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Keywords: Trade liberalization, Input trade, Quality upgrading
JEL classification: F13, F14, O32

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Does Trade Liberalization Boost Quality Upgrading?: Evidence from Indonesian Plant-Product-Level Data

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Abstract: In this study, we examine the effects of tariff reduction on firms' quality upgrading by employing an Indonesian plant-product-level panel dataset matched with a plant-level dataset. We explore the effects of lower output and input tariffs separately, by focusing on the apparel industry. By estimating the Berry-type demand function, we derive product-quality indicators based on the Khandelwal (Review of Economic Studies, 2010) methodology, which enables us to isolate quality upgrading from changes in prices. Our findings are as follows. First, a reduction in output tariffs does not affect product quality upgrading. Second, a reduction in input tariffs boosts quality upgrading in general. In particular, this impact is greater for import firms, which is consistent with the fact that the source of the boost is the import of high-quality foreign inputs.

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1. Introduction

The impact of trade liberalization in the home country on corporate performance has

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been studied by policy makers as well as researchers. This is because both export-led growth and import-led growth have emerged as important tools of development strategies (see, for example, Lawrence and Weinstein, 1999). However, the gains from trade liberalization in the home country and its channels of transmission, have not yet been adequately explained. For example, on the one hand, lowering the tariff on a product lowers production costs for firms that use that product as inputs. Such a reduction of “input tariffs” may also improve firms’ output quality through the import of high-quality inputs. On the other hand, domestic market oriented firms may face fierce competition against imported goods. Under such reduction of “output tariffs,” some firms may boost the quality of their output to escape the competition from imports. In short, the effects of tariff reduction on domestic firms’ output will vary.

In this paper, we examine these effects of a reduction in tariffs on firms’ quality upgrading by employing an Indonesian plant-product-level panel dataset matched with a plant-level dataset. In particular, we explore the effects of a reduction in output and input tariffs separately. We focus on the apparel industry for the following reasons. First, the Indonesian apparel industry has faced fierce competition from China especially after the conclusion of a free trade agreement (FTA) in 2005. Second, although plant-product-level data are notoriously noisy, data for the apparel industry is relatively well organized. For example, although product quantities in our dataset are based on different types of units even within a nine-digit level of product classification, in the case of the apparel industry, there are only a few quantity units within a detailed product classification. By estimating a Berry-type demand function, we derive product-quality indicators based on the Khandelwal (2010) methodology, which enables us to isolate quality upgrades from changes in prices.

It is important, particularly for Indonesia, to clarify these effects of trade liberalization in the home country. Recently, the idea of more FTAs has drawn some negative views. These are, in part, because of the dramatic increase in imports from China in the wake of the ASEAN-China FTA (ACFTA). Indeed, the ACFTA may be having various kinds of impacts on Indonesian firms. On the one hand, for example, since *on average* input quality is not very different between China and Indonesia, a lowering of tariffs on inputs from China may not lead to a quality upgrading in Indonesian firms. On the other hand, a lowering of tariffs on output may have a significant impact on quality upgrading to escape the fiercer competition with respect to that output. The analysis presented in this study contributes to uncovering how Indonesian manufacturing firms react to the tariff reduction at home through FTAs in terms of quality upgrading.

This study is built on various strands of other studies. First, it is related to empirical studies on the nexus between trade liberalization and product quality, which has been explored by Amiti and Khandelwal (2013) and Fernandes and Paunov (2013). Amiti and Khandelwal (2013) estimate a Berry-type demand function using cross-country US import data and derive product-quality indicators. They then provide macro-level evidence that tariff reduction induces product quality upgrading especially for products closer to the technology frontier. Fernandes and Paunov (2013) use Chilean firm-product level data and investigate the effect of transport-cost reduction on product quality measured by unit values, and find that transport-cost reduction promotes product quality upgrading. However, they do not consider the effects of changes in input tariffs separately from the effects of changes in output tariffs.

The second group of related studies uses firm-level productivity measures and examines the impact of trade liberalization at the firm level. For example, Amiti and Konings (2007) use Indonesian plant-level data and investigate the impact of output and input tariff reduction on total factor productivity (TFP). They find that input tariff reduction induces productivity improvement especially for importing firms and that the impact is at least twice as great as that of output tariff reduction. The TFP is a so-called revenue productivity measure, which uses the revenue deflated by the industry average price as an output measure. Since product price and quality vary by firms in the differentiated-products sector, the revenue productivity may reflect differences in product quality and market structure as well as in cost efficiency. Therefore, the impact of trade liberalization on revenue productivity may capture both the improvement in cost efficiency and quality upgrading. In this study, we focus on the effect of trade liberalization on quality upgrading instead of TFP growth and attempt to examine whether the result of the effect on TFP growth in Amiti and Konings (2007) comes partially from the effect on quality upgrading.

