC for each country-product pair. These two equations, (4) and (5), are our key equations to infer the PAC and the FCR. Note that the left- and right-hand sides (LHS and RHS) of equation (5) are decreasing functions of $\theta_i(l)$. Figure 4 depicts both sides of equation (5). The horizontal axis represents $\theta_i(l)$ and the vertical axis represents the LHS and RHS of equation (5). In the figure, for LHS ($t = t'$) and RHS ($t = t^*$), the MFN tariff rate is set to 20% and 10%, respectively. The RTA tariff rate is set to 0% for both cases. We set the import ratio so that the RTA utilization rate for the LHS becomes 90% and that for the RHS becomes 20%. The shape parameter of the Pareto distribution and the demand elasticity are set to 3.09 and 2.25, respectively. As can be seen in the figure, there is a unique intersection between the blue solid line and the red dotted line, meaning that the solution of $\theta_i(l)$ is uniquely determined.[19] After obtaining the value of the PAC with equation (5), we can calculate the value of the FCR based on equation (4).[20]

=== Figure 4 ===

Finally, we discuss the empirical feasibility of our approach. The key hurdle is that, to obtain the solution of the PAC in equation (5), we need the data for at least two years with different tariff ratios ($\mu_{it'}(l)$ and $\mu_{it^*}(l)$) and different import ratios ($Q_{it'}^{M}(l)/Q_{it'}^{R}(l)$ and $Q_{it^*}^{M}(l)/Q_{it^*}^{R}(l)$). The reason is that equation (5) only holds either when both the tariff ratios and the import ratios are the same across those two years, or when both the tariff ratios and the import ratios differ across the two years. The former case is rarely observed in our data. Moreover, it would mean that the blue solid and the red dotted line in Figure 4 completely overlap and a unique solution for the PAC cannot be obtained. Therefore, we

[19] We theoretically demonstrate this uniqueness in Appendix B.

[20] It should be noted that our estimates of the PAC and the FCR based on equations (4) and (5) are not affected by the fact that the theoretical setup is based on a partial equilibrium model. Meanwhile, although the term $Q_i^M(l)/Q_i^R(l)$ in equation (3) is affected by the wage level, we directly compute it using data on trade by tariff scheme. Therefore, how the wage is determined does not affect our estimates. Also, it should be noted that so-called "multilateral resistance terms" used in the gravity literature, such as the price indexes in the exporting and importing countries, do not appear in equations (4) and (5). Finally, the fact that our model is a static one may cause some biases if exporters dynamically decide which tariff scheme to use. This is an issue that it might be useful to explore in the future.

need two years with different tariff ratios and import ratios. Furthermore, whether the solution falls into a reasonable range depends on the tariff ratios, import ratios, and other parameter values. Specifically, the solution for the PAC is reasonable when inequalities (1) and (2) as well as $\theta_i(l) \geq 1$ hold. However, any of these conditions might be violated. For instance, there is a case in our sample where the tariff ratio is higher and the import ratio is lower in one year than in other years. Although we observe such a case in practice, from a theoretical perspective they seem unnatural, since the import ratio should be higher when the tariff ratio is higher. In this case, we may obtain an unnatural value for the PAC that violates one or more of the above three conditions.

3. Overview of ACFTA Utilization

In this section, we briefly review the utilization of ACFTA in Thailand's imports from China. As of December 2017, Thailand had concluded and implemented 12 RTAs with 17 major trading partners. Since the launch of the ASEAN Free Trade Area (AFTA) in 1993, Thailand has signed and implemented six bilateral RTAs: with India, Australia, New Zealand, Japan, Peru, and Chile. In addition, Thailand, together with the other ASEAN members, has concluded five regional agreements: with China, Japan, Korea, India, and with Australia and New Zealand.[21] Among these RTAs, we focus on ACFTA, which entered into force between the 10 ASEAN countries and China in 2005.[22] Our main data are Thai Customs data for the period from 2007 to 2015. The data include imports from China at the tariff-line level (i.e., the HS eight-digit level) classified by tariff scheme. Data on MFN and ACFTA tariff rates are also obtained from Thai Customs. We refer to products for which ACFTA tariff rates are lower than MFN rates as ACFTA preferential products.[23]

Figure 5 depicts the time-series changes of three measures. First, the bars represent the number of ACFTA preferential products in Thailand. Overall, the number increased gradually until 2012 and has remained more or less unchanged since then. In the legal text of ACFTA, products are categorized into either normal track, sensitive, or highly sensitive products. The magnitude and timing of tariff reductions depend on the category of each product. Thus, the chart indicates that for some products tariff reductions started with a time lag. Second, the blue solid line represents the share of imports based on ACFTA tariffs

[21] China had entered 12 RTAs as of January 2018.

[22] Another reason for focusing on ACFTA is to avoid any overlap of RTAs. Thailand has both regional and bilateral RTAs with Australia, India, Japan, and New Zealand. Moreover, for intra-ASEAN trade, at least six regional RTAs are available. Our theoretical model does not consider such multiple RTAs between two countries.

[23] ACFTA tariff rates are either lower or as low as MFN tariff rates. Even if ACFTA tariff rates are the same level as MFN tariff rates, firms may use ACFTA tariff rates because in order to cumulate the value of imported inputs in certifying the origin of their export products, they have to import those inputs under the ACFTA scheme. In this sense, firms can utilize the ACFTA scheme for all products. To make the advantage of tariff rates clear, therefore, we call products with ACFTA tariff rates below MFN rates "ACFTA preferential products."

in Thailand's total imports from China.[24] The share rose gradually until 2011 and has remained almost unchanged at around 30% since then. The trend thus is very similar to the number of ACFTA preferential products and therefore likely reflects the growing coverage of ACFTA preferential products. Third, the orange dotted line represents the share of imports under ACFTA but only among ACFTA preferential products. This measure is called the RTA utilization rate in the literature (see, for example, Keck and Lendle, 2012). The rate rose dramatically from 2007 to 2008, slightly decreased in 2009, and then increased gradually again.

=== Figure 5 ===

It is worth considering the developments in the RTA utilization rate over time. First, the rise in the rate in 2008 likely is due to the reduction of ACFTA tariff rates on some products. As mentioned, for certain products, tariff reduction started only with a lag; however, there were also products where tariffs were reduced gradually. Second, the substantial increase in the number of products subject to tariff reductions in 2009 went hand in hand with a drop in the utilization rate in 2009. This implies that firms made less use of the ACFTA scheme for products on which tariffs had been newly reduced than for products on which tariffs had already been reduced in 2007 and 2008. Third, the rise in the utilization rate from 2009 to 2010 likely is due to the further reduction of ACFTA tariffs, reflecting the fact that many products that became subject to tariff reductions in 2009 saw further reductions in 2010. Finally, the utilization rate remained relatively stable during 2012–2014, since there were no tariff reductions on new products or further reductions for products on which tariffs had already been reduced by 2012. The reason for the slight decrease in the utilization rate in 2015 is similar to that for 2009, that is, there was an increase in new products on which tariffs were lowered.

