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FDI and the Export Price-Quality Divergence

Thi Hang BANH

Ammu GEORGE

Bowen YAN

Huanhuan ZHENG

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Exporting Better for Less: FDI and the Export Price-Quality Divergence *

Thi Hang Banh[a] Ammu George[b] Bowen Yan[c] Huanhuan Zheng[d]

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Abstract

This study examines the impact of foreign direct investment (FDI) inflows on export performance, with a particular focus on the quality and price of exports. We find that FDI inflows improve export quality while exerting a negative effect on export unit values, consistent with FDI-related technology diffusion that enhances production efficiency and reduces costs. We interpret this pattern as reflecting the transfer of process, product, and organisational technologies embedded in FDI, which enable firms to enhance product quality while pricing more competitively. The magnitude of these effects is moderated by the technological context of exported products. For technologically mature products with high initial technological endowments, FDI results in larger quality gains and stronger unit value declines. In contrast, for products closer to the technological frontier, quality improvements remain strong, but price effects are muted, reflecting higher entry barriers and limits to technology diffusion.

Keywords: Export Sophistication, Foreign Direct Investment, Product Quality, Unit Value, Technological Growth, Technological Endowment

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[a]Asia Competitiveness Institute, Lee Kuan Yew School of Public Policy, National University of Singapore, 469C Bukit Timah Road, Singapore 259772, Singapore. Email: hangbanh@nus.edu.sg

[b]**Corresponding author**; Queen's Business School, Queen's University Belfast, 185 Stranmillis Rd, Belfast BT9 5EE, United Kingdom. Email: ammu.george@qub.ac.uk

[c]Asia Competitiveness Institute, Lee Kuan Yew School of Public Policy, National University of Singapore, 469C Bukit Timah Road, Singapore 259772, Singapore. Email: yanbowen@nus.edu.sg

[d]City University of Hong Kong, 83 Tat Chee Ave, Kowloon Tong, Hong Kong. Email: H.Zheng@cityu.edu.hk

1 Introduction

Foreign direct investment (FDI) is a powerful conduit for international technology diffusion, carrying process innovations, proprietary product designs, and managerial practices into host economies. For technology-focused policy and strategy, a critical question is not merely whether FDI raises productivity, but how the specific technologies embedded in FDI alter the relationship between the quality of exported goods and the prices at which they are sold. Yet prevailing narratives often presume a tight coupling between higher quality and higher prices, implicitly equating export performance with unit values and overlooking how technology can simultaneously raise quality and compress costs. Understanding these mechanisms is crucial for designing effective FDI screening, technology transfer frameworks, and Investment Protection.

The literature has advanced our understanding of FDI spillovers on productivity and upgrading, including diffusion channels (Liu & Wang, 2003; García et al., 2013; Liang, 2017; Javorcik et al., 2018; Nguyen & Diez, 2019; Bajgar & Javorcik, 2020; Damioli & Marin, 2024), but it typically treats export prices as proxies for quality or examines them in isolation. This risk obscures the effects of process and organisational innovations that can raise quality while compressing costs. More importantly, the literature often abstracts from the technological content of FDI—process, product, and organisational technologies—and how these distinct channels differentially affect quality and pricing, particularly across products at varying stages of technological maturity and at the frontier.

To address these gaps, we draw on highly disaggregated bilateral trade, greenfield FDI, and patent data from 2003–2019. We document a systematic export price-quality divergence: the technology embodied in FDI drives a significant upgrade in export quality, while paradoxically exerting downward pressure on export unit values. This finding decouples the traditional quality-price link, suggesting that FDI enables host economies to produce "better for less". We interpret this pattern as reflecting the productivity consequences of technology transfer: superior process innovations and quality control systems enable firms to produce higher-quality variants at lower marginal costs, thereby supporting more aggressive pricing despite quality improvements.

Critically, we show that this effect is not uniform; it is strictly moderated by the technological maturity of the exported products. For technologically mature products with high initial endowments, high absorptive capacity allows process innovations to diffuse rapidly. In these products, we find stronger evidence of the "better for less" dynamic, where FDI results in massive efficiency gains that drive the sharpest declines in export prices alongside quality improvements. Conversely, for products at the technological frontier characterised by rapid technological growth, a similar direction of "better for less" effects is not evident. While FDI leads to steeper gains in export quality due to the introduction of advanced product technologies in such products, the price-reducing effect of FDI is weaker. In these frontier products, high entry barriers and the strategic protection of tacit knowledge limit the diffusion of cost-saving knowledge, preventing the full pass-through of efficiency gains to export prices.

Empirically, we address the endogeneity of FDI on export performance measures using a shift-share (Bartik) instrumental variable that exploits plausibly exogenous variation in source-country shocks interacted with pre-existing exposure patterns. The results firmly support a technology-centred interpretation: FDI inflows are associated with significant increases in export quality alongside declines in unit values, consistent with technology-driven productivity improvements and competitive pricing.[1] By decoupling quality from price, FDI-embedded technology reshapes comparative advantage—enabling host countries to upgrade their export baskets while competing more effectively on cost. This technological reframing highlights why the welfare and policy implications of FDI cannot be inferred solely from prices alone; quality-adjusted performance and the structure of technological diffusion are central to understanding how FDI transforms export outcomes.

The remainder of the paper is structured as follows: Section 2 presents the literature review and hypothesis development; Section 3 presents the empirical specifications to test the hypotheses; Section 4 details the data sources and variable construction; Section 5 presents the results; and finally Section 6 concludes.

2 Literature review and hypothesis development

Foreign direct investment should be understood not only as a movement of capital, but also as a conduit for the international transfer of technology and knowledge (Daude & Fratzscher, 2008; Padilla-Pérez, 2008). Multinational enterprises (MNEs) account for a substantial share of global R&D activity, patenting, and the development of advanced production and organisational technologies, making FDI a key source through which such technologies are transferred across borders (Bloom & Van Reenen, 2010; Cadestin et al., 2018; Ladeira & Ferreira, 2025). Consequently, FDI inflows serve as a pipeline connecting host economies to the global technological frontier, facilitating the diffusion of a diverse bundle of product technologies such as proprietary designs, components, etc (Monteiro et al., 2008) as well as process technologies like automation, lean management, and quality control (Kostova & Roth, 2002; Verbeke et al., 2018).

2.1 FDI and the Export Price-Quality Divergence

Despite efforts to internalise core product technologies, MNEs inevitably generate knowledge spillovers to host-country firms. Upstream MNEs facilitate upgrading by supplying

[1] Unit value and export price are synonymous.

higher-quality inputs, capital goods, and technologies to local affiliates (Godart & Görg, 2013; Javorcik et al., 2018; Bajgar & Javorcik, 2020; Ciani & Imbruno, 2017; Poupakis, 2022) while downstream MNEs often promote local suppliers upgrading through training, technical assistance, and quality requirements (Javorcik et al., 2008; Li et al., 2018; Bajgar & Javorcik, 2020; Di Ubaldo & Siedschlag, 2022). Additional spillovers could arise horizontally when local firms are co-located with foreign affiliates in the same industry (Harding & Javorcik, 2012; Swenson & Chen, 2014; Liang & Tan, 2024) and through labour mobility from foreign affiliate firms to domestic firms (Haskel et al., 2007; Balsvik, 2011; Poole, 2013; Greenaway et al., 2004; Keller & Yeaple, 2009; Liu & Wang, 2022; Wang & Zhou, 2025).

The above literature often assumes a linear relationship where technological transfer in product technologies from FDI leads to higher export quality and, consequently, higher export prices. We argue that the technology embedded in FDI creates a more complex dynamic. By transferring process technologies alongside product technologies, FDI enables host firms to decouple quality from cost. This technological spillover from FDI drives a "better for less" phenomenon, where export quality improves while unit values decline.

The diffusion of process technologies from FDI enhances efficiency and compresses costs in host countries. The superior managerial practices and organisational routines of MNEs allow foreign affiliates in host countries to operate more efficiently, with lower marginal and average costs, compared to domestic firms (Boardman et al., 1997; Douma et al., 2006). Through knowledge spillovers, domestic firms may adopt similar practices, improving input allocation and cost efficiency (Fu, 2012). Aitken et al. (1997) shows that the presence of exporting MNEs reduces the fixed costs of exporting for Mexican firms, enabling domestic producers to supply foreign markets at lower unit costs. These productivity gains shift firms' supply curves outward, creating scope for lower export prices.

Beyond direct technology transfer, FDI triggers competitive restructuring. The entry of highly productive foreign affiliates disrupts the market dominance of incumbents, increasing the elasticity of demand and compressing markups. Consistent with heterogeneous-firm models, this intensified competition generates a selection effect: less productive firms exit, while surviving firms are compelled to adopt aggressive pricing strategies and eliminate inefficiencies to compete (Aitken & Harrison, 1999; Melitz, 2003). Additionally, integration into MNE networks allows firms to exploit economies of scale, spreading fixed costs over larger export volumes and further reducing average total costs (Luo, 2007; Sousa & Bradley, 2008).

