Foreign Direct Investment and Quality Upgrading in Indonesian Manufacturing

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Abstract: Product quality is the key to the export success of firms in developing countries. Employing plant product-level data from Indonesian manufacturing, we examine whether and to what extent inward foreign direct investment (FDI) affects the product quality of local plants. This study provides two implications to the literature. First, we explicitly consider the channels through which inward FDI improves the product quality. Second, we examine whether every local plant, both exporters and non-exporters, can benefit from quality upgrading spillovers. We find that backward FDI upgrades the product quality of exporters only. In contrast, plant productivity positively affects the product quality of any plant, suggesting that non-exporters can improve the quality of their products as long as they benefit from productivity spillovers from multinational enterprises.

Keywords: Developing country, Export upgrading, Foreign direct investment, Product quality, Spillovers

JEL classification: F23, L15, O14

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1. Introduction

Product quality plays an important role in international trade and economic development (Kremer, 1993; Grossman and Helpman, 1991). Generally, high-quality products are produced by firms in developed countries and exported to distant markets (Schott, 2004; Hummels and Skiba, 2004). However, product quality is also the key to the export success of firms in developing countries. Verhoogen (2008) extended the model of firm heterogeneity and trade (Melitz, 2003) to include firms' endogenous choice of product quality. The study showed that a large demand for high-quality goods in developed countries induces firms in developing countries to export higher-quality products than those sold in the domestic market. Consequently, identifying the determinants of product quality has attracted significant research interest (Amiti and Khandelwal, 2013; Bernini et al., 2015). For example, Kugler and Verhoogen (2012) found that Columbian exporting firms use high-quality inputs to produce high-quality outputs. Similarly, input tariff reductions accelerate quality upgrading in China (Fan et al., 2015).

We contribute to the literature by analyzing whether and to what extent inward foreign direct investment (FDI) affects the product quality of local firms in developing countries. Technology spillovers from multinational enterprises (MNEs) are considered an important channel of technology diffusion from developed to developing countries (Blalock and Gertler, 2009; Javorcik, 2004). Several studies have evaluated their impact on productivity, wages, or employment of local firms (Crespo and Fontoura, 2007; Görg and Greenaway, 2004; Smeets, 2008). A meta-analysis by Havranek and Irsova (2011) indicates that backward FDI has an economically significant impact. Quantitatively, a 10-percentage-point increase in the share of MNEs in downstream industries raises the productivity of local firms by 9.4%.

Recent literature on export upgrading discusses the quality impact of inward FDI on exported products. It argues that interactions with MNEs allow local firms to learn their business practices, such as employee training and quality control, to upgrade their products (Bajgar and Javorcik, 2020; Javorcik and Spatareanu, 2009). Local firms can also purchase high-quality inputs from MNEs in upstream industries (Amiti and Konings, 2007). Using cross-country trade data, Harding and Javorcik (2012) demonstrated that attracting inward FDI is effective in raising the unit value of exports from developing countries. Amighini and Sanfilippo (2014) confirmed the same effect on African exports. At the firm level, Stiebale and Vencappa (2018) showed that foreign acquisitions improve the quality of goods produced by acquired Indian firms. Bajgar and Javorcik (2020) found that forward FDI has a positive impact on the quality of products exported by Romanian firms. Ciani and Imbruno (2017) obtained similar results for Bulgarian firms.

These studies have greatly improved our understanding of the role of MNEs in the quality upgrading of local exporters. However, because their focus was limited to exporters and their products, it is not clear whether other local firms, such as non-exporters, can benefit from quality upgrading spillovers. This contrasts with the studies on productivity spillovers.

For instance, Blalock and Gertler (2008) found that local firms, including non-exporters, can receive spillover benefits on their productivity. Considering that exporters constitute a small fraction of manufacturing firms, identifying the beneficiaries of quality upgrading spillovers has important implications. Suppose that quality upgrading spillovers improve the product quality of non-exporters considerably. This may induce them to export their products. In this case, attracting MNEs is effective in increasing the number of exporters—specifically, the extensive margin of trade in host countries.

Another concern regarding export upgrading spillovers is that their distinction from productivity spillovers is not clear. In general, firms can change the quality of their products by adjusting their marginal and/or fixed costs (Shaked and Sutton, 1987). For instance, the intensive use of high-quality inputs and high-skill workers increases a firm's marginal costs (Baldwin and Harrigan, 2011; Fan et al., 2015; Hallak and Sivadasan, 2013; Kugler and Verhoogen, 2012). Fixed costs include expenses related to research and development investment, production management, and quality control (Antoniades, 2015; Picard, 2015). Because more productive firms can afford to pay higher marginal and/or fixed costs associated with quality upgrading, product quality increases with firm productivity. In other words, productivity spillovers should indirectly cause export upgrading[1].

