Foreign Direct Investment and Quality-Upgrading Spillovers in Indonesia

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Abstract: This study examines whether and to what extent inward foreign direct investment (FDI) contributes to quality upgrades for local firms in developing countries. Product quality is the key to firms' export performance. Recent studies have stressed that non-exporters producing intermediates are also required to satisfy quality standards to transact with multinational enterprises in downstream industries in the host country. Employing firm-product level data on Indonesian manufacturing, we find that backward FDI improves the product quality of local exporters and intermediate suppliers. Our results suggest that attracting backward FDI effectively enhances the competitiveness of local firms involved in global competition.

Keywords: Foreign direct investment, product quality, spillovers
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1. Introduction

Product quality is key to the performance of exporting firms in global markets. Generally, high-quality products are more likely to be exported to distant countries with highly competitive markets than their low-quality counterparts (Harrigan et al., 2015; Hummels and Skiba, 2004). The demand for quality increases with the per capita income of the destination countries (Bastos and Silva, 2010; Hallak, 2006; Manova and Zhang, 2012). Baldwin and Harrigan (2011) theoretically demonstrate that only firms that produce sufficiently high-quality products can successfully engage in international trade (see also Kugler and Verhoogen, 2012).

Recent studies have stressed that non-exporting firms are involved in global competition through domestic production networks. Dhyne et al. (2021) find that most non-exporting firms in Belgium engage in indirect exports by selling their products to firms that subsequently trade internationally. The role of domestic production networks is not negligible in developing countries, particularly in those participating in global value chains (GVCs) such as China and Mexico (Chen et al., 2022; De la Cruz et al., 2013). GVC participation requires firms to meet certain quality standards (Gereffi, 2018; Nadvi, 2008; Rodrik, 2018). For instance, multinational enterprises (MNEs) attracted to developing countries source their inputs from local firms that meet strict requirements for product quality (Blalock and Gertler, 2008; Javorcik and Spatareanu, 2009). To summarize, quality matters not only for local exporters, but also for local intermediate suppliers in developing countries. Consequently, identifying determinants of product quality has received considerable attention in academic and policy circles.

Quality-upgrading is accompanied by quality investments (Grossman and Helpman, 1991). Hence, the existing literature focuses on the role of knowledge transfer from developed to developing countries. For example, Stiebale and Vencappa (2018) show that foreign acquisitions improve the quality of goods produced by Indian firms. Spillovers from MNEs are also considered important channels for technology diffusion (Blalock and Gertler, 2008; Javorcik, 2004). While many studies have identified their impact on the productivity, wages, or employment of local firms (e.g., Crespo and Fontoura, 2007; Görg and Greenaway, 2004; Smeets, 2008), only a few have examined their impact on product quality.

Based on cross-country trade data, Amighini and Sanfilippo (2014) and Harding and Javorcik (2012) demonstrate that attracting inward foreign direct investment (FDI) is effective at raising export prices from developing countries. At the firm level, Bajgar and Javorcik (2020) confirmed export-upgrading spillovers in Romanian manufacturing. They found that FDI in upstream industries (forward FDI) has a positive impact on the quality of products exported by local firms (see also Ciani and Imbruno, 2017). These findings suggest that attracting inward FDI can improve the quality of local exporters in developing countries.

However, quality measurements require detailed data on sales and the quantity of individual products sold. These studies rely on trade or customs data, inevitably limiting their focus to export firms and/or export products. Hence, whether quality-upgrading spillovers from MNEs benefit local intermediate suppliers not engaging in export activities remains an empirical issue. Enhanced opportunities to transact with MNEs are likely to increase local firms' incentives to upgrade product quality. If local firms learn about MNEs' advanced technology and business practices, attracting inward FDI contributes to the host economy by strengthening the competitiveness of local intermediate suppliers. Therefore, this study analyzes whether and to what extent inward FDI affects the product quality of local firms in developing countries by classifying goods between exported and domestically traded goods and between intermediate and consumption goods.

For this purpose, we used the Indonesian Manufacturing Census. Indonesia provides an interesting case study of quality-upgrading spillovers. Indonesia's economy was predominantly based on agriculture and mining; however, 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. Indonesia is currently an important part of international production networks.

These data are suitable for our purposes. They are collected at the firm-product level, and the shipment values and quantity shipped are available for every product produced by all medium and large manufacturing firms. More importantly, because the data indicate whether each product is exported, we can track changes in the export status of individual goods. Using the unit price and quantity of individual products shipped, we first estimated the quality of each product in a theory-consistent manner. Then, by employing an instrumental variable (IV) estimator, we relate the product quality estimates to the variables that measure the intensity of MNE activity.

Our results can be summarized as follows. While previous studies confirm quality-upgrading spillovers from inward FDI in upstream industries, this study shows that inward FDI into downstream industries (backward FDI) is the key to product quality improvement. We then classify the exported and domestically traded products to identify the beneficiaries of quality-upgrading spillover. The results indicate that, regardless of their export status, any local firm can benefit from backward FDI. Furthermore, by classifying goods as either intermediate or consumption, we find that only local firms that produce the former can receive spillover benefits. These findings suggest that MNEs in downstream industries encourage local exporters and intermediate suppliers to improve their product quality. In other words, attracting backward FDI effectively enhances local firms' competitiveness, particularly those competing in global markets.