Third, we complement recent empirical studies that estimate the Berry-type demand function from firm/plant-level data. Examples include Smeets et al. (2014) and Bernini et al. (2015). Smeets et al. (2014) use Danish apparel manufacturers’ product data and investigate how Danish firms respond to China’s accession to the WTO. They demonstrate that the distribution of quality tightened up owing to increased pressure from international competition. Bernini et al. (2015) explore the heterogeneous response to real exchange-rate fluctuations based on product quality using Italian firm-level trade data. Their findings suggest that while those exporters that use imported inputs intensively are able to offset exchange-rate variations, this effect is weaker for firms importing high-quality inputs. However, we focus on the effects of tariff reduction on firms' quality upgrading.

The rest of this paper is organized as follows. Section 2 explains our empirical methodology. After introducing our data sources in Section 3, we report our empirical results in Section 4. Section 5 concludes the paper.

2. Methodology

In our empirical study, we regress the measure of quality at plant-product level on output and input tariff changes as well as plant-related characteristics to examine the effects of trade liberalization on product quality upgrading. Therefore, a key issue is how to obtain plant-product-level quality. As mentioned in the Introduction, we follow Khandelwal (2010) and Amiti and Khandelwal (2013).[1] Namely, we use Berry's discrete choice framework, which is common in recent empirical literature on industrial organization.

Assume consumers have a choice between two levels of differentiated goods as illustrated in Figure 1. They can choose to buy from any of the product groups (e.g., outerwear, underwear, or sportswear). They can further decide to go with a particular variety, i.e., with a product produced by a certain plant in that group. We assume that each individual n consumes one unit of variety (i) that has the highest utility:

$$u_{ni} > u_{nk},\ \forall k \in g,$$

where g indicates a product or a group of varieties. We call g a "nest." We assume that the indirect utility function for product i for consumer n is as follows:

$$u_{ij} = z_{it} - \alpha P_{it} + \zeta_{igt} + (1-\sigma)\varepsilon_{nit}, \tag{1}$$

where P_{it} is the price for variety i in year t, which is measured by unit values (i.e., values divided by quantity). z_{it} captures the quality factors. ζ_{igt} and ε_{nit} are the valuation of utility by consumer n for variety i for different nests of varieties and across varieties belonging to the same nest, respectively. σ is the within-group correlation in consumer taste for varieties i. We assume that ε_{nit} follows an identical independent type I extreme value distribution.

=== Figure 1 ===

Berry (1994) shows that the market share of variety i is given by:

[1] Explanations for the quality-measure estimation are based on Hayakawa et al. (2014).

$$s_{it} = \frac{\exp[(z_{it} - \alpha P_{it})/(1-\sigma)]}{\sum_{k\in g}\exp[(z_{kt} - \alpha P_{kt})/(1-\sigma)]} \cdot \frac{\sum_{k\in g}[\exp[(z_{it} - \alpha P_{it})/(1-\sigma)]]^{1-\sigma}}{\sum_{g}\sum_{k\in g}[\exp[(z_{kt} - \alpha P_{kt})/(1-\sigma)]]^{1-\sigma}}. \quad (2)$$

This demand system is completed by introducing an outside good; the consumers may decide not to purchase any of the varieties. Assuming that ε_{nit} follows an identical independent type I extreme value distribution, Berry demonstrates that the log difference between s_{it} and the market share of an outside variety s_{Ot} can be written in linear form:

$$\ln s_{it} - \ln s_{Ot} = -\alpha P_{it} + z_{it} + \sigma \ln s_{igt}, \quad (3)$$

where s_{it} is the market share for variety *i* in year *t*, and s_{ot} is the share of "outside goods" in year *t*. P_{it} is the price and s_{igt} is the nest share, namely the share of variety *i* within product group *g*. We assume that product quality z_{it} may be decomposed into three factors, $\delta_t + \delta_i + \delta_{it}$, namely time fixed effects, variety fixed effects, and the variety-time deviation from fixed effects, respectively. We control the first two factors by time and plant-product fixed effects. We consider the third factor δ_{it} as residuals. The equation to be estimated becomes:

$$\ln s_{it} - \ln s_{Ot} = -\alpha P_{it} + \delta_t + \delta_i + \sigma \ln s_{igt} + \delta_{it}. \quad (4)$$