In the empirical analysis below, we impose two restrictions on the products included. First, we restrict the analysis to products for which the code in the HS 2007 can be matched with that in the HS 2012 due to the change in HS versions in 2012. The correspondence table between the two HS versions at the eight-digit level is available from Thai Customs. In cases where multiple codes in the HS 2012 correspond to a single code in the HS 2007, we drop the codes in both versions if the MFN tariff levels for these multiple codes differ in the HS 2012. We do the same if the ACFTA tariffs differ. We then aggregate imports under each scheme during 2012–2015 based on the eight-digit code of the HS 2007. We end up with 7,093 HS 2007 codes in our dataset. The second restriction we impose is to focus only on ACFTA preferential products that have a record of non-zero imports regardless of the tariff scheme used. In other words, we drop products for which there were no imports during our observation period.

[24] The imports based on ACFTA tariffs include those in the products where ACFTA tariff rates are the same level as MFN rates.

Figure 6 shows the number of products imported under MFN tariffs only, under RTA tariffs only, and under both tariffs. By definition, the share of ACTFA imports in imports under MFN tariffs only is 0%, while the share of ACFTA imports under RTA tariffs only is 100%. Regarding products for which there are imports under both tariff schemes, the share is positive but less than 100%. Except for 2007, products imported under both tariff schemes make up the largest share among the three groups. Furthermore, following the sharp increase in the number of products on which tariffs were reduced under ACFTA, the share of products for which there were imports under both tariff schemes increased dramatically. Thus, for most products where ACFTA offers tariffs reductions, some exporters use RTA tariffs, while others use MFN tariffs.

=== Figure 6 ===

4. Empirical Analysis

In this section, we apply our approach to Thailand's imports from China to demonstrate how it works in practice. We start by reporting our estimates of the PAC and the FCR for Thailand's imports from China. We then examine the validity of our assumption that the FCR is time-invariant, which is key in our computation of the PAC. Finally, we conduct some simulation analyses.

4.1. Solving for the PAC and FCR

In this subsection, we compute the PAC and FCR using equations (4) and (5). To this end, we employ the same import and tariff data as in Section 3. Before the computation, we investigate which observations we can actually use by checking whether they satisfy our requirements. We focus on ACFTA preferential products that have a record of non-zero imports. The number of products that meet this requirement in at least one year is 4,515. In addition, we need information on the elasticity of substitution and the shape parameter of the productivity distribution. We obtain this from Crozet and Koenig (2010), who estimated both the demand elasticity and the shape parameters using data on manufacturing firms in France.[25] Since these estimates are available only for some

[25] We map the estimates by Crozet and Koenig (2010) to the four-digit ISIC revision 3 and then to the HS-base dataset. Alternatively, we could use the demand elasticities estimated by Broda et al. (2017) or Kee et al. (2008) and the shape parameter estimated by Spearot (2016). Using these alternative sources would allow us to use the shape parameters for China instead of France and the demand elasticity specific for Thailand. However, for the relationship between the demand elasticity and the shape parameter, it is necessary to assume that $\alpha - \nu + 1 > 0$, as discussed by Akgul et al. (2015). In practice, using the estimates in Broda et al. (2017), Kee et al. (2008), and Spearot (2016), this theoretical relationship does not necessarily hold. On the other hand, Crozet and Koenig (2010) provide the elasticity and shape parameters estimated under this theoretical restriction. We therefore choose the

manufacturing industries, we are left with 3,066 products.

Our approach requires further restrictions. First, as shown in Section 2, our approach works when both the RTA and the MFN scheme are used. The number of products falling into this group in at least one year is 2,588. Second, when computing the PAC in equation (5), we need at least two years with different tariff and import ratios. We therefore focus on products for which the ACFTA tariff rate below the MFN rate changed during our observation period, since for almost all Thai imports the MFN rates did not change during our observation period. Naturally, this focus forces us to drop products for which the reduction or elimination of tariffs was already completed before our observation period. After this check, 808 products remain.

Using the remaining observations, we compute the PAC and FCR based on equations (4) and (5).[26] Our empirical procedure is as follows. In equation (5), we need two years with different RTA tariff rates and import ratios for each product. If more than two years are available, we compute the PACs for all possible combinations of two of the available years. We then check whether the following three theoretical conditions – inequality (1), inequality (2), and $\theta_i(l) \geq 1$ – hold. Although we assume that the FCR is time-invariant, it may decline over time if there are stronger learning effects in RTA utilization than in general exporting. To minimize the impact of such learning effects on our results, we choose our estimates based on a combination of the first and the second year for each product that the three conditions hold. Finally, we drop products in the top 3% in terms of the FCR as outliers.

Since the PAC is obtained by solving the non-linear equation (5), we set some initial values for θ in this solution. In the selection of the initial values, we first refer to Cherkashin et al. (2015), who, as mentioned, use a 15% cost increase (i.e., θ = 1.15). We then also try half and twice this value, i.e., cost increases of 7.5% and 30% (θ = 1.075 and 1.30). In addition, we use the case in which PACs are zero, i.e., we use a value of one. We employ the Newton-Raphson method to solve equation (5). The results for the PAC and FCR are presented in Table 1 based on the initial value of the PAC. The table reports descriptive statistics for our estimates of the PAC and FCR, including the number of products, the standard deviation (SD), the mean, median (p50), and the 25 and 75 percentiles. The number of products for which our approach "succeeds" in computing the two costs differs depending on the initial values. It lies in a range from 396 to 425 and is smaller when we use the higher initial value for the PAC in the solution of equation (5).

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estimates by Crozet and Koenig (2010), although they do not include agriculture, food manufacturing, and several other industries.

[26] Due to the restrictions, the summary statistics for our estimates of the PAC and FCR may suffer from some biases. For example, we exclude products imported under MFN tariffs or RTA tariffs only during our observation period. Products are likely to be imported under MFN tariffs only when the PAC and FCR are high. When they are low, only RTA tariffs are likely to be used. Thus, since the summary statistics of our estimates may be either underestimated or overestimated, the final direction of these biases is not clear.

=== Table 1 ===

The results are as follows. The mean and median of the PAC are around 1.05 and 1.04, respectively. This implies that compliance with RoOs requires firms to accept a 4-5% rise in procurement costs. This estimate of the magnitude of the rise in procurement costs is much smaller than that obtained by Cherkashin et al. (2015), which is 15%.[27] We believe that our estimates are more accurate, since they are obtained by employing actual data. On the other hand, the estimates of the FCR are more sensitive to the initial value in the computation. The standard deviation is smaller when the initial value is higher. In terms of mean values, the FCR is estimated to be 0.29-0.39, while the median values of the FCR are around 0.26-0.27. Thus, the difference across the initial values is smaller in the median values. Specifically, the median values imply that RTA utilization involves 26-27% additional fixed costs. In contrast to our estimate for the PAC, these estimates for the FCR are larger than that obtained by Cherkashin et al. (2015), which is 0.016.[28] One reason for the smaller estimate of the FCR in Cherkashin et al. (2015) is the difference in the PAC, since a larger PAC results in a lower FCR, as shown in Figure 3.