The remainder of this paper is organized as follows: Section 2 reviews the literature. Section 3 discusses the empirical methodology used in this study. Section 4 describes the data and variable construction. Section 5 presents our estimation results. Section 6 concludes with a summary of the results and policy implications.

2. Related literature

This study is primarily related to two strands of literature. First, it relates to studies that investigate the impact of FDI spillovers on firm productivity. Numerous studies have identified FDI spillovers in the productivity of local firms in the host economy (Crespo and

Fontoura, 2007; Görg and Greenaway, 2004; Smeets, 2008). A meta-analysis by Havranek and Irsova (2011) indicated that backward FDI has an economically significant impact on productivity. Most studies employ revenue-based total factor productivity (TFP) as a measure of firm productivity. Revenue is deflated by industry-level price indices, implying that the observed change in productivity reflects a change in product prices that is not explained by industry trends or a change in production technology (Katayama et al., 2009). Since product prices partly reflect product quality, the results of previous studies may reflect both productivity and quality-upgrading spillovers from MNEs.

However, even if previous studies identify the existence of quality-upgrading spillovers, the estimated impacts on product quality are likely to be underestimated. 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 skilled workers increases marginal costs (Baldwin and Harrigan, 2011; Fan et al., 2015; Hallak and Sivadasan, 2013; Kugler and Verhoogen, 2012). Thus, firms that upgrade product quality must reduce their revenue-based TFP to the extent that they increase their marginal costs. In summary, previous studies may indicate the existence of quality-upgrading spillovers but have not formally examined them. This study complements this research by rigorously quantifying the impact of inward FDI on product quality using a theory-consistent quality estimate.

This study also identified factors affecting product quality. Previous studies linked quality upgrades to the use of high-quality inputs. For instance, several studies have concluded that input tariff reductions increase high-quality intermediate imports into developing nations, thereby accelerating the quality-upgrading of local firms (Amiti and Konings, 2007; Bas and Paunov, 2021; Fan et al., 2015). Inward FDI in upstream industries should have a similar impact by enabling local firms to purchase high-quality inputs (Bajgar and Javorcik, 2020; Ciani and Imbruno, 2017).

In contrast, this study demonstrates that backward FDI can enhance the quality of goods produced by local firms, especially intermediate inputs. Blalock and Gertler (2008) argued that MNEs in downstream industries in Indonesia source intermediate inputs from local firms. GVC firms must comply with international quality standards (Nadvi, 2008). Thus, MNEs in the host country impose strict requirements regarding technological sophistication and product quality on local suppliers (Javorcik and Spatareanu, 2009). We examine whether enhanced opportunities to transact with foreign firms in downstream industries increase local intermediate suppliers' incentives to learn about MNEs' advanced technology and business practices to upgrade the quality of their products.

This study makes an additional contribution to the literature. The literature on firm heterogeneity states that highly productive firms self-select export markets (Melitz, 2003). Regarding the source of their productivity advantages, Alvarez and López (2005) explain that Chilean firms consciously increase their productivity prior to export with the explicit purpose of becoming exporters (see also Eliasson et al., 2012). Iacovone and Javorcik (2012) conclude that Mexican firms improve the quality of their products before they begin exporting them. Our results suggest that FDI spillovers can be a source of quality upgrades prior to exports for local non-exporters.

3. Empirical framework

Quality is a product characteristic that influences consumer utility. We consider the following utility function for the differentiated product j in year t (Fan et al., 2015; Feenstra and Romalis, 2014):

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

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

$$(2) \qquad q_{ijt} = p_{ijt}^{-\sigma_j} \lambda_{ijt}^{\sigma_j - 1} P_{jt}^{\sigma_j - 1} E_{jt},$$

where p_{ijt} is the price of firm product ij and $P_{jt} \equiv \left(\sum_l p_{ljt}^{1-\sigma_j} \lambda_{ljt}^{\sigma_j - 1} \right)^{\frac{1}{1-\sigma_j}}$ represents the price index. Equation (2) demonstrates that the higher the quality of a firm's product, the greater its demand.

To estimate the quality of firm product ij, we take the log of both sides of Equation (2) and rearrange it as follows:

$$(3) \qquad \ln q_{ijt} + \sigma_j \ln p_{ijt} = f_{jt} + \varepsilon_{ijt},$$

where $f_{jt} \equiv (\sigma_j - 1) \ln P_{jt} + \ln E_{jt}$ is the product-year fixed effects, capturing the price index and the expenditure, and $\varepsilon_{ijt} \equiv (\sigma_j - 1) \ln \lambda_{ijt}$ denotes residuals, capturing product quality. Given σ_j, we can estimate Equation (3) using ordinary least squares (OLS) and derive the quality estimates for each firm-product-year observation as follows:

(4) $\ln \lambda_{ijt} = \frac{\hat{\varepsilon}_{ijt}}{\sigma_j - 1}$.

Using the estimated product quality, we estimate the following equation to examine the impact of MNE activity intensity on product quality:

(5) $\ln \lambda_{ijt} = \beta_1 HZN_{krt} + \beta_2 FWD_{krt} + \beta_3 BWD_{krt} + \mathbf{X_{ijt}}\boldsymbol{\beta} + f_{ij} + f_{Rt} + f_{jt} + \xi_{ijt}$,

where HZN_{krt}, FWD_{krt}, and BWD_{krt} measure the intensity of MNE activity in industry k to which product j belongs and district r to which firm i is located[1]. Specifically, HZN_{krt} measures the level of inward FDI in the same industry as firm product ij (horizontal FDI), and FWD_{krt} and BWD_{krt} measure the investment levels of foreign firms in the upstream and downstream industries for the concerned firm product, respectively. $\mathbf{X_{ijt}}$ is a vector of control variables; f_{ij}, f_{Rt}, and f_{jt} are the firm-product, province-year, and product-year fixed effects, respectively[2]; and ξ_{ijrt} represents disturbances.

