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FDI dominance and the scope for a modern domestic industry

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ABSTRACT

This paper examines the "more is actually less" FDI argument in the context of a high-tech industry using Vietnam's electronics industry as a case study, where multinational corporations dominate output and capital investment. We connect Gereffi's global value chain governance framework with Meyer's country-of-origin perspective to analyze intra- and inter-industry spillovers. In doing so, we examine how FDI shapes domestic firms' managerial capabilities and technological upgrading. Using a ten-year firm-level panel and a metafrontier approach, we find that domestic firms achieve only 52 % efficiency in converting inputs to outputs and operate at just 64 % of the FDI technological frontier, with little improvement over time. Horizontal FDI enhances domestic management practices but fails to deliver meaningful technology spillovers. Its growing dominance also widens the technology gap, indicating the growing backwardness of domestic technology. Vertical FDI has mixed effects: upstream FDI supports managerial improvement, while downstream FDI encourages technological upgrading under competitive pressure. Spillovers vary by industry and FDI origin, with ASEAN- and China/Taiwan-based FDI offering modest technological and productivity gains. Our findings highlight the asymmetry between managerial and technology spillovers, suggesting that without stronger local linkages, FDI dominance may constrain, rather than enable, domestic upgrading in high-tech sectors.

1. Introduction

Foreign direct investment (FDI) has long been regarded as a key driver of economic development, especially in developing economies. By introducing advanced technologies, managerial practices, and access to global markets, FDI is expected to promote domestic upgrading and productivity growth. The developmental promise of FDI is based on several well-established spillover channels. Horizontal spillovers can enhance local managerial and technological capabilities through strategic FDI-domestic partnerships (Aitken and Harrison, 1999; Blalock and Gertler, 2009), observation and imitation (Goldberg and Pavcnik, 2007; Crescenzi et al., 2015; Newman et al., 2015), competitive pressure that spur innovation and efficiency (Cappelli et al., 2014), and labor mobility (Poole, 2013; Berger and Diez, 2008). Vertical spillovers, especially through backward linkages with local suppliers, can improve domestic firm performance through training, quality standards, and sustained business relationships (Javorcik, 2004; Kugler, 2006; Jordaan, 2008; Ito et al., 2012). These mechanisms are widely credited with supporting productivity growth, as observed in South Korea and China (Lee et al., 2006; Liang, 2017; Crescenzi and Harman, 2022).

However, this optimistic view is not universally supported. In Mexico, Kokko (1994) provides evidence of the absence of productivity spillovers when FDI dominates labor-intensive industries. Huang (2001) even finds that a greater prevalence of FDI can negatively affect domestic productivity in China, suggesting the "more is actually less" FDI phenomenon. Similarly, Nguyen and Diez (2019) also raise the striking fact about limited productivity spillovers from increased backward FDI presence in Vietnam's labor-intensive manufacturing industries. As Lee et al. (2018) explain, high export performance accompanied by low domestic value added characterizes only the initial *"in" phase* of a country's participation in global value chains (GVCs). In this stage, developing economies integrate into GVCs primarily through assembly and processing activities, with limited technological capability or domestic innovation. In producer-driven industries such as electronics, lead firms retain control over design, research and development (R&D), and core technologies, keeping local firms dependent on foreign inputs and standards. This structure creates a developmental trap: while FDI inflows expand production and employment, they offer few channels for domestic firms to accumulate indigenous capabilities. From the *GVC-to-innovation systems* perspective, the key challenge is not merely to attract

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FDI but to overcome structural constraints and capability gaps that prevent economies from advancing beyond the *"in" phase* toward the *"out"* and *"back-in"* stages of autonomous innovation and high-value reintegration.

Yet despite such evidence, the developmental implications of FDI dominance in high-tech, strategic sectors remain underexplored. This paper addresses that gap by asking: what happens when FDI takes control of a strategic value chain, such as electronics? We examine this question in the context of Vietnam's electronics industry, a sector that is capital-intensive, technology-intensive, and central to the country's industrial ambitions. Between 2018 and 2023, Vietnam attracted more than USD 18 billion in FDI in electronics, more than any other ASEAN country (MPI, 2023). Multinational corporations (MNCs) like Samsung, LG, and Intel account for over 90 % of industry output and primarily operate as wholly owned subsidiaries rather than joint ventures. The industry is tightly vertically integrated, with FDI firms, primarily from Japan, South Korea, and ASEAN countries such as Thailand and Malaysia, controlling both upstream and downstream segments of the value chain.

Despite policy efforts, domestic participation remains marginal, with input localization rates ranging between 5 and 15 % (Nguyen, 2023). Vertical linkages, especially between local suppliers and FDI customers, are weak (Nguyen and Diez, 2019). Empirical evidence from Vietnam supports this. Domestic firms remain on the periphery of FDI-led production networks, with limited technology transfer and productivity gains (Nguyen and Diez, 2019; VCCI, 2022). Japanese firms show relatively higher levels of local sourcing, whereas Korean firms often bring suppliers from their home countries (VCCI, 2022). Meanwhile, regional integration has begun to foster new linkages between ASEAN-based foreign firms and Vietnamese suppliers (The ASEAN Secretariat, 2025), although these remain limited in scope.

Drawing on Gereffi et al.'s (2005) GVC governance framework, we argue that in producer-driven, high-tech industries like electronics, FDI dominance constrains domestic firms' upgrading potential. Lead firms such as Samsung and Intel centralize control over design, technology, and standards, while R&D activities are predominantly based at MNC headquarters or specialized centers in developed countries. Vietnam, in this structure, functions mainly as a manufacturing hub, and domestic firms are relegated to low-margin, assembly-based roles. Without joint ventures or mandated linkages, traditional spillover channels are weakened or blocked.

These constraints intensify as FDI presence increases. Section 2 draws on Gereffi et al.'s (2005) GVC governance framework, the country-of-origin perspective (Meyer et al., 2009; Tan and Meyer, 2011), and the "more is actually less" argument (Kokko, 1994; Huang, 2001; Nguyen and Diez, 2019) to highlight how growing FDI dominance further limits spillovers. FDI firms tend to operate as wholly owned subsidiaries or partner primarily with other foreign firms, limiting opportunities for local collaboration. Such practices become increasingly common with higher FDI presence, reinforcing country-of-origin effects. MNCs often replicate home-country routines, prefer trusted foreign partners, and retain proprietary control over core technologies. As a result, domestic firms struggle to access high-value segments and face intensified competition for limited supplier roles. While managerial spillovers may occur through demonstration effects and competitive pressure, technology spillovers remain constrained, especially in the absence of deliberate mechanisms for integration.

Using firm-level data from the Vietnam Enterprise Surveys (2011−2020), we focus on two dimensions of upgrading: management capabilities and technology. We apply a metafrontier approach to distinguish between these two dimensions. We find that horizontal FDI presence is associated with modest gains in managerial efficiency, suggesting some diffusion of managerial practices. However, technological upgrading is limited. Domestic firms operate at only 64.4 % of the technological frontier defined by foreign firms, and this gap has remained unchanged over the past decade. Domestic electronics firms with better management capabilities do not appear to catch up when FDI dominance is high. In fact, greater horizontal FDI correlates with lower productivity among domestic firms, as competitive pressures outweigh efficiency gains. The impacts of vertical FDI vary by sector, often producing contrasting outcomes for domestic management and technology, especially for FDI in downstream industries. One exception is found in vertical linkages involving Chinese and ASEAN investors, where domestic firms show some improvements in technology use, likely due to more inclusive sourcing practices. However, these cases are limited to backward FDI and do not shift the overall industry pattern.

Our study makes several important contributions to the existing literature on FDI and domestic upgrading. First, it develops a theoretical framework that integrates Gereffi et al.'s (2005) GVC governance framework, Tan and Meyer (2011) country-of-origin perspective, and the "more is actually less" FDI trap. This integration offers a new explanation for why FDI spillovers are often limited in high-tech sectors, namely, the dominance of lead firms operating closed production systems, where demonstration effects are weak and domestic firms are excluded from core production tasks.

Second, this is one of the first empirical studies to examine FDI dominance in a high-tech industry in a developing economy, contrasting sharply with the existing literature that focuses primarily on labor-intensive sectors (Kokko, 1994; Huang, 2001; Nguyen and Diez, 2019). Third, we introduce a distinction between managerial and technological capabilities, allowing us to identify an important asymmetry in spillover effects that has received limited attention in the existing literature. Finally, the study highlights variation across regional FDI sources, suggesting that ASEAN and Chinese investors may offer relatively more inclusive opportunities for technological upgrading compared to Korean or Japanese firms.

2. Literature review

Trade and industrial organization theories suggest that the presence of FDI in a value chain can boost domestic firms' management practices, technology advancement, and productivity (Javorcik, 2004; Kugler, 2006; Poole, 2013; Newman et al., 2015). This process, known as *upgrading* of domestic industry, refers to improvements in firms' capabilities that allow them to move toward higher efficiency or more advanced tasks within global production networks (Giuliani et al., 2005). In particular, process upgrading - enhancements in technology and management practices - emerges as a central channel of domestic learning (Lee et al., 2018). FDI contributes to such upgrading through multiple spillover pathways, broadly classified into *horizontal* (intra-industry) and *vertical* (inter-industry) linkages.

Domestic firms may benefit directly from horizontal linkages with foreign investors through joint ventures, subcontracting, or participation in shared supply (Javorcik, 2004; Kugler, 2006; Jordaan, 2008; Ito et al., 2012). They may also learn indirectly via demonstration effects or labor mobility, as workers trained in MNCs bring new knowledge into domestic firms (Fosfuri et al., 2001; Berger and Diez, 2008; Tomohara and Takii, 2011; Fu, 2012; Poole, 2013). Competition with foreign entrants can further compel local firms to improve efficiency and innovate (Cappelli et al., 2014). Vertical linkages generate spillovers when MNCs supply advanced inputs to local customers (forward linkages) or source components from local firms (backward linkages), often accompanied by training or technical assistance (Aitken and Harrison, 1999; Lipsey and Sjöholm, 2004; Njikam and Leudjou, 2019). On this basis, greater FDI prevalence is generally expected to benefit the domestic sector through both horizontal and vertical channels.