4.2. Extension and Overview of the results

Our approach to computing the FCR requires the estimates of the PAC, for which we need at least two years with different tariff ratios. This requirement decreases the number of products for which we can compute the FCR. One way to mitigate this decrease in the number of products is to use estimates of the PAC for "other" products. RoOs, which give rise to the PAC, are essentially set at the HS six-digit level. This means that that the size of the PAC might be similar across HS eight-digit codes within the same six-digit code. Based on this line of reasoning, we compute the mean and median of the PAC in each HS

[27] Cherkashin et al. (2015) focus on the export of men's/boys' cotton trousers (HS 620342) from Bangladesh to the EU under the GSP scheme. While estimates based on our approach for the same product are not available, we estimate the PAC for 15 apparel products in HS 61 for comparison. We find that the mean and median values are 1.08 and 1.06, respectively. Thus, even for similar products, our estimates are much smaller. In the EU's GSP scheme, RoOs for men's/boys' cotton trousers require firms in Bangladesh to manufacture the trousers from domestic fabric. However, unlike firms in China, Bangladeshi apparel exporters struggle to procure fabric domestically, since it is technically difficult for Bangladeshi textile manufacturers to produce good quality fabric. This difficulty likely is one of the reasons for the higher PAC in Cherkashin et al. (2015).

[28] Cherkashin et al. (2015) consider three types of fixed costs, consisting of costs for foreign market entry, production costs, and costs for the documentation of RoO compliance. Trying to quantify these costs, Cherkashin et al. (2015) arrive at estimates of US$251,250, US$6,404, and US$4,240, respectively. Using these figures, we calculate the FCR to arrive at a value of 0.016 (= 4,240/ (251,250 + 6,404)). On the other hand, in our estimates for the 15 knitted apparel products in HS 61, we obtain a value of 0.32 for both the mean and the median of the FCR.

six-digit code and use it for the computation of the FCR, i.e., equation (4). As a result, we can compute the FCR even for products for which the tariff ratio did not change over time.[29] The results for the FCR when using the mean and median of the PAC are shown in the upper and lower panels of Table 2, respectively. The number of products increases by more than 100 in each case. Compared with the results in Table 1, the means of the FCR in the extended sample are larger while the medians are slightly smaller.

=== Table 2 ===

Next, we provide an overview of our estimates by industry. These estimates are based on the results in Table 1 rather than those in Table 2. Moreover, we focus on the case when the initial value is 1.15. The results by industry are shown in Table 3. Industries are defined at the one-digit level of the Standard International Trade Classification (SITC). We use the elasticity of substitution and the shape parameter estimated by Crozet and Koenig (2010), which do not include agriculture, food manufacturing, and several other industries. Therefore, the industries/products we focus on here include chemicals, manufactured goods classified by material, machinery and transport equipment, and other manufacturing industries. Among these products/industries, machinery and transport equipment have a relatively low PAC and a relatively high FCR. The reason for the high FCR likely is that this industry requires a relatively large number of parts and components, so that the costs to gather the required information for the certification of origin are much greater than in other industries.

=== Table 3 ===

Based on our estimates, we consider the benefit of the use of RTA schemes in terms of price changes. Typically, the benefits of trade agreements such as RTAs are measured in terms of the tariff margin, that is, the MFN rate minus the RTA rate. In our model, we measure the benefit in terms of the tariff ratio, μ, which is the ratio of one-plus the RTA tariff rate to one-plus the MFN rate. The upper panel of Table 4 presents descriptive statistics for this tariff ratio. Looking at the median for all observations, this suggests that the use of RTA rates lowers export prices by about 6.7% (=1−0.933). This reduction in tariffs can be regarded as the direct benefit of RTAs. However, our estimation results suggest that this ratio should be discounted by the PAC to gauge the net benefit of RTA tariff reductions or the "true" change in prices. This "discounted tariff ratio" can be expressed as prices under the RTA scheme relative to those under the MFN scheme (i.e., p^R/p^M) and is given by $\mu\theta$. Descriptive statistics for $\mu\theta$ are reported in the lower panel of Table 4. The median for all observations indicates that the benefit in terms of price reductions decreases

[29] As in the computation in Table 1, we choose our estimates in the first year for each product where the three conditions hold and drop products in the top 3% in terms of the FCR as outliers.

to 2.8% (=1−0.972), which is considerably smaller than the result based on the simple tariff ratio. This result suggests that it is important to take the PAC into account when evaluating the benefit of RTA schemes in terms of prices.

=== Table 4 ===

4.3. Time-variability of the FCR

Next, we examine our assumption that the FCR is time-invariant. To this end, we take an indirect approach. As mentioned in Section 2, it seems reasonable to regard the PAC as time-invariant, since in most RTAs RoOs do not change. The shape parameter and the elasticity of substitution are usually assumed to be constant over time at least over a short period. Thus, we have to consider the relationship among FCR on the LHR and the import ratio and tariff ratio on the RHS in equation (4). Let us consider the case of products that are imported under both MFN and RTA rules and assume the tariff ratio does not change over time. In this case, equation (4) suggests that if the FCR is time-invariant, the import ratio should be time-invariant, too. Using this relationship, we investigate whether the import ratio is time-invariant in order to check whether the FCR is time-invariant. If the FCR is constant over time for products that are imported under both MFN and RTA rules and for which the tariff ratio is constant, the import ratio should also not change over time.

Specifically, our test procedures and results are as follows. First, we restrict observations only to goods (i) for which the ACFTA rate is lower than the MFN rate, (ii) that are imported under both ACFTA and MFN rules, and (iii) for which estimates by Crozet and Koenig (2010) are available. Second, we take the one-year difference in the import ratio and further restrict observations to those where the one-year difference of the tariff ratio is zero (i.e., the tariff ratio does not change). Third and finally, we test the hypothesis that the one-year difference in the import ratio equals zero. The t-value for this test is reported in column (I) of Table 5 and indicates that the null hypothesis that the one-year difference is zero is not rejected at conventional significance levels.

=== Table 5 ===

We also regress the one-year difference of the import ratio on various fixed effects and then compute the F-value for the null hypothesis that all coefficients are zero. Specifically, we estimate the following equation:

$$R_t(l) - R_{t-1}(l) = \lambda_s + \lambda_t + \varepsilon_{lt},$$

where $R_t(l) \equiv Q_t^M(l)/Q_t^R(l)$. We drop export country subscript i because in our analysis the only exporting country is China. λ_s and λ_t are industry (defined at the one-digit SITC level) and year fixed effects, respectively. ε_{lt} is the error term. We estimate the equation using ordinary least squares. The results are shown in columns (II) to (IV) of Table 5, with those in column (II) including industry fixed effects, those in column (III) including year fixed effects, and those in column (IV) including both fixed effects. All cases show that the null hypothesis is not rejected, indicating that the import ratio does not change over time. In sum, we obtain indirect evidence that the FCR is time-invariant. One crucial reason for this might be that we use the ratio between two fixed costs. While the fixed costs of exporting and the costs of RTA utilization may both decline over time as firms gain experience, the *ratio* of the two types of costs does not significantly change over time. As a result, our assumption that the FCR is time-invariant does not appear to be excessively strong.