Following Javorcik (2004) and Blalock and Gertler (2008), we construct HZN_{krt}, FWD_{krt}, and BWD_{krt} as follows:

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

(7) $FWD_{krt} = \sum_l \nu_{lk} HZN_{lrt}$, and

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

where $i \in krt$ refers to a firm in a given industry, district, and year; L_i is the total number of workers in firm i; MNE_L_i is the total number of workers in firm i if it is multinational,

[1] Indonesia is geographically divided into provinces, which are further divided into districts. We use each district (*kabupaten* or *kota*) as a geographical unit representing r.

[2] R refers to a province to which the district r belongs. Due to the product-year fixed effects f_{jt} in Equation (3), our quality estimates are normalized to zero mean within the same product-year group. In other words, the quality level of firm-products is not comparable across different products nor years.

and zero otherwise; v_{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.

As the subscript r in Equations (6) to (8) suggests, we assume that the benefits of spillovers decay with distance and appear only within a district. The underlying assumption is that technology is embodied in workers' skills. Workers in local firms can learn about technology and business practices from MNEs and introduce them into their production systems[3]. However, learning from MNEs becomes difficult if they are located far away from their firms. For instance, in the United States, human capital spillovers mostly occur between individuals within a distance of 25 miles (Rosenthal and Strange, 2008).

A comment is in order here. Endogeneity may matter when estimating Equation (5). 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. On the other hand, since MNEs are generally larger and more productive than local firms, their entry intensifies competition in local product and labor markets (Javorcik and Spatareanu 2005). Hence, local firms that compete with them do not necessarily find it beneficial to locate close to them. The control variables and fixed effects in Equation (5) alleviate the endogeneity problem to the extent that they control for unobserved shocks to product quality.

To address the endogeneity issue further, we estimate Equation (5) by IV using instruments obtained from the predicted number of workers in MNEs in district r. This

[3] Poole (2013) concludes 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).

prediction is based on the corresponding number of workers in the initial year, and the growth rate of MNEs workers in districts other than r (Diamond 2016; Glaeser et al. 2006; Saiz 2010):

$$(9) \qquad \widehat{MNE\_L}_{krt} = \left(1 + \frac{MNE\_L_{k-Rt} - MNE\_L_{k-R0}}{MNE\_L_{k-R0}}\right) MNE\_L_{kr0},$$

where subscripts $-R$ and 0 denote all provinces other than province R and the initial year of the observation period, respectively. 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 except R. The predicted number of workers in MNEs from Equation (9) is substituted into Equations (6)–(8) to derive the corresponding instruments (i.e., HZN_{krt}^{IV}, FWD_{krt}^{IV}, BWD_{krt}^{IV}).

The validity of our instruments depends on the following assumptions. The first assumption is that employment in MNEs in districts other than r should not be affected by unobserved contemporaneous shocks to product quality specific to district r. This assumption is violated if the shocks occurring in district r spill over to neighboring districts. To alleviate this concern, employment growth in other districts in province R is excluded from Equation (9) (Baum-Snow and Ferreira, 2015). In addition, the shocks are aggregated over all provinces other than R. Thus, they are less likely to be correlated with the shocks specific to district r after controlling for the shocks common to product j at year t, but common to all regions by the product-year fixed effects.

The second assumption is that the number of workers in MNEs in district r in the initial year should not correlate with the location product-specific fundamentals. The risk of violating this assumption is reduced as long as the fixed effects in Equation (5) control for the fundamentals. Firm-product fixed effects should capture the time-invariant shocks specific to firms in district r producing product j while province-year and product-year fixed effects should absorb the corresponding time-varying shocks.

4. Data and variable construction

The primary data source was 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 the instruments in Equation (9) to reduce the endogeneity risk in the initial year[4]. Microdata are available only for firms with 20 or more employees, covering 60% of the total value added in Indonesian manufacturing (Ramstetter, 2009)[5]. This dataset reports a firm's location and share of foreign capital. We define MNEs as firms with foreign capital share greater than 20%[6]. Local firms are defined as firms without foreign ownership throughout the estimation period.

The dataset contains production and cost information at the firm level, including industry classification for the main product, the number of production and non-production workers, and labor costs for each type of worker. The survey also asked whether each firm had imported materials. Industry is defined based on the three-digit International Standard

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[4] The number of workers predicted by Equation (9) is equivalent to the actual number of workers in case of the initial year.

[5] "Plants" would be a more accurate expression. However, since most firms in Indonesia are single-plant firms (Kasahara et al. 2016), this distinction is not critical.

[6] 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 (Blalock and Gertler, 2009).

Industrial Classification (ISIC) Revision 3. The total number of workers within a firm was combined with the 2000 input-output (IO) table published by the BPS to construct variables that measure the intensity of MNE activity[7]. Firm-level wages are estimated by dividing labor costs by the number of workers, adjusted by the consumer price index. The estimated wages averaged at the industry-district-year level are used as a proxy for the input price.