Based on these mechanisms, we propose that FDI generates a distinctive "better for less" export outcome in host countries:

Hypothesis 1. *Higher FDI inflows lead to higher export quality by diffusing product and organisational technologies.*

Hypothesis 2. *Higher FDI inflows lead to lower export prices by diffusing process technologies and intensifying competitive pressure.*

2.2 The moderating role of the technological context of exported products

The impact of FDI on quality and price is not uniform; it is strictly moderated by the technological context of the exported products. We distinguish between products characterised by high technological endowment (mature industries) and those defined by high technological growth (frontier industries). In product segments with high initial technological endowments, production technologies are relatively standardised and codified. In these mature industries, the appropriability of firm-specific knowledge is lower (Kapoor & Adner, 2012), and the absorptive capacity of domestic firms is generally higher (Buckley et al., 2002; Álvarez & Molero, 2005; Zhang et al., 2010). This compatibility facilitates the rapid diffusion of FDI-induced process innovations.

In such contexts, the entry of MNEs intensifies price competition significantly because local firms can easily replicate and adopt incoming efficiency improvements. Consequently, we expect the strongest "better for less" effect in these sectors: the rapid diffusion of process technology drives costs (and prices) down, while cumulative learning and standardisation drive quality up.

Hypothesis 3. *For technologically mature products (characterised by a high initial technological endowment), the impact of FDI on export price-quality divergence is amplified; FDI leads to larger quality gains and steeper declines in export unit values due to high absorptive capacity and intense price competition.*

Conversely, industries at the technological frontier are characterized by rapid innovation, high R&D intensity, and substantial entry barriers. In these high-growth environments, knowledge is often tacit and strategically protected to preserve the MNE's competitive edge. MNEs in these sectors have a strong incentive to internalise their technological advantages within their affiliates, limiting the diffusion of knowledge to domestic rivals (Arrow, 1972; Di Minin & Bianchi, 2011; Fu & Gong, 2011).

While the presence of these foreign affiliates still upgrades the host country's export basket by introducing sophisticated varieties, the competitive pressure to lower prices is dampened by the high barriers to entry (García et al., 2013). Knowledge in these sectors is more tacit and strategically protected, enabling MNEs to internalise technological advantages within their foreign affiliates and limit diffusion to domestic firms (Arrow, 1972; Di Minin & Bianchi, 2011; Fu & Gong, 2011). Consequently, FDI inflows in frontier industries generate weaker competitive effects on domestic firms (García et al., 2013). Foreign affiliates may seek to protect the MNE's competitive edge and preserve price markups associated with superior technology or product differentiation (Sembenelli & Siotis, 2008). As a result, domestic firms cannot easily replicate the cost structures of foreign entrants, muting the pass-through of efficiency gains to export prices.

Hypothesis 4. *For products at the technological frontier (characterised by high technological growth), the impact of FDI on export price-quality divergence is limited; Although FDI leads to steeper gains in export quality due to the advanced product technologies employed in foreign affiliates, the price-reducing effect of FDI is weaker due to high entry barriers and strategic investment protection.*

3 Model

In this section, we present the empirical specifications used to test the hypotheses derived in Section 2. To examine the effect of FDI inflows on export performance, we use the following gravity model specification:

$$y_{jdmt} = \alpha_0 + \alpha_1 ln(FDI_{jd,t-1}) + \alpha_2 ln(Exp_{h,t-1}) + \alpha_3 NRCA_{jd,t-1} + \alpha_{dt} + \alpha_{mt} + \alpha_{dm} + \alpha_j + \epsilon_{jdmt}; \quad (1)$$

where y_{jdmt} refers to one of the following dependent variables, the natural logarithms of the export quality, export quantity, export value, and unit value of product j exported from country d to market m at year t. $FDI_{jd,t-1}$ refers to FDI inflows to exporting country d pertaining to product j in year t. The coefficient α_1 captures the effect of FDI inflows on export performance. A positive and statistically significant estimate of $\alpha_1 > 0$, when y_{jdmt} measures log of export quality would provide support for hypothesis 1. Similary, a finding of $\alpha_1 > 0$ when export quantity and trade value are dependent variables would suggest that FDI inflows host countries to export more volume and value of exports. Whereas, a negative and statistically significant estimate of $\alpha_1 < 0$, when y_{jdmt} measures log of export price would provide support for hypothesis 2.

Our specifications control for the one-period lag of log of world export value at the HS-4 digit level ($ln(Exp_{h,t-1})$), one-period lag of normalized revealed comparative advantage index of product j produced by country d ($NRCA_{jd,t-1}$), exporter-year fixed effects α_{dt}, importer-year fixed effects α_{mt}, exporter-importer fixed effects α_{dm}, and HS-6 digit product fixed effects α_j. Including the world export value, exporter-year fixed effects, and importer-year fixed effects capture macro shocks at the industry, country, and global levels such as economic growth, capital availability, and global economic policy uncertainty. The NRCA index controls for changes in the structure of exports and shocks at the HS-6 digit product level in each country. Including the HS-6 digit product fixed effect not only captures products' characteristics but also ensures that the estimations of the effects on quality and quantity exploit the within-product variation of quality and quantity due to differences in scales and measurements. The exporter-importer fixed effects control for bilateral relationships between country pairs in a gravity model, such as distance, common languages, or if both countries are members of any free trade agreement.

Although we control for a large set of fixed effects, which are likely to capture country and sector characteristics responsible for both higher quality and larger FDI inflows, and use lagged values for the main explanatory variable, the endogeneity problem may arise due to the reverse causality of product quality on FDI inflows. Thus, we instrument for the FDI variable using a shift-share instrumental variable (IV) (Bartik, 1991).

To test hypothesis 3 and hypothesis 4, we revise Eq. (1) by incorporating the technology variables and their interactions with FDI inflows in the equation below:

$$\begin{aligned} y_{jdmt} =& \alpha_0 + \alpha_1 \ln(FDI_{jd,t-1}) \\ &+ \beta_1 \ln(\text{tech}_{jd}^{\text{endow}}) + \beta_2 \ln(FDI_{jd,t-1}) \times \ln(\text{tech}_{jd}^{\text{endow}}) \\ &+ \beta_3 \text{tech}_{jd}^{\text{growth}} + \beta_4 \ln(FDI_{jd,t-1}) \times \text{tech}_{jd}^{\text{growth}} \\ &+ \alpha_2 \ln(Exp_{h,t-1}) + \alpha_3 NRCA_{jd,t-1} + \alpha_{dt} + \alpha_{mt} + \alpha_{dm} + \alpha_j + \epsilon_{jdmt}, \end{aligned} \tag{2}$$

where $\text{tech}_{jd}^{\text{endow}}$ refers to technological endowment pertaining to product j in exporter country d and $\text{tech}_{jd}^{\text{growth}}$ refers to technological growth pertaining to product j in exporter country d. These variables distinguish between technologically mature products (high endowment) and those at the technological frontier (high growth). Support for hypothesis 3 requires a positive and statistically significant coefficient for β_2 when y_{jdmt} represents export quality or unit value, suggesting that the impact of FDI on price-quality divergence is more pronounced for technologically mature products. Conversely, hypothesis 4 is supported if β_4 is significantly positive for export quality but significantly negative for export unit value, indicating that FDI has stronger effects on export quality while the effects are weaker for export prices, for products at the technological frontier.

4 Data and variable selection

We construct the variables in our study by utilising data from three major databases: trade data from *CEPII*, FDI data from *fDI Markets*, and patent data from *PATSTAT*. This section elaborates on the data and variables used to test the empirical models in Section 3.

4.1 Dependent variables

To construct our export performance measures ($y_{jdm,t}$) on quality, quantity, trade value, and unit value, we draw on the BACI database compiled by CEPII (Gaulier & Zignago, 2010), which provides annual data on bilateral trade flows at the product level (HS 6-digit, 1992 classification). The dataset reports export quantities and export trade values, from which we compute export unit values by dividing the reported export value by the corresponding export quantity. The sample covers the period from 2003 to 2019. [2]

We estimate the main dependent variable of interest, export quality, following the methodology in Khandelwal et al. (2013). According to this method, for any two varieties with the same unit value, the variety with a higher market share is assigned a higher quality. Within each HS-6-digit product category, we treat each product-exporter-market as a distinct variety. The product quality at the product-exporter-market-year is estimated using the following OLS regression:

$$ln(q_{jdmt}) + \sigma_{jm} ln(p_{jdmt}) = \alpha_j + \alpha_{mt} + \epsilon_{jdmt} \ , \tag{3}$$

where $log(q_{jdmt})$ and $log(p_{jdmt})$ refer to the natural logarithm of the export quantity and unit price of HS-6 digit product j from exporter d to destination market m in time t, respectively. The product fixed effects, α_j, control for the differences in units of measurement of prices and quantities across product categories. The market-year fixed effects, α_{mt}, capture the destination market's income and price index.

σ_{jm} denotes the import demand elasticity of product j in market m. Due to the lack of data on the unit cost of exports and domestic output for various countries, measures of σ_{jm} are taken from Broda & Weinstein (2006). Using estimated demand elasticity from the literature allows us to avoid estimating the demand for each good before inferring quality. Since our country sample extends beyond the list of 73 countries in Broda & Weinstein (2006), we use imputed elasticity of substitution data for the remaining countries. For countries with missing elasticity data, we impute the data from the geographically closest country for which data is available. We use the distance measure from the CEPII gravity database to identify the geographically closest country with elasticity data. Our imputation methodology is based on the underlying assumption that countries with strong regional ties tend to share similar consumption preferences (Bajan et al., 2021; Guiso et al., 2009).