This study addresses these two issues to characterize the role of quality upgrading spillovers in the context of international trade and economic development. Specifically, we examine whether and to what extent inward FDI affects the product quality of local firms,

[1] Saito and Matsuura (2016) examine this indirect channel in the context of agglomeration economies.

including both exporters and non-exporters. In doing so, we explicitly consider the indirect impact of productivity spillovers on product quality. To achieve this objective, we employ plant product-level data from Indonesian manufacturing. Indonesia provides an interesting case study on quality upgrading spillovers. Indonesia's economy was based predominantly on agriculture and mining, but a sharp decline in oil prices in the early 1980s drove the government to diversify its economic structure. The government adopted export-oriented industrialization policies and attracted a number of MNEs. Currently, Indonesia receives considerable research attention regarding the impact of globalization on local firms' performance (e.g., Blalock and Gertler, 2008; Lipsey and Sjöholm, 2004; Takii, 2005). The economic role of product quality has been addressed in these studies. For example, Amiti and Konings (2007) argued that access to high-quality imported inputs is the key to enhancing productivity. Blalock and Gertler (2008) explained that technology transfer from MNEs enables local suppliers to produce higher-quality inputs at lower costs. In addition, the recent surge in offshoring in East Asia has provided local firms producing products of international quality and price with opportunities for business with foreign firms. These instances suggest that local firms in Indonesia have an incentive to upgrade their product quality.

Our data are well suited to a study on product quality. Shipment and quantity shipped values are available for each product produced by manufacturing plants in Indonesia. The obtained unit value and quantity shipped of individual products are used to estimate the quality of each product in a theory-consistent manner. Product quality is related to variables that measure the intensity of MNE activity. The results indicate a positive and significant impact of backward FDI on the product quality of local firms, even after controlling for plant productivity. However, once we classify plants into exporters and non-exporters, the impact is statistically significant only for exporters, implying that quality upgrading spillovers work only for them. In contrast, plant productivity positively affects the product quality of any plant, suggesting that non-exporters can improve the quality of their products as long as they benefit from productivity spillovers from MNEs (Blalock and Gertler, 2008). These findings are robust to a variety of identification strategies, including instrumental variable (IV) estimation and the use of alternative measures of product quality.

The remainder of this paper is organized as follows. Section 2 discusses the conceptual and empirical methodology. Section 3 describes the data and variable construction. Section 4 presents the estimation results. Finally, Section 5 provides the conclusions with a summary of the results and some policy implications.

2. Conceptual and empirical framework

2.1 Conceptual framework

In economics, quality is regarded as a product characteristic that influences consumers' utility. Following Feenstra and Romalis (2014) and Fan et al. (2015), we consider the following aggregate utility function for product j in year t:

(1) $$U_{jt} = \left[\sum_i \left(\lambda_{ijrt} q_{ijrt}\right)^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}} \text{ with } \sigma > 1,$$

where $\lambda_{ijrt} (> 0)$ and q_{ijrt} respectively denote the quality and quantity of product produced by plant i located in region r. Suppose consumers spend E_{jt} on product j in year t. Maximizing Equation (1) subject to a budget constraint yields the following demand function:

(2) $$q_{ijrt} = p_{ijrt}^{-\sigma}\lambda_{ijrt}^{\sigma-1}P_{jt}^{\sigma-1}E_{jt},$$

where $P_{jt} \equiv (\sum_l p_l^{1-\sigma}\lambda_l^{\sigma-1})^{\frac{1}{1-\sigma}}$ represents the price index. Equation (2) demonstrates that the higher the quality of a product, the greater the demand for it.

Next, we consider the supply side of the economy. Firms produce their products under constant returns to scale technology using one unit of composite input. We further assume that product quality varies through adjustment of the fixed costs of quality investment. For instance, Picard (2015) argues that as firms spend more on quality investment, such as production management and employee training, product quality increases, but at a decreasing rate (see also Antoniades, 2015; Fan et al., 2015). Specifically, we consider the following total cost of production:

(3) $$TC_{ijrt} = \frac{w_{jrt}}{A_{ijrt}}q_{ijrt} + \exp(\gamma\lambda_{ijrt}),$$

where w_{jrt} and A_{ijrt} denote the price of a composite input and productivity of plant i, respectively. γ measures the cost of quality investment: the lower γ, the lower the cost of quality investment to achieve quality level λ_{ijrt}.

Given Equations (2) and (3), firms maximize their profits with respect to price and product quality[2]:

[2] We do not consider neither economies of scope nor multi-plant production. Thus, in the case of multi-product plants, they maximize the aggregate profits from individual products. Moreover, the number of multi-plant firms is very small in Indonesia (Blalock and Gertler 2008).