Regarding firm-product-level variables, the dataset reports product classification, values of shipment, quantity shipped, and export share for each firm product. Product classification is available at the seven-digit level, the first four digits of which correspond to the four-digit ISIC code. Because not all products are necessarily subject to quality differentiation, we restrict our sample to differentiated goods for consistency with the model assumptions laid out in the previous section. Following Khandelwal (2010), individual goods are grouped according to Rauch's (1999) conservative product classification[8]. Fan et al. (2015) indicated that only differentiated products based on Rauch's classification show an improvement in quality after input tariff reductions in China.

The unit price is obtained by dividing the shipment value by the quantity shipped. However, our data do not indicate the destination countries for exported products. Furthermore, the dataset does not record the value of shipments or quantities shipped separately for domestic and international sales. It provides only the export share for each

[7] We use the concordance table provided by BPS to link the industry codes used in the IO table to the three-digit ISIC codes.

[8] We use the concordance table between the Standard International Trade Classification and HS codes provided by the United Nations and the concordance table between the HS and Indonesian product codes provided by BPS.

firm-product observation. Hence, for firms' products sold in both domestic and foreign markets, we cannot estimate the unit price and quality by market. To evaluate the quality of these products, we first identify the main market in which they are sold based on their export share. Then, we obtain the unit price in the main market, assuming that all the output of a firm's product is sold in the main market. Note that this assumption is not as strong as it seems because most firms' products are sold almost exclusively in domestic or foreign markets. The proportions of firm-product observations with export shares within the range of 0-25%, 25-50%, 50-75%, and 75-100% are 90%, 1%, 1%, and 7%, respectively. To further ensure consistency with this assumption, we exclude firm-product observations whose export share is between 25% and 75% and retain those mostly exported to foreign countries (the export share is greater than 75%) and those mostly traded in the domestic (i.e., Indonesian) market (the export share is less than 25%).

However, two issues remain unresolved. First, the price index and expenditure captured by the product-year fixed effects f_{jt} in Equation (3) vary between the foreign and domestic markets. Equation (10) modifies Equation (3) to allow the product-year fixed effects to take different values depending on the main market m of firm-product ij in year t:

(10) $$\ln q_{ijt} + \sigma_j \ln p_{ijt} = f_{jt}^{m} + \varepsilon_{ijt},$$

where $f_{jt}^{m} \equiv D_{ijt}^{ex} f_{jt}^{f} + (1 - D_{ijt}^{ex}) f_{jt}^{d}$; D_{ijt}^{ex} is a dummy variable that takes value one if a firm-product ij is mainly exported in year t; and f_{jt}^{f} and f_{jt}^{d} are the product-year fixed effects in foreign and domestic markets, respectively.

Second, the elasticity of substitution σ_j in Equations (4) and (10) also varies across countries. We employ the elasticity of substitution reported by Broda et al. (2006), who provide elasticity by country at the three-digit Harmonized System (HS) level[9]. Since our firm-product data do not indicate destination countries for exported products, we averaged the elasticity across the ten major export destinations of Indonesian manufacturing using the total export values as a weight. Trade data are obtained from the UN Comtrade database. Then, we replace σ_j in Equations (4) and (10) with the obtained value for firm-products mainly exported to foreign countries and with the elasticity in Indonesia for those mainly traded domestically. However, as Indonesia constitutes part of the international production network, some parts produced there are likely to be exported to assembling plants in other Asian countries and re-exported to final destinations. In other words, the obtained elasticity may not reflect the elasticity of consumers at their final destinations. To explicitly consider final demand, we introduce another measure: the weighted average of the elasticity across ten major export destinations among OECD countries. As these two measures yield very similar results, we present the results obtained using the latter measure below. The summary statistics for the quality and other variables used in this study are presented in Table 1[10].

5. Estimation results

Table 2 demonstrates the correlation between our quality measure and the sales of firm

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[9] We use the concordance table between the HS and Indonesian product codes.
[10] We exclude as outliers firm-product observations whose price lies in the top or bottom 5% of each product-year-main-market category.

products. Column (1) indicates that the better the quality of a firm's product, the greater its sales, implying that quality-upgrading is the key to firm competitiveness. Previous studies such as Baldwin and Harrigan (2011) and Manova and Zhang (2012) demonstrate that sales of exported products increase with product quality. To examine whether this relationship holds for non-exported goods, Column (2) divides firms' products into those mainly exported to foreign countries and those mainly traded in the domestic market. By interacting two dummy variables, D_{ijt}^{ex} and $1 - D_{ijt}^{ex}$, with the quality measure, we find that the sales of both types of firm products are positively correlated with their quality by a similar magnitude. As seen in the previous section, because most firm products are mainly traded in the domestic market, exploring the existence and extent of spillover effects on the quality of domestically traded products is important for the Indonesian economy. Finally, Columns (3) and (4) present the correlations between product quality and unit price. Regardless of export status, high-quality products tend to have higher prices.