Since the data is noisy, we exclude observations with trade values that fall below the 5th percentile or above the 95th percentile of its distribution within each market and SITC 4-digit sector for estimation of the product quality. We restrict the sample to manufacturing industries (SITC 5-8) and exclude homogeneous goods defined by Rauch (1999). Estimated quality is then the residual of regression (3), $ln(\hat{z}_{jdmt}) = \hat{\epsilon}_{jdmt}$. After obtaining an estimate of product quality, we trim observations with estimated quality below the 5th or above the 95th percentiles of quality within each sector to mitigate

[2] The FDI data are available beginning in 2003, which determines the start of our sample period. We end the sample in 2019 to focus on the period prior to the COVID-19 pandemic.

measurement error stemming from the estimation of quality.

We also utilise the BACI database to construct additional measures of export performance used in our robustness analysis, including the number of destination markets served by product from the exporting country (number of export markets) and the number of products exported within each 3-digit NAICS industry (number of exported products within industries).

4.2 Independent variable

We utilise the *fDI Markets* database, which tracks cross-border greenfield FDI activities in all countries and sectors worldwide, to obtain data on our independent variable of interest: FDI inflows to the exporting country ($FDI_{jd,t1}$). The database conducts real-time monitoring of greenfield projects, capital investments and job creation. *fDI Markets* uses publicly available sources for data collection by monitoring media sources daily in addition to leading industry organisations and Investment Promotion Agencies. Each project identified is cross-referenced against multiple sources, with a primary focus on direct company sources. Several multilateral organisations like UNCTAD and World Bank use *fDI Markets* database for greenfield FDI activity information. Additionally, many FDI studies uses *fDI Markets* database as the greenfield FDI data source (Sun & Zheng, 2020; Zheng, 2020; Chang & Chen, 2021; Crescenzi et al., 2021; Paglialunga et al., 2022; McCauley et al., 2022).

The project-level data provided by *fDI Markets* comprise information on the capital expenditure (USD million), parent firm initiating the project, the location of the parent firm (source country - administrative region - state - city), FDI destination (destination country - state - city), industry sector, industry subsector. Next, we aggregate the firm-level capital investment data to secure greenfield FDI (USD million) at the exporting country (FDI destination)- industry subsector - year level.

The industry subsector information corresponds to a classification system specific to *fDI Markets*. We map the *fDI Markets* subsector to the NAICS 2012 industry code using Nayyar (2022). Next, we perform a concordance of the NAICS 2012 industry code to HS-6 digit product code using Pierce & Schott (2012). There are two caveats to such a concordance. First, there is no concordance between NAICS 2012 code and HS-6 digit code for 101 NAICS industries. Consequently, our FDI data sample corresponds to a universe with concordance between NAICS 2012 codes and HS-6 digit codes. This shrinks our project-level FDI data sample by 115326 observations. Second, multiple NAICS 2012 industry codes correspond to the same HS-6 digit code. The reverse also holds true in the concordance, i.e., multiple HS-6 digit codes correspond to the same NAICS 2012 code. To cater to such multiple concordance items, we do a *m:m* merge between the NAICS 2012 industry-level FDI data and the HS-6 digit product code. After the merging, one

HS-6 digit classification is associated with many NAICS 2012 industries, but one NAICS 2012 industry also consists of many HS-6 digit products. Therefore, to compute the product-country-year level FDI data, first, we compute the FDI inflow to destination d for each HS-6 digit product j corresponding to NAICS industry i at year t ($FDI_{ijd,t}$) by using the share of each product's export in total NAICS industry exports in 2003 as the weight, as below:

$$FDI_{ijd,t} = FDI_{id,t} \times \frac{X_{ijd,2003}}{\sum_{j \in i} X_{ijd,2003}} \tag{4}$$

where subscripts j and i denote the HS-6 digit product codes and the NAICS 2012 industry codes, respectively. $FDI_{id,t}$ refers to greenfield FDI inflows (US$ million) to NAICS 2012 industry i in exporting country d at year t. $X_{ijd,2003}$ denotes the export of HS-6 digit product j in NAICS industry i from country d in the starting year of our sample, i.e. 2003. Finally, $\sum_{j \in i} X_{ijd,2003}$ corresponds to the sum of exports from country d in 2003 across all products j that has a concordance with industry i. We fix the share to the figures in 2003, the first year in our sample, to mitigate any endogeneity concern on the reverse effect of export growth on FDI and export quality.

FDI inflow at the product-country-year level, then, is computed as the sum of all product-industry-country-year level FDI within each product (note that after the merging, one HS-6 digit classification corresponds with many NAICS 2012 industries), and we have:

$$FDI_{jd,t} = \sum_{i \in j} FDI_{ijd,t} \tag{5}$$

4.3 Instrumental variable (IV)

We instrument the independent variable of interest $FDI_{jd,t}$ using a shift-share instrumental variable, more popularly known as the Bartik instrument (Bartik, 1991). The instrument of the greenfield FDI inflows from a source market in a NAICS industry to an exporting country by the simple average of FDI inflows from the same source to the same industry in all other host countries countries; i.e., the instrument of $FDI_{idt} = \sum_s FDI_{idst}$ in equation (4) is $\sum_s (\frac{1}{N} \sum_{-d} FDI_{i(-d)st})$, where subscripts $-d$ refers to all other exporting countries except d, s denotes source market, and N is the total number of host countries countries except d received FDI inflows from the same source as d. As a robustness check, we also calculate a second type of IV using all other FDI to all other exporting countries belonging to the same income group as the designated exporter country d. [3]

Two conditions for the validity of our IV are the relevance and exclusion restriction. The IV needs to be correlated with the FDI_{idt} variable to satisfy the relevance condition, which is likely since the exporter-year fixed effects (see Eq. (1)) capture exporting

[3]The countries are categorised into "high", "middle", and "low" income groups according to World Bank's country classifications by income level in 2003, the first year in our sample, to mitigate endogeneity concerns.

countries' conditions determining FDI inflows, while product characteristics and industry technology and productivity shocks affecting FDI inflows are picked up by product fixed effects, world export, and NRCA index. Therefore, the identification likely exploits the variation at the product-source market-year level coming from the source countries' determinants of FDI inflows such as the availability of funds. Additionally, the correlation between the FDI inflows and the IV is 0.54. This evidence confirms the validity of the relevance condition of our instrument.

The exclusion restriction requires the IV to affect the outcomes only through its effect on the FDI_{idt} variable. For example, our IV is invalid when FDI inflows from a certain source to other exporting countries lead to increased competition in the global market, which in turn affects the exports from the considered destination. The competition effect, as well as any technology or productivity shocks impacting the outcomes in this example, are captured by world export and the NRCA index at the product-exporter-year level in (see Eq. (1)). Moreover, by fixing the weight in Eq. (4) to the figures in 2003, the first year in our sample, there is no endogeneity issue caused by the weight.

There are two possible caveats of our identification strategy. First, we cannot compute values of the IV for industry-destination groups where their source markets invest in only one industry-exporting country group. Our sample excludes these observations.[4]

Another possible challenge to our identification strategy arises when a source market shifts its FDI from one destination to another, which we are unable to verify due to data limitations. This FDI switching activity may affect the relevance condition only if the shift is gradual, resulting in lower FDI inflows to the original destination but higher FDI inflows to the new destination. This gradual shift in FDI might weaken the relationship between the FDI_{idt} variable and its IV. We conduct the tests for under-identification and weak identification of the IV using the Kleibergen-Paap LM statistics and the Kleibergen-Paap Wald F statistics, respectively; and reject the null hypothesis of under-identification and weak identification in all specifications. These statistics confirm the informativeness of our instrumental variable.

A shift in FDI may influence the validity of the exclusion restriction condition if the shift in FDI is related to any other variables that may affect the outcomes. This threat is mitigated by the inclusion of a large set of fixed effects and controls in our model specifications (see Section 3).

4.4 Moderators

To construct the data on our moderators, which are technology variables - technological endowment ($\text{tech}_{jd}^{\text{endow}}$) and technological growth ($\text{tech}_{jd}^{\text{growth}}$), we use the patent data

[4] Table A.1 presents the list of source countries that invest in a single exporting country from 2003-2019.

retrieved from the European Patent Office (EPO)'s PATSTAT database, 2022 Spring edition. PATSTAT is a database with highly comprehensive coverage of bibliographic patent data from 202 patent offices worldwide. When seeking patent protection, applicants must file a patent application with the patent office in the respective jurisdiction. Such patent application document contains valuable bibliographical information, including the application filing date, the country of residence of the applicants, and the technical content, which many studies have used to construct technology variables (Aghion et al., 2018; Bergeaud et al., 2025; Boeing & Mueller, 2019; Picci, 2010). Nonetheless, given that patent data is reported by patent offices with varying documentation requirements, incomplete information is not uncommon. Hence, we use imputed PATSTAT data following the method provided by (Ge et al., 2022) to facilitate cross-country comparison.