4.4. Simulation

This subsection presents two simulation analyses using our estimates of the PAC and FCR. First, we examine the effect of a change in the FCR on ACFTA utilization. For instance, governments might be able to reduce the FCR by simplifying origin certification procedures. To investigate what effect a reduction in the FCR would have, we define the RTA utilization rate $U(l)$ as follows:

$$U(l) \equiv \frac{Q^R(l)}{Q^M(l)+Q^R(l)} = \frac{1}{Q^M(l)/Q^R(l)+1}. \tag{6}$$

The relationship between $Q^M(l)/Q^R(l)$ in the denominator of (6) and the FCR can be obtained by rearranging (3):

$$\frac{Q^M(l)}{Q^R(l)} = \frac{[FCR(l)]^{\frac{\alpha(l)-v(l)+1}{v(l)-1}} - \left[\left(\frac{1}{\theta(l)\mu(l)}\right)^{v(l)} - 1\right]^{\frac{\alpha(l)-v(l)+1}{v(l)-1}}}{\left[\left(\frac{1}{\theta(l)\mu(l)}\right)^{v(l)} - 1\right]^{\frac{\alpha(l)-v(l)+1}{v(l)-1}} \left(\frac{1}{\theta(l)\mu(l)}\right)^{v(l)-1}}. \tag{7}$$

These two equations allow us to compute the RTA utilization rate by using the FCR, the tariff ratio, the PAC, and exogenous parameters.

We simulate the impact of a reduction in the FCR by half on the RTA utilization rate. To this end, we divide the FCR obtained in Table 3 by half, insert this into equation (7), and then compute the hypothetical RTA utilization rate using equation (6). Finally, we take the difference between the original and hypothetical utilization rates. If the hypothetical rate exceeds a value of one, we regard full utilization as having been attained and replace the rate with 100%. The results are shown in the upper panel of Table 6 and suggest that a reduction in the fixed costs of RTA utilization relative to the fixed costs of exporting (i.e., the FCR) by half raises the RTA utilization rate by 21 percentage points on average. In terms of the median, the RTA utilization rate rises by 13 percentage points. The size of these increases is substantial and economically significant. Thus, the simulation results show that a decrease in the fixed costs of RTA utilization would lead to a substantial rise in the RTA utilization rate. Looking at the results by industry, we find that the impact differs across industries. The impact of a reduction in the FCR on the utilization rate varies depending on the various elements on the right-hand side of equation (7). Our simulation analysis indicates that, in terms of the median, the impact would be relatively large in the chemical industry, while it would be quite small in manufactured goods classified by material.

=== Table 6 ===

Second, we examine how much the RTA utilization rate would rise if PACs were completely eliminated. In other words, we examine the change in RTA utilization rates when θ is reduced to a value of one. If RoOs were abolished, the fixed costs of RTA utilization (and thus the FCR) would fall to zero. However, in our simulation, we assume that fixed costs for RTA utilization remain constant, since it might be possible to fully eliminate PACs through a revision of RoOs to make them more business friendly, although this would require considerable renegotiation among RTA member countries. In this simulation, we insert the estimates of the FCR obtained in Table 3 and the PAC with a value of one into equation (7) and then compute the hypothetical RTA utilization rate using equation (6). Finally, we take the difference between the original rate and the hypothetical rate. If the hypothetical rate exceeds a value of one, we replace it with 100%. The results are reported in the lower panel of Table 6. In total, the RTA utilization rate rises by 43 percentage points in terms of the mean and by 32 percentage points in terms of the median. The size of these increases is much larger than the effect of a reduction in the FCR by half in the first simulation.

5. Concluding Remarks

In this study, we proposed a new approach for quantifying the procurement adjustment cost (i.e., PAC) and the additional fixed costs (i.e., the FCR) that are associated with the utilization of RTAs. Our approach relies on two key equations derived from an international trade model in which heterogeneous exporters choose which tariff scheme to use. The computation consists of two steps. In the first step, we compute the PAC assuming that the FCR is time-invariant. With this assumption, we can derive one equation that describes the relationship among the PAC and the trade values and tariff rates by tariff scheme in two periods of time. Employing data on the trade value and tariffs by tariff scheme, we can solve this equation for the PAC. The second step is to solve another equation for the FCR, which expresses the FCR as a function of the PAC and the trade value and tariff rates by tariff scheme. Employing the PAC obtained in the first step in this function, we can then solve for the FCR. This approach can be performed relatively easily and is less restrictive in terms of data requirements than the approaches proposed in previous studies. Thus, it is potentially applicable to many countries.

To demonstrate how our approach works, we applied it to Thailand's imports from China and obtained the following results. In the median estimate, RTA utilization in exporting requires 27% of additional fixed costs. Exporters incur additional costs to adjust procurements that are equivalent to 4% of per-unit production costs. In addition, there are some quantitative differences across industries in both PACs and FCRs. For example, in the machinery and transport equipment industry, the PAC is relatively low while the FCR is relatively high. Furthermore, to examine whether it would be more effective to reduce the fixed costs of RTA utilization or to eliminate PACs in order to increase the utilization rate of RTAs, we conducted simulations using the estimates obtained in our analysis. Our simulation indicated that a reduction of the fixed costs of RTA utilization relative to the fixed costs of exporting by half would raise the utilization rate by 13 percentage points. On the other hand, the complete elimination of PACs would raise the utilization rate by 32 percentage points.

Finally, two caveats should be noted. The first caveat is that although our approach has some advantages, as just mentioned, it can be employed only for products to which two different RTA tariff rates below MFN rates applied during the observation period. Because of this constraint, the number of products for which our approach can be employed may be limited when one applies it to the RTAs under GATT Article XXIV, of which developed countries are major signatories. The reason is the following: Developed countries tend to have zero MFN rates for a larger number of products than developing countries. Also, in RTAs under GATT Article XXIV, tariff rates tend to be immediately eliminated in the first year. As a result, tariff rates on most products are likely to already be zero in the first year. Our approach cannot be applied to such products. For this reason, our approach may be more suitable for the analysis of cases in which a developing country is the importer. The second caveat is that the determinants of the PAC and the FCR may vary depending on the combination of importing and exporting countries. It is therefore important to explore the factors that affect the PAC and the FCR by estimating these costs for various pairs of importing and exporting countries. Policy measures to influence the factors affecting the PAC and the FCR thus can potentially help to increase RTA utilization by firms. We leave these issues for future research.

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Table 1. Descriptive Statistics for the PAC and FCR

	Initial	N	SD	Mean	p25	p50	p75
PAC							
	1.000	425	0.048	1.052	1.018	1.038	1.067
	1.075	425	0.048	1.052	1.018	1.038	1.067
	1.150	414	0.048	1.053	1.018	1.039	1.067
	1.300	396	0.048	1.053	1.018	1.039	1.068
FCR							
	1.000	425	0.607	0.385	0.195	0.268	0.377
	1.075	425	0.607	0.385	0.195	0.268	0.377
	1.150	414	0.211	0.317	0.193	0.265	0.367
	1.300	396	0.151	0.290	0.188	0.257	0.357

Source: Authors' computation using data from Thai Customs and Crozet and Koenig (2010).

Notes: The PAC and FCR are computed at an HS eight-digit level. "Initial" refers to the initial value of the PAC when solving equation (5). "N" and "SD" refer to the number of observations and standard deviation, respectively. "p25," "p50," and "p75" refer to the 25, 50, and 75 percentile.