Yet, in high-tech industries such as electronics, the spillover effects of FDI are more complex and often less beneficial than theory predicts. These complexities can be explained through two theoretical perspectives: Gereffi et al.'s (2005) *GVC governance framework*, which shows how producer-driven chains restrict upgrading opportunities, and the *country-of-origin framework* (Meyer and Nguyen, 2005; Tan and Meyer,

2011), which highlights how MNCs' home-country practices shape their local sourcing and knowledge-sharing behaviors.

Gereffi et al. (2005) discuss *five modes* of governance: market, modular, relational, captive, and hierarchical, suggesting different levels of power relations and their implications on how FDI managerial knowledge and technology can be shared with local businesses. These five governance modes are distinguished by three key factors: (i) the complexity of transactions, (ii) the ability to codify information and transmit knowledge, and (iii) the capabilities of suppliers. For example, when transactions are simple and easily codified, market governance prevails; when knowledge is highly tacit and suppliers are strong, relational or hierarchical forms dominate. Captive governance emerges when lead firms face complex but codifiable transactions with suppliers of limited capability, leading them to exercise high levels of monitoring and control (Gereffi et al., 2005).

Electronics operate within producer-driven GVCs, where lead firms retain control over design, R&D, and advanced manufacturing. Within this structure, governance often takes the form of captive chains, as described by Gereffi et al.'s (2005) GVC governance framework. Lead firms tightly monitor and set stringent standards for dependent suppliers, centralizing innovation and confining local firms to standardized, low-value tasks. This combination of producer-driven dynamics and captive governance restricts opportunities for domestic upgrading, as high-value functions remain concentrated within multinational networks. For example, Apple's iPhone supply chain is tightly orchestrated, with design and core technologies retained in the U.S. while production tasks are outsourced to contract manufacturers like Foxconn, largely limiting opportunities for technology diffusion to host economies.

Country-of-origin effects compound these constraints. The "country of origin" refers not merely to the national territory or political classification of foreign investors, but to the distinctive technological capabilities, industrial organization, and institutional environments in which multinational corporations (MNCs) are embedded. These characteristics shape how foreign firms operate abroad and determine the degree to which they engage with or transfer knowledge to local firms (Meyer and Nguyen, 2005; Tan and Meyer, 2011). Japanese firms, for instance, often operate through keiretsu-style networks of trusted long-term suppliers, restricting collaboration with untested local partners. Korean chaebols such as Samsung and LG frequently transplant their established supplier bases into Vietnam, privileging Korean-owned affiliates over domestic firms. By contrast, Chinese, Taiwanese, and ASEAN investors tend to operate with smaller technological and institutional gaps relative to Vietnamese firms, which reduces coordination barriers and fosters greater openness to domestic linkages (Berger and Diez, 2008; Nguyen and Diez, 2019). This variation highlights how country-of-origin effects and technology gaps jointly shape the scope of vertical spillovers in high-tech industries.

These insights suggest that FDI dominance in high-tech industries creates a paradox. On the one hand, the prevalence of MNCs may improve managerial capabilities in local firms because managerial practices - such as quality control systems, supply chain logistics, or workforce organization - are more visible and transferable. On the other hand, FDI dominance within a captive GVC limits both horizontal and vertical technology spillovers, given the high levels of monitoring and control by lead firms. The following sections build on these frameworks to explain how FDI dominance interacts with GVC governance and country-of-origin effects to shape horizontal and vertical spillovers. We develop hypotheses on contrasting spillover dynamics: positive managerial spillovers through horizontal channels, but limited technology spillovers through both horizontal and vertical pathways.

2.1. Horizontal FDI dominance, managerial and technology spillovers

Electronics GVCs are typically producer-driven and exhibit captive governance: lead firms such as Apple, Samsung, or Intel face complex but codifiable transactions and coordinate suppliers of limited capability. This results in high levels of monitoring and control, strict standards, and limited autonomy for suppliers (Gereffi et al., 2005). Local firms in host countries like Vietnam often operate as dependent contractors, confined to narrowly defined, low-value tasks such as assembly, testing, or component supply (Gereffi et al., 2005; Gereffi, 2011; Lee et al., 2018). Innovation, R&D, and product design are centralized within lead firms, while suppliers face high switching costs and limited autonomy. This structure restricts domestic firms' opportunities for process or technological upgrading, since knowledge flows are carefully controlled, and only codifiable, routine tasks are shared downstream. While captive chains restrict technology diffusion, they still expose local firms to observable practices in logistics, quality control, or workforce organization, facilitating managerial learning.

2.1.1. FDI dominance and positive horizontal managerial spillovers

Horizontal FDI presence can significantly enhance domestic managerial capabilities even in captive GVCs. Managerial knowledge - such as lean production, supply chain optimization, or quality assurance - is codifiable, observable, and often transferable through indirect channels (Bloom et al., 2012; Newman et al., 2015). Domestic firms may imitate visible practices from MNCs, absorb skills via labor mobility, or respond to competitive pressures by upgrading managerial systems (Tomohara and Takii, 2011; Poole, 2013). For instance, in Vietnam, the presence of Korean and Japanese electronics assemblers has raised expectations for production efficiency and labor discipline, which even non-partnering domestic firms attempt to emulate (Nguyen and Diez, 2019). In developing economies, where modern management is scarce, the increased prevalence of horizontal FDI accelerates upgrades (Liu et al., 2000; Meyer, 2004). Even without strong partnerships, the visibility of MNCs transforms the competitive landscape, driving locals to enhance efficiency and adapt strategically, distinct from technological constraints.

These dynamics suggest that horizontal FDI dominance fosters managerial spillovers by setting benchmarks and exposing domestic firms to advanced practices.

Hypothesis H1. In high-tech industries with FDI dominance, horizontal FDI presence significantly enhances management capabilities among domestic firms.

2.1.2. FDI dominance and limited horizontal technology spillovers

By contrast, horizontal FDI is less conducive to technology diffusion in a captive GVC governance like electronics. Captive GVC governance limits domestic upgrading by restricting access to R&D and advanced design tasks, which are protected as proprietary assets (Gereffi et al., 2005; Gereffi, 2011; Lee et al., 2018). Even when technologies are partially observable, they are often tacit, complex, or difficult to codify such that the demonstration effects become ineffective. Moreover, horizontal FDI dominance reduces opportunities for alliances or joint ventures, as MNCs prefer internal transfers within their global networks, reducing the scope for local participation and learning (Kotabe and Swan, 1994; Huang, 2001; Meyer et al., 2009; Tan and Meyer, 2011). For example, Apple's supply chain relies heavily on trusted global partners like Foxconn, while excluding new domestic entrants from higher-value roles (Sturgeon and Kawakami, 2010). In Vietnam, studies show that domestic firms in electronics are confined to low-value-added tasks, with limited evidence of technological upgrading despite decades of FDI growth (Berger and Diez, 2008; Nguyen and Diez, 2019).

We argue that limited horizontal spillovers in the presence of FDI dominance arise from two primary factors:

(i) Limited domestic participation: When FDI presence is relatively limited, foreign firms may seek to form alliances or joint ventures with local partners, even if the latter exhibit low absorptive capacity (Chen et al., 2004; Tan and Meyer, 2011; Andrenelli et al., 2019; Long and Cai, 2023). In contrast, when horizontal FDI is dominant, lead MNCs favor internal transactions or suppliers

from their home countries, prioritizing trust and technical compatibility capabilities (Swamidass and Kotabe, 1993; Kotabe and Swan, 1994; Huang, 2001). For example, in Vietnam's manufacturing sector, locals are relegated to low-value tasks with minimal technology transfer despite the increased prevalence of manufacturing FDI firms (Nguyen and Diez, 2019). Producer-driven chains, like Apple's iPhone ecosystem, centralize R&D, confining locals to assembly (Gereffi, 2011). Unlike settings with limited FDI, where MNCs are more inclined to partner with local firms to compensate for weaker technical capabilities, FDI dominance enables MNCs to rely on their own global networks. This aligns with Corden's (1974) theory of intra-firm trade and is often reinforced by partnerships with other firms from their home countries (Meyer et al., 2009; Tan and Meyer, 2011).

(ii) Reduced competitive pressure: Kokko (1994) and Gereffi (2011) demonstrate that when there is little to no overlap in market competition, technology spillovers fail to materialize. Technology spillovers are less likely when domestic and foreign firms occupy distinct market segments or differ significantly in technological sophistication. In such cases, foreign technologies may be too advanced or irrelevant for domestic adaptation. In contrast, a dominant FDI presence in the value chain would further intensify competition, crowding out domestic firms or confining them to low-value-added segments with limited opportunities for technological upgrading (Tybout et al., 1991; Aitken and Harrison, 1999; Chen et al., 2011; Nguyen and Diez, 2019).

These dynamics suggest that FDI dominance can limit horizontal spillovers. Because of this, rapid advancements in MNCs' technology can lead to a widening technology gap between foreign and domestic firms.

Hypothesis H2. In high-tech industries with dominant FDI, horizontal FDI presence does not generate significant technology spillovers to domestic firms.

2.2. FDI dominance, weakened vertical linkages, and limited vertical technology spillovers

Vertical spillovers, through forward and backward linkages, are particularly sensitive to the interaction between GVC governance and the country of origin of FDI. When horizontal FDI presence is low, domestic firms may still benefit from increased FDI presence in upstream or downstream sectors. To minimize the costs of importing intermediate inputs or exporting outputs, FDI firms may engage domestic firms as customers or suppliers (Tan and Meyer, 2011). These vertical linkages can promote strategic collaborations, facilitating the transfer of technology and managerial knowledge from foreign to local firms.