For the purposes of this study, we need to construct the technology variables at the product-exporter-year level. To achieve that, we have made the following methodological decisions. Firstly, we count the number of DOCDB patent families, rather than patent applications. A DOCDB patent family in PATSTAT refers to a collection of patent applications covering the same invention. One key advantage of this approach is that it avoid inflating the actual innovation performance of a given country since oftentimes there are multiple patent applications associated with the same invention. Secondly, regarding the temporal indicator, the earliest filing year among all patent applications within the same family is chosen as it is closest to the time when the invention is created. Thirdly, the country to which a patent family belongs is defined by the countries of residence of the patent applicants who filed the first filing. [5]

Regarding product-level classification, PATSTAT uses NACE2 (Statistical Classification of Economic Activities in the European Community, version 2) classification to determine which industries a patent application belongs to. Specifically, each patent application is assigned one or more 2-4 digit NACE2 codes, with corresponding weights that add up to 1. The higher the weight, the closer the relationship between the patent and the industry. By summing up the weights at the NACE2-applicant country-year level, we obtain the number of patent families categorised under 84 NACE2 industries. The next step is to convert NACE2 to product-level classification. However, there is no direct NACE2-HS concordance. Thus, the NAICS 2012 classification is used as an intermediate to conduct two rounds of m:m merging. There are only 40 unique NACE2 codes successfully mapped to NAICS 2012 codes then to HS-2 digit product codes. In this process, 53.5% of patent observations are lost. [6] After merging, one NACE2 code

[5] If the same patent application has multiple applicants from different countries, each country is counted once, no matter how many applicants are from the same country. For example, if a patent is applied for by two Japanese and one American, Japan and the US will be counted as one each.

[6] In the original patent dataset at NACE2 classification, there are 84 NACE2 codes. Among them, there are 44 codes that cannot be matched to the HS2 digit codes. 53.5% is the share of observations with such NACE2 codes out of all observations in the original patent dataset.

corresponds to many HS-2 digit product codes, and vice versa. Therefore, to obtain product-country-year level technology variables, we compute the average of patent family counts at the HS2-exporter-year level observations. Finally, we derive $\text{tech}_{jd}^{\text{endow}}$ as the number of patent families in 2003 pertaining to HS2-digit product j in exporter country d and $\text{tech}_{jd}^{\text{growth}}$ refers to growth in the number of patent families between 2003 to 2019 pertaining to HS2-digit product j in exporter country d.

4.5 Control variables

We construct the control variables of world export values as HS-4 digit level ($Exp_{h,t}$) and the normalized revealed comparative advantage index (NRCA) at product-exporting country level ($NRCA_{jd,t}$), using again the BACI database compiled by CEPII. NRCA is defined as $NRCA_{jd,t} = \dfrac{RCA_{jd,t} - 1}{RCA_{jd,t} + 1}$, where $RCA_{jd,t}$ is the Balassa (1965) revealed comparative advantage index and computed as the ratio of product j's share in country d's exports ($Exp_{jd,t}/Exp_{d,t}$) to its share in the world exports (Exp_{jt}/Exp_t).[7]

After mapping all variables as described above, the dataset forms an unbalanced panel of 34,861,806 observations, covering 176 exporting countries, 208 destination markets, and 3492 HS-6-digit products annually from 2003 to 2019. Summary statistics for the variables used in the study are presented in Table 1.

5 Results

Before presenting the estimation results, we first document the correlations between FDI and key export performance indicators using a binned scatter plot in Fig. 1.[8] The plots indicate a positive association between FDI inflows and export quality, providing illustrative evidence consistent with our hypothesis that FDI enhances export sophistication. Fig. 1 further shows that FDI is positively correlated with other export performance measures, including quantity and trade value. The notable exception is unit value, which exhibits a negative relationship with FDI inflows.

5.1 Baseline

Table 2 presents the estimation results of Eq. (1). Panel A reports the OLS estimates with fixed effects, with each column corresponding to one of the four export performance measures: quality, quantity, trade value, and unit value. Panel B reports the IV regression results. The OLS estimates in Panel A (see column (1)) indicate that a 1% increase in

[7] A positive NRCA, i.e. the corresponding revealed comparative advantage index is greater than one ($RCA_{jt}^{d} > 1$), implies that country d has a comparative advantage in producing product j at time t.

[8] Given the size of the dataset, the visualization is generated using Stata's binned scatterplots program.

Table 1: Descriptive statistics

	N	Min	Mean	Max	SD
Dependent variables					
Quality	16710640	-1428.85	-4.83	678.65	34.57
Quantity	16710640	-6.91	0.87	14.36	3.28
Trade value	16710640	-6.91	3.79	14.90	2.71
Unit value	16710640	-9.91	2.92	19.31	1.83
Independent variable					
FDI	16710640	-21.69	-1.38	9.90	3.00
Instrumental variable					
Shift-share FDI IV	16710640	-23.02	-1.05	8.35	2.82
Shift-share FDI IV (alternate definition)	15412692	-23.02	-1.36	8.59	2.80
Moderators					
Technological endowment	14676977	-3.58	3.80	9.12	2.30
Technological growth	14676977	-0.99	0.92	67.41	3.48
Control variables					
World exports	16710640	-3.38	16.16	20.39	1.58
NRCA	16709373	-1.00	-0.04	0.99	0.41
Other export performance measures					
No. of export destination markets	430191	0	3.00	4.584967	1.14
No. of products exported	10851	0	3.71	7.534228	1.94

Note: The dependent variables are export performance measures: log of product quality, log of quantity, log of trade value and log of unit value. These are measured at the HS6 product – exporting country – importing country – year level. The independent variable, FDI, represents log of total greenfield FDI inflows at the HS6 product – exporting country – year level. The shift-share FDI instrument serves as the IV, also at the HS6 product – exporting country – year level. The technology moderators are time invariant and measured at the HS6 product – exporting country level. The control variable for world exports is measured at the HS4 product – year level. The other control variable, NRCA is also measured at the HS6 product – exporting country – year level. We also use additional export performance measures for robustness, including the number of export destination markets (HS6 product – exporting country – year) and the number of products exported (NAICS 3-digit industry – exporting country – year).

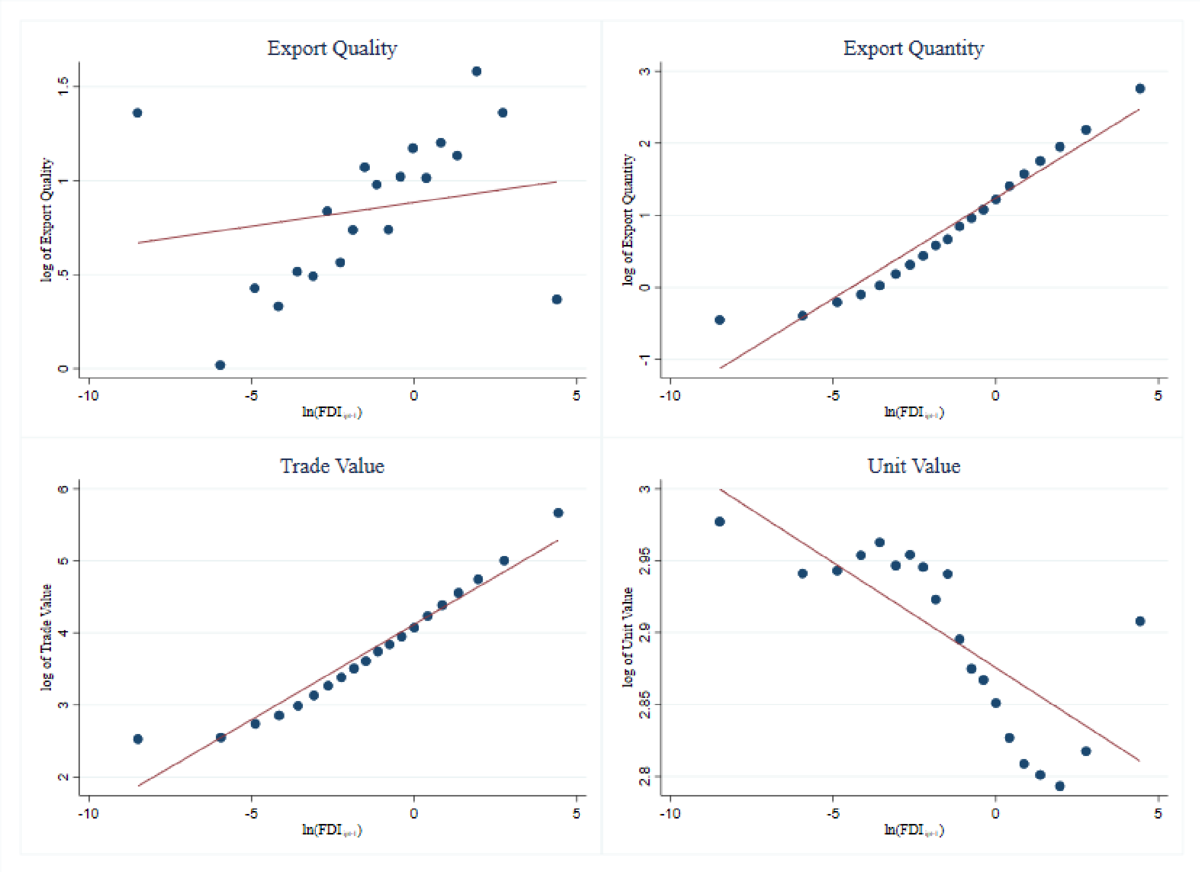

Figure 1: FDI and export performance, (2003-2018)

FDI inflows is associated with a 0.08% improvement in export quality, highlighting FDI as a positive and significant determinant of export sophistication. The corresponding IV estimate in Panel B corroborates this finding in sign and significance, confirming that FDI inflows enhance export sophistication. The large KP statistics further indicate that weak instruments are unlikely to pose a concern in the IV regression results.