Table 2. Descriptive Statistics for the FCR in the Expanded Sample

	Initial	N	SD	Mean	p25	p50	p75
Mean							
	1.000	571	3.441	0.793	0.159	0.247	0.387
	1.075	571	3.441	0.793	0.159	0.247	0.387
	1.150	556	0.517	0.369	0.157	0.243	0.365
	1.300	527	0.319	0.311	0.150	0.235	0.338
Median							
	1.000	571	2.530	0.670	0.159	0.248	0.388
	1.075	571	2.530	0.670	0.159	0.248	0.388
	1.150	556	0.514	0.369	0.157	0.243	0.365
	1.300	527	0.319	0.311	0.153	0.235	0.338

Source: Authors' computation using data from Thai Customs and Crozet and Koenig (2010).

Notes: The PAC and FCR are computed at an HS eight-digit level. This table reports our estimates of the FCR when applying the mean and median of the PAC in each HS six-digit code to all eight-digit codes belong to that six-digit code. "N" and "SD" represent the number of observations and standard deviation, respectively. "p25," "p50," and "p75" refer to the 25, 50, and 75 percentile.

Table 3. Descriptive Statistics for the PAC and FCR by Industry

	N	SD	Mean	p25	Median	p75
PAC						
Chemicals	28	0.053	1.043	1.017	1.032	1.048
Manuf. goods classified by material	170	0.044	1.051	1.018	1.040	1.065
Machinery and transport equipment	48	0.054	1.050	1.016	1.033	1.073
Miscellaneous manuf. articles	168	0.048	1.057	1.018	1.042	1.070
Total	414	0.048	1.053	1.018	1.039	1.067
FCR						
Chemicals	28	0.161	0.260	0.154	0.209	0.353
Manuf. goods classified by material	170	0.236	0.322	0.184	0.265	0.364
Machinery and transport equipment	48	0.197	0.335	0.232	0.300	0.360
Miscellaneous manuf. articles	168	0.193	0.317	0.199	0.255	0.391
Total	414	0.211	0.317	0.193	0.265	0.367

Source: Authors' computation using data from Thai Customs and Crozet and Koenig (2010).

Notes: The PAC and FCR are computed at an HS eight-digit level. In this table, we use 1.15 as the initial value of the PAC when solving equation (5). "N" and "SD" represent the number of observations and standard deviation, respectively. "p25," "p50," and "p75" refer to the 25, 50, and 75 percentile.

Table 4. Discounted Tariff Ratios by Industry

	N	SD	Mean	p25	Median	p75
μ						
Chemicals	28	0.048	0.924	0.904	0.944	0.955
Manuf. goods classified by material	170	0.046	0.920	0.875	0.933	0.955
Machinery and transport equipment	48	0.057	0.918	0.862	0.955	0.955
Miscellaneous manuf. articles	168	0.046	0.912	0.862	0.933	0.933
Total	414	0.047	0.917	0.862	0.933	0.955
$\mu\theta$						
Chemicals	28	0.045	0.962	0.956	0.975	0.993
Manuf. goods classified by material	170	0.032	0.965	0.956	0.975	0.986
Machinery and transport equipment	48	0.040	0.962	0.955	0.973	0.989
Miscellaneous manuf. articles	168	0.035	0.962	0.953	0.969	0.988
Total	414	0.035	0.963	0.955	0.972	0.988

Source: Authors' computation using data from Thai Customs and Crozet and Koenig (2010).

Notes: The tariff ratios are computed at an HS eight-digit level. In this table, we employ the estimates of PAC (θ) in Table 2 when the initial value is 1.15. "N" and "SD" represent the number of observations and standard deviation, respectively. "p25," "p50," and "p75" refer to the 25, 50, and 75 percentile.

Table 5. Time-Invariability of Import Ratios

	(I)	(II)	(III)	(IV)
t-value	-0.92			
F-value		0.87	1.48	1.18
Industry fixed effects		X		X
Year fixed effects			X	X
Number of obs.	7,677	7,677	7,677	7,677

Notes: The *t*-value is the test statistic for the null hypothesis that the one-year difference of import ratios is zero. In addition, the *F*-value is the test statistic for the null hypothesis that all coefficients are zero when regressing the one-year difference of the import ratio on various fixed effects. Observations are restricted to those where ACFTA tariffs are lower than MFN tariffs, goods are imported under both MFN and RTA rules, estimates by Crozet and Koenig (2010) are available, and the one-year difference of the tariff ratio is zero.

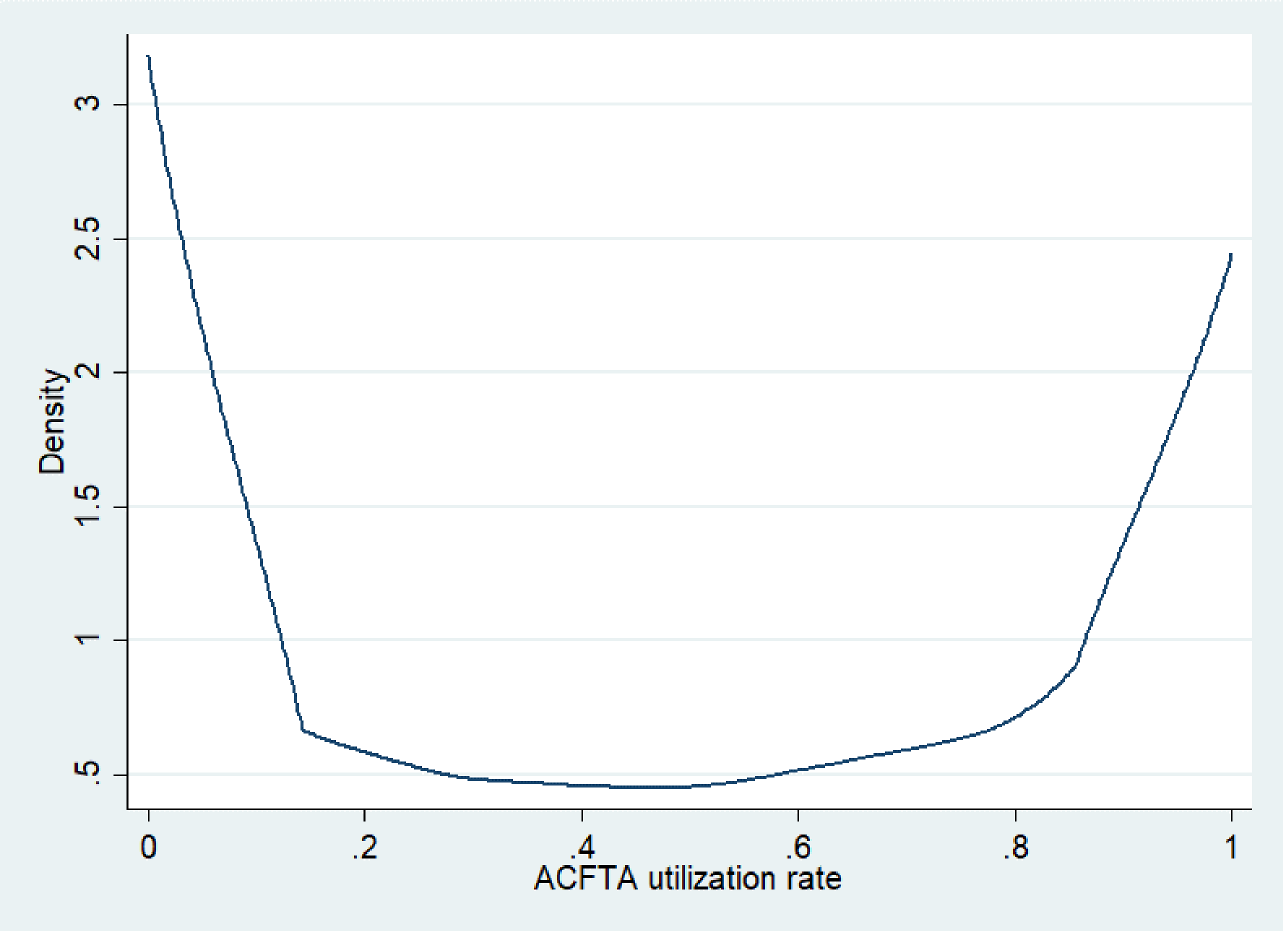
Table 6. Simulation Results: Increase in RTA Utilization Rates (Percentage Points)