However, when FDI becomes dominant within a producer-driven chain like electronics, the dynamics shift. The dominance of foreign firms amplifies **country-of-origin effects**, as MNCs often replicate their home-country practices abroad. As Lee et al. (2018) emphasize, during the *"in" phase* of GVC participation, multinational firms in producer-driven industries often rely on established global or home-country supplier networks rather than local ones. This pattern reflects both the limited capability of domestic suppliers and the lead firms' preference for reliable, proven partners (Tan and Meyer, 2011; Lee et al., 2018). As a result, vertical linkages remain weak, as seen in Brazil's automotive and aerospace sectors or Mexico's maquiladora industries, where foreign assemblers dominate with minimal local sourcing, constraining learning and technology diffusion in host economies (Lee et al., 2018).

(i) Forward linkages: MNCs often prioritize supplying foreign affiliates, facilitating faster improvements among FDI counterparts rather than local customers (Yue, 2022). This preference can be attributed to higher similarities in institutional factors and technological capabilities and standards among FDI firms, which streamline coordination and reduce transaction costs (Nguyen and Diez, 2019). In producer-driven chains like the electronics industry, innovation is typically centralized within lead firms, leaving locals with standardized inputs (Gereffi, 2011) with fewer benefits from advanced technologies.

(ii) Backward linkages: Under captive governance, lead firms exert tight control over suppliers and often favor established networks over new local partners (Gereffi et al., 2005; Gereffi, 2011; Tan and Meyer, 2011). Japanese MNCs rely on keiretsu-style networks, preferring affiliated suppliers over untested local firms (Tan and Meyer, 2011). Korean chaebols often transplant entire ecosystems of home-country suppliers into Vietnam, narrowing the scope for domestic participation. U.S. firms emphasize IP protection and high entry barriers, further limiting opportunities for local firms to engage in knowledge-intensive linkages (Meyer et al., 2009; Tan and Meyer, 2011; Nguyen and Diez, 2019). As the presence of FDI intensifies, this preference increasingly leads to a crowding-out effect on domestic firms, confining them to simple tasks and offering limited opportunities for technological advancement.

Based on the above discussions, the following hypotheses are proposed:

Hypothesis H3. In FDI-dominated high-tech industries, greater forward FDI presence lowers technology spillovers to domestic firms.

Hypothesis H4. In FDI-dominated high-tech industries, greater backward FDI presence lowers technology spillovers to domestic firms.

However, research also documents differentiated impacts of FDI from emerging economies in Asia. Generally, Chinese, Taiwanese, and ASEAN investors exhibit smaller technology gaps relative to Vietnamese firms and are less constrained by rigid supplier systems. As Nguyen and Diez (2019) show, such firms are more willing to source locally, provide technical assistance, and integrate domestic suppliers into their networks. For example, Taiwanese electronics assemblers in Vietnam have engaged local component makers in joint production, enabling incremental learning and upgrading. Thus, the magnitude of vertical spillovers depends critically on the country of origin, with advanced-economy MNCs crowding out local firms and regional investors offering more entry points.

Taken together, the GVC governance and country-of-origin perspectives explain why FDI in high-tech industries like electronics produces uneven effects. Managerial spillovers are facilitated by observable practices and competitive pressures, especially under horizontal FDI dominance. In contrast, technology spillovers remain limited: horizontally, because proprietary knowledge is tightly controlled; vertically, because captive governance reinforces reliance on home-country networks, especially for advanced-economy MNCs. By contrast, regional investors with smaller technology gaps, such as Chinese, Taiwanese, and ASEAN firms, may open limited channels for domestic upgrading. This dual perspective highlights the paradox of FDI dominance in high-tech GVCs: it strengthens managerial convergence while widening the technology gap.

3. Research methodology and data

Previous analyses of FDI commonly rely on TFP as an indicator for technology (Blomström and Kokko, 1998; Ernst and Kim, 2002; Barry et al., 2003; Simona and Axèle, 2012; Pittiglio et al., 2015). This approach offers limited insights into how FDI presence may influence domestic technology. This is because it is almost impossible to disentangle the various sources contributing to changes in TFP, including technology and management efficiency.

Our approach extends beyond traditional TFP analyses by examining

the distinct impacts of FDI on domestic technology and management efficiency. Our examination of technology and managerial spillovers involves three main steps. First, we directly measure the technology gaps between domestic and FDI electronics firms, and management capabilities among domestic firms using the metafrontier framework developed by O'Donnell et al. (2008). Next, these estimated technology gaps will be used as the dependent variables to assess the influence of FDI, considering potential endogeneity of management efficiency as absorptive capacity. Our proposed approach lays out the foundations to explain documented productivity spillovers (if any) while offering meaningful insights into the long-term productivity implications of FDI. Then, we complement our technology and managerial spillover analyses by looking at the aggregate effect of FDI on domestic TFP. Details of our proposed framework can be described as follows:

3.1. Measurement of management capabilities and technology gaps

3.1.1. The metafrontier framework for measuring technology and management efficiency

We apply the metafrontier framework for panel data developed by O'Donnell et al. (2008) to estimate firm-level management efficiency and technology ratios when firms operate under different technologies. The basic idea is to divide electronics firms into two groups: domestic firms and FDI firms. The underlying assumption is that FDI firms use advanced technology that produces higher outputs at any given level of input mix. These group-specific technologies are estimated to capture existing technological constraints, and the levels of technical efficiency that firms achieve given their specific input mix and the technology available to them.

The metafrontier is defined as the production technology available to all electronics firms. Technology ratios, which measure the gap between domestic and FDI technologies, are then calculated based on the distance between the domestic frontier and the metafrontier. This framework has been widely adopted in measuring technology ratios and management efficiency, for instance, in the electronics industry by Chiu et al. (2019) and Lyu et al. (2019), and in the manufacturing sector by Walheer and He (2020).

Fig. 1 presents the metafrontier framework used to measure management capability among domestic electronics firms and to evaluate their technology ratios relative to the industry's best technology. Assume a domestic firm operates at point A, using an input mix X_A and producing output $0D$, which lies below the domestic production frontier. If the firm were fully efficient with its domestic production technology while using the same input level X_A, it would operate at point B on the domestic frontier, achieving the maximum feasible output $0E$ attainable with that technology. If, under the same input level, it had access to the best industry technology (mainly embodied in FDI firms), it could reach point C on the industry metafrontier, corresponding to the maximum feasible output $0F$.

The firm's technical efficiency with respect to the domestic frontier, reflecting its managerial capability in utilizing available resources, is calculated as:

$$TE^D = \frac{Output\ at\ A}{Maximum\ output\ at\ B} = \frac{0D}{0E};\ 0 \le TE^D \le 1 \quad (1)$$

Given the same input mix X_A, if the firm could employ the best industry technology available, it would operate at point C on the metafrontier and produce an output of $0F$. The firm's technical efficiency relative to the metafrontier is therefore defined as:

$$TE^M = \frac{Output\ at\ A}{Maximum\ output\ at\ C} = \frac{0D}{0F};\ 0 \le TE^M \le 1 \quad (2)$$

The technology ratio, TR^D, which indicates the gap between domestic technology and the industry technology, is defined as the ratio of the firm's metafrontier efficiency to its domestic efficiency:

$$TR^D = \frac{0E}{0F} = \frac{TE^M}{TE^D};\ 0 \le TR^D \le 1 \quad (3)$$

3.1.2. Estimation of the frontiers

The translog functional form for the metafrontier using all electronics firms, and for the domestic frontier using the sample of domestic electronics firms, takes the following form:

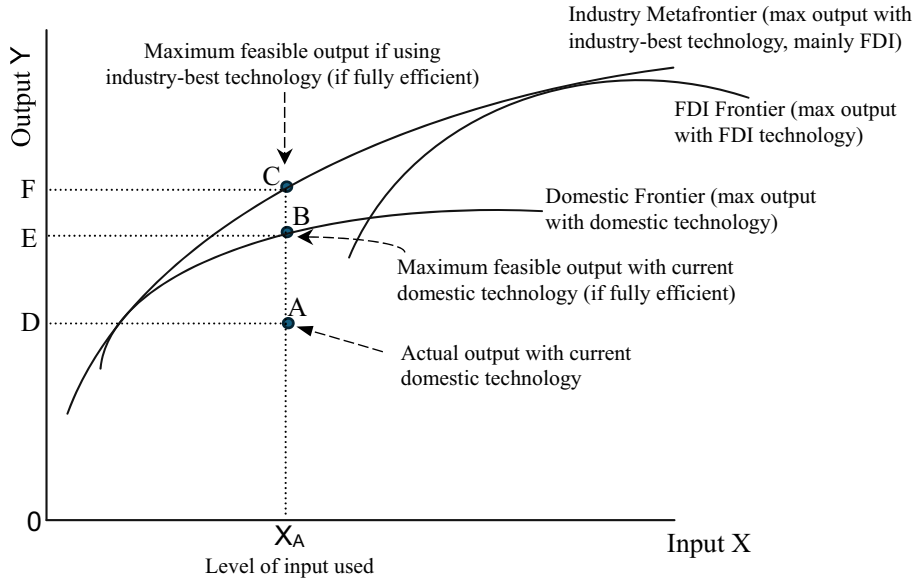

Fig. 1. The Metafrontier framework for measuring management capability and technology ratios.
Note: The Domestic Frontier represents the maximum output achievable with domestic technology, the FDI Frontier reflects the maximum output achievable with foreign-invested firms' technology, and the Industry Metafrontier captures the best available technology overall, often shaped by FDI. Example firm positions (A, B, C) are evaluated at the same input mix X_A, where A = actual output with current domestic technology, B = maximum feasible output with domestic technology (if fully efficient), and C = maximum feasible output with industry-best technology. The vertical distances from 0D, 0E, and 0F (corresponding to A, B, and C) underpin the technical efficiency and technology ratio measures used in the analysis.
Source: Authors' demonstration.

$$ln(Y_{it}) = \alpha_i + \sum_{k=1}^{3} \beta^k ln(X_{it}^k) + \frac{1}{2} \sum_{k=1}^{3} \sum_{m=1}^{3} \pi^{km} ln(X_{it}^k) * ln(X_{it}^m) + v_{it} - u_{it} \quad (4)$$

where Y_{it} is the output (total revenue) of firm i in year t. X_{it} is a vector of inputs used by firm i in year t, including total capital, total number of labor, and total amount of intermediate costs (in 2010 equivalent value). β^k and π^{km} are the set of parameters to be estimated. V_{it} is statistical noise and is assumed to be independently and identically distributed. U_{it} represents the time-varying inefficiency component, used to estimate technical efficiency that reflects management capabilities. α_i is the estimate for firm-specific time-invariant (unobserved) factors on outputs. Following Tybout et al. (1991) and Javorcik (2004), we adjust the number of labor in Eq. (4) according to skill levels using the efficiency units. This measure is calculated by dividing total company wages by total wages under the assumption that all employees receive minimum wages. To account for year-to-year variations in technology, we introduce into Eq. (4) a set of time dummies.