Table 3 presents the estimation results of Equation (5)[11]. The first-stage F-statistic was sufficiently high, suggesting that our instruments were strong enough to provide unbiased results. Table A1 in the Appendix presents the corresponding first-stage estimates. Columns (1)–(3) examine the impact of horizontal, forward, and backward FDI on product quality. Column (4) simultaneously evaluates the impacts of these three linkages. The estimation results indicate that backward FDI has a positive and significant effect. This

[11] In the estimation, we replaced f_{jt} in Equation (5) with f_{jt}^{m} to consider the main market where firm-product ij is sold in year t.

finding contrasts with previous research, in which forward FDI has a positive impact on product quality. According to Blalock and Gertler (2008), MNEs located in Indonesia are export-oriented and generally do not supply Indonesian firms. Instead, the MNEs in downstream industries source intermediate inputs from local firms. Our findings are consistent with the argument that enhanced opportunities to transact with MNEs in downstream industries provide local firms with incentives to improve their product quality.

Regarding the control variables, the lagged log of total employment has a positive impact on product quality; however, neither the use of imported intermediate inputs nor lagged skill intensity improves product quality. This does not necessarily imply that these two factors are not sources of quality improvement. Instead, they may not vary much across time within firm-products[12]. Finally, regional wages have an unexpected positive impact on product quality. Dingel (2017) argues that firms in high-income areas tend to produce high-quality goods because of their high demand and the abundant endowment of high-skilled workers needed to produce them in those regions. Hence, regional wages may reflect the purchasing power and/or skill composition of the workers in these regions.

Equation (11) extends Equation (5) to allow the quality impact of FDI spillovers to vary between products mainly exported to foreign markets and those mainly traded in domestic markets[13]:

[12] Due to the firm-product fixed effects, identification comes from changes over time within a firm-product.

[13] As Table A2 shows, the instruments, HZN_{krt}^{IV}, FWD_{krt}^{IV}, BWD_{krt}^{IV}, are interacted with D_{ijt}^{ex} or $1 - D_{ijt}^{ex}$ in the first-stage estimation.

(11) $$\ln \lambda_{ijt} = \beta_1 HZN_{krt} \times D_{ijt}^{ex} + \beta_2 HZN_{krt} \times \left(1 - D_{ijt}^{ex}\right) + \beta_3 FWD_{krt} \times D_{ijt}^{ex} + \beta_4 FWD_{krt} \times \left(1 - D_{ijt}^{ex}\right) + \beta_5 BWD_{krt} \times D_{ijt}^{ex} + \beta_6 BWD_{krt} \times \left(1 - D_{ijt}^{ex}\right) + \mathbf{X_{ijt}\beta} + f_{ij} + f_{Rt} + f_{jt}^{m} + \xi_{ijt}.$$

Table 4 presents the estimation results. Similar to Table 3, we find that backward FDI affects the quality of the goods produced by local firms. More importantly, FDI spillovers improve the quality of any firm's products, regardless of its export status (Column 4). Although the impact was greater for exported products, the difference between the two types of products was not statistically significant. The literature argues that firms in developing countries enhance the competitiveness of their products prior to exports by increasing productivity (Alvarez and López, 2005) or improving product quality (Iacovone and Javorcik, 2012). The results presented in Table 4 suggest that attracting inward FDI to downstream industries is effective for the latter.

The estimation results in Table 4 indicate that all firms' products in Indonesia benefit from quality-upgrading spillovers from MNEs in downstream industries. However, a question may arise. Indonesia was categorized as a lower-middle income country during the estimation period, with a gross domestic product per capita of USD 1,860 in 2007. Because the average purchasing power of residents was not high, it may not be plausible to suppose that every local firm was concerned about quality improvement. Local firms involved in global competition, namely those exporting their products or supplying inputs for MNEs located in Indonesia, should have had a stronger incentive to upgrade their products. In other words, quality-upgrading spillovers from backward FDI should be stronger for intermediate goods than for consumption goods, at least for non-exported products.

To test this hypothesis, we classified each product by its end-use categories based on the classification by Broad Economic Categories[14]. By distinguishing between capital or intermediate ($D_j^{int} = 1$) and consumption goods ($D_j^{int} = 0$), we extend Equation (5) to consider the different impacts of inward FDI on the quality of each type of good:

$$(12) \quad \ln \lambda_{ijt} = \beta_1 HZN_{krt} \times D_j^{int} + \beta_2 HZN_{krt} \times \left(1 - D_j^{int}\right) + \beta_3 FWD_{krt} \times D_j^{int} + \beta_4 FWD_{krt} \times \left(1 - D_j^{int}\right) + \beta_5 BWD_{krt} \times D_j^{int} + \beta_6 BWD_{krt} \times \left(1 - D_j^{int}\right) + \mathbf{X_{ijt}\beta} + f_{ij} + f_{Rt} + f_{jt}^m + \xi_{ijt}.$$

The results in Columns (3) and (4) of Table 5 confirm that backward FDI only increases the product quality of intermediate goods[15]. The results do not change even if we limit our sample to non-exported firm-product observations in Column (5). Consequently, quality-upgrading spillovers from backward FDI are likely to arise when MNEs source intermediate inputs from local suppliers.

Thus far, we have examined quality-upgrading spillovers using a theory-consistent measure of product quality. This measure allows us to estimate the impact of FDI on product quality precisely. In contrast, previous studies have employed unit price as a proxy for product quality. Although unit price is not a precise measure of product quality, it relies on fewer assumptions than ours. Table 6 repeats the estimation using the unit price. We can

[14] We use the concordance table between the HS and Indonesian product codes.
[15] Column (4) should be interpreted with caution because the first-stage F-statistic is low. Baum et al. (2007) argue that weak identification is likely a problem when the F-statistic is less than 10. The first-stage estimates for the excluded instruments are available in Table A3.

confirm the robustness of our results using an alternative measure. In other words, backward FDI increases the unit price of goods produced by local firms. The unit prices of both exported and domestically traded products increase as inward FDI into downstream industries increases. However, only local firms that produce intermediate goods can benefit from backward FDI and increase unit prices.