Columns (2)–(4) report the effects of FDI inflows on other export performance measures, namely export quantity, trade value, and unit value. Both the OLS and IV estimates in columns (2) and (3) show a statistically significant positive association between FDI inflows and export quantity and trade value. In contrast, column (4) indicates that higher FDI inflows significantly reduce export unit values. Because export unit value serves as a proxy for export price, it is often used as an indicator of export quality (Schott, 2004). The divergent effects of FDI on export quality and unit value observed in Table 2 align with the findings of previous studies that highlight the limitations of using unit values as proxies for product quality (Khandelwal, 2010; Szczygielski & Grabowski, 2012; Jakel & Sorensen, 2020).[9] Despite the negative effect of FDI inflows on export unit values, the overall impact of FDI on export trade value remains significantly positive.

[9]Higher prices may reflect wage differentials, production costs, or trade costs rather than differences in product quality.

Given that trade value is the product of export quantity and unit value, this result suggests that the positive effect of FDI on export quantity more than offsets its negative effect on unit value, yielding a net positive effect on export trade value.

Table 2: FDI and export performance: Baseline results

	(1) Quality	(2) Quantity	(3) Trade value	(4) Unit value
Panel A: FE regression				
$\ln(FDI_{jdt-1})$	0.082***	0.113***	0.103***	-0.010***
	(0.004)	(0.003)	(0.002)	(0.001)
Panel B: IV regressions				
$\ln(FDI_{jdt-1})$	0.117***	0.161***	0.148***	-0.013***
	(0.006)	(0.004)	(0.003)	(0.001)
KP LM stat	12713.264	12713.264	12713.264	12713.264
KP Wald F stat	124916.133	124916.133	124916.133	124916.133
Observations	16708352	16708352	16708352	16708352
Controls	Yes	Yes	Yes	Yes
Exporter-Year FE	Yes	Yes	Yes	Yes
Importer-Year FE	Yes	Yes	Yes	Yes
Exporter-Importer FE	Yes	Yes	Yes	Yes
HS6 FE	Yes	Yes	Yes	Yes

Notes: The dependent variables are the log of product quality, log of quantity, log of trade value, and log of unit value. FDI_{jdt-1} refers to total greenfield FDI flows to exporter d in HS6 product j at year *t-1*. All regressions include exporter–year, importer–year, exporter–importer, and product (HS6) fixed effects, and they also control for the lagged log of world export value at the HS4 level, as well as the lagged normalised revealed comparative advantage at the exporter–HS6–year level. The table also reports the Kleibergen-Paap LM statistic for underidentification and the Kleibergen-Paap Wald F statistic for weak identification of the instrumental variable. The sample used to estimate product quality excludes observations with export values that are below the 5th and above the 95th percentiles. The table trims observations with product quality that are below the 5th and above the 95th percentiles. Standard errors clustered at the HS6-exporter level are reported in parentheses. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level, respectively.

Taken together, these results suggest that FDI-driven technology diffusion raises export quality while simultaneously exerting downward pressure on prices, consistent with productivity-enhancing process and organisational innovations. This price–quality divergence highlights the importance of distinguishing technological upgrading from price-based indicators when assessing the impact of FDI on export performance.

5.2 Robustness

To ensure the reliability and generalizability of our baseline findings, we conduct a series of robustness checks using multiple approaches. First, we examine the sensitivity of our results to potential measurement errors in the product quality estimates by comparing the trimmed sample with the full sample. Second, we assess whether the baseline results hold across different sub-samples of exporting countries, distinguishing between advanced and emerging markets. Third, we test the robustness of our instrumental variable strategy by constructing an alternative IV that accounts for income group similarities among destination countries. Finally, we explore additional measures of export performance, including the number of export markets and the number of exported products, to verify that our conclusions are not limited to the traditional measures of quality, quantity, trade value, and unit value.

Full sample To mitigate potential measurement errors arising from the quality estimation procedure, the estimation results in Table 2 are based on the data sample that excludes the bottom and top 5% within each exporter and SITC 4-digit sector from the product quality distribution. Table 3 shows that our results remain unchanged when using the entire sample for the regressions.

Table 3: FDI and export performance: Robustness (Full Sample)

	Quality		Quantity		Trade value		Unit value	
	(1) FE	(2) IV	(3) FE	(4) IV	(5) FE	(6) IV	(7) FE	(8) IV
$\ln(FDI_{jdt-1})$	0.239***	0.300***	0.113***	0.161***	0.103***	0.149***	-0.010***	-0.012***
	(0.084)	(0.116)	(0.003)	(0.003)	(0.002)	(0.003)	(0.001)	(0.001)
Observations	18593317	18593317	18593317	18593317	18593317	18593317	18593317	18593317
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Exporter-Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Importer-Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Exporter-Importer FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
HS6 FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
KP LM stat		12631.000		12631.000		12631.000		12631.000
KP Wald F stat		124595.913		124595.913		124595.913		124595.913

Notes: The dependent variables are the log of product quality, the log of quantity, the log of trade value, and the log of unit value. FDI_{jdt} refers to total greenfield FDI flows to exporter d in HS6 product j at year t. All regressions include exporter–year, importer–year, exporter–importer, and product (HS6) fixed effects, and they also control for the lagged log of world export value at the HS4 level, as well as the lagged normalised revealed comparative advantage at the exporter–HS6–year level. The table also reports the Kleibergen-Paap LM statistic for underidentification and the Kleibergen-Paap Wald F statistic for weak identification of the instrumental variable. Standard errors clustered at the HS6-exporter level are reported in parentheses. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level, respectively.

Sub-samples Next, we estimate Eq. (1) for two sub-samples. The first sub-sample includes exporting countries classified as advanced markets, while the second sub-sample includes countries classified as emerging markets. We define emerging markets as countries in the *middle* and *low* income groups, and advanced markets as countries in the *high* income group, based on the World Bank's 2003 income-level classification.[10] Panels A and B in Table 4 present the sub-sample estimation results for advanced and emerging market exporters, respectively. The results indicate that the baseline findings hold for both groups, suggesting that the observed effects are a general phenomenon across different types of exporting countries.

[10] We use the 2003 classification, the first year in our sample, to mitigate potential endogeneity concerns.

Table 4: FDI and export performance: Robustness (sub-samples)

Panel A: Sub-sample of advanced market exporting countries

	Quality		Quantity		Trade value		Unit value	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	FE	IV	FE	IV	FE	IV	FE	IV
$ln(FDI_{jd,t-1})$	0.071***	0.098***	0.105***	0.156***	0.095***	0.142***	-0.010***	-0.014***
	(0.005)	(0.008)	(0.003)	(0.004)	(0.002)	(0.004)	(0.001)	(0.002)
Observations	9951985	9951985	9951985	9951985	9951985	9951985	9951985	9951985
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Exporter-Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Importer-Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Exporter-Importer FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
HS6 FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
KP LM stat		6652.032		6652.032		6652.032		6652.032
KP Wald F stat		56614.328		56614.328		56614.328		56614.328

Panel B: Sub-sample of emerging market exporting countries

	Quality		Quantity		Trade value		Unit value	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	FE	IV	FE	IV	FE	IV	FE	IV
$ln(FDI_{jd,t-1})$	0.081***	0.112***	0.111***	0.157***	0.099***	0.142***	-0.012***	-0.015***
	(0.005)	(0.007)	(0.004)	(0.005)	(0.003)	(0.004)	(0.001)	(0.001)
Observations	6756110	6756110	6756110	6756110	6756110	6756110	6756110	6756110
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Exporter-Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Importer-Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Exporter-Importer FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
HS6 FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
KP LM stat		7025.600		7025.600		7025.600		7025.600
KP Wald F stat		61530.037		61530.037		61530.037		61530.037

Notes: The dependent variables are the log of product quality, log of quantity, log of trade value, and log of unit value. FDI_{jdt} refers to total greenfield FDI flows to exporter d in HS6 product j at year t. All regressions control for the lag of log of world export value at the HS4 level and lag of normalized revealed comparative advantage at the exporter-HS4-year level. The Kleibergen-Paap LM statistic for underidentification and the Kleibergen-Paap Wald F statistic for weak identification of the instrumental variable are reported at the bottom of the table. The table trims observations with product quality that are below the 5th and above the 95th percentiles. Standard errors clustered at the HS6-exporter level are reported in parentheses. *, **, and *** indicate coefficients significantly different from zero at the 10%, 5%, and 1% level, respectively.