The estimation of Eq. (4) for the metafrontier, and for the domestic frontier, is done using the maximum likelihood estimators described in O'Donnell et al. (2008). After estimating the metafrontier and the domestic frontier, we obtain the estimates for management capabilities relative to the metafrontier for all firms using Eq. (2) and for domestic firms relative to their own frontier using Eq. (1). After this, the technology ratios, TR^D, which reflect the distance between domestic technology and the metafrontier, is calculated using Eq. (3).

3.2. Managerial and technology spillover analyses

3.2.1. Estimation models

After obtaining the estimates for technical efficiencies and technology ratios using the panel stochastic frontier approach, we model how FDI dominance, or prevalence, in the vertical value chain of the electronics industry, might have contributed to management capabilities (TE^D) and technology ratios (TR^D) among domestic electronics firms.

(1) *Modelling technical efficiency (TE^D) as management capabilities*

$$TE_{it}^D = \partial_{i0} + \beta_1 FDI_t + \beta_2 FDI_t^{fw} + \beta_3 FDI_t^{bw} + \sum_{k=1}^{4} \beta^k X_{it}^k + \sum_{l=1}^{2} \alpha^l E_t^l + v_{it} \quad (5)$$

This technical efficiency, or managerial capabilities, affects the scope for technology spillovers for two reasons. First, domestic firms with a high level of technical efficiency are more likely to innovate to grow (because they are almost at the production frontier). Second, FDI firms are more likely to establish linkages with efficient firms, leading to potential spillovers.

(2) *Modelling technology ratios (TR^D)*

$$TR_{it}^D = \omega_{i0} + \gamma_1 FDI_t + \gamma_2 FDI_t^{fw} + \gamma_3 FDI_t^{bw} + \gamma_4 TE_{it}^D + \sum_{k=1}^{4} \gamma^k X_{it}^k + \sum_{l=1}^{2} \gamma^l E_t^l + \varepsilon_{it} \quad (6)$$

where FDI_t, FDI_t^{fw}, and FDI_t^{bw} are FDI revenue shares in year t in the electronics industry, the upstream industries, and downstream industries, respectively. This measurement of FDI presence using revenue share is appropriate to capture the 'real' presence of FDI through market interactions. These FDI variables are calculated at the industry level such that all domestic firms have the same value for these variables for the same year. X_{it}^k is a set of firm specifics, including *(1) market share* for domestic firm i in year t in the domestic market, used to capture the effects of a firm's market power on its ability to materialize FDI spillovers, *(2) labor share* of domestic firm i in total industry employment, capturing potential effects of labor exchange, *(3) Skill-adjusted labor*, which accounts for heterogeneity in labor quality and skills across firms, calculated by dividing total firm's actual wages by total minimum wages under the assumption that all employees are compensated at minimum wage in low-skilled positions (Tybout et al., 1991; Javorcik, 2004), *(4) Export ratio (Export),* and *(5) Import ratio (Import)* of domestic firms, measured as the share of exports and imports in total revenue, to capture potentially distinct impacts of exports and imports on domestic firm's technological and managerial upgrading.

For other variables, (Mirzaei et al., 2013; González et al., 2019) E_t^l is a vector of provincial-level factors reflecting the local business environment that might affect firm management capabilities and technological progress. As suggested by micro-level evidence for Vietnam by V. T. C. Ha et al. (2023), we include *(1) a corruption index* and *(2) a transparency index* constructed by The Vietnam Chamber of Commerce and Industry (VCCI).

In Eq. (6) explaining technology ratios, TE_{it}^D acts as absorptive capacity determining the scope for domestic firms to innovate. First, technically efficient firms are more likely to engage in the supply chain of the industry. Second, highly efficient firms face limited room for productivity improvements, thus having a greater incentive to upgrade their technologies. We also introduce a set of interactions between TE_{it}^D and FDI presence variables to understand how domestic absorptive capacity might and might not work when FDI dominates the value chain.

(3) *Estimation techniques*

Our dependent variables, TE_{it}^D and TR_{it}^D, are bounded in the range (0; 1) and therefore, traditional linear models for continuous variables such as Ordinary Least Squares (OLS) regressions, fixed-effects (FE) regressions, and generalized methods of moments (GMM) are not appropriate for two reasons. First, the predicted values for TE_{it}^D and TR_{it}^D might lie outside the range (0; 1). Second, a fixed-effects or GMM model cannot work well on a dependent variable that is slowly changing over time such as a firm's efficiency and technology.

We identify two alternatives for the estimation of TE_{it}^D and TR_{it}^D. The first option is panel Fractional Binomial models (Logit or Probit) for fractional data developed by Papke and Wooldridge (2008). The second option is a generalized linear model (GLM) for dependent variables bounded in the range (0; 1). Between these two alternatives, the panel estimates from Fractional Binomial models outperform their GLM counterparts in terms of outcome predictions. Therefore, we focus our interpretations using Fractional Binomial model results. We also report the estimates from GLM and fixed-effects regressions for cross-checking.

3.2.2. Addressing potential endogeneity of management capabilities

The estimates for TE_{it}^D and *FDI* from Eq. (6) are likely to suffer from endogeneity because TE_{it}^D is potentially determined by *FDI*, which also affects the technology ratios, as illustrated in Eq. (5). Due to this endogeneity, one cannot isolate the effects of a firm's own management capabilities on technology ratios from the effects of FDI presence and other factors.

We adopt the two-step Hsiao method to address this potential issue in a panel setting. First, we apply a panel method to model TE_{it}^D as a function of FDI presence using Eq. (5). After this, we obtain the combined residuals for TE_{it}^D, which include entity-fixed effects and residuals. Next, these combined residuals are then used to replace TE_{it}^D in Eq. (6). These combined residuals are, therefore, free of the effects of time-varying factors, including FDI presence within and outside the electronics industry, which also appears in Eq. (6). This approach is simple yet efficient and intuitive for addressing potential confounding issues when one independent variable is affected by other independent variables in a model.

3.3. Aggregate productivity spillovers from FDI

The rationale behind this analysis is that if FDI dominance generates significant managerial and/or technology spillovers, these spillovers would be translated into increases in firm-level productivity. As such, our analyses of domestic management and technology lay out solid foundations to explain the sources of any productivity improvements documented.

Firm-level TFP is estimated using the standard Cobb-Douglas production function introduced by Wooldridge (2009), where firm-level TFP is the residuals unexplained by labor and capital. Next, firm-level TFP for domestic electronics firms will be modeled as a function of FDI presence, controlling for firm specifics and the local business environment. The set of variables used in this TFP analysis is the same as those in Eqs. (5) and (6) explained above.

$$TPF_{it} = \alpha_{i0} + \alpha_1 FDI_t + \alpha_2 FDI_t^{fw} + \alpha_3 FDI_t^{bw} + \sum_{k=1}^{4} \alpha^k X_{it}^k + \sum_{l=1}^{2} \alpha^l E_t^l + \nu_{it} \quad (7)$$

Eq. (7) is estimated using both the standard fixed-effects estimators and the generalized method of moments (GMM) to account for the dynamic nature of TFP while addressing potential endogeneity of lagged TFP and some other independent variables. With regard to GMM, we apply the two-step system GMM because the Arellano-Bond tests for higher-order correlation (AR2), and Sargan/Hansen tests for joint validity of the third lag of TFP and the chosen instruments satisfy. Common shocks to domestic firm productivity (TFP) are controlled for using a set of time dummies.

One may argue that FDI capital share is a more appropriate measure of FDI presence, as capital investment better reflects the presence of advanced management and technologies that can benefit domestic firms through the demonstration effect. To address this, we conducted robustness checks using FDI capital share as an alternative measure.

The results reported in the appendices for Eq. (5) (Table 4B), Eq. (6) (Table 5B), and Eq. (7) (Table 6B) show little differences in the estimates for horizontal FDI on domestic management capabilities, technology, and productivity when using FDI capital share. However, notable differences emerge for forward FDI in the cable industry and backward FDI in the measurement industry. In these cases, increased FDI output appears to widen the technology gap between domestic and FDI electronics firms, whereas using FDI capital instead suggests a narrowing of this gap. These contrasting results indicate that using FDI capital share may overstate FDI impacts, as capital primarily reflects production capacity. In contrast, technology spillovers are more likely to happen through market interactions, particularly via supplier-buyer linkages.

3.4. Data

This analysis uses the most comprehensive firm-level data in Vietnam – the Vietnam Enterprise Surveys (VES) conducted annually by the General Statistics Office of Vietnam (GSO). The VES surveys collect information on firm's ownership, firm demographics as well as firm performance from firms operating in all sectors across all provinces and cities. For big cities such as Hanoi or Ho Chi Minh, all firms with over 50 employees are required to fill in the surveys, and firms with less than 50 employees are randomly selected. For other remote areas, all registered firms are covered. This makes the VES surveys the richest enterprise data available in Vietnam.