Finally, regarding the economic impact of the estimated coefficients, a 10-percentage-point increase in the employment share of MNEs in downstream industries, which is equivalent to approximately one standard deviation (see Table 1), increases the quality of firm products by 14% (Column 4 of Table 3). Interestingly, the impact of inward FDI on product quality is of almost the same magnitude as its impact on productivity[16]. However, if we restrict the sample to intermediate goods, the impact increases by 22% (see Column 3 of Table 5). The impacts on product prices were similar in magnitude.

6. Summary and conclusions

International trade literature has emphasized the role of product quality: the higher the quality of a product, the more likely it is to be exported, and the greater its export sales. Thus, identifying the determinants of product quality has important implications for successful exports. Recent studies on production networks show that non-exporting firms indirectly engage in exports by supplying products to firms that trade internationally. However, to participate in these networks, local intermediate suppliers must satisfy strict technological

[16] Havranek and Irsova (2011) conclude that a 10-percentage-point increase in the share of MNEs in downstream industries generally raises the productivity of local firms by 9.4%.

sophistication and product quality requirements. Hence, upgrading product quality is a concern not only for exporting firms but also for non-exporting firms.

This study focuses on the role of inward foreign direct investment (FDI) in upgrading local firms' product quality in developing countries. If increased transactions with MNEs reduce the costs associated with quality upgrades, attracting inward FDI would be effective. We tested this hypothesis by employing firm-product-level data on Indonesian manufacturing. The estimation results show the positive and significant impact of backward FDI on the quality of both exported and domestically traded products. In addition, the impact is stronger for intermediate goods than for consumption goods. These findings are robust for the use of alternative product quality measures.

This study sheds new light on the role of inward FDI. Previous studies have focused on the impact on local firms' productivity. We complement them by providing evidence that attracting inward FDI is also effective in upgrading the quality of local firms. Moreover, we identify a new channel through which quality-upgrading spillovers occur. While previous studies confirm quality-upgrading spills over from forward FDI, we show that backward FDI is key for the quality-upgrading of local exporters or non-exporters producing intermediate inputs. Overall, these findings suggest that quality-upgrading spillovers effectively enhance the competitiveness of local firms, particularly those involved in global competition. Finally, we identify quality-upgrading spillovers in developing countries. Identifying how spillovers arise is important for further investigation. If we can identify the precise mechanism through which inward FDI affects the product quality of local firms, governments can develop more detailed policies that maximize the economic benefits of inward FDI to the host country.

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Table 1. Summary Statistics

Variable	Mean	Std. dev.
Firm-product level variable		
Log of product quality ($\ln \lambda$)	-0.041	1.545
Log of unit price ($\ln p$)	3.721	2.892
Dummy for firm-products mainly exported to foreign countries (D^{ex})	0.073	0.260
Dummy for intermediate products (D^{int})	0.335	0.472
Firm-level variable		
Lagged ratio of skilled to total employment (SKL_{t-1})	0.152	0.160
Lagged log of total employment ($\ln L_{t-1}$)	4.029	1.069
Dummy for material import (D^{imp})	0.141	0.348
Region-level variable		
Horizontal FDI (HZN)	0.084	0.209
Forward FDI (FWD)	0.031	0.072
Backward FDI (BWD)	0.042	0.100
Log of regional wages in 1,000 Rp (2000=100; $\ln W$)	8.574	0.794

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

Table 2: Correlation between Product Quality, and Sales or Price

	(1)	(2)	(3)	(4)
Variable	Log of sales		Log of price	
$\ln \lambda$	0.579***		0.746***	
	(0.00656)		(0.00318)	
$\ln \lambda \times D^{ex}$		0.606***		0.581***
		(0.0203)		(0.0137)
$\ln \lambda \times (1 - D^{ex})$		0.577***		0.758***
		(0.00673)		(0.00314)
R-squared	0.933	0.933	0.994	0.994
Observations	131,907	131,907	131,907	131,907

Note: The dependent variable is indicated in the table header. Heteroscedasticity-robust standard errors are indicated in parentheses. Firm-product, province-year, and product-year-main-market 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: Base Model

Variable	(1)	(2)	(3)	(4)
HZN	0.00234			-0.228
	(0.164)			(0.205)
FWD		-0.317		-0.410
		(0.367)		(0.368)
BWD			0.899^{*}	1.377^{**}
			(0.468)	(0.582)
D^{imp}	-0.0319	-0.0310	-0.0332	-0.0321
	(0.0485)	(0.0485)	(0.0485)	(0.0485)
$\ln W$	0.199^{***}	0.198^{***}	0.197^{***}	0.198^{***}
	(0.0226)	(0.0226)	(0.0225)	(0.0226)
SKL_{t-1}	0.0157	0.0156	0.0165	0.0163
	(0.0504)	(0.0504)	(0.0505)	(0.0505)
$\ln L_{t-1}$	0.133^{***}	0.133^{***}	0.132^{***}	0.131^{***}
	(0.0187)	(0.0187)	(0.0187)	(0.0187)
Kleibergen-Paap F statistic	268.4	31.67	93.88	26.05
Observations	126,156	126,156	126,156	126,156