	N	SD	Mean	p25	Median	p75
Reduction of FCR by half						
Chemicals	28	21	22	3	19	39
Manuf. goods classified by material	170	23	21	3	12	28
Machinery and transport equipment	48	27	24	2	15	38
Miscellaneous manuf. articles	168	22	21	4	14	30
Total	414	23	21	3	13	31
Eliminating the PAC						
Chemicals	28	33	48	13	42	76
Manuf. goods classified by material	170	35	43	13	34	75
Machinery and transport equipment	48	33	41	18	27	61
Miscellaneous manuf. articles	168	32	43	18	32	65
Total	414	33	43	15	32	70

Source: Authors' computation using data from Thai Customs and Crozet and Koenig (2010).

Notes: The simulations are conducted at the HS eight-digit level. In this table, we employ the PAC and FCR obtained in Table 2 when the initial value is 1.15. "N" and "SD" represent the number of observations and standard deviation, respectively. "p25," "p50," and "p75" refer to the 25, 50, and 75 percentile.

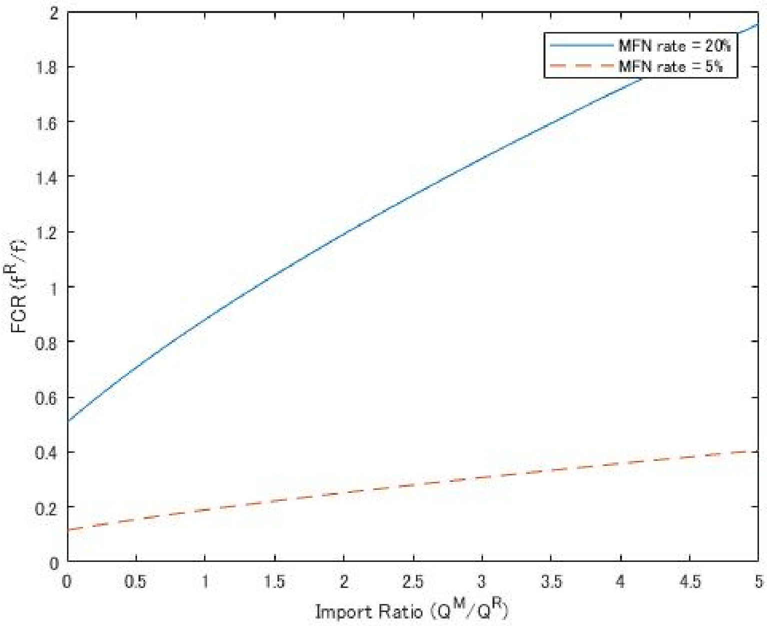
Figure 1. Distribution of the RTA Utilization Rate in Thailand's Imports from China at the Product Level in 2015



Source: Calculated by the authors using data from Thai Customs.

Notes: The "ACFTA utilization rate" is defined as the share of imports on the basis of the ASEAN-China Free Trade Agreement (ACFTA) in Thailand's total imports from China. The figure shows the utilization in 2015 at the product level. Products are defined at the tariff-line level. We restrict products to those for which the ACFTA tariff rate is lower than the MFN tariff rate and for which imports are non-zero. Based on this restriction, the figure includes observations for 5,007 products.

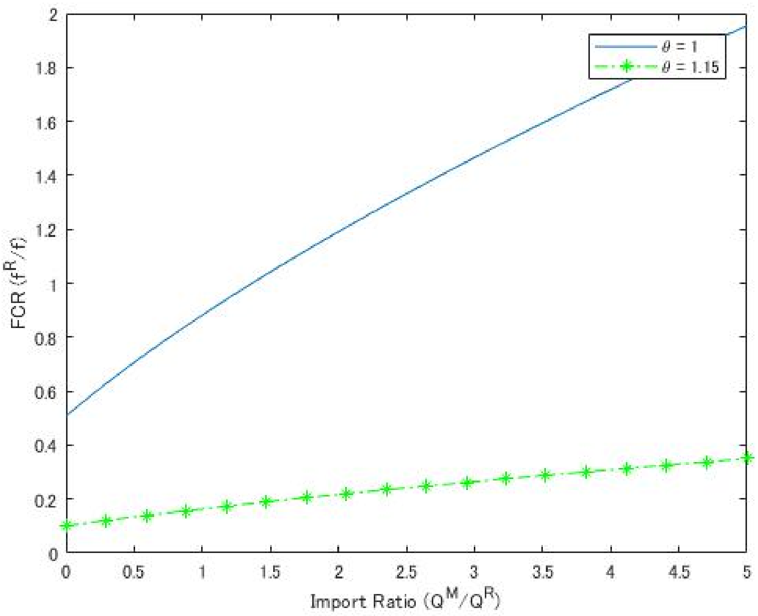
Figure 2. The FCR and the Import Ratio: Different MFN Rates



Source: Authors' calculation using equation (3).

Notes: RTA tariff rates are assumed to be zero. The PAC is set to a value of one. The shape parameter of the Pareto distribution and the demand elasticity are set to 3.09 and 2.25, respectively.

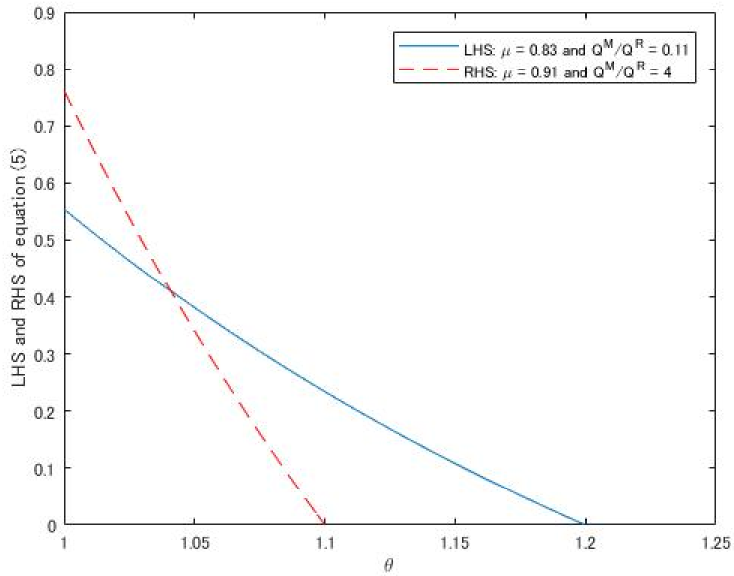
Figure 3. The FCR and the Import Ratio: Different PACs



Source: Authors' calculation using equation (3).