We identify electronics firms in the manufacture of electronic components and boards using the four-digit Vietnamese Standard Industrial Code (VSIC-4 = 2610). The VES data provides a panel of 794 distinct electronics firms with complete information between 2011 and 2020, of which 300 firms are domestically owned. We refine our analysis to an unbalanced panel of 2.820 year-observations with complete information on variables of interest. It is important to note that no joint ventures are identified in Vietnam's electronics industry. Instead, FDI firms are established in the form of wholly-owned FDI affiliates. Data on local business environments, including corruption and public transparency, is collected at the provincial level using the Provincial Competitiveness Index data conducted by VCCI, as explained in Sub-section 3.2.

Table 1 summarizes the means and standard deviations of variables for estimating the metafrontier and domestic frontier (Eq. (4)), and for FDI impacts (Eqs. (5)–(7)). On average, FDI electronics firms are much larger in size than domestic electronics firms, reflected by higher values for total capital assets, intermediate costs, labor used, and net revenue. In particular, an average FDI electronics firm is over 10 times as large in terms of capital and number of workers (unadjusted for skills), and generates a net revenue that is approximately twenty times greater than that of a domestic firm. FDI firms are more cost-intensive, as reflected by a greater proportion of intermediate costs in net revenue. Consistent with their size, FDI electronics firms hold greater shares in both the product and labor markets. As expected, FDI electronics firms are more connected to international markets, demonstrated by higher ratios of imports and exports to their total revenue, relative to domestic electronics firms.

We measure FDI presence using FDI revenue share within each industry using VES data. Horizontal FDI presence in the electronics industry is calculated as the share of FDI revenue in total industry revenue. To identify forward and backward FDI linkages, we use the most recent Input-Output (I/O) table for Vietnam (2012). Based on the I/O structure, forward industries are those that supply inputs to the electronics sector, while backward industries are those that purchase outputs from it. Forward industries include four key sectors: (1) chemicals, (2) metal, (3) cables and wires, and (4) trade and services. Backward industries include, but are not limited to, (1) plastics, (2) measurement equipment, (3) broadcast and telecommunications, (4) software Engineering, and (5) machinery.

We calculate FDI revenue shares in each of these industries using VES data using their corresponding VSIC-4 codes. To focus on industries with potentially meaningful impacts, we retain only those with at least a 3 % revenue share in at least one year. As a result, our empirical models include three forward industries: metal, cables and wires, and trade and services, and three backward industries: plastics, measurement equipment, and broadcast and telecommunications. Finally, using firms' tax codes, we look up the country of origin of FDI firms in these industries, as previous studies have highlighted how linkages between FDI and Vietnamese firms often vary depending on FDI origin (VCCI, Ni et al., 2017; 2022).

Table 2 presents the distribution of FDI across the electronics value chain in Vietnam. FDI firms dominate the electronics industry, accounting for 92.6 % of total industry output and 96.8 % of capital, with minimal variation over time. Using firm-level information, we classify FDI by country of origin to examine how different investor backgrounds shape spillover dynamics. In doing so, we explicitly distinguish Taiwanese firms from those of mainland China. Although the United Nations classifies Taiwan as a province of China, Taiwanese and mainland Chinese firms exhibit very different industrial and technological profiles. Recognizing this distinction is important for capturing meaningful heterogeneity in FDI impacts.

The majority of electronics FDI originates from developed economies such as South Korea, Japan, and the United States. South Korean electronics firms, for instance, tend to establish closed supply networks, often supported by other Korean firms operating in Vietnam (VCCI, 2022). A prime example is Samsung, which brings in a system of its own suppliers. Japanese firms exhibit relatively stronger linkages with domestic suppliers, about 37 % source inputs from Vietnamese firms, though this figure remains lower than in Thailand (41 %) and Malaysia (55 %) (VCCI, 2022).

On the upstream side, the electronics industry sources inputs from FDI-dominated industries such as cables and metals, with many established firms from Japan, South Korea, and recent entrants from Taiwan and mainland China. For example, Maruichi Sun Steel Joint Stock

Table 1
Statistics of electronics firms and business environment.

Variables	Units	Domestic firms (302 firms, 793 observations)		FDI firms (492 firms, 2023 observations)	
		Mean	Std. Dev.	Mean	Std. Dev.
Net revenue	Million VND	41,417.01	138,514.90	897,070.50	2,913,421.00
Total capital	Million VND	16,631.88	118,232.20	211,040.80	576,637.70
Intermediate costs	Million VND	37,199.56	137,031.80	817,590.00	2,682,808.00
Labor - unadjusted	Persons	81.24	149.88	608.50	1105.66
Skill-adjusted Labor	Persons equivalent	30.50	19.20	39.80	20.75
Market share	%	0.02	0.05	0.38	1.24
Labor share	%	0.05	0.09	0.37	0.84
Export	%	9.58	29.46	52.14	49.96
Import	%	14.12	34.85	57.17	49.49
Transparency index	10-point scale	6.17	0.46	6.17	0.46
Corruption index	10-point scale	5.95	0.87	5.95	0.87

Source: Authors' calculations from VES data.

Table 2
FDI presence in the electronics value chain.

Variables	Units	Popular Countries of FDI origin	FDI revenue share (%) in the industry		FDI capital share (%) in the industry	
			Mean	Std. Dev.	Mean	Std. Dev.
FDI	%	South Korea, USA, Japan, mainland China	92.62	11.96	96.84	1.41
$FDI^{fw\text{-}cable}$	%	South Korea, Japan, Taiwan	54.29	3.25	50.34	3.80
$FDI^{fw\text{-}trade}$	%	Malaysia, South Korea, Thailand	4.62	3.26	3.85	2.07
$FDI^{fw\text{-}metal}$	%	Japan, South Korea, Taiwan	35.18	4.50	57.34	18.34
$FDI^{bw\text{-}plastic}$	%	Japan, South Korea, Malaysia	41.65	3.17	41.67	3.16
$FDI^{bw\text{-}measurement}$	%	South Korea, Taiwan, Thailand	47.72	21.31	44.29	23.63
$FDI^{bw\text{-}broadcast}$	%	South Korea, Japan, Taiwan	99.37	0.47	98.67	0.82

Source: Authors' calculations from VES data.

Company is a Japanese-invested firm that has been supplying metal products to electronics manufacturers since 1998. This upstream industry has witnessed increasing competition, particularly with the entry of Taiwanese firms such as Formosa Ha Tinh Steel Corporation, which began targeting key market segments in the early 2010s. On the downstream side, electronics products are sold to FDI-heavy industries like broadcast, measurement, and plastics. FDI presence in these downstream industries is also significant, often exceeding 41 % of industry revenue and capital, and includes recent entrants from emerging Asian economies within the ASEAN region such as Malaysia and Thailand. Given the similarity in institutional factors, technological base, and agreements within the ASEAN Economic Community (The ASEAN Secretariat, 2025), FDI from these economies is expected to establish stronger linkages with local firms in Vietnam.

This diversity in FDI origin and technology levels across the value chain implies potentially differentiated impacts on domestic electronics firms, reinforcing the need to distinguish between forward and backward FDI effects in our analysis.

4. Domestic management capabilities and technology ratios

4.1. The metafrontier and domestic frontier

We use Eq. (4) to estimate the metafrontier for all electronics firms, and the frontier for domestic firms. The results for these frontiers are presented in Table 3. The estimates from the translog function are all statistically significant, after controlling for potential year-to-year variations in technology in the industry. Consistent with the data description in Table 1, we find that the best domestic technology is more labor intensive as the estimate for ln_labor is much larger in size, 0.460, compared with 0.290 for the best industry technology.

After estimating the metafrontier for all electronics firms and the domestic frontier for domestic firms, we obtain the estimates for technical efficiencies of domestic firms relative to their corresponding frontier. Technology ratios, which reflect how close a domestic firm's technology is to its best industry technology, are calculated using Eq. (3). In addition, we also calculate TFP for domestic firms following the methodology described in Sub-section 3.3. A summary of domestic management capabilities, technology ratios, and TFP is provided in Fig. 2. To maintain simplicity, we visualize these indicators against horizontal FDI in the electronics industry, along with one forward FDI in the metal industry and one backward FDI in the plastics industry, where FDI presence is high.

Table 3
Metafrontier and domestic frontier for electronics firms.

	(1)	(2)
Variable	Metafrontier	Domestic frontier
Ln_capital	0.333***	0.367***
Ln_labor	0.290***	0.460***
ln_intermediate	0.400***	0.199***
Ln^2_capital	−0.025***	−0.017**
Ln^2_labor	0.020***	0.025***
Ln^2_intermediate	0.038***	0.073***
Ln_capital x Ln_labor	0.045***	0.070***
Ln_capital x Ln_intermediate	0.005	−0.026**
Ln_labor x Ln_intermediate	−0.085***	−0.131***
Year-fixed effects	Yes	Yes
Observations	2820	797
Number of id	794	302

Source: Authors' calculations.
*** $p < 0.01$.
** $p < 0.05$.

4.2. Domestic management capabilities and technology ratios

On average, managerial capability among domestic electronics firms remains low, with an estimated technical efficiency of 52.2 %. This implies that, using their current technology, Vietnamese electronics firms could nearly double their output by improving efficiency alone,

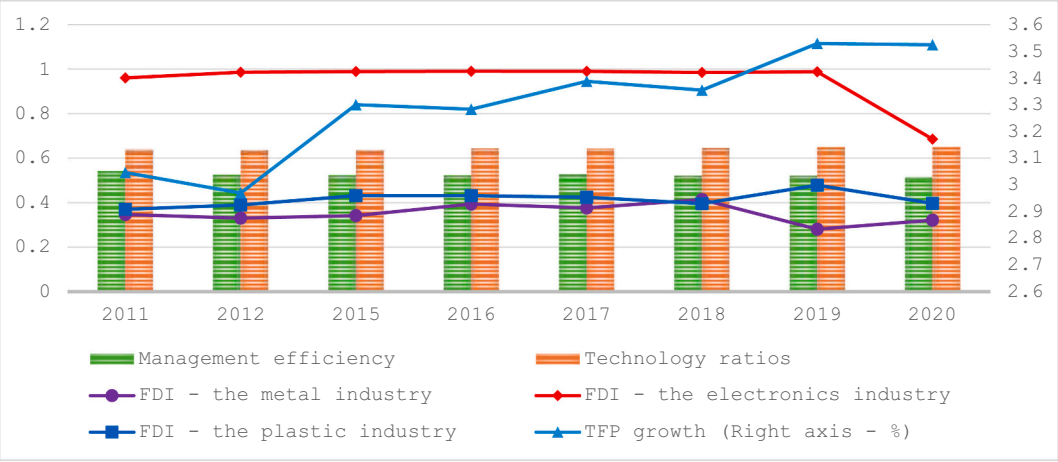

Fig. 2. Management capability and technology ratio evolution.
Source: Authors' calculations.

without increasing their input use. Domestic technology is relatively backward. Fig. 2 demonstrates that domestic firms have been employing technologies that produce as much as 64.4 % of the output an FDI firm can produce using the same level of input mix. This technology ratio is stable over time despite the prevalence of FDI in the value chain in a ten-year period. Despite limited improvements in technology ratios and management capabilities, TFP among domestic electronics firms increases.