(4) $$\max_{p_{ijrt},\lambda_{ijrt}} p_{ijrt}q_{ijrt} - TC_{ijrt}.$$

First-order conditions for profit maximization are:

(5) $$w_{jrt}\sigma - p_{ijrt}A_{ijrt}(\sigma - 1) = 0, \text{ and}$$

(6) $$\gamma A_{ijrt}\exp(\gamma\lambda_{ijrt}) - p_{ijrt}^{-\sigma}\lambda_{ijrt}^{\sigma-2}P_{jt}^{\sigma-1}E_{jt}(A_{ijrt}p_{ijrt} - w_{jrt})(\sigma - 1) = 0.$$

Equation (5) shows that the price is determined by a constant markup over marginal cost:

(7) $$p_{ijrt} = \frac{\sigma}{(\sigma-1)}\frac{w_{jrt}}{A_{ijrt}}.$$

Note that Equation (7) does not depend on λ_{ijrt}, implying that the price of goods does not necessarily reflect their quality level.

By substituting p_{ijrt} in Equation (6) with Equation (7) and applying the implicit function theorem to it, we have

(8) $$\frac{\partial\lambda_{ijrt}}{\partial\gamma} = -\frac{(\gamma\lambda_{ijrt}+1)A_{ijrt}\exp(\gamma\lambda_{ijrt})}{B},$$

where $B \equiv \gamma^2 A_{ijrt}\exp(\gamma\lambda_{ijrt}) - p_{ijrt}^{-\sigma}\lambda_{ijrt}^{\sigma-3}P_{jt}^{\sigma-1}E_{jt}w_{jrt}(\sigma - 2)$ is assumed to be positive, such that the second-order condition for profit maximization is satisfied. Hence, the partial derivative in Equation (8) takes a negative sign, indicating that product quality improves as the cost of quality investment declines. Similarly, we can show that $\partial\lambda_{ijrt}/\partial A_{ijrt} > 0$ and $\partial\lambda_{ijrt}/\partial w_{jrt} < 0$. Note that the former inequality demonstrates that more productive firms can afford to pay higher fixed cost of quality investment. The results are summarized in the following proposition.

Proposition: *The quality of products improves if (i) the cost of quality investment declines, (ii) plant productivity increases, or (iii) the input prices decrease.*

The proposition shows that there are two channels through which inward FDI can affect product quality of local firms. First, suppose that learning technology and business practices from MNEs reduce the cost of quality investment. The reduced cost enables local firms to upgrade their products. We refer to this channel as quality upgrading spillovers. Second, productivity spillovers from inward FDI increase the productive efficiency of local firms, which indirectly improves the quality of their products. In summary, attracting MNEs is effective in improving the product quality of local firms directly through quality upgrading spillovers and indirectly through productivity spillovers. In other words, we need to control for the indirect channel to appropriately identify quality upgrading spillovers.

2.2 Empirical framework

The above discussion shows that the product price does not necessarily reflect its quality level. To estimate the product quality for each plant product in a theory-consistent manner, we take the log of both sides of Equation (2) and rearrange it:

(9) $$\ln q_{ijrt} + \sigma \ln p_{ijrt} = f_{jt} + \varepsilon_{ijrt},$$

where f_{jt} is the product-year fixed effects, capturing the price index P_{jt} and expenditure E_{jt}. Following Khandelwal et al. (2013), we obtain the elasticity of substitution σ from Broda et al. (2006). Given σ, we can estimate Equation (9) using ordinary least squares (OLS) and derive the quality estimates for each plant-product-year observation as follows:

(10) $$\ln \lambda_{ijrt} = \frac{\hat{\varepsilon}_{ijrt}}{\sigma - 1}.$$

The estimated product quality is related to variables measuring the intensity of MNE activity:

(11) $\ln \lambda_{ijrt} = \mathbf{MNE\beta} + \mathbf{X\beta} + \mathbf{F} + \xi_{ijrt}$,

where $\mathbf{MNE}$ is a vector of variables measuring the intensity of MNE activity in industry k to which product j belongs; $\mathbf{X}$ is a vector of control variables, including the average wage of plants in region r in industry k, and productivity of plant i to control for the input prices and productivity spillovers from MNEs, respectively; $\mathbf{F}$ is a vector of fixed effects to control for unobserved shocks on product quality; and ξ_{ijrt} represents disturbances. Following Javorcik (2004) and Blalock and Gertler (2008), we consider the following three types of $\mathbf{MNE}$ variables:

(12) $HZN_{krt} = \frac{\sum_{i \in krt} MNE\_L_i}{\sum_{i \in krt} L_i}$

(13) $FWD_{krt} = \sum_l \rho_{lk} HZN_{lrt}$

(14) $BWD_{krt} = \sum_l \theta_{kl} HZN_{lrt}$

where L_i is the total number of workers in plant i; MNE_L_i is the total number of workers in plant i if it is multinational, and zero otherwise; ρ_{lk} is the share of inputs purchased by industry k from industry l; and θ_{kl} is the proportion of industry k output supplied to industry l. Hence, Equation (12) measures the level of inward FDI into the same industry and region as the concerned product (i.e., horizontal FDI), while Equations (13) and (14) measure the level of inward FDI into upstream and downstream industries for the concerned product in the concerned region, respectively (i.e., forward and backward FDI, respectively).