Notes: MFN and RTA tariff rates are set to 20% and 0%, respectively. The shape parameter of the Pareto distribution and the demand elasticity are set to 3.09 and 2.25, respectively.

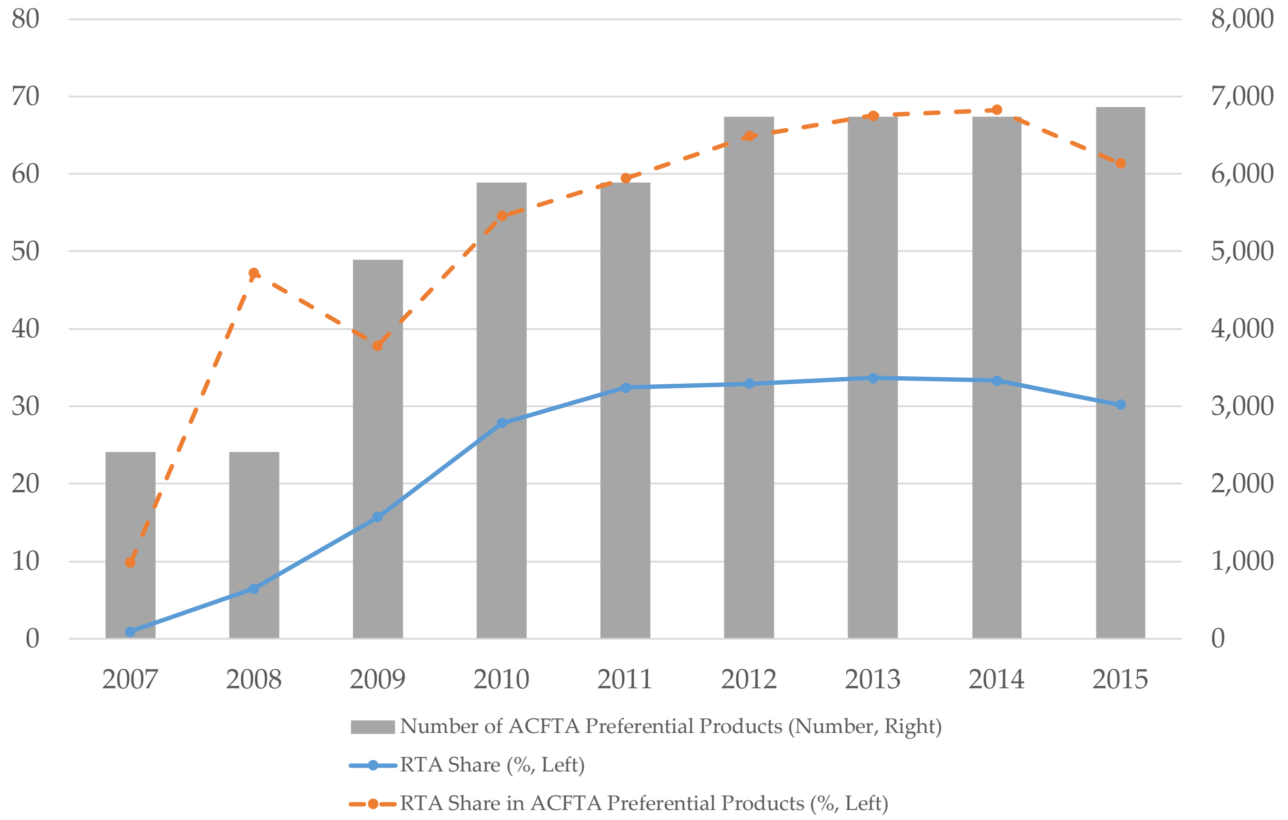
Figure 4. Numerical Example of the Estimation of the PAC



Source: Authors' calculation using equation (5).

Notes: For the LHS and RHS, MFN tariff rates are set to 20% and 10%, respectively. The RTA tariff rate is set to 0% for both cases. We set the import ratio so that the RTA utilization rate for the LHS becomes 90% and that for the RHS becomes 20%. The shape parameter of the Pareto distribution and the demand elasticity are set to 3.09 and 2.25, respectively.

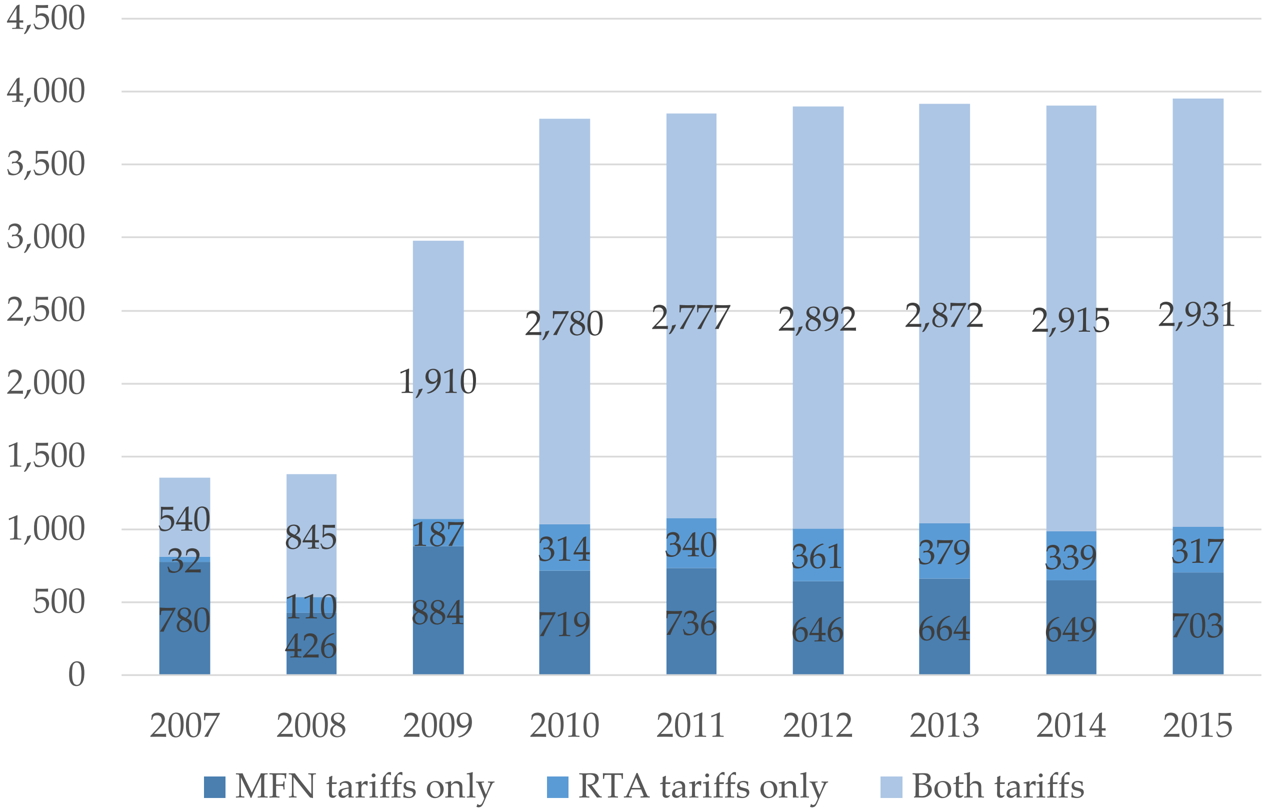
Figure 5. Utilization of ACFTA in Thailand's Imports from China



Source: Authors' compilation using data from Thai Customs.