5. Managerial and technology spillovers

5.1. Managerial spillovers from FDI in Vietnam's electronics industry

We proceed with an analysis of how FDI dominance affects management capabilities among domestic electronics firms. As mentioned in Sub-section 3.2, we estimate Eq. (5) using the share of FDI revenue as FDI presence. Table 4 presents the results from Fractional Binomial models, along with alternative estimation methods used for robustness checks. For straightforward interpretations, we report the Odd Ratios (OR) from the Fractional estimates, which indicate the likelihood that we observe improved management capabilities in response to changes in each explanatory variable, relative to the case where we observe no improvements. Overall, the results are highly consistent in terms of statistical significance and coefficient signs across estimation methods. However, we base our interpretations on the Fractional Binomial estimates for methodological reasons justified in Sub-section 3.2.

Domestic management capabilities are endogenous to FDI, confirming hypothesis H1. The OR values for horizontal (electronics) FDI are significantly greater than 1, suggesting that the increased prevalence of electronics FDI is associated with greater probabilities we observe improvements in managerial capabilities among domestic electronics firms. This finding is reinforced by the statistical significance of the positive coefficients from both the GLM and fixed-effects models. FDI presence in the electronics industry is high, at more than 92 % of total industry revenue, as shown in Table 2. Given limited production linkages between FDI and domestic electronics firms (VCCI, 2022), this managerial spillover is likely the result of the demonstration effect, as the prevalence of FDI within the electronics industry creates an opportunity for domestic firms to observe and imitate advanced management practices and business models at low costs. Our results are in line with the existing literature suggesting positive demonstration effects of horizontal FDI management on management capabilities among domestic firms (Aitken and Harrison, 1999; Barry et al., 2003; Javorcik, 2004; Scott-Kennel, 2007; Hamida and Gugler, 2009; Long and Cai, 2023).

Forward FDI has mixed impacts on management capabilities among domestic electronics firms. Table 4 shows that increased FDI presence in the cable industry, largely dominated by long-established Japanese and Korean firms like LS Vina Cable and Nissei Electric Vietnam, enhances domestic management. These FDI suppliers have historically supported local firms, and rising competition from new entrants, such as Taya Electric Wire and Cable Joint Stock Company from Taiwan and Tai Sin Electric Cables Company Limited from Malaysia, has further compelled them to strengthen managerial engagement with domestic electronics customers.

In contrast, a greater FDI presence in the metal and trade industries is associated with a decline in management capabilities among domestic electronics producers. These industries, key suppliers to electronics firms, are increasingly dominated by recent FDI entrants, including Fomorsa from Taiwan and Securemetric (Malaysia), disrupting

Table 4
Management capabilities among domestic electronics firms.

	(1)	(2)	(3)	(4)
	Fractional Logit	Fractional Probit	GLM	Fixed-effects
	OR	OR		
FDI	1.632***	1.359***	0.121***	0.121***
$FDI^{fw\text{-}metal}$	0.540***	0.681***	−0.152***	−0.152***
$FDI^{fw\text{-}cable}$	1.925***	1.505***	0.161***	0.161***
$FDI^{fw\text{-}trade}$	0.931***	0.955***	−0.019***	−0.019***
$FDI^{bw\text{-}plastic}$	0.300***	0.471***	−0.297***	−0.297***
$FDI^{bw\text{-}broadcast}$	0.045***	0.144***	−0.766***	−0.766***
$FDI^{bw\text{-}measurement}$	1.125***	1.076***	0.029***	0.029***
Market Share	0.994***	0.996***	−0.002***	−0.002***
Labor Share	1.000	1.000	−0.000	−0.000
Skill-adjusted Labor	1.000	1.000*	−0.000*	−0.000*
Export	1.000**	1.000**	−0.000	−0.000
Import	1.000	1.000	0.000	0.000
Transparency Index	1.000**	1.000**	0.000*	0.000*
Corruption Index	1.000	1.000	−0.000	−0.000
Constant	27.259***	7.893***	1.317***	1.248***
Year-fixed effects	Yes	Yes	Yes	Yes
Firm-fixed effects	Yes	Yes	Yes	Yes
Observations	793	793	793	793
R-squared				0.997
Number of id				300

Source: Authors' calculations.
*** $p < 0.01$.
** $p < 0.05$.
* $p < 0.1$.

traditional supplier relationships (Vietnam Times, 2017). While this shift may offer access to better inputs, it pressures domestic firms to adjust operations, often at the expense of efficiency. The technological edge and market power of foreign suppliers also raise input costs, exacerbating managerial strain. These findings echo Nguyen et al. (2021), who observe reduced efficiency among domestic manufacturers in the presence of strong FDI suppliers.

Backward FDI in the downstream plastics and broadcast industries similarly undermines management capabilities among domestic electronics firms. These industries, sourcing inputs from electronics firms, are dominated by high-standard FDI buyers from Japan and South Korea. Given the dominance of electronics FDI output, as these foreign customers expand, domestic electronics firms face tougher competition for supply roles, often losing ground due to technological and managerial limitations. This forces them into niche markets with reduced efficiency. This finding supports concerns raised by prior analyses about FDI crowding out domestic firms, especially in industries dominated by foreign players (Kokko, 1994; Aitken and Harrison, 1999; Huang, 2001; Nguyen and Diez, 2019).

Conversely, backward FDI in the measurement industry supports domestic management capabilities. FDI - accounting for over 44 % of industry revenue - includes recent entrants from emerging Asian economies such as Autel Vietnam Company Limited from China and UHM Vietnam Co., Ltd. from Thailand. Due to greater organizational and technological affinity with Vietnamese firms, and regional integration under the ASEAN Economic Community (The ASEAN Secretariat, 2025), these FDI linkages have fostered managerial knowledge transfer and expanded market access, enabling domestic electronics firms to achieve economies of scale.

5.2. Technology spillovers from FDI

Table 5 presents the estimates for Eq. (6) explaining the technology ratios between domestic electronics firms and the industry frontier. In the first four columns, we assume that the effects of FDI on domestic electronics technology are the same across domestic electronics firms, regardless of their management capabilities (*Efficiency*), or absorptive capacity. In the last two columns, we allow for the possibility that domestic management capabilities may shape the effects of FDI on domestic technological upgrading. Most of the OR values for interactions between *Efficiency* and FDI variables are insignificant, suggesting that once FDI dominates the value chain, better management capabilities enhance the ability of domestic firms to benefit from the increased presence of FDI technology. This result aligns with Scott-Kennel (2007) who attributes limited technology spillovers in New Zealand to weak FDI-domestic interactions, despite the country's arguably high levels of absorptive capacity.

The OR values for horizontal FDI are significantly lower than 1 while the estimates from GLM and fixed-effects models are statistically negative. These results suggest that the increased dominance of FDI electronics output widens the gap (or lowers the ratios) between domestic technology and the best industry technology. This supports Hypothesis H2, which posits that FDI dominance in the electronics industry does not generate technology spillovers. The growing technology gap between domestic and FDI electronics firms likely reflects rapid advancements among FDI electronics firms in Vietnam, driven by the introduction of cutting-edge technologies by multinational giants such as Samsung and Intel, coupled with the absence of technology spillovers to local firms. Two factors help explain the limited technological catch-up among domestic firms. First, the electronics industry is arguably a producer-driven supply chain where product designs are highly safeguarded by intellectual property while frontier technologies are rarely accessible for

Table 5
FDI and technology ratios for domestic electronics firms.

	Homogenous absorptive capacity effect				Heterogenous absorptive capacity effect	
	(1)	(2)	(3)	(4)	(5)	(6)
	Fractional Logit	Fractional Probit	GLM	Fixed-effects	Fractional Logit	Fractional Probit
	OR	OR			OR	OR
FDI	0.647***	0.764***	−0.101***	−0.101***	0.646***	0.764***
$FDI^{fw\text{-}cable}$	0.557***	0.697***	−0.135***	−0.135***	0.557***	0.697***
$FDI^{fw\text{-}trade}$	1.076***	1.046***	0.017***	0.017***	1.078***	1.048***
$FDI^{fw\text{-}metal}$	1.725***	1.399***	0.126***	0.126***	1.726***	1.400***
$FDI^{bw\text{-}plastic}$	2.939***	1.944***	0.249***	0.249***	2.946***	1.946***
$FDI^{bw\text{-}measurement}$	0.898***	0.936***	−0.025***	−0.025***	0.898***	0.936***
$FDI^{bw\text{-}broadcast}$	13.846***	5.043***	0.603***	0.603***	13.872***	5.048***
Efficiency	0.000***	0.000***	−3.460***	−3.460***	1.492e+115	8.754e+61
Efficiency x FDI					1.822e+14	1.332e+08
Efficiency x $FDI^{fw\text{-}cable}$					0.000	0.000
Efficiency x $FDI^{fw\text{-}trade}$					0.000	0.000
Efficiency x $FDI^{fw\text{-}metal}$					0.000	0.000
Efficiency x $FDI^{bw\text{-}plastic}$					0.000	0.000
Efficiency x $FDI^{bw\text{-}measurement}$					116.807	12.887
Efficiency x $FDI^{bw\text{-}broadcast}$					0.000	0.000
Market Share	1.025***	1.015***	0.005***	0.005***	1.025***	1.015***
Labor Share	1.002***	1.001***	0.000***	0.000***	1.003***	1.002***
Skill-adjusted Labor	1.001***	1.001***	0.000***	0.000***	1.001***	1.001***
Export	1.001***	1.000***	0.000***	0.000***	1.001***	1.000***
Import	1.000	1.000	0.000	0.000	1.000	1.000
Transparency Index	0.999***	0.999***	−0.000***	−0.000***	0.999***	0.999***
Corruption Index	1.000	1.000	0.000	0.000	1.000	1.000
Constant	0.152***	0.315***	0.076***	0.076***	0.152***	0.315***
Year-fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Firm-fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	793	793	793	793	793	793
R-Squared				0.998		
Number of id				300		

Source: Authors' calculations.
*** $p < 0.01$.

commercial adoption, limiting the demonstration effect of FDI technology for domestic firms. Second, due to the dominance of foreign electronics firms and the relatively weak technological base of local producers, domestic electronics firms are often excluded from the core production network and thus miss out on technological linkages (VCCI, 2022).