Two comments are in order here. First, we suppose that technology is embodied in worker skills. Workers in local firms learn technology and business practices from MNEs and introduce them into their production systems. For example, Poole (2013) confirmed that the movement of workers trained in MNEs to local firms is the key to knowledge transfer between them (see also Haskel et al., 2007; Kosová, 2010). Second, as the subscript r in Equations (12) to (14) suggests, we assume that the benefits of spillovers decay with distance, and more specifically, only appear within a region. For workers in local firms, learning from distant MNEs is more difficult than learning from nearby MNEs. According to Rosenthal and Strange (2008), human capital spillovers mostly occur between individuals within a distance of 25 miles in the United States.

Equation (11) is estimated using OLS. However, Blalock and Gertler (2008) argued that the more competitive local firms are in terms of their productivity and product quality, the more attractive that place is for MNEs, especially for those doing business with them. Thus, reverse causality may matter when estimating Equation (11). The fixed effects in Equation (11) can alleviate it to the extent that they control for the unobserved attractiveness of the region for MNEs. To address endogeneity further, we estimate Equation (11) by IV. To construct instruments, the number of workers in MNEs in region r is estimated based on the corresponding number of workers in the initial year and the growth rate of MNEs workers in regions other than r:

(15) $$MNE\_L_{krt} = \left(1 + \frac{MNE\_L_{k-Rt} - MNE\_L_{k-R0}}{MNE\_L_{k-R0}}\right) MNE\_L_{kr0}.$$

A comment is in order. Indonesia is geographically divided into provinces, which are further divided into regencies. We use each regency as a geographical unit representing r. The subscripts $-R$ and 0 in MNE_L_{k-R0} denote all provinces other than province R to which the regency r belongs and the initial year of the observation period, respectively. Therefore, the second term in parentheses measures the growth rate of MNE workers in industry k from the initial year to year t in all provinces other than R. The estimated number of workers in MNEs from Equation (15) is substituted into Equations (12) to (14) to derive the corresponding instruments.

Our IV strategy works properly if MNEs in regions other than r behave in a similar manner in terms of employment as those in region r, and their employment is not affected by the product-quality shocks specific to region r. Note that employment growth in other regencies in province R is excluded in Equation (15) to address the threat that the product-quality shocks occurring in region r may spill over to the neighboring regions. Furthermore, because the shocks are aggregated over all provinces other than R, they are less likely to be correlated with the shocks specific to region r after controlling for the shocks common to all regions by product-year fixed effects.

3. Data and variable construction

The primary data source is the *Annual Survey of Medium and Large Manufacturing Establishment* published by Statistics Indonesia (Badan Pusat Statistik, BPS). The estimation period is from 2002 to 2012, but we use observations from 2002 only to construct instruments in Equation (15) to reduce the endogeneity risk in the initial year. Microdata are only available for plants with 20 or more employees. This dataset reports the plant's location, industry classification for its main product, product classification for each product, and share of foreign capital. Regarding the definition of the region, we use each regency as a geographical unit. The industry is defined based on the three-digit International Standard Industrial Classification (ISIC) Revision 3. Product classification is available at the seven-digit level. The first four digits of the product codes correspond to four-digit ISIC codes. Lastly, following Blalock and Gertler (2009), we define MNEs as firms whose foreign capital share is greater than 20%[3]. Local firms are defined as those without any foreign ownership throughout the estimation period.

The dataset contains production and cost information at the plant level, including the total value of production, number of production and non-production workers, book value of fixed capital assets, material, electricity, energy inputs, and labor costs for each type of worker. In addition, shipment and quantity shipped values are available at the product level. The survey also asks whether they import material at the plant level and whether they export products at the product level. Value-added is obtained by subtracting intermediate consumption (material, electricity, and energy inputs) from the revenue. The obtained value is deflated by the wholesale price index. The initial capital stock is proxied by fixed tangible assets deflated by the price index for gross fixed capital formation in Indonesia's System of National Accounts. Capital stock in the following periods is constructed by the perpetual inventory method, assuming a depreciation rate of 9% (Brandt et al. 2012).