Alternate definition of IV In the baseline results reported in Table 2, we instrument exporters' FDI inflows using the average FDI inflows from the same source countries to all other destination countries, excluding the exporter.[11] To assess the robustness of our findings, we construct an alternative instrument that restricts the set of other destination countries to those within the same income group as the exporter. Estimates using this second instrument, as shown in Table 5, are consistent with our baseline findings that FDI inflows are a positive and significant determinant of export performance measures such as quality, quantity, and trade value, while negatively affecting export unit values.

Table 5: FDI and export performance: Robustness (Instrument Variable)

	Quality		Quantity		Unit value		Trade value	
	(1) FE	(2) IV	(3) FE	(4) IV	(5) FE	(6) IV	(7) FE	(8) IV
$\ln(FDI_{jdt-1})$	0.085***	0.131***	0.117***	0.179***	-0.010***	-0.013***	0.107***	0.165***
	(0.004)	(0.006)	(0.003)	(0.004)	(0.001)	(0.001)	(0.002)	(0.004)
Observations	15410457	15410457	15410457	15410457	15410457	15410457	15410457	15410457
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Exporter-Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Importer-Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Exporter-Importer FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
HS6 FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
KP LM stat		12209.888		12209.888		12209.888		12209.888
KP Wald F stat		73649.475		73649.475		73649.475		73649.475

Notes: The dependent variables are the log of product quality, log of quantity, log of trade value, and log of unit value. FDI_{jdt-1} refers to total greenfield FDI flows to exporter *d* in HS6 product *j* at year *t-1*. All regressions control for the lag of log of world export value at the HS4 level and lag of normalized revealed comparative advantage at the exporter-HS6-year level. The Kleibergen-Paap LM statistic for underidentification and the Kleibergen-Paap Wald F statistic for weak identification of the instrumental variable are reported at the bottom of the table. The sample used to estimate product quality excludes observations with export values that are below the 5th and above the 95th percentiles. The table trims observations with product quality that are below the 5th and above the 95th percentiles. Standard errors clustered at the HS6-exporter level are reported in parentheses. *, **, and *** indicate coefficients significantly different from zero at the 10%, 5%, and 1% level, respectively.

Other export performance measures Our discussion of baseline results in Section 5.1 focuses on the export performance measures of quality, quantity, trade value and unit value. Export upgradation of economies can also occur through the introduction of more export products and entry into new export markets (Shepherd, 2010; Guo et al., 2020). Hence, in this section, we further examine the effect of FDI on two additional measures of export performance: the number of export markets and the number of exported products.

Table 6 presents the estimation results where the dependent variable is either a) the number of export markets for product j exported from country d at time t, or b) the number of HS-6 digit products exported by country d within NAICS-3 digit industry ("subsector") i at time t. The results in columns (1)-(2) indicate that FDI inflows have a positive and statistically significant impact on the number of export markets served by

[11] Source countries refer to those from which FDI flows into the exporter, as identified in our greenfield FDI dataset. See Section 4 for details on the IV construction.

a product on average. Columns (3)-(4) also indicate that FDI inflows into an industry have a statistically significant positive effect on the number of products exported from the industry. [12] This indicates that FDI serves as a catalyst for both market expansion and product diversification. Increased FDI inflows enable host countries to serve a greater number of export destinations and export new products.

Table 6: FDI on other export performance

	Export Market		Export Product	
	(1) FE	(2) IV	(3) FE	(4) IV
$\ln(FDI_{jd,t-1})$	0.024***	0.035***		
	(0.001)	(0.001)		
$\ln(FDI_{id,t-1})$			0.039***	0.106***
			(0.006)	(0.012)
Observations	429588	429588	10578	10578
Controls	Yes	Yes	No	No
Exporter-Year FE	Yes	Yes	Yes	Yes
HS6 FE	Yes	Yes		
NAICS2-Year FE			Yes	Yes
KP LM stat		13319.889		429.336
KP Wald F stat		203989.912		826.406

Notes: The dependent variables of column (1) and (2) are the log of the number of export markets of HS6 product j exported from country d in year t. The dependent variables of column (3) and (4) are the log of the number of HS6 products exported by country d in NAICS3-digit subsector i in year t. $\ln(FDI_{jd,t-1})$ refers to total greenfield FDI flows to exporter d in HS6 product j at year *t-1*. $\ln(FDI_{id,t-1})$ refers to total greenfield FDI flows to exporter d in NAICS3-digit subsector i in year *t-1*. Regressions in column (1) and (2) control for the lag of log of world export value at the HS4 level and lag of normalized revealed comparative advantage at the exporter-HS6-year level. The Kleibergen-Paap LM statistic for underidentification and the Kleibergen-Paap Wald F statistic for weak identification of the instrumental variable are reported at the bottom of the table. The sample used to estimate product quality excludes observations with export values that are below the 5th and above the 95th percentiles. The table trims observations with product quality that are below the 5th and above the 95th percentiles. Standard errors clustered at the NAICS-year level are reported in parentheses. *, **, and *** indicate coefficients significantly different from zero at the 10%, 5%, and 1% level, respectively.

5.3 Role of technological context in FDI effect on export performance

The results in Section 5.1 show that FDI inflows increase export quality while negatively impacting export unit value. A plausible mechanism for these diverging effects is the diffusion of technological and managerial spillovers from FDI, which enhances domestic

[12] See Eq. (A.1) and Eq. (A.2) in the Appendix for details on the empirical specification when the export performance measures are number of products exporter and number of export destination markets served.

productivity and enables exporting countries to produce higher-quality goods at lower cost (Liu, 2008; Fu, 2012; Perri & Peruffo, 2016). Consequently, exporting countries can offer more sophisticated products at lower unit prices (positive competition effect). Such competition effects are likely to be stronger in technologically mature industries, as they may have a higher capability to make more effective use of FDI-related knowledge spillovers - absorptive capacity (Meyer & Nguyen, 2005; Lu et al., 2017; Sultana & Turkina, 2020). In such industries, lower entry barriers and higher production efficiencies further reduce costs, allowing firms to offer high-quality products at more competitive prices. As a result, the negative effect of FDI on unit values is likely to be stronger in such settings. By contrast, the negative effect of FDI on export unit values is likely to be weaker in technologically advanced or frontier industries, where higher entry barriers limit competitive pressures and greater protection of technology may prevent export prices from falling even in the presence of FDI-induced spillovers.

To illustrate this point using industry examples, Fig. 2 plots the average growth rate of patent families between 2003 and 2019 on the x-axis and the average number of patent families in 2003 on the y-axis for each industry at the NAICS 3-digit level. The furniture industry can be considered as an example of a technologically mature industry, exhibiting a high level of technological endowment at the start of the period (number of patent families in 2003), but showing little to no technological growth over the sample period (negative growth in patent families between 2003 and 2019). In line with the discussion above, in these industries, the positive impact of FDI on export quality and the negative impact on unit value are expected to be stronger. In contrast, the computer and electronics industry represents a technological frontier industry, characterised by high technological growth, which indicates higher entry barriers. We therefore expect the negative impact of FDI on export prices to be more muted in such frontier industries.

Table 7 reports the estimation results for each of the dependent variables of interest - export quality, quantity, trade value and unit value. Table 7 initially presents the estimation results obtained when each technology variable, technological endowment and technological growth, and its interaction terms are included individually. It subsequently reports the results that incorporate both technology variables jointly, together with all corresponding interactions, as defined in Eq. (2).

The results in Table 7 show that our baseline findings remain robust under the revised specifications. FDI inflows continue to have a positive and significant impact on export performance, as measured by export quality, quantity, and trade value, while exerting a significant negative effect on export unit values. The interaction term $\ln(FDI_{jd,t-1}) \times \ln(\text{tech}_{jd}^{\text{endow}})$ in columns (1), (3)-(4), (6)-(7), (9)-(10), and (12) is positive and significant when the dependent variable is export quality/quantity/trade value, and is negative and economically meaningful when the dependent variable is export unit value. These findings support our discussion earlier that a higher initial technological level, character-