Once we obtain the estimates in equation (4), product quality is recovered using the following equation:

$$\hat{Q}_{it} = \hat{\delta}_t + \hat{\delta}_i + \hat{\delta}_{it}. \quad (5)$$

Because price and nest share are endogenous variables, we estimate equation (4) using instrumental variable (IV) estimation techniques. Four instrument variables are used. First, we use the average price for competing varieties provided by other firms for variety *i*, which is the instrument of product prices. The changes in competitors' prices may affect the pricing strategies of a firm but will be independent of firms' product quality since it is not easy to adjust product quality immediately after competitors' price changes. Second, supply-side information is often used as an instrument variable when estimating a demand function. We use the average electricity price as an instrument for prices. Third, we use two indicators related to the competitive environment for each market as instrument variables for the nest share (s_{igt}), namely the number of competing varieties in the same market and the number of products provided by the same firm.

Using the above estimates on quality, we examine how changes in output and input tariffs affect firms' quality upgrading by estimating the following equation (we omit a subscript on plants):

$$\ln Q_{it+1} - \ln Q_{it} = \beta_1 Outtariff_{gt} + \beta_2 Intariff_{gt} + \mathbf{X}_{gt}\boldsymbol{\gamma} + \varphi_{tl} + \varepsilon_{it}, \quad (6)$$

where $Outtariff_{gt}$ and $Intariff_{gt}$ represent the output and input tariffs for a product or group of variety g in year t, respectively. $\mathbf{X}$ indicates a vector of control variables, including trade status dummy variables (e.g., exporter dummy or importer dummy) and a log of output values. The exporter dummy takes the value one if a product concerned is exported, whereas the importer dummy does that if a plant imports any products. We include year-island fixed effects, φ_{tl}, to control for some differences in quality upgrading across regions (Sumatra, Java, Kalimantan, Sulawesi, and others). This equation is our baseline equation and is estimated by the ordinary least squares (OLS) method.

By interacting firms' trade status with these tariff variables, we also examine the different effects of tariffs on quality upgrading. If the effect of input tariffs is sourced from the greater use of foreign inputs of higher quality, import firms are more likely to be affected. Similarly, if output tariffs provide the motivation for escaping the competition posed by imported output, the impact on exporters will be smaller because they do not compete with imported output in the domestic market. To investigate these heterogeneous effects, we introduce the interaction terms between export status and output tariffs and between import status and input tariffs.

Following Amiti and Khandelwal (2013), we also control the distance to quality frontier (proximity to frontier) in t. This variable is the ratio of quality, Q_{it}, to the maximum quality within a product group-year, which is defined as:

$$Proximity\ to\ frontier_{it} = Q_{it} / \max_{i \in g}[Q_{it}]. \quad (7)$$

We also include its interaction terms with *Outtariff* and *Intariff*. We expect proximity to frontier in year t to have a negative coefficient because low-quality producers catch up faster. That is, the interaction terms of proximity to frontier with tariffs may capture the "discouragement" effect of competition, as suggested by Aghion et al. (2009). This means that increased competition may discourage firms far from the technology frontier from upgrading their product quality because they know that it would be difficult to survive even if they engaged in more innovation. If this effect works, the coefficients of the interaction terms will be negative.

3. Data Issues

We now introduce our data sources. We first report those for our basic variables on plants and plant products. Then, we provide details of the computation of our tariff variables.

3.1. Data

Two datasets are available for Indonesian manufacturing. One dataset contains production and cost information at a plant level, including the total number of workers, the amount of capital stock, total value of production, value added, costs of material inputs and labor, and the value and quantity of electricity used. Another one is a more unique plant-product-level dataset. It reports the value, quantity, and export share of each product produced by a plant, as well as the nine-digit level of the Commodity Classification of Indonesia (*KKI: Klasifikasi Komoditi Indonesia*).[2] Both datasets are drawn from annual surveys by Indonesia's Statistical Agency (BPS-Statistics), which cover manufacturing plants with 20 or more workers. Using a common plant-identification code, we can merge the two datasets and estimate demand and quality equations by taking advantage of each dataset.