The impacts of forward FDI suppliers on domestic electronics technology are mixed, varying by industry and potentially influenced by the country of FDI origin. The growing presence of forward FDI output in the metal and trade industries appears to help narrow the technology gaps between domestic and FDI electronics firms. As discussed in Sub-section 3.4, these industries have seen an influx of FDI from emerging Asian countries and economies such as mainland China, Taiwan, and Malaysia. This increased presence heightens competition among supplier networks, thereby enhancing technological support from FDI providers and promoting technological upgrading among domestic electronics firms. However, despite these technological benefits, domestic electronics firms may struggle to maintain operational efficiency due to rising cost pressures and increasing reliance on FDI-led supply chains, as noted in Sub-section 5.1.

In the case of the upstream cable industry, a dual impact is also observed. On the one hand, the increased presence of FDI cable firms and their output has contributed positively to the management efficiency of domestic electronics firms, as shown in Table 4. On the other hand, the continued expansion of FDI output in the cable industry appears to widen the technology gap between domestic and FDI electronics firms. This suggests that technology gains in the cable industry disproportionately benefit FDI firms, leading to growing technological divergence. In this context, while domestic firms may experience managerial improvements, they remain at a disadvantage in terms of technological catch-up. Overall, these findings do not contrast Hypothesis H3 stating that in an FDI-dominated high-tech industry, greater forward FDI activity lowers technology spillovers to domestic firms.

The effects of backward FDI in downstream industries vary by sector, often producing contrasting outcomes for domestic management and technology. In the plastic and broadcast industries, we observe negative impacts on management efficiency of electronics firms (Table 4) but positive effects on their technological upgrading, as indicated by OR values greater than 1 in Table 5. These industries, largely dominated by Japanese and South Korean firms, impose stringent quality standards on their electronics suppliers, compelling domestic firms to enhance their technological capabilities. This demand-driven pressure incentivizes domestic electronics firms to upgrade their production technologies and quality control systems, helping to reduce the technology gap between them and their FDI electronics counterparts.

In contrast, backward FDI in the measurement industry, which is associated with improved management capabilities, shows limited evidence of meaningful technology spillovers. Although the growing presence of FDI customers in this sector, mostly from ASEAN countries such as Thailand and Malaysia, helps strengthen managerial practices through linkages and knowledge sharing, the technologies involved are highly specialized and often proprietary. Therefore, while these linkages may enhance operational scale and coordination, they do not necessarily enable domestic firms to catch up technologically with their FDI counterparts. These findings on downstream FDI customers are consistent with previous evidence of limited technology spillovers in Vietnam's manufacturing sector, as reported by Nguyen and Diez (2019). Despite industry-specific effects on domestic electronics technology, the data presented in Fig. 2 reveals limited technological upgrades, aligning with Hypothesis H4 prediction of reduced technology spillovers from backward FDI in FDI-dominated high-tech industries.

6. Productivity spillover analyses using TFP

We further investigate the overall effect of FDI on domestic productivity. Table 6 presents the estimates on TFP using Eq. (7) using panel estimators, including fixed-effects and GMM. To ensure robustness, standard errors were bootstrapped. When productivity dynamics have been accounted for using TFP(t-1), FDI in the trade and measurement industries was excluded from the GMM model because of multicollinearity. The results are consistent across methods in terms of statistical significance, direction, and magnitude.

Table 6
TFP estimation results.

	(1)	(2)	(3)
	FE	Bootstrapped FE	GMM
TFP(t-1)			−0.233
FDI	−5.699***	−5.699***	−20.030**
$FDI^{fw\text{-}cable}$	−1.932	−1.932	−5.404
$FDI^{fw\text{-}trade}$	2.656	2.656	–
$FDI^{fw\text{-}metal}$	4.175**	4.175**	5.283
$FDI^{bw\text{-}plastic}$	8.503**	8.503**	9.302
$FDI^{bw\text{-}measurement}$	−0.675	−0.675	–
$FDI^{bw\text{-}broadcast}$	71.111**	71.111**	−5.840
Market Share	0.534	0.534	4.034
Labor Share	1.168**	1.168	1.856
Skill-adjusted Labor	1.884***	1.884***	3.356***
Export	−0.018	−0.018	−0.426
Import	−0.099	−0.099	0.076
Transparency Index	0.018	0.018	0.071
Corruption Index	0.016	0.016	−0.100
Constant	−66.624**	−66.624**	25.627
AR(1)			0.099
AR(2)			0.762
Hansen test			0.902
Year-fixed effects	Yes	Yes	Yes
Observations	785	785	389
R-squared	0.268	0.268	
Number of id	300	300	212

A dash (−) in the GMM model denotes missing coefficients due to multicollinearity.
Source: Authors' calculations.
*** $p < 0.01$.
** $p < 0.05$.

Electronics FDI is found to reduce domestic electronics productivity. In contrast, the growing presence of forward FDI in the metal industry has a positive productivity impact on domestic electronics firms. Although forward FDI in the upstream cable and trade industries has shown mixed effects on domestic management capabilities and technological upgrading, it does not appear to enhance productivity among domestic electronics firms. Increased downstream FDI output in the plastic and broadcast industries is associated with productivity gains for domestic firms. However, the expansion of FDI output in the measurement industry does not yield similar benefits, showing little evidence of productivity spillovers to domestic electronics suppliers.

How consistent are these TFP estimates with the above management and technology analyses? And how consistent are these results with the trends in technology gap and domestic management capabilities presented in Fig. 2? We synthesize the distinct impacts of FDI, and other important factors, on management catchup, technology, and TFP in Table 7. This practice is important to understand the authentic sources of TFP growth, and to draw implications concerning the prospects to promote technology and productivity in the electronics industry.

Kokko (1994) argues that spillovers are unlikely where a high technology gap and high FDI presence coincide. Huang (2001) questions the productivity gains from horizontal FDI in labor-intensive industries. Our findings for horizontal FDI on TFP reinforce both views: despite operating in a high-tech industry, FDI dominance appears to reduce domestic productivity. Although FDI electronics firms may enhance domestic management efficiency through the demonstration effect, their dominance may intensify competition in the product markets, placing downward pressure on domestic productivity. This result aligns with the negative productivity effects of horizontal FDI in Vietnam's manufacturing sector by V. Ha et al. (2023).

Table 7
Distinct impacts of FDI on domestic management capabilities, technology, and TFP.

	FDI countries (descending order of popularity)	Impacts on		
		Management	Technology	TFP
FDI	South Korea, USA, Japan, China	+	−	−
$FDI^{fw\text{-}metal}$	Japan, South Korea, Taiwan	−	+	+
$FDI^{fw\text{-}cable}$	South Korea, Japan, Taiwan	+	−	No
$FDI^{fw\text{-}trade}$	Malaysia, South Korea, Thailand	−	+	No
$FDI^{bw\text{-}plastic}$	Japan, South Korea, Malaysia	−	+	+
$FDI^{bw\text{-}measurement}$	South Korea, Taiwan, Thailand	+	−	No
$FDI^{bw\text{-}broadcast}$	South Korea, Japan, Taiwan	−	+	+

Notes: (+) positive impact, (−) negative impact, (No) no significant impact.

As shown in Table 7, vertical FDI productivity spillovers are shaped by the balance between managerial and technological effects, which vary across industries. In upstream industries, such as cable manufacturing, long-established FDI firms improve input quality and provide managerial support. Yet, their increased presence appears to benefit foreign firms more technologically, deepening the gap with domestic suppliers. This may explain the nonsignificant TFP impacts from FDI in this industry. Nevertheless, increased FDI output in the metal industry, where foreign firms hold a high market share, is associated with productivity gains for domestic electronics firms. This supports the idea that vertical FDI can generate positive productivity spillovers, consistent with findings for Vietnam's manufacturing sector by Newman et al. (2015).

FDI in downstream industries, such as plastic and broadcast industries, reduces management efficiency among domestic electronics firms, likely due to increased competition. Yet, this same pressure encourages technological upgrading, leading to TFP gains. Conversely, FDI in the measurement industry, mainly from Thailand and Malaysia, enhances managerial practices through linkages but fails to deliver productivity improvements due to limited technology transfer.

Overall, our findings reveal an asymmetry between managerial and technology spillovers: FDI providers and customers rarely provide both. The nature and extent of spillovers depend not only on value chain positions but also on the complexity of technologies and strategic behavior of FDI firms. FDI dominance alone does not guarantee technology diffusion or productivity growth. Rather, domestic TFP gains appear to be driven more by internal efforts, including human capital development and firm-level innovation, than by external spillovers.