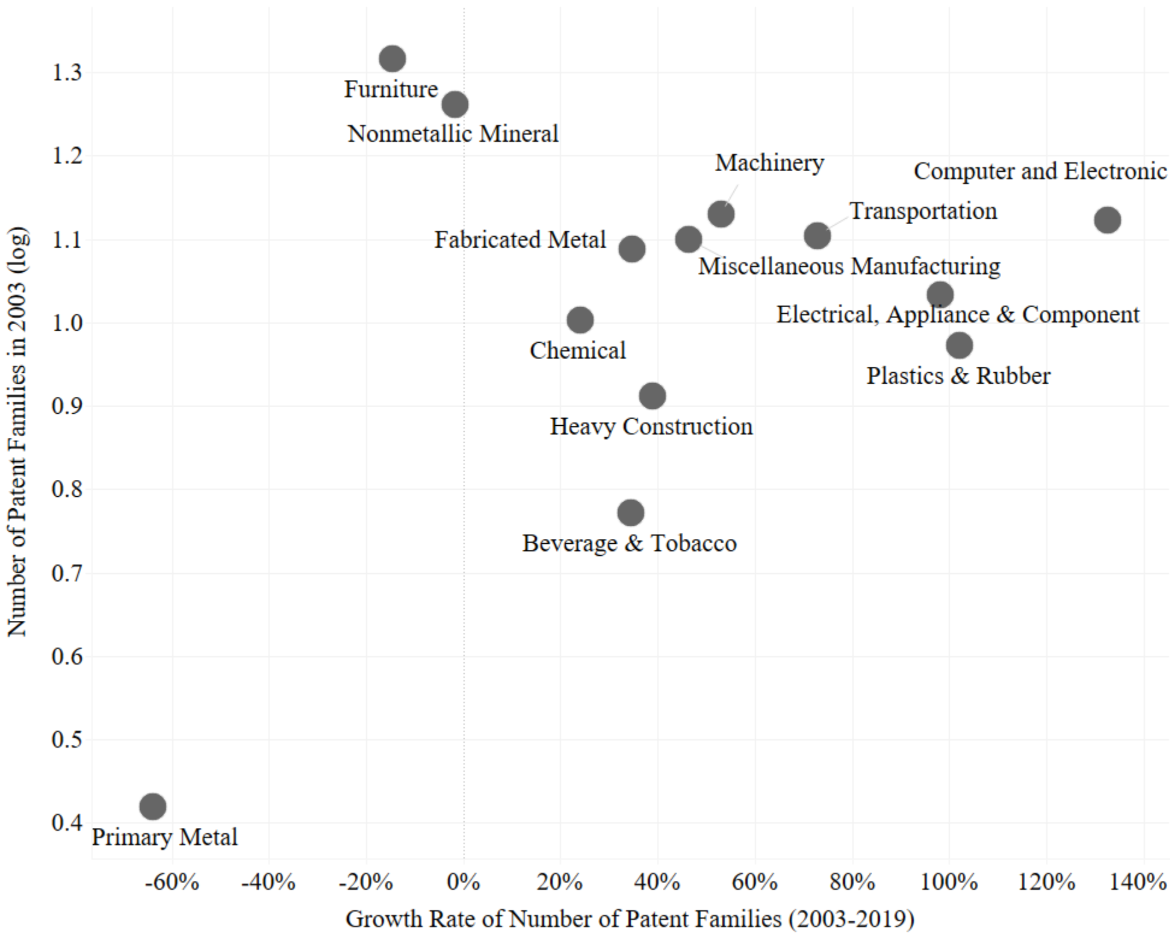

Figure 2: Technological endowment (2003) and technological growth (2003–2019) across industries

istic of more mature and competitive industries, amplifies the impact of FDI on export performance.[13]

A different pattern emerges when considering technological growth. The interaction coefficient $\ln(FDI_{jd,t-1}) \times \text{tech}_{jd}^{\text{growth}}$ is positive and economically significant across all export performance measures as the dependent variable (see columns (2)-(3), (5)-(6), (8)-(9), and (11)-(12)). Notably, the interaction term remains positive and significant even when export unit value is the dependent variable (see columns (11)-(12)). This suggests that the negative impact of FDI on export unit value becomes less pronounced for products located closer to the technological frontier. In other words, higher technological progress, supported by greater research and development investment and accompanied by higher entry barriers and protection, mitigates the adverse competition effects of FDI on export unit values.[14]

[13]Downstream sectors also have low entry barriers. Table A.4 in the Appendix shows that the diverging effect of FDI on export quality and unit value is stronger in these products.

[14]The negative effect of FDI on unit values is weaker for high R&D products (above the 50th percentile) than for low R&D products at the HS2 level. See Table A.3 in the Appendix.

Table 7: FDI and export performance: The role of technology

	Quality			Quantity			Trade value			Unit value		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
$\ln(FDI_{jd,t-1})$	0.062***	0.114***	0.059***	0.072***	0.161***	0.071***	0.068***	0.149***	0.066***	-0.004**	-0.013***	-0.005***
	(0.009)	(0.007)	(0.009)	(0.005)	(0.004)	(0.005)	(0.004)	(0.003)	(0.004)	(0.002)	(0.001)	(0.002)
$\ln(FDI_{jd,t-1}) \times \ln(\text{tech}_{jd}^{\text{endow}})$	0.018***		0.016***	0.027***		0.026***	0.025***		0.024***	-0.002***		-0.002***
	(0.002)		(0.002)	(0.001)		(0.001)	(0.001)		(0.001)	(0.000)		(0.000)
$\ln(\text{tech}_{jd}^{\text{endow}})$	0.183***		0.207***	0.081***		0.091***	0.089***		0.102***	0.007		0.011
	(0.027)		(0.028)	(0.014)		(0.015)	(0.012)		(0.013)	(0.007)		(0.007)
$\ln(FDI_{jd,t-1}) \times \text{tech}_{jd}^{\text{growth}}$		0.011***	0.009***		0.007***	0.004***		0.009***	0.006***		0.001***	0.002***
		(0.001)	(0.001)		(0.001)	(0.001)		(0.001)	(0.001)		(0.000)	(0.000)
$\text{tech}_{jd}^{\text{growth}}$		0.049***	0.059***		0.021***	0.024***		0.029***	0.034***		0.009***	0.009***
		(0.011)	(0.011)		(0.008)	(0.008)		(0.008)	(0.008)		(0.002)	(0.002)
Observations	14675790	14675790	14675790	14675790	14675790	14675790	14675790	14675790	14675790	14675790	14675790	14675790
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Exporter-Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Importer-Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Exporter-Importer FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
HS6 FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
KP LM stat	9857.950	10500.556	10157.930	9857.950	10500.556	10157.930	9857.950	10500.556	10157.930	9857.950	10500.556	10157.930
KP Wald F stat	48885.246	52639.528	33750.837	48885.246	52639.528	33750.837	48885.246	52639.528	33750.837	48885.246	52639.528	33750.837

Notes: The dependent variables are the log of product quality, log of quantity, log of trade value, and log of unit value. FDI_{jdt-1} refers to total greenfield FDI flows to exporter d in HS6 product j at year *t-1*. $\ln(FDI_{jd,t-1}) \times \ln(\text{tech}_{jd}^{\text{endow}})$ refers to the interaction term between FDI_{jdt-1} and the log of number of patent families in 2003. $\ln(FDI_{jd,t-1}) \times \text{tech}_{jd}^{\text{endow}}$ refers to the interaction term between $FDI_{jd,t-1}$ and the grow rate of the number of patent families between 2003 and 2019. All regressions control for the lag of log of world export value at the HS4 level and lag of normalized revealed comparative advantage at the exporter-HS6-year level. All regressions control for the lag of log of world export value at the HS4 level and lag of normalized revealed comparative advantage at the exporter-HS6-year level. The Kleibergen-Paap LM statistic for underidentification and the Kleibergen-Paap Wald F statistic for weak identification of the instrumental variable are reported at the bottom of the table. The sample used to estimate product quality excludes observations with export values that are below the 5th and above the 95th percentiles. The table trims observations with product quality that are below the 5th and above the 95th percentiles. Standard errors clustered at the HS6-exporter level are reported in parentheses. *, **, and *** indicate coefficients significantly different from zero at the 10%, 5%, and 1% level, respectively.

6 Conclusion

This study provides a comprehensive global analysis of the impact of FDI on export sophistication, utilising highly disaggregated bilateral trade, FDI, and patent data from 2003 to 2019. By addressing the endogeneity of FDI through a novel shift-share instrumental variable, we establish a robust positive relationship between FDI inflows and the upgrading of export quality in host countries.

A central finding of the analysis is the divergence between export quality and export prices following FDI inflows. While FDI is consistently associated with improvements in export quality, it simultaneously exerts downward pressure on export unit values. This pattern is consistent with technology-driven productivity gains that allow firms to enhance product attributes while reducing marginal costs. The results underscore the limitations of relying on unit values as proxies for quality and emphasize the need to distinguish technological upgrading from price-based measures of export performance when assessing the impact of FDI.

We find that the FDI effects on quality and price are moderated by the technological contexts of the exported products. In technologically mature products, FDI intensifies price competition and quality upgrading through traditional spillover channels. Conversely, in frontier products with higher R&D intensity and entry barriers, the negative effect on prices is muted, while the positive effect on export quality remains stronger.

These findings suggest that a blanket approach to attracting FDI may yield varied results depending on a sector's technological maturity. While FDI is a powerful catalyst for export upgrading, it may also drive down export prices through efficiency gains. Strategies to enhance export sophistication should therefore be tailored to the specific technological context of the exported products to maximise the benefits of knowledge spillovers and competitive restructuring from FDI.