Note: The dependent variable is the log of product quality. Standard errors clustered at the industry-district level are shown in parentheses. Firm-product, province-year, and product-year-main-market 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: Exported vs. Domestically Traded Goods

Variable	(1)	(2)	(3)	(4)
$HZN \times D^{ex}$	-0.142			-0.962*
	(0.347)			(0.503)
$HZN \times (1 - D^{ex})$	0.0115			-0.193
	(0.167)			(0.208)
$FWD \times D^{ex}$		1.704		1.660
		(1.136)		(1.111)
$FWD \times (1 - D^{ex})$		-0.372		-0.483
		(0.374)		(0.379)
$BWD \times D^{ex}$			0.912	2.519**
			(0.828)	(1.194)
$BWD \times (1 - D^{ex})$			0.898*	1.382**
			(0.475)	(0.595)
D^{imp}	-0.0319	-0.0303	-0.0332	-0.0314
	(0.0485)	(0.0484)	(0.0485)	(0.0484)
$\ln W$	0.198***	0.198***	0.197***	0.198***
	(0.0226)	(0.0226)	(0.0225)	(0.0226)
SKL_{t-1}	0.0154	0.0175	0.0165	0.0177
	(0.0504)	(0.0504)	(0.0505)	(0.0505)
$\ln L_{t-1}$	0.133***	0.133***	0.132***	0.131***
	(0.0187)	(0.0187)	(0.0187)	(0.0187)
Kleibergen-Paap F statistic	135.2	16.22	46.12	13.26
Observations	126,156	126,156	126,156	126,156

Note: The dependent variable is the log of product quality. Standard errors clustered at the industry-district level are shown in parentheses. Firm-product, province-year, and product-year-main-market 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: Intermediate vs. Consumption Goods

Variable	(1)	(2)	(3)	(4)	(5)
$HZN \times D^{int}$	0.343			0.193	0.0657
	(0.356)			(0.397)	(0.402)
$HZN \times (1 - D^{int})$	-0.132			-0.369	-0.402
	(0.183)			(0.272)	(0.292)
$FWD \times D^{int}$		0.147		-0.827	-1.014
		(1.334)		(1.503)	(1.438)
$FWD \times (1 - D^{int})$		-0.374		-0.425	-0.339
		(0.368)		(0.360)	(0.369)
$BWD \times D^{int}$			2.168**	2.156**	2.090**
			(1.001)	(0.986)	(0.976)
$BWD \times (1 - D^{int})$			0.420	1.201	0.906
			(0.514)	(0.772)	(0.801)
D^{imp}	-0.0318	-0.0314	-0.0344	-0.0323	-0.00159
	(0.0485)	(0.0484)	(0.0485)	(0.0485)	(0.0511)
$\ln W$	0.198***	0.198***	0.198***	0.197***	0.203***
	(0.0226)	(0.0226)	(0.0225)	(0.0226)	(0.0226)
SKL_{t-1}	0.0164	0.0156	0.0170	0.0173	0.0168
	(0.0504)	(0.0504)	(0.0505)	(0.0505)	(0.0536)
$\ln L_{t-1}$	0.133***	0.133***	0.132***	0.131***	0.114***
	(0.0187)	(0.0187)	(0.0187)	(0.0187)	(0.0205)
Kleibergen-Paap F statistic	63.01	16.04	15.55	4.498	10.12
Observations	126,156	126,156	126,156	126,156	114,978

Note: The dependent variable is the log of product quality. The sample is restricted to the non-exported firm products in Column (5). Standard errors clustered at the industry-district level are shown in parentheses. Firm-product, province-year, and product-year-main-market 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

Variable	(1)	(2)	(3)	(4)
HZN	-0.117			
	(0.166)			
FWD	-0.469			
	(0.314)			
BWD	1.185**			
	(0.482)			
$HZN \times D^{ex}$		-0.660*		
		(0.396)		
$HZN \times (1 - D^{ex})$		-0.0980		
		(0.169)		
$FWD \times D^{ex}$		-0.460		
		(1.237)		
$FWD \times (1 - D^{ex})$		-0.463		
		(0.310)		
$BWD \times D^{ex}$		2.712***		
		(0.873)		
$BWD \times (1 - D^{ex})$		1.089**		
		(0.488)		
$HZN \times D^{int}$			0.215	0.101
			(0.341)	(0.350)
$HZN \times (1 - D^{int})$			-0.248	-0.274
			(0.203)	(0.213)
$FWD \times D^{int}$			-0.345	-0.519
			(1.221)	(1.215)
$FWD \times (1 - D^{int})$			-0.535*	-0.536*
			(0.306)	(0.326)
$BWD \times D^{int}$			1.678**	1.722**
			(0.856)	(0.845)
$BWD \times (1 - D^{int})$			1.097*	0.860
			(0.621)	(0.663)
D^{imp}	-0.0667	-0.0668	-0.0671	-0.0422
	(0.0421)	(0.0421)	(0.0421)	(0.0433)
$\ln W$	0.118***	0.118***	0.117***	0.122***
	(0.0163)	(0.0163)	(0.0163)	(0.0161)
SKL_{t-1}	0.00303	0.00325	0.00385	-7.32e-05
	(0.0411)	(0.0411)	(0.0411)	(0.0437)
$\ln L_{t-1}$	0.0169	0.0171	0.0168	0.0147
	(0.0144)	(0.0144)	(0.0144)	(0.0156)
Kleibergen-Paap F statistic	26.05	13.26	4.498	10.12
Observations	126,156	126,156	126,156	114,978

Note: The dependent variable is the log of unit price. The sample is restricted to the non-exported firm products in Column (4). Standard errors clustered at the industry-district level are shown in parentheses. Firm-product, province-year, and product-year-main-market fixed effects are included in every specification. ***, ** and * represent statistical significance at the 1%, 5%, and 10% levels, respectively.