7. Conclusion and policy recommendations

Using the data on Vietnam's electronics industry, this paper provides compelling evidence that FDI dominance in a high-tech industry offers limited benefits to the domestic sector. Our estimates from the meta-frontier framework highlight that domestic electronics technology is far behind FDI technology while management capabilities among domestic firms are low. Despite the increased prevalence of FDI output and technology in the vertical value chain, domestic technology and management efficiency remain largely unchanged over a ten-year window. Our estimates show that there are limited spillovers from this horizontal electronics FDI, except for some managerial spillovers domestic firms benefit from the demonstration effect. Our findings on limited horizontal spillovers extend the "more is actually less" FDI phenomenon (Kokko, 1994; Huang, 2001; Nguyen and Diez, 2019), highlighting its special relevance in a high-tech industry. Prior literature and evidence often emphasize the importance of backward FDI in facilitating technology transfer and spillovers (Javorcik, 2004; Kugler, 2006). However, our findings suggest that, rather than benefiting directly from such transfers and spillovers, domestic electronics firms tend to upgrade their capabilities in response to the demands and opportunities involved in becoming suppliers to FDI customers (Javorcik, 2004; Kugler, 2006).

Given the dominance of FDI within the electronics industry, domestic electronics firms face intensified competition for supplier roles, driving deteriorated efficiency. As a result, domestic electronics productivity does not benefit significantly from the increased downstream FDI. This result for backward FDI is consistent with earlier findings for Vietnam by Nguyen and Diez (2019).

Our analysis of technology ratios suggests that technology transfer and spillovers do not materialize automatically, despite the widespread presence of FDI. Consequently, the Vietnamese government's efforts, such as financial incentives aimed at attracting multinational companies, may fall short of achieving the intended goal of upgrading and modernizing the domestic electronics industry. This issue is not unique to Vietnam. Evidence from other developing countries with FDI-dominated industries suggests similar challenges. For example, in Indonesia, high FDI concentration in technology-intensive manufacturing industries has not led to substantial local innovation or domestic value chain integration, as foreign firms often rely on global suppliers within their networks (Yasin et al., 2024). Similarly, in Mexico's maquiladora industry and Sub-Saharan African textile industry, FDI has largely focused on low-value assembly and export-oriented production, with limited technology transfer to domestic firms (Paus and Gallagher, 2008; Morris and Barnes, 2009). While this research does not suggest limiting financial and non-financial incentives, we highlight the need for a policy that fosters the integration of FDI capital and technology into the Vietnam economy.

International experiences with FDI suggest multiple ways host developing countries can leverage FDI for technology and managerial spillovers. Promoting linkages and collaboration between FDI and domestic firms is considered important for China in the process of modernizing its economy (Fanzhang, 1995; Young and Lan, 1997; Crescenzi and Harman, 2022). A significant challenge faced by Vietnam and many developing countries is the limited interactions between FDI firms and domestic suppliers or consumers. Vital for this process of technological upgrading and management catchup is the strong commitment of the host countries to human capital development. Successful stories with FDI in China and South Korea demonstrate that investments in human capital and domestic research capacity are crucial for nurturing a domestic talent pool capable of leveraging FDI inflows effectively and driving technological advancements (Crescenzi and Harman, 2022; Pyun and Sun, 2022).

From a broader perspective, Vietnam's trajectory may be understood through Lee et al.'s (2018) "in–out–in" framework of GVC participation. In the first "in" phase, FDI serves as a gateway into global value chains, enabling rapid industrial entry. But to escape dependency, Vietnam must eventually move to the "out" phase, where domestic firms develop their own capabilities, often by stepping back from reliance on foreign-led supply chains. This phase of partial disconnection is critical for building technological independence. Here, human capital development becomes decisive: only with a skilled workforce and stronger research capacity can domestic firms innovate, compete, and sustain themselves outside the shadow of FDI dominance. The final "in" phase then represents reintegration into global production networks, but on stronger terms - where local firms participate in higher-value segments and exercise greater bargaining power.

Our analyses are, however, subject to some limitations that merit future research. First, domestic firms' readiness for FDI presence can be determined by the levels of accumulative investments in R&D and/or technology. Future research would benefit from this information where it is available at the firm level. Second, our analyses focus mostly on firm- and industry-level economic factors while political and

institutional factors (e.g., governance, regulatory frameworks) likely play a critical role in shaping FDI success. Future research could investigate how these factors mediate FDI's impacts on domestic technology and management capabilities.

CRediT authorship contribution statement

Nguyen Chau Trinh: Writing – review & editing, Writing – original draft, Software, Methodology, Investigation, Formal analysis, Conceptualization. **Pham Thi Thu Tra:** Writing – review & editing, Investigation, Conceptualization. **Ha Thi Cam Van:** Writing – review & editing, Writing – original draft, Methodology, Investigation, Data curation. **Dao Le Trang Anh:** Writing – review & editing, Writing – original draft, Methodology, Data curation.

Declaration of Generative AI and AI-assisted technologies in the writing process

During the preparation of this work the authors used ChatGPT to improve language and readability. After using this tool, the authors reviewed and edited the content as needed and take full responsibility for the content of the publication.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A

Table 4B
Management efficiency estimates using FDI capital share.

	(1)	(2)	(3)	(4)
	Fractional Logit	Fractional Probit	GLM	Fixed-effects
	OR	OR		
FDI	8.671***	3.851***	0.531***	0.531***
$FDI^{fw\text{-}metal}$	1.000	1.000	−0.000	−0.000
$FDI^{fw\text{-}cable}$	0.909***	0.942***	−0.023***	−0.023***
$FDI^{fw\text{-}trade}$	0.739***	0.829***	−0.073***	−0.073***
$FDI^{bw\text{-}plastic}$	0.583***	0.714***	−0.133***	−0.133***
$FDI^{bw\text{-}broadcast}$	0.428***	0.587***	−0.212***	−0.212***
$FDI^{bw\text{-}measurement}$	0.988***	0.993***	−0.003***	−0.003***
Market Share	0.994***	0.996***	−0.002***	−0.002***
Labor Share	1.000	1.000	−0.000	−0.000
Skill-adjusted Labor	1.000	1.000*	−0.000*	−0.000*
Export	1.000**	1.000**	−0.000	−0.000
Import	1.000	1.000	0.000	0.000
Transparency Index	1.000**	1.000**	0.000*	0.000*
Corruption Index	1.000	1.000	−0.000	−0.000
Constant	0.551***	0.691***	0.358***	0.289***
Year-fixed effects	Yes	Yes	Yes	Yes
Firm-fixed effects	Yes	Yes	Yes	Yes
Observations	793	793	793	793
R-squared				0.997
Number of id				300

Source: Authors' calculation.
*** $p < 0.01$.
** $p < 0.05$.
* $p < 0.1$.

Table 5B
FDI capital share and technology ratios for domestic electronics firms.

	Homogenous absorptive capacity effect			
	(1)	(2)	(3)	(4)
	Fractional Logit	Fractional Probit	GLM	Fixed-effects
	OR	OR		
FDI	0.150***	0.311***	−0.436***	−0.436***
$FDI^{fw\text{-}cable}$	1.075***	1.045***	0.016***	0.016***
$FDI^{fw\text{-}trade}$	1.265***	1.155***	0.052***	0.052***
$FDI^{fw\text{-}metal}$	1.000	1.000	0.000	0.000
$FDI^{bw\text{-}plastic}$	1.625***	1.349***	0.113***	0.113***
$FDI^{bw\text{-}measurement}$	1.010***	1.006***	0.002***	0.002***
$FDI^{bw\text{-}broadcast}$	2.144***	1.601***	0.177***	0.177***
Efficiency	0.000***	0.000***	−3.460***	−3.460***
Market Share	1.025***	1.015***	0.005***	0.005***
Labor Share	1.002***	1.001***	0.000***	0.000***

(*continued on next page*)

Table 5B (*continued*)

	Homogenous absorptive capacity effect			
	(1)	(2)	(3)	(4)
	Fractional Logit	Fractional Probit	GLM	Fixed-effects
	OR	OR		
Skill-adjusted Labor	1.001***	1.001***	0.000***	0.000***
Export	1.001***	1.000***	0.000***	0.000***
Import	1.000	1.000	0.000	0.000
Transparency Index	0.999***	0.999***	−0.000***	−0.000***
Corruption Index	1.000	1.000	0.000	0.000
Constant	4.181***	2.421***	0.835***	0.835***
Year-fixed effects	Yes	Yes	Yes	Yes
Firm-fixed effects	Yes	Yes	Yes	Yes
Observations	793	793	793	793
R-Squared				0.998
Number of id				300

Source: Authors' calculation.
*** $p < 0.01$.

Table 6B
TFP estimation results using FDI capital share.

	(1)	(2)	(3)
	FE	Bootstrapped FE	GMM
TFP(t-1)			−0.234
FDI	−20.758*	−20.758*	–
$FDI^{fw\text{-}cable}$	3.241	3.241	−12.788***
$FDI^{fw\text{-}trade}$	6.944	6.944	−21.037*
$FDI^{fw\text{-}metal}$	−0.248	−0.248	1.615
$FDI^{bw\text{-}plastic}$	1.642	1.642	12.929**
$FDI^{bw\text{-}measurement}$	0.120	0.120	−0.310
$FDI^{bw\text{-}broadcast}$	13.737	13.737	–
Market Share	0.534	0.534	4.034
Labor Share	1.168**	1.168	1.856
Skill-adjusted Labor	1.884***	1.884***	3.356***
Export	−0.018	−0.018	−0.426
Import	−0.099	−0.099	0.076
Transparency Index	0.018	0.018	0.071
Corruption Index	0.016	0.016	−0.100
Constant	6.577	6.577	4.332
AR(1)			0.099
AR(2)			0.762
Hansen test			0.902
Year-fixed effects	Yes	Yes	Yes
Observations	785	785	389
R-squared	0.268	0.268	
Number of id	300	300	212

A dash (−) in the GMM model denotes missing coefficients due to multicollinearity.
Source: Authors' calculation.
*** $p < 0.01$.
** $p < 0.05$.
* $p < 0.1$.

Data availability

Data and codes can be made available from the corresponding author upon reasonable request.

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