Using these variables, productivity at the plant level is obtained as residuals from the

[3] According to Blalock and Gertler (2009), the samples of foreign affiliated firms obtained under this definition are mostly equivalent to those doing business under the foreign capital investment licenses in Indonesia.

following Cobb–Douglas value-added production function estimates for each two-digit ISIC industry[4]:

(16) $\ln VA_{ikrt} = \beta_N \ln L^N_{ikrt} + \beta_P \ln L^P_{ikrt} + \beta_K \ln K_{ikrt} + \ln A_{ikrt}.$

where VA_{ikrt}, L^N_{ikrt}, L^P_{ikrt}, and K_{ikrt} denote the value-added, the number of nonproduction and production workers, and capital stock of plant i in year t, respectively. We estimate the production function (16) using the methodology proposed by Ackerberg et al. (2015) with material as a proxy for unobserved productivity. They extended the work of Olley and Pakes (1996) and Levinsohn and Petrin (2003) to address the simultaneity bias between unobserved A_{ikrt} and inputs, and the potential collinearity in the first stage of the Levinsohn and Petrin estimator[5]. As the obtained productivity is not comparable across industries in the estimation, we take the deviation from the industry average.

With regard to plant product-level variables, the unit value is obtained for each product by dividing the value of shipment by quantity shipped. Then, the quality of products is estimated based on Equations (9) and (10). When computing the quality, we exclude as outliers plant-product observations whose price lies in the top or bottom 10% of each product category. Finally, for regional-level variables, the number of workers is used to construct variables measuring the intensity of MNE activity along with data from the 2000 input–output (IO) table published by BPS[6]. Plant-level wages are estimated by dividing labor costs,

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[4] Productivity at plant product-level cannot be obtained because cost information is not available at that level.

[5] We use the Stata code used in De Loecker and Warzynski (2012) for the production function estimation.

[6] We use the concordance table to link the industry codes used in the IO table to the three-digit ISIC codes.

adjusted by the consumer price index, by the number of workers. The estimated wages, averaged at the industry-region-year level, are used as a proxy for the price of a composite input. Summary statistics are presented in Table 1.

4. Estimation Results

Before examining the quality upgrading effect of FDI spillovers, we demonstrate the behavior of our product quality variable. In Panel A of Table 2, we regress product quality λ_{ijrt} on export or import dummies, regional wage, or lagged plant productivity. Consistent with Hummels and Skiba (2004) and Verhoogen (2008), exported products tend to have higher quality than non-exported products. Plants importing inputs can produce higher-quality products than plants that do not import material (Amiti and Konings, 2007). However, regional wages unexpectedly have a positive impact on product quality. Dingel (2017) found that firms in high-income areas tend to produce high-quality goods because of the large demand for them and the abundant endowment of high-skill workers needed to produce them in those regions. Hence, regional wages may reflect the purchasing power and skill composition of workers in the respective regions. Finally, we confirm the proposition that more productive plants produce higher-quality products.

In Panel B of Table 2, we replace product quality with product price, a measure frequently used in the literature as a proxy for product quality (Hallak, 2006; Schott, 2004). The results are the same, except for the insignificant impact of material imports. Because the price of a product reflects the marginal cost of production, the price declines if plants can replace domestically produced inputs with imported ones of the same quality but sold at lower prices. In sum, our measure of product quality conforms to the theoretical expectations. Below, we first present the results based on our product quality measure and confirm the robustness of the results by comparing the results with those obtained using product prices.

Table 3 shows the baseline results. Column (1) shows the OLS estimates with province-product, province-year, and product-year fixed effects. Province-product fixed effects capture unobserved time-invariant regional effects on the quality of the concerned product. The other two types of fixed effects absorb any region- or product-specific time-varying shocks on product quality. We find that inward FDI in both upstream and downstream industries positively contributes to quality upgrading in local firms. In Column (2), we replace province-product fixed effects with plant-product fixed effects. The latter are more comprehensive than the former, capturing not only any time-invariant regional effects on the quality of the concerned product, but also the unobserved ability of plants to produce high-quality products. In this specification, identification comes from changes over time within a plant product, in addition to cross-sectional changes across regions or products for each year. The results show that backward FDI still has a positive and significant impact on the product quality of local firms, but forward FDI no longer has any significant impact. These results differ from those of Bajgar and Javorcik (2020) but seem reasonable because MNEs in Indonesia are export-oriented and generally do not supply to Indonesian customers (Blalock and Gertler, 2008). Furthermore, horizontal FDI has a negative and significant impact on its quality, presumably due to intensified competition with MNEs (Ciani and

Imbruno, 2017). The impact of material imports weakens because a plant's import status generally has limited time-series variation. In Columns (3) and (4), we introduce lagged plant productivity to control for its ability to produce a high-quality product (Proposition 1). Moreover, it is supposed to reflect past productivity spillovers from MNEs[7]. After controlling for the indirect channel on quality upgrading from productivity spillovers, a positive coefficient on $\mathbf{MNE}$ can be interpreted as quality upgrading spillovers from inward FDI. Columns (3) and (4) confirm that MNEs in downstream industries contribute to the quality upgrading of local firms.