For our empirical analysis, which uses these datasets, "product," "nest," and "outside goods" are defined as follows. At the most disaggregated level, differences of apparel products are identified as type of product (e.g., overcoats/suits/…, etc.), for men/women, fabric used, method of making (e.g., knitted or crocheted/others), and batik/non-batik. In our empirical analysis, "product" is defined based on the type of product and sex, ignoring other differences. To estimate the nested logit model in equation (4), we have to define "group of variety" or "nests" prior to estimation. In our analysis, "nest" is defined the same as "product."[3] Therefore, the underlying assumption of consumers' decisions is that they first decide whether to purchase domestic products, then choose a "product" (="nest"), and finally choose a producer (="variety"). As in previous studies, imported products that correspond to domestic products are treated as "outside goods," which is an option for consumers to purchase

[2] The first five digits of the *KKI* correspond to the Indonesian Standard Industrial Classification (*KBLI*), which is a modified version of the International Standard Industrial Classification of All Economic Activities (ISIC) Rev 3, to accommodate the specific conditions of manufacturing in Indonesia. Most of the four-digit *KBLI* codes correspond to the ISIC four-digit codes, except for clay product industries.

[3] Indonesia's domestic apparel market that is analyzed here consists of 36 "nests" (see Table A1 in Appendix). Apparel for babies and accessories are excluded from our sample.

when they decide not to purchase domestic apparel products.[4]

Under these definitions, and the above two datasets, we construct the plant-product-level panel dataset for our empirical analysis. First, we check units used to report quantity in each record. In more than 97.5 percent of the total records, quantity is reported in terms of pieces. For consistency, we drop those records in which quantity is reported in units other than pieces. Second, several plants are excluded from our sample because they report an unreliably large value or quantity of production. In addition, this dataset contains data for non-respondents, whose value of production and employment are estimated by BPS-Statistics. We exclude observations for non-respondents.[5] Third, the value and quantity (in pieces) of plants' products classified at the nine-digit *KKI* are aggregated according to the definition of "products" by plant and year. Fourth, using the aggregated records, we create a plant-product-level panel dataset. Finally, to the panel dataset, we add plant-level variables, including the value of total production, export status, and import status.

Using this plant-product-level panel dataset, we compute all variables except for tariff variables and the variable on outside goods. The price variable (P_{it}) is calculated as total value divided by quantity for each product. As in the product-level data in other countries, the unit price variable contains somewhat noisy observations. Therefore, before running regressions, observations outside the two-sided 90 percent confidence interval of the unit price in logarithm for each product have been dropped from the sample while estimating the demand equation.

3.2. Output and input tariff rates

As a WTO member, Indonesia has attempted to reduce its tariff rates since the mid-1990s. The MFN tariff rates imposed on apparel products at the nine-digit *KKI* ranged from 25 to 30 percent in 1996. By 2001, this had declined to 10 to 15 percent. A rough comparison with other manufacturing products in Indonesia shows that the apparel industry, and the textile industry that has been its main supplier, has been highly protected. According to the WTO (2003), the average MFN rates on "textile and clothing" were 14.6 and 10.5 percent in 1998 and 2002, respectively, while the average rates on industrial products were 9.7 and 7.0 percent during the same period. The

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[4] Because the units used to measure quantity in the dataset are different from that in trade data, we calculate the share of "outside goods" (s_{Ot}) as import penetration (in terms of value) following Amiti and Khandelwal (2013), instead of calculating quantity share. Import penetration is calculated as the total value of imports divided by the sum of the values of imports and domestic production.

[5] As a result, 34 percent of the total records were dropped.

average tariff rates on textile and clothing were the fourth highest, after transport equipment, prepared food, and footwear.

Although the MFN rates on apparel products have not changed since 2001, Indonesia has continued to liberalize its trade regime through FTAs. Under the Common Effective Preferential Tariff (CEPT) Scheme for the ASEAN Free Trade Area, tariffs on apparel imports from other ASEAN economies were reduced to 5 percent by 2001. By 2009, before the ASEAN Trade in Goods Agreement (ATIGA) went into force in 2010, all of the tariffs on apparel products were eliminated. In addition, as a member of ASEAN, Indonesia established FTAs with China (in 2005), Korea (in 2007), and India (in 2010). Indonesia also established the bilateral Economic Partnership Agreement with Japan (JIEPA, in 2008). Comparing preferential tariff rates on apparel products under these schemes in 2010, we find that all of the 499 apparel products at the nine-digit *KKI* are tariff free under ATIGA and JIEPA, while the average tariff rate and the percentage of tariff-free products are 5.1 percent and 41 percent, respectively, under the ASEAN-China FTA. The corresponding averages and percentages are 3.9 percent and 50 percent under the ASEAN-Korea FTA, and 14.2 percent and 0 percent under the ASEAN-India FTA.