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Appendix

Model specification for further export performance measures

$$ln(\#Export\ Market)_{jdt} = \alpha_0 + \alpha_1 ln(FDI_{jd,t-1}) + \alpha_2 ln(Exp_{h,t-1}) + \alpha_3 NRCA_{jd,t-1} + \alpha_{dt} + \alpha_j + \epsilon_{jdmt} \tag{A.1}$$

where $ln(\#Export\ Market)_{jdt}$: log of the number of export markets of product j exported from country d at time t.

$$ln(\#Export\ Product)_{idt} = \alpha_0 + \alpha_1 ln(FDI_{id,t-1}) + \alpha_{dt} + \alpha_{it} + \epsilon_{idt} \tag{A.2}$$

where $ln(\#Export\ Product)_{idt}$: log of the number of HS-6 digit products exported by country d in NAICS-3 digit industry ("subsector") i at time t

Tables

Table A.1: List of source countries which invest in single destination (2003-2019)

2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
ATG	AGO	ARM	AFG	BRB	AND	AGO	ALB	AFG	AND	BDI	BFA	AGO	ALB	AND	ABW	AGO
BGD	ALB	AZE	ARM	DOM	BHS	AND	ARM	AND	BDI	BGD	CIV	AZE	AND	BIH	AFG	ARM
BHS	AND	BHS	BHS	GRL	BIH	BGD	BRB	ARM	BHS	BOL	COD	BGD	BDI	BTN	AGO	BFA
CYM	AZE	BLR	CIV	HND	BRN	BHS	BWA	BHS	BRB	BWA	ECU	BLZ	BLZ	CMR	BHS	BIH
DOM	CIV	BRB	DZA	IRQ	ERI	BWA	COD	BLZ	DZA	CUB	FJI	BOL	BRN	FSM	BIH	BRB
ECU	DOM	CMR	ECU	JAM	GRL	CMR	ECU	BRN	ETH	DZA	GAB	BRB	BWA	GHA	COG	BRN
GUY	GEO	CRI	FSM	LKA	KGZ	DZA	FJI	CUB	HND	GEO	LAO	BWA	CUB	GTM	CRI	CRI
KGZ	GHA	DOM	NAM	MMR	KHM	ETH	GEO	ECU	ISL	GNQ	NIC	CIV	ECU	IRQ	CUB	GAB
MAC	HND	ECU	NGA	MTQ	MAC	FJI	HTI	GAB	KAZ	HTI	SEN	COG	FJI	KGZ	DOM	GEO
MAR	KEN	GRL	PAN	SDN	MDA	GHA	MKD	MDA	MAR	KHM	SLV	CUB	GAB	KHM	ECU	GNQ
MKD	LKA	GTM	PER	SRB	MWI	IRQ	MLI	NCL	MOZ	MAC	SYR	DZA	GHA	LBY	GUY	HTI
MUS	MLT	HND	PSE	TZA	NAM	KGZ	MNE	NIC	MWI	MMR	TCA	GAB	GTM	MAC	IRQ	LBY
NGA	MNG	IRQ	SDN	UGA	NPL	KHM	MNG	NPL	NIC	MNE		GEO	LBY	MLI	JAM	MNG
OMN	PAN	KGZ	TTO	URY	SYR	MWI	PNG	SDN	NPL	NIC		GHA	MNE	MNG	KAZ	NPL
SLV	URY	LBY	WSM		TZA	PYF	TTO	SEN	PAN	SYR		GNQ	MNG	PSE	MDG	SEN
SYR	ZWE	LCA			UGA	RWA	TUN	SLV	PSE	UGA		GRL	MWI	RWA	MKD	TTO
TUN		MUS			URY	SYR	UGA	URY	SEN			HND	SLE	SEN	MNG	UZB
		PAN			WSM	URY	URY		SMR			KHM	SLV	TZA	PNG	
		PER				ZMB	YEM		SYR			LAO	SMR	ZWE	PRY	
		SVK							UZB			SYC	SYR		SEN	
		TGO							YEM			VEN	TGO		SLV	
		TTO							ZMB				TJK			
		UGA											TKM			
													ZWE			

Table A.2: FDI and export performance - The role of host country technological development

	Quality		Quantity		Unit value		Trade value	
	(1) FE	(2) IV	(3) FE	(4) IV	(5) FE	(6) IV	(7) FE	(8) IV
$\ln(FDI_{jdt-1}) \times HighTech_{jd}$	0.112*	0.108	0.037***	0.046***	0.011**	0.009	0.048***	0.055***
	(0.061)	(0.071)	(0.012)	(0.014)	(0.005)	(0.006)	(0.011)	(0.013)
$\ln(FDI_{jdt-1})$	0.116**	0.173**	0.126***	0.182***	-0.009**	-0.009	0.116***	0.174***
	(0.053)	(0.079)	(0.011)	(0.015)	(0.004)	(0.006)	(0.010)	(0.014)
Observations	1261574	1261574	1261574	1261574	1261574	1261574	1261574	1261574
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Exporter-Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Importer-Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Exporter-Importer FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
HS6 FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
KP LM stat		620.789		620.789		620.789		620.789
KP Wald F stat		2464.111		2464.111		2464.111		2464.111

Notes: The dependent variables are the log of product quality, log of quantity, log of trade value, and log of unit value. FDI_{jdt-1} refers to total greenfield FDI flows to exporter d in HS6 product j at year *t-1*. $\ln(FDI_{jdt-1}) \times HighTech$ refers to the interaction term between FDI_{jdt-1} and the dummy variable which equals to 1 if the exporter demonstrates a patent growth rate at 50 percentile at the HS6 (2-digit) level. All regressions control for the lag of log of world export value at the HS4 level and lag of normalized revealed comparative advantage at the exporter-HS6-year level. The Kleibergen-Paap LM statistic for underidentification and the Kleibergen-Paap Wald F statistic for weak identification of the instrumental variable are reported at the bottom of the table. Standard errors clustered at the HS6-exporter level are reported in parentheses. *, **, and *** indicate coefficients significantly different from zero at the 10%, 5%, and 1% level, respectively.

Table A.3: FDI and export performance - The role of R&D intensity

	Quality		Quantity		Unit value		Trade value	
	(1) FE	(2) IV	(3) FE	(4) IV	(5) FE	(6) IV	(7) FE	(8) IV
$\ln(FDI_{jdt-1})$	0.077***	0.039*	0.133***	0.174***	-0.027***	-0.031***	0.106***	0.143***
	(0.017)	(0.022)	(0.005)	(0.006)	(0.002)	(0.002)	(0.004)	(0.005)
$\ln(FDI_{jdt-1} \times rnd_j)$	0.059***	0.154***	-0.022***	-0.012**	0.021***	0.023***	-0.001	0.011**
	(0.020)	(0.025)	(0.005)	(0.006)	(0.002)	(0.002)	(0.005)	(0.005)
Observations	17410267	17410267	17410267	17410267	17410267	17410267	17410267	17410267
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Exporter-Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Importer-Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Exporter-Importer FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
HS6 FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
KP LM stat		11418.511		11418.511		11418.511		11418.511
KP Wald F stat		59504.614		59504.614		59504.614		59504.614

Notes: The dependent variables are the log of product quality, log of quantity, log of trade value, and log of unit value. $FDIjdt - 1$ refers to total greenfield FDI flows to exporter d in HS6 product j at year *t-1*. $\ln(FDI_{jdt-1} \times rnd_j)$ refers to the interaction term between FDI_{jdt-1} and the dummy variable which equals to 1 if the exported product demonstrates an R&D at 50 percentile at the HS2 level. All regressions control for the lag of log of world export value at the HS4 level and lag of normalized revealed comparative advantage at the exporter-HS6-year level. The Kleibergen-Paap LM statistic for underidentification and the Kleibergen-Paap Wald F statistic for weak identification of the instrumental variable are reported at the bottom of the table. The sample used to estimate product quality excludes observations with export values that are below the 5th and above the 95th percentiles. Standard errors clustered at the HS6-exporter level are reported in parentheses. *, **, and *** indicate coefficients significantly different from zero at the 10%, 5%, and 1% level, respectively.

Table A.4: FDI and export performance - The role of GVC downstreamness

	Quality		Quantity		Unit value		Trade value	
	(1) FE	(2) IV	(3) FE	(4) IV	(5) FE	(6) IV	(7) FE	(8) IV
$\ln(FDI_{jdt-1})$	0.079***	0.109***	0.105***	0.155***	-0.010***	-0.015***	0.095***	0.140***
	(0.005)	(0.006)	(0.003)	(0.004)	(0.001)	(0.001)	(0.003)	(0.004)
$\ln(FDI_{jdt-1} \times dutu_j)$	0.005	0.014	0.031***	0.028***	-0.000	0.007***	0.030***	0.035***
	(0.008)	(0.010)	(0.005)	(0.005)	(0.002)	(0.002)	(0.004)	(0.005)
Observations	15642823	15642823	15642823	15642823	15642823	15642823	15642823	15642823
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Exporter-Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Importer-Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Exporter-Importer FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
HS6 FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
KP LM stat		11449.803		11449.803		11449.803		11449.803
KP Wald F stat		59385.267		59385.267		59385.267		59385.267

Notes: The dependent variables are the log of product quality, log of quantity, log of trade value, and log of unit value. FDI_{jdt-1} refers to total greenfield FDI flows to exporter d in HS6 product j at year *t-1*. $\ln(FDI_{jdt-1} \times dutu_j)$ refers to the interaction term between FDI_{jdt-1} and the dummy variable which equals to 1 if the exported product demonstrates a downstreamness level at 50 percentile at the HS2 level. All regressions control for the lag of log of world export value at the HS4 level and lag of normalized revealed comparative advantage at the exporter-HS6-year level. The Kleibergen-Paap LM statistic for underidentification and the Kleibergen-Paap Wald F statistic for weak identification of the instrumental variable are reported at the bottom of the table. The sample used to estimate product quality excludes observations with export values that are below the 5th and above the 95th percentiles. The table trims observations with product quality that are below the 5th and above the 95th percentiles. Standard errors clustered at the HS6-exporter level are reported in parentheses. *, **, and *** indicate coefficients significantly different from zero at the 10%, 5%, and 1% level, respectively.