Notes: Products are defined at the HS eight-digit level. "ACFTA Preferential Products" refers to products where ACFTA tariffs are lower than MFN tariffs. "RTA Share" represents the share of imports on the basis of ACFTA in Thailand's total imports from China. Finally, "RTA Share in ACFTA Preferential Products" represents the share of imports on the basis of ACFTA in ACFTA preferential products.

Figure 6. Number of Products Imported under MFN Tariffs Only, under RTA Tariffs Only, and under Both Tariffs



Source: Authors' calculation using data from Thai Customs.

Notes: "MFN tariffs only" ("RTA tariffs only") refers to products for which imports only under the MFN (RTA) scheme are observed. "Both tariffs" refers to imports for which imports under both the MFN and RTA schemes are observed.

Appendix A. Derivation of Equation (3)

In a heterogeneous regime where goods are imported under both MFN and RTA rules, imports under each of the schemes are given by

$$Q_i^M(l) \equiv \int_{\overline{\varphi}_i^M(l)}^{\overline{\varphi}_i^{R>M}(l)} p_i^M(l,k)c_i^M(l,k)G_l(\varphi) = \frac{1}{\alpha(l)-v(l)+1}\left(\zeta_i(l)\left[\frac{1}{T(l)}\right]^{v(l)}\right)^{\frac{\alpha(l)-v(l)+1}{v(l)-1}}$$

$$\left\{\left[\frac{1}{w_i f_i(l)}\right]^{\frac{\alpha(l)-v(l)+1}{v(l)-1}} - \left(\frac{1}{w_i f_i^R(l)}\left[\left(\frac{1}{\theta_i(l)\mu_i(l)}\right)^{v(l)} - 1\right]\right)^{\frac{\alpha(l)-v(l)+1}{v(l)-1}}\right\}$$

$$\left(\frac{1}{T(l)\tau_i(l)w_i}\frac{v(l)-1}{v(l)}\right)^{v(l)-1} \alpha(l)[p(l)]^{v(l)-1}\beta(l)Pc,$$

$$Q_i^R(l) \equiv \int_{\overline{\varphi}_i^{R>M}(l)}^{\infty} p_i^R(l,k)c_i^R(l,k)G_l(\varphi)$$

$$= \frac{1}{\alpha(l)-v(l)+1}\left(\frac{\zeta_i(l)}{w_i f_i^R(l)}\left[\frac{1}{T(l)}\right]^{v(l)}\left[\left(\frac{1}{\theta_i(l)\mu_i(l)}\right)^{v(l)} - 1\right]\right)^{\frac{\alpha(l)-v(l)+1}{v(l)-1}}$$

$$\left(\frac{1}{\theta_i(l)\mu_i(l)T(l)\tau_i(l)w_i}\frac{v(l)-1}{v(l)}\right)^{v(l)-1} \alpha(l)[p(l)]^{v(l)-1}\beta(l)Pc.$$

Thus,

$$\frac{Q_i^R(l)}{Q_i^M(l)} = \frac{\left[\left(\frac{1}{\theta_i(l)\mu_i(l)}\right)^{v(l)} - 1\right]^{\frac{\alpha(l)-v(l)+1}{v(l)-1}}\left(\frac{1}{\theta_i(l)\mu_i(l)}\right)^{v(l)-1}}{[FCR_i(l)]^{\frac{\alpha(l)-v(l)+1}{v(l)-1}} - \left[\left(\frac{1}{\theta_i(l)\mu_i(l)}\right)^{v(l)} - 1\right]^{\frac{\alpha(l)-v(l)+1}{v(l)-1}}}.$$

Solving this equation for $FCR_i(l)$, we obtain equation (3).

Appendix B. Uniqueness

In this appendix, we show the uniqueness of the solution for the PAC, $\theta_i(l)$, in equation (5). For both sides of the equation, it can be shown that $\partial LHS/\partial\theta_i(l) < 0$, $\partial RHS/\partial\theta_i(l) < 0$, $\partial^2 LHS/\partial[\theta_i(l)]^2 > 0$, and $\partial^2 RHS/\partial[\theta_i(l)]^2 > 0$, indicating that both sides of equation (5) are monotonically decreasing in $\theta_i(l)$ and strictly convex. Therefore, the intersection of the solid and the dotted line in Figure 4 is unique if and only if the slope of the tangent of one of these two lines is always steeper or flatter than that of the other line. The slope of the solid line in Figure 4 – that is, the slope of the tangent on the LHS of equation (5) – corresponds to the first derivative:

$$
\begin{aligned}
\frac{\partial LHS}{\partial \theta_i(l)} = &-\left(\left[\theta_i(l)\mu_{it'}(l)\right]^{1-\upsilon(l)} \frac{Q^M_{it'}(l)}{Q^R_{it'}(l)} + 1\right)^{\frac{\upsilon(l)-1}{\alpha(l)-\upsilon(l)+1}} \mu_{it'}(l)\left[\theta_i(l)\mu_{it'}(l)\right]^{-\upsilon(l)} \Bigg\{\upsilon(l)\left[\theta_i(l)\mu_{it'}(l)\right]^{-1} \\
&+ \frac{[\upsilon(l)-1]^2}{\alpha(l)-\upsilon(l)+1} \frac{Q^M_{it'}(l)}{Q^R_{it'}(l)}\left(\left[\theta_i(l)\mu_{it'}(l)\right]^{-\upsilon(l)} - 1\right)\left(\left[\theta_i(l)\mu_{it'}(l)\right]^{1-\upsilon(l)} \frac{Q^M_{it'}(l)}{Q^R_{it'}(l)} + 1\right)^{-1}\Bigg\} \\
&< 0.
\end{aligned}
$$

It can be shown that

$$
\frac{\partial}{\partial \mu_{it'}(l)}\left(\frac{\partial LHS}{\partial \theta_i(l)}\right) > 0,
$$

$$
\frac{\partial}{\partial\left[Q^M_{it'}(l)/Q^R_{it'}(l)\right]}\left(\frac{\partial LHS}{\partial \theta_i(l)}\right) < 0.
$$

Analogous relationships can be obtained for the RHS. These relationships indicate that the slopes on the left- and right-hand sides of equation (5) positively and negatively depend on μ and Q^M/Q^R, respectively. Therefore, the slopes on the two sides of equation (5) generally differ from each other (remember that $\mu_{it'}(l) \neq \mu_{it^*}(l)$ and $Q^M_{it'}(l)/Q^R_{it'}(l) = Q^M_{it^*}(l)/Q^R_{it^*}(l)$ in our investigation), so that the equilibrium becomes unique.