Given this backdrop, we examine the following two kinds of tariff variables: input tariffs and output tariffs. The input tariffs ($Intariff_{gt}$) for "product" or group of variety g in year t are computed as a weighted average of tariffs on inputted products:

$$Intariff_{gt} = \sum_{h} w_{hg} \times Outtariff^{*}_{ht},$$

where $Outtariff^{*}_{ht}$ is output tariffs in year t for industry h at a four-digit level of ISIC Revision 3, and w_{hg} is the cost share of manufacturing inputs from industry h for producers of products in the variety g group. To calculate the cost share, we first identify plants producing products in the variety g group. Then, for these plants, we calculate the average cost share of manufacturing inputs from industry h using detailed input information for each plant from the same sources as the plant-level dataset.

The output tariffs at a four-digit level of ISIC, which are used to construct *Intariff*, are computed as follows. First, we identify tariff rates in all tariff schemes including preferential schemes such as FTAs in Indonesia. The tariff-line level data are obtained from the World Integrated Trade Solution (WITS) database.[6] We use tariff-equivalent rates for non–ad valorem tariff products. Second, at a tariff-line level, we identify the

[6] Unfortunately, in the WITS database, Indonesia does not report the tariff rates for JIEPA, which is the FTA with the country that has the third-largest export values to Indonesia. Thus, we obtain this data from the legal text of the FTA between Japan and Indonesia.

lowest tariff rates among all schemes available for each country when exporting to Indonesia. Third, tariff rates at the tariff-line level are converted to those at the four-digit level of ISIC using the conversion table available on the website of United Nations Statistics Division (UNSD). We apply the simple average for this aggregation. Furthermore, we modify the ISIC classification to match the industry classification (*KBLI*) in Indonesia. Lastly, the tariff rates in all countries are aggregated to single tariff rates by employing the share of import values from each country in total imports as a weight. The weight is based on import values mid-sample i.e., 2006. These data are obtained from the World Trade Atlas.

Apart from using the output tariffs at a four-digit level of ISIC to compute the input tariffs, we need to calculate output tariffs for "product" or the variety *g* group ($Outtariff_{gt}$) to analyze the impact of output tariff reduction on quality upgrading. First, we identify tariff line codes corresponding to the apparel products at the nine-digit level of the *KKI* based on information on the type of product, for men/women, fabric used, method of making, and batik/non-batik. Second, at a tariff-line level, we identify the lowest tariff rates as explained above. Third, tariff rates at the tariff-line level are converted to those at the "product" level. Lastly, these tariff rates in all countries are similarly aggregated to single tariff rates using weights of import values.

4. Empirical Results

We now report our estimation results. We first show the results of estimating the demand function to obtain our quality estimates. We then provide the results of estimating the effects of output and input tariffs on quality upgrading.

4.1. Demand estimation and quality estimates

First, we estimate the demand function. The results are presented in Table 1. We run OLS and IV regression for the sake of comparison. Consistent with the theoretical requirements in our demand function, both OLS and IV estimates for a price coefficient are negative and significant, whereas those for a nest share coefficient are significant and lie between zero and one. First stage *F*- test statistics for both price and nest share are high enough to reject the null hypothesis that all the coefficients are jointly zero, suggesting that the instrumental variables have some power. Hansen *J*-test statistics rejects the null hypothesis for over-identification, but it is not clear if the reason for rejection is that the instrumental variable is invalid or that it is probably owing to a large number of observations.[7] As expected, the absolute magnitude of the price and nest share coefficients is larger in OLS than in IV estimation probably because both price and nest share are correlated with unobserved quality and suffer from bias.

=== Table 1 ===

We use IV estimates of the demand function to construct the quality estimates following equation (5). Before proceeding to the empirical analysis of the impact of changes in tariffs, we examine the relationship of prices with quality and plant size in terms of output values, as in Smeets et al. (2014). The results are presented in Table 2. We control for year fixed effects and product fixed effects in columns (I) and (II), whereas year fixed effects and plant-product fixed effects are controlled for in column (III). In all specifications, plant sizes are positively correlated with prices. Furthermore, as found in columns (II) and (III), there is a significantly positive correlation between prices and quality, implying that the widely used measure of quality, i.e., prices, at least partly plays a role of proxy for the quality.

=== Table 2 ===

4.2. Impact of tariff on price and quality

We now report our estimation of equation (6).[8] Before estimating for quality upgrading, as in previous studies, we estimate for price changes (i.e., $\ln P_{it+1} - \ln P_{it}$) for the purpose of comparison. After reporting the results for price changes, we present the estimation results for quality changes.