The estimation results by IV are listed in Table 4. The first-stage F-statistic is sufficiently high, suggesting that our instrument is strong enough to provide unbiased results. The results in Column (1) are almost the same as those of the OLS results. However, once we control for plant productivity in Column (2), backward FDI no longer has a significant impact. This may suggest reverse causality that MNEs increase their employment in regions with positive shocks to product quality. Another explanation is that not all products benefit from quality upgrading spillovers. Fan et al. (2015) concluded that the scope of quality differentiation determines the level of quality improvement from input tariff reductions. Khandelwal (2010) also argued that the homogeneous goods defined by Rauch (1999) exhibited no quality differentiation. To be consistent with the model assumptions laid out in the previous section, we follow Khandelwal (2010) and restrict the sample to differentiated

[7] We avoid using productivity in the current period to reduce the endogeneity bias. However, we confirmed that employing it did not alter our conclusions.

products on the basis of Rauch's (1999) conservative product classifications. Columns (3) and (4) indicate that backward FDI significantly improves the quality of the differentiated products[8].

Indonesia was categorized as a lower-middle-income country during the estimation period. Its gross domestic product per capita was 1,860 U.S. dollars in 2007, and the purchasing power of its residents was not high. As Verhoogen (2008) demonstrated, it is very likely that exported goods are different from domestically consumed goods in terms of product quality. Stated differently, not all local plants are necessarily concerned with quality improvement. Local firms involved in global markets, that is, those exporting their products or supplying inputs for MNEs, should have a stronger incentive to upgrade their products[9]. Thus, we classify plants into exporters and non-exporters. Non-exporters are plants that never exported their products throughout the estimation period. Table 5 presents the results for non-exporters (Columns (1) and (2)) and exporters (Columns (3) and (4))[10]. We observed a clear distinction between them. Non-exporters do not benefit from any type of inward FDI, but exporters derive strong benefit from backward FDI. Moreover, horizontal FDI negatively affects the product quality of exporters alone, suggesting that the quality of their products is high enough to compete with MNEs. In contrast, plant productivity has a positive impact on product quality, regardless of the type of plant, suggesting that non-exporters can improve the

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[8] We estimated the same model for the homogeneous goods but found insignificant impact of inward FDI on product quality.
[9] To become suppliers to MNEs, local firms must satisfy strict requirements about product quality and technological sophistication (Javorcik and Spatareanu, 2009).
[10] The sample is restricted to differentiated products.

quality of their products as long as they benefit from productivity spillovers from multinational enterprises. Lastly, the absorptive-capacity hypothesis argues that high-productivity plants are more likely to be able to absorb new knowledge from MNEs (Cohen and Levinthal, 1989). Since exporters tend to have higher productivity than non-exporters, the distinction between them in Columns (1) to (4) may just reflect the difference in the absorptive capacity between plants. To consider this case, we add the interaction terms between $\mathbf{MNE}$ variables and plant productivity in Columns (5) and (6), but we do not find significant evidence that the absorptive capacity enhances knowledge transfer from MNEs. Stated differently, our results indicate that exporters have a stronger incentive to upgrade their products.

Thus far, we have examined quality upgrading spillovers using a theory-consistent measure of product quality. Table 6 repeats the estimation using product prices. We confirmed the robustness of our results using another measure. Namely, plants producing differentiated products benefit from spillovers from MNEs in improving the quality of their products. However, a closer look reveals that only exporters can receive quality upgrading spillovers. This contrasts with the impact of plant productivity, which improves the product quality of non-exporters.

Finally, we evaluate the quantitative impact of quality upgrading spillovers. A 10% increase in the employment share of MNEs in downstream industries increases the quality of differentiated products by 9.0% (Column (4) of Table 4). Therefore, the average impact of inward FDI on product quality is almost of the same magnitude as its impact on productivity

(Havranek and Irsova, 2011). However, if we restrict the sample to exporters, the impact increases to 24.6% (Column (4) of Table 5). In terms of product prices, the price of differentiated goods increases by 6.8% (Column (4) of Table 6). Exporters can increase the price of their products by 18.1% (Column (8) of Table 6). Overall, quality upgrading spillovers have an economically significant impact on product quality.

5. Summary and Conclusions

Recent studies in international trade literature have emphasized the role of product quality: the higher the quality of a product, the greater its export sales. Thus, identifying the determinants of product quality has important implications for the export success of firms in developing countries. This study focuses on the role of inward FDI in the quality upgrading of local firms. If interactions with MNEs reduce the marginal or fixed costs associated with quality upgrading or if local firms can purchase high-quality inputs from MNEs, attracting inward FDI is an effective policy instrument for that purpose.

The objective of this study was to examine whether and to what extent inward FDI affects the product quality of local firms in developing countries. This study extends previous studies on export upgrading by including both exporters and non-exporters to determine whether every local firm can benefit from quality upgrading spillovers. In doing so, we explicitly consider the impact of plant productivity on product quality to distinguish between quality upgrading spillovers and productivity spillovers. For this purpose, we employ plant product-level data from Indonesian manufacturing. Our data allow us to estimate the quality of each product produced by local firms in a theory-consistent manner.