Appendix

Table A1. First-Stage Estimates for Column (4) of Table 3

Excluded instrument	(1) HZN	(2) FWD	(3) BWD
HZN^{IV}	0.736***	0.0414*	0.0121
	(0.0485)	(0.0225)	(0.0153)
FWD^{IV}	-0.0817	0.575***	-0.0339
	(0.0707)	(0.107)	(0.0240)
BWD^{IV}	0.191	-0.0491	0.776***
	(0.130)	(0.0712)	(0.0936)
Observations	126,156	126,156	126,156

Note: Standard errors clustered at the industry-district level are shown in parentheses. ***, **, and * represent statistical significance at the 1%, 5%, and 10% levels, respectively.

Table A2. First-Stage Estimates for Column (4) of Table 4

Excluded instrument	(1) $HZN \times D^{ex}$	(2) $HZN \times (1-D^{ex})$	(3) $FWD \times D^{ex}$	(4) $FWD \times (1-D^{ex})$	(5) $BWD \times D^{ex}$	(6) $BWD \times (1-D^{ex})$
$HZN^{IV} \times D^{ex}$	0.688***	0.0345	0.00171	0.0280	0.0187	-0.00951
	(0.0678)	(0.0545)	(0.0248)	(0.0189)	(0.0208)	(0.0176)
$HZN^{IV} \times (1-D^{ex})$	0.00679*	0.729***	0.000855	0.0404*	0.000334	0.0114
	(0.00409)	(0.0478)	(0.00154)	(0.0225)	(0.00104)	(0.0153)
$FWD^{IV} \times D^{ex}$	-0.166*	-0.0207	0.460***	0.0269	-0.0651*	-0.00933
	(0.0986)	(0.0916)	(0.142)	(0.0956)	(0.0374)	(0.0377)
$FWD^{IV} \times (1-D^{ex})$	-0.00870	-0.0652	-0.00876**	0.589***	-0.00463	-0.0258
	(0.00781)	(0.0719)	(0.00400)	(0.108)	(0.00299)	(0.0229)
$BWD^{IV} \times D^{ex}$	0.322*	0.0994	0.0114	-0.0221	0.846***	0.0604
	(0.178)	(0.170)	(0.0470)	(0.0666)	(0.0860)	(0.0988)
$BWD^{IV} \times (1-D^{ex})$	0.0339*	0.140	-0.00758	-0.0447	0.0206**	0.745***
	(0.0194)	(0.125)	(0.00600)	(0.0709)	(0.00925)	(0.0928)
Observations	126,156	126,156	126,156	126,156	126,156	126,156

Note: Standard errors clustered at the industry-district level are shown in parentheses. ***, **, and * represent statistical significance at the 1%, 5%, and 10% levels, respectively.

Table A3. First-Stage Estimates for Column (4) of Table 5

Excluded instrument	(1) $HZN \times D^{int}$	(2) $HZN \times (1-D^{int})$	(3) $FWD \times D^{int}$	(4) $FWD \times (1-D^{int})$	(5) $BWD \times D^{int}$	(6) $BWD \times (1-D^{int})$
$HZN^{IV} \times D^{int}$	0.708***	0.0115**	0.0133	0.00344	-0.0281	0.00363
	(0.0668)	(0.00523)	(0.0173)	(0.00328)	(0.0193)	(0.00262)
$HZN^{IV} \times (1-D^{int})$	0.00281	0.729***	0.00230	0.0552*	0.00162	0.0286
	(0.00270)	(0.0603)	(0.00156)	(0.0330)	(0.00129)	(0.0188)
$FWD^{IV} \times D^{int}$	0.0830	-0.0198	0.566***	-0.0273	-0.0474	-0.000594
	(0.150)	(0.0260)	(0.117)	(0.0183)	(0.0503)	(0.0146)
$FWD^{IV} \times (1-D^{int})$	-0.00271	-0.0944	0.000419	0.580***	0.000375	-0.0302
	(0.00856)	(0.0723)	(0.00378)	(0.116)	(0.00351)	(0.0239)
$BWD^{IV} \times D^{int}$	-0.0262	-0.000970	0.0234	-0.00171	0.756***	0.00185
	(0.155)	(0.0202)	(0.0399)	(0.0131)	(0.138)	(0.0103)
$BWD^{IV} \times (1-D^{int})$	-0.0225	0.311*	-0.0154*	-0.0760	-0.00357	0.777***
	(0.0202)	(0.168)	(0.00909)	(0.104)	(0.00581)	(0.109)
Observations	126,156	126,156	126,156	126,156	126,156	126,156

Note: Standard errors clustered at the industry-district level are shown in parentheses. ***, **, and * represent statistical significance at the 1%, 5%, and 10% levels, respectively.