The result for price changes is shown in column (I) in Table 3. While the coefficient for output tariffs is insignificant, that for input tariffs is estimated to be significantly negative. That is, while the reduction of input tariffs raises product prices, there is no effect when output tariffs are reduced. The coefficients for the trade status dummies, i.e., exporter dummy and importer dummy, are insignificant. In this equation, we also include a variable of proximity to frontier, which is specified like equation (7) but is evaluated in terms of price rather than quality. Its coefficient is estimated to be significantly negative, indicating that plants closer to the frontier experience a smaller rise in product prices. The coefficient for plant size in terms of output is insignificant.

7 As suggested by Nevo (2001), it is known that the test of over-identification is often rejected when the number of observations is large.

8 Basic statistics are available in Table A2 in the Appendix.

=== Table 3 ===

The results of the estimation for quality upgrading are presented in column (II) and are similar to those for price changes shown in column (I). Thus, we may say that most of the results for price changes come from the effects on quality upgrading. The insignificant result for the exporter dummy implies that there are no significant differences in quality upgrading between non-exporters and exporters. This may be because, as pointed out in Chongbo (2007), the textile and garment industry in Indonesia was over-dependent on the quota system (known as the Multi-Fiber Agreement (MFA)) and the American market.[9] Specifically, exporters may have been reluctant to pursue quality upgrading. The coefficients for the importer dummy and proximity to frontier are estimated to be significantly positive and negative, respectively. Therefore, importers and the plants with quality farther from the frontier have high-quality upgrading. The latter result indicates convergence in quality across plants.

The results on tariffs are as follows. First, the reduction of output tariffs does not affect firms' quality upgrading. There are at least two possible reasons. One is that our variable on output tariffs does not change much across products and over time, especially when compared with that on input tariffs.[10] The other is that significant effects of output tariffs appear once plants invest in machines for manufacturing in order to differentiate their output from imported products. However, it is difficult for firms in Indonesia to do that because local banks have generally avoided lending to the textile industry owing to high risks (Chongbo, 2007). Second, as expected, reducing input tariffs boosts quality upgrading. That is, lower prices for imported inputs encourage firms to increase imports, thereby boosting the upgrade of their output quality.

In column (III), we introduce various interaction terms with tariff variables. While the interaction term of output tariffs with the exporter dummy has an insignificant coefficient, that of input tariffs with the importer dummy is negatively significant. The former result indicates that both non-exporters and exporters do not boost their quality upgrading. The latter result implies that our above interpretation of the result in input

[9] The abolishing of MFA may affect our results. Therefore, we also estimate the model with the interaction terms of our variables with the MFA dummy, which takes the value one for years before 2005 and zero otherwise. We obtain insignificant results in the interaction term between the MFA dummy and the exporter dummy. These estimation results are available upon request.

[10] For example, the average change in output and input tariffs from 2001 to 2010 are 2.0 and 0.8 percentage points, respectively. Furthermore, in 2010, the coefficient of variance is 0.13 in output tariffs and 0.19 for input tariffs.

tariffs is more valid for importers. However, even after including such an interaction term, the coefficient for input tariffs is still significantly negative, implying that non-importers also boost quality upgrading when input tariffs are reduced. Again, there are two possible interpretations for this result. One is that non-importers may purchase lower-priced foreign inputs through trading companies. The other is the competition effect in inputs—namely, the increase of imports of lower-priced foreign inputs lowers the prices of inputs produced domestically. Such a lowering of input costs may enable non-importers to invest in the machines for upgrading.[11]

We also do some other estimations. First, we introduce the interaction terms of tariff variables with the proximity to frontier. The results are reported in column (I) of Table 4. There is no qualitative change in the results for the original variables. The new interaction terms have insignificant results. That is, we do not find the effects of tariffs based on proximity to frontier. Second, we estimate our model for small- and large-sized plants separately. We split the estimation sample based on whether the overtime average of plant-level output values is greater than the median among all plants or not. The results are reported in columns (II) and (III). We can see that the result for the larger-sized plants is similar to that in Table 3. The coefficients for input tariffs and their interaction term with the importer dummy are found to be negatively significant. The former result may be because larger-sized plants, i.e., plants producing a larger volume of output, reduce the (variable) costs for inputs to a greater extent and thus are more likely to invest in machines for upgrading. The latter result may indicate that the larger-sized plants are better at generating an output of higher quality that uses better quality foreign inputs.