The estimation results confirm quality upgrading spillovers. We observe a positive and significant impact of backward FDI on the product quality of local firms, even after controlling for plant productivity. However, once we classify samples into exporters and non-exporters, quality upgrading spillovers are confirmed for exporters alone. In contrast, the positive and significant impact of plant productivity on product quality implies that productivity spillovers can indirectly contribute to the quality upgrading of local firms, including both exporters and non-exporters.

Our study sheds new light on the role of inward FDI. Quality upgrading spillovers can enhance the competitiveness of incumbent exporters. However, we do not find any evidence that they encourage non-exporters to export their products, for which productivity spillovers would be effective instead. Finally, although our focus is on the identification of quality upgrading spillovers in developing countries, it is important to examine the extent to which our results hold among plants in developed countries. In Indonesia, not all local plants are concerned with quality improvement. In contrast, non-exporters in developed countries should have an incentive to do so to meet the large demand for high-quality products. Whether quality upgrading spillovers work for non-exporters in developed countries remains an important topic for further investigation.

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Table 1. Summary Statistics

Variable	Mean	Std. dev.
Plant-product level variable		
Log of product quality	-0.045	1.240
Export dummy	0.118	0.323
Plant-level variable		
Log of lagged productivity	-0.085	1.053
Material import dummy	0.145	0.352
Region-level variable		
Horizontal FDI	0.084	0.209
Forward FDI	0.031	0.069
Backward FDI	0.042	0.099
Log of regional wages in 1,000 Rp (2000=100)	8.570	0.812

Source: BPS, Annual Survey of Medium and Large Manufacturing Establishments, various years.

Table 2: Correlation between Product Quality or Price and Characteristics

Variable	(1)	(2)	(3)	(4)
A. Dependent variable: $\ln \lambda_{ijrt}$				
Export dummy	0.395***			
	(0.0109)			
Material import dummy		0.436***		
		(0.0117)		
Log of regional wages			0.499***	
			(0.00847)	
Log of lagged productivity				0.214***
				(0.00483)
R-squared	0.035	0.038	0.055	0.082
Observations	184,254	184,254	184,254	113,743
B. Dependent variable: $\ln p_{ijrt}$				
Export dummy	0.0662***			
	(0.0123)			
Material import dummy		0.0175		
		(0.0126)		
Log of regional wages			0.158***	
			(0.00800)	
Log of lagged productivity				0.0675***
				(0.00494)
R-squared	0.741	0.741	0.741	0.769
Observations	226,522	226,522	226,522	138,230

Note: Heteroscedasticity-robust standard errors are in parentheses. Product-year fixed effects are included in every specification. ***, ** and * represent statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 3: Determinants of Product Quality: Ordinary Least Squares Estimates

Variable	(1)	(2)	(3)	(4)
Horizontal FDI	-0.0112	-0.212***	-0.0217	-0.193**
	(0.0364)	(0.0588)	(0.0487)	(0.0786)
Forward FDI	0.289***	-0.0736	0.276***	-0.158
	(0.0750)	(0.128)	(0.0951)	(0.169)
Backward FDI	0.485***	0.404***	0.622***	0.529**
	(0.0847)	(0.149)	(0.115)	(0.208)
Material import dummy	0.352***	0.0406*	0.353***	0.0472
	(0.0132)	(0.0241)	(0.0175)	(0.0309)
Log of regional wages	0.398***	0.127***	0.362***	0.148***
	(0.0143)	(0.0129)	(0.0171)	(0.0169)
Log of lagged productivity			0.156***	0.0577***
			(0.00547)	(0.00600)
Province-product fixed effects	Yes	No	Yes	No
Plant-product fixed effects	No	Yes	No	Yes
R-squared	0.243	0.774	0.289	0.787
Observations	184,254	184,254	113,743	113,743

Note: The dependent variable is the log of product quality. Standard errors clustered at the regency-product-year level are shown in parentheses. Province-year and product-year fixed effects are included in every specification. ***, ** and * represent statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 4: Determinants of Product Quality: Instrumental Variable Estimates

	(1)	(2)	(3)	(4)
Variable	All products		Differentiated products	
Horizontal FDI	-0.420^{***}	-0.547^{***}	-0.432^{***}	-0.503^{**}
	(0.144)	(0.190)	(0.159)	(0.208)
Forward FDI	-0.579	-0.582	-0.671	-0.500
	(0.435)	(0.608)	(0.505)	(0.700)
Backward FDI	0.574^{*}	0.673	0.930^{**}	0.897^{*}
	(0.325)	(0.427)	(0.387)	(0.503)
Material import dummy	0.0409^{*}	0.0468	0.0218	0.00908
	(0.0241)	(0.0309)	(0.0316)	(0.0405)
Log of regional wages	0.128^{***}	0.150^{***}	0.136^{***}	0.184^{***}
	(0.0129)	(0.0169)	(0.0155)	(0.0212)
Log of lagged productivity		0.0575^{***}		0.0539^{***}
		(0.00599)		(0.00863)
Kleibergen-Paap F statistic	223.2	149.3	146.1	108.5
Observations	184,254	113,743	117,619	72,446