=== Table 4 ===

5. Concluding Remarks

In this study, we examined the effects of lowering tariffs on firms' quality upgrading by employing an Indonesian plant-product-level panel dataset matched with a plant-level dataset. In particular, we explored separately the effects of a reduction in output and input tariffs. The top three important factors for economic growth are technology, labor, and capital. In particular, the enhancement of technology is crucially important for

[11] We also tried to differentiate existing exporters/importers from new exporters/importers by introducing the interaction terms of tariff variables with the new exporter/importer dummy. However, such terms have insignificant results. These estimation results are available upon request.

developing countries since capital has become much more mobile across countries, and developing countries usually have many low-wage laborers. One form of such technology enhancement is to upgrade firms' product quality. Therefore, our analysis has important implications for developing countries. Employing the Khandelwal (2010) methodology, we estimated a Berry-type nested logit demand function for Indonesian domestic apparel products and derived product-quality indicators that enable us to isolate quality upgrading from changes in prices.

Our main findings are twofold. One is that the reduction of output tariffs does not boost quality upgrading by firms producing that output. This result should not be interpreted as an encouragement to governments not to liberalize trade in those goods. Rather, it may indicate that reducing output tariffs leads to quality upgrading only if other necessary conditions for upgrading, such as capital investment, are met. The other is that reducing input tariffs boosts quality upgrading in all firms through inputting more foreign goods and/or lowering domestic costs via the competition effect. Thus, it is highly recommended to liberalize trade in goods in order to boost firms' quality upgrading.

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Table 1. Demand Function Estimation

	(I) OLS	(II) IV
ln Price	-0.0025***	-0.0643**
	(0.0002)	(0.0285)
ln Nest share	0.8333***	0.8359***
	(0.0099)	(0.2141)
Number of Observations	9,791	9,791
R-squared	0.9021	
Number of plant-product	2,928	2,928
Hansen J test (p-value)		0.0002
First stage F-value (Price)		20.73
First stage F-value (Nest share)		15.64

Notes: The dependent variable is the log difference between the shares of a domestic good and an outside good. ***, **, and * represent significance at the 1%, 5%, and 10% statistical levels, respectively. In parenthesis is the robust standard error.

Table 2. Price–Quality Correlation Estimation

	(I)	(II)	(III)
ln Quality		0.2401***	0.2356***
		(0.002)	(0.005)
ln Output	0.1082***	0.0227***	0.0146*
	(0.005)	(0.003)	(0.008)
Number of observations	9,791	9,791	9,791
R-squared	0.141	0.682	0.679
Number of plant-product			2,928
Year-Island Fixed Effect	YES	YES	YES
Product Fixed Effect	YES	YES	No
Plant-product Fixed Effect	No	No	YES

Notes: The dependent variable is the log of prices. ***, **, and * represent significance at the 1%, 5%, and 10% statistical levels, respectively. In parenthesis is the robust standard error.

Table 3. Baseline Estimation

Dependent Variable	(I) Price	(II) Quality	(III) Quality
Outtariff	-0.0001	-0.0000	0.0006
	(0.005)	(0.002)	(0.003)
* Exporter dummy			-0.0010
			(0.004)
Intariff	-0.0196*	-0.0103***	-0.0084**
	(0.011)	(0.003)	(0.003)
* Importer dummy			-0.0244*
			(0.013)
Exporter dummy	0.0172	0.0106	0.0243
	(0.032)	(0.010)	(0.054)
Importer dummy	0.0346	0.0221*	0.2130**
	(0.036)	(0.013)	(0.102)
Proximity to frontier	-0.8239***	-0.2873***	-0.2896***
	(0.061)	(0.024)	(0.024)
ln Output	-0.0035	-0.0037	-0.0036
	(0.007)	(0.002)	(0.002)
Number of observations	4,562	4,562	4,562
R-squared	0.083	0.213	0.214