Note: The dependent variable is the log of product quality. Standard errors clustered at the regency-product-year level are shown in parentheses. Plant-product, province-year, and product-year fixed effects are included in every specification. ***, ** and * represent statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 5: Determinants of Product Quality: Exporters vs. Non-exporters

Variable	(1)	(2)	(3)	(4)	(5)	(6)
	Non-exporters		Exporters		All plants	
Horizontal FDI	-0.324	-0.265	-1.019***	-1.077***	-0.507**	-0.502**
	(0.201)	(0.281)	(0.295)	(0.360)	(0.209)	(0.208)
Forward FDI	0.0888	-0.133	-3.805**	-2.199	-0.513	-0.498
	(0.569)	(0.793)	(1.543)	(1.994)	(0.699)	(0.699)
Backward FDI	-0.341	-0.932	2.430***	2.455***	0.919*	0.878*
	(0.572)	(0.842)	(0.560)	(0.632)	(0.503)	(0.502)
Horizontal FDI × Log of lagged productivity					0.0503	-0.00660
					(0.0698)	(0.0705)
Forward FDI × Log of lagged productivity					0.203	-0.0160
					(0.146)	(0.152)
Backward FDI × Log of lagged productivity					0.0202	-0.0783
					(0.150)	(0.151)
Material import dummy	0.0251	0.0419	-0.00155	-0.0820	0.00892	0.00909
	(0.0419)	(0.0564)	(0.0527)	(0.0636)	(0.0405)	(0.0405)
Log of regional wages	0.132***	0.190***	0.116***	0.155***	0.186***	0.183***
	(0.0166)	(0.0242)	(0.0402)	(0.0541)	(0.0212)	(0.0212)
Log of lagged productivity		0.0573***		0.0314**		0.0584***
		(0.0108)		(0.0151)		(0.0110)
Kleibergen-Paap F statistic	217.1	168	19.41	16.06	54.60	54.62
Observations	89,544	53,139	28,075	19,307	72,446	72,446

Note: The dependent variable is the log of product quality. The sample is restricted to differentiated products. Standard errors clustered at the regency-product-year level are shown in parentheses. Plant-product, province-year, and product-year fixed effects are included in every specification. ***, ** and * represent statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 6: Determinants of Product Price

	(1)	(2)	(3)	(4)	(5)	(5)	(7)	(8)
			Differentiated products					
Variable	All products		All plants		Non-exporters		Exporters	
Horizontal FDI	-0.185*	-0.217	-0.259**	-0.248	-0.170	0.0249	-0.657***	-0.740***
	(0.104)	(0.141)	(0.119)	(0.162)	(0.149)	(0.220)	(0.225)	(0.282)
Forward FDI	-0.506*	-0.355	-0.484	-0.196	-0.116	-0.0597	-1.203	0.0608
	(0.260)	(0.340)	(0.298)	(0.390)	(0.324)	(0.422)	(1.037)	(1.352)
Backward FDI	0.483**	0.459	0.849***	0.677*	0.0325	-0.675	1.741***	1.805***
	(0.235)	(0.317)	(0.284)	(0.384)	(0.419)	(0.635)	(0.409)	(0.481)
Material import dummy	-0.0183	-0.0205	-0.0228	-0.0506*	-0.0189	-0.0303	-0.0374	-0.100*
	(0.0170)	(0.0218)	(0.0227)	(0.0298)	(0.0286)	(0.0393)	(0.0439)	(0.0558)
Log of regional wages	0.0542***	0.0744***	0.0598***	0.0949***	0.0539***	0.0859***	0.0563**	0.107***
	(0.00710)	(0.00960)	(0.00942)	(0.0130)	(0.00992)	(0.0140)	(0.0267)	(0.0360)
Log of lagged productivity		0.0134***		0.0169***		0.0163***		0.00638
		(0.00349)		(0.00531)		(0.00624)		(0.0113)
Kleibergen-Paap F statistic	223.2	149.3	146.1	108.5	217.1	168	19.41	16.06
Observations	184,254	113,743	117,619	72,446	89,544	53,139	28,075	19,307

Note: The dependent variable is the log of the product price. Standard errors clustered at the regency-product-year level are shown in parentheses. Plant-product, province-year, and product-year fixed effects are included in every specification. ***, ** and * represent statistical significance at the 1%, 5%, and 10% levels, respectively.