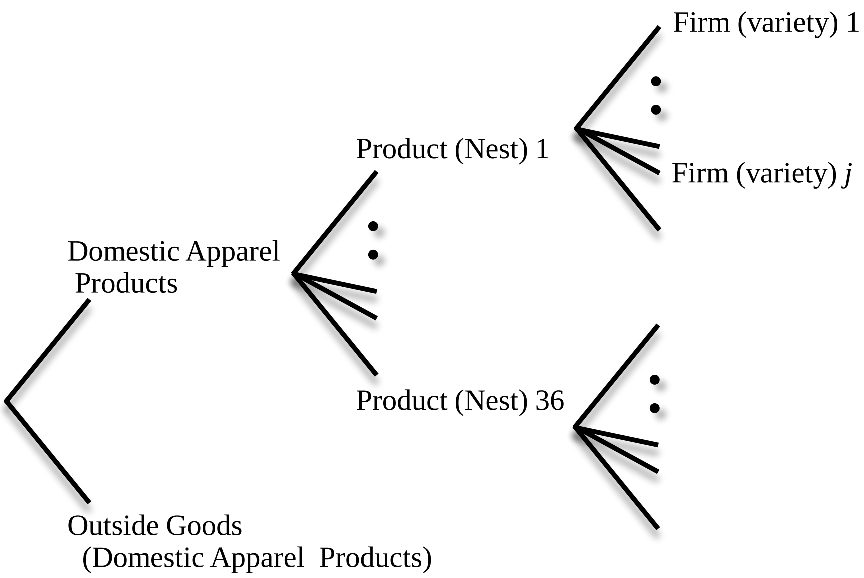
Notes: The dependent variable is the log difference of prices/quality. ***, **, and * represent significance at the 1%, 5%, and 10% statistical levels, respectively. In parenthesis is the robust standard error. In all specifications, year-island fixed effects are included.

Table 4. Additional Estimation

Sample	(I) All	(II) Large	(III) Small
Outtariff	0.0028	0.0036	-0.0022
	(0.009)	(0.004)	(0.004)
* Exporter dummy	-0.0010	-0.0071	0.0034
	(0.004)	(0.005)	(0.005)
* Proximity to frontier	-0.0042		
	(0.017)		
Intariff	-0.0208*	-0.0113**	-0.0045
	(0.012)	(0.005)	(0.005)
* Importer dummy	-0.0264**	-0.0239*	0.0030
	(0.013)	(0.013)	(0.067)
* Proximity to frontier	0.0207		
	(0.020)		
Exporter dummy	0.0247	0.1153	-0.0525
	(0.054)	(0.077)	(0.077)
Importer dummy	0.2286**	0.1891*	0.0247
	(0.104)	(0.106)	(0.525)
Proximity to frontier	-0.3912*	-0.3138***	-0.2645***
	(0.233)	(0.033)	(0.035)
ln Output	-0.0035	0.0002	-0.0255***
	(0.002)	(0.004)	(0.007)
Number of observations	4,562	2,400	2,162
R-squared	0.214	0.224	0.239

Notes: The dependent variable is the log difference of quality. ***, **, and * represent significance at the 1%, 5%, and 10% statistical levels, respectively. In parenthesis is the robust standard error. In all specifications, year-island fixed effects are included. "Large" plants are defined as those in which the average of plant-level output values over time is greater than the median among all plants.

Figure 1. Consumers' Decision Tree



Appendix

Table A1. Types of Apparel Products

Overcoats (1. for women; 2. for men)
Suits (3. for women; 4. for men)
Blazers/Jackets (5. for women; 6. for men)
Sweaters/Ensembles (7. for women; 8. for men)
Vests (9. for women; 10. for men)
Shirts/Blouses (11. for women; 12. for men)
Kebaya (13. for women)
Gowns (14. for women)
Skirts (15. for women)
Trousers (16. for women; 17. for men)
Other outer garments (18. for women; 19. for men)
Slips (20. for women)
Undershirts (21. for men)
Singlets (22. for women; 23. for men)
Underpants (24. for women; 25. for men)
Other underwears (26. for women; 27. for men)
Nightwears (28. for women; 29. for men)
Pajamas (30. for women; 31. for men)
Dressing gowns/(Bath)Robes (32. for women; 33. for men)
Brassieres/Corsets (34. for women)
T-shirts (35. unisex)
Sweaters/Vest/Other garments (36. unisex)

Note: Kebaya is the traditional Indonesian dress.

Table A2. Basic Statistics

	Mean	S.D.	p10	p90
D.ln Price	0.0386	0.5837	-0.4929	0.5596
D.ln Quality	-0.0218	0.2146	-0.2109	0.1842
Outtariff	14.1493	1.5099	13.4011	14.8739
* Exporter dummy	4.8287	6.7560	0	14.8332
* Proximity to frontier	7.5338	2.6274	4.8053	11.3889
Intariff	7.8642	1.0063	6.4400	8.8533
* Importer dummy	0.8650	2.4753	0	6.6898
* Proximity to frontier	4.1947	1.5068	2.6298	6.4864
Exporter dummy	0.3431	0.4748	0	1
Importer dummy	0.1103	0.3132	0	1
Proximity to frontier	0.5327	0.1759	0.3536	0.7995
ln Output	14.5056	1.6702	12.7004	17.0534