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Linked in by foreign direct investment

The role of firm-level relationships in knowledge transfers in Africa and Asia

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Abstract: This study combines evidence from interviews in seven countries with (i) government institutions responsible for attracting foreign direct investment (FDI), (ii) 102 multinational enterprises (MNEs), and (iii) 226 domestic firms linked to these foreign affiliates as suppliers, customers, or competitors. The purpose of the interviews was to identify whether relations between MNEs and domestic firms lead to direct transfers of knowledge/technology. We first document that there are relatively few linkages between MNEs and domestic firms in sub-Saharan Africa compared with Asia. However, when linkages are present in sub-Saharan Africa, they raise the likelihood of direct knowledge/technology transfers from MNEs to domestic firms as compared with linked-in firms in Asia. Finally, we do not find that direct knowledge/technology transfers are more likely to occur via FDI than through trade. As such, our results are not consistent with the view that tacit knowledge transfers are more likely to occur through localized linkages.

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1 Introduction

Governments in developing countries allocate significant public funds to attract foreign direct investment (FDI). The rationale relies on the premise that FDI (besides bringing more jobs and foreign capital) brings superior know-how, managerial skills, and technologies that can diffuse into the domestic sector through various mechanisms.[1] These intangible assets are seen as an important source of productivity growth for domestic firms in the developing world. They help emerging industries catch up to the technology frontier.

Knowledge/technology transfers from foreign affiliates to domestic firms have received a lot of attention in the academic literature, and there are many well-explored theoretical mechanisms through which such spillovers may be realized. Existing studies typically consider spillovers via horizontal (intrasector) or vertical (intersector) linkages. Horizontal spillovers occur when knowledge/technology used by the multinational enterprise (MNE) is 'transferred' to competing local domestic firms in the same sector. Vertical spillovers are transfers of intangible assets through the supply chain from foreign intermediate suppliers to domestic producers (referred to as forward linkages) or from MNEs to domestic input suppliers (referred to as backward linkages). The empirical literature is inconclusive as to the nature and range of FDI spillovers. Estimates of the impact depend to a large extent on the specific country context, the data used, and the methods applied.

A common feature of the FDI spillover literature is the indirect approach to measuring knowledge/technology spillovers. Giroud (2012) provides a critique highlighting that this literature has only considered FDI spillovers as externalities of MNE activities which occur strictly through indirect mechanisms such as competition, demonstration effects, and labour mobility. More specifically, the focus has been on uncovering indirect evidence of externalities. This has been done by looking for associations between the increased presence of MNEs in a sector and productivity improvements in local domestic firms in the same sector (horizontal spillovers) or in local domestic firms in other sectors through upstream or downstream mechanisms (vertical spillovers). We argue that the effect of these indirect spillover mechanisms depends on interindustry linkages and underlying industrial structures. Lack of economic complexity will limit the scope for knowledge/technology diffusion of FDI spillover externalities (Bahar et al. 2014; Hidalgo et al. 2007). This means that the way in which knowledge/technology spillovers are typically measured leads us to hypothesize that FDI spillover externalities (*ceteris paribus*) are less likely to occur in countries where absorptive capacity is weak (in Africa) as compared with countries with more complex industrial structures (in Asia) (Marin and Bell 2006).

Yet direct linkages may also be at play. Arrow (1969) highlights that knowledge diffusion often requires direct (interpersonal) interaction, and that knowledge diffusion is not an automatic process; the potential for actual linkages is also dependent on the absorptive capacity of local domestic firms as well as MNE objectives and activities (Marin and Bell 2006). To get a more complete picture of MNE knowledge/technology transfers, we therefore need to understand both the direct linkages and the indirect spillover effects of FDI. Arguably, treating these concepts separately in empirical studies may yield insights to help unpack the heterogeneous country effects of FDI knowledge/technology transfers found in the literature. Due to data limitations, only a few studies have focused on the nature and existence of direct FDI linkages (Giroud et al. 2012; Jindra

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[1] See Caves (1996), Markusen and Venables (1999), Rodriguez-Clare (1996), and Yeaple (2013) on the theoretical underpinnings of productivity spillovers from foreign to domestic firms.

et al. 2009; Newman et al. 2015), and to our knowledge no study has tried to verify information about direct FDI linkages using information from both MNEs and linked local domestic firms.

The aim of this study is to provide new evidence on the existence of direct FDI linkages in developing country contexts. We rely on a specially designed survey instrument implemented in seven countries (Cambodia, Ethiopia, Ghana, Kenya, Mozambique, Uganda, and Viet Nam), enabling us to identify direct linkages between domestic and foreign affiliates. We use data triangulation to identify direct MNE-local domestic firm links. This is done to obtain as accurate a measure of direct knowledge/technology transfers as possible, using information from both 'nodes' forming the relationship. To distinguish possible MNE spillover effects from vertical linkages stemming from international trade, additional domestic firms not directly linked to MNEs within the country were included in the sampling frame if they engaged vertically with a foreign company outside the country. We obtained information from the seven central government bodies responsible for national FDI relations, 102 MNEs linked to 132 domestically owned firms as either suppliers or customers, and 94 domestically owned firms vertically linked to MNEs via trade.[2] Our approach helps us to identify whether relations between MNEs and domestic firms lead to recognized direct transfers of knowledge/technology. Thus, the contribution of our paper is twofold: (i) conditional on MNE client or supplier relations, we document the extent to which direct technology/knowledge transfers between MNEs and domestic firms actually take place, and (ii) we analyse firm attributes likely to be associated with these direct transfers.

We document relatively few linkages between MNEs and domestic firms in sub-Saharan Africa as compared with Asia. The relative scarcity of linkages documented in sub-Saharan African countries is puzzling, since the MNEs in this study were selected using a purposive sampling approach, where the national investment promotion agencies (IPAs) in each country were asked to select the foreign affiliates most likely to be linked to domestic clients and suppliers. Hence, the documented linkages are likely to be upper-bound estimates. However, when these linkages are present, the likelihood of direct knowledge/technology transfers from MNEs to domestic firms is higher in Africa compared with Asia. Our results therefore suggest that in the absence of sufficient economic complexity—which would normally facilitate indirect technology spillover externalities—establishing direct linkages between foreign and domestic partners through binding contractual agreements may be an effective policy in helping to ensure that MNE presence leads to technology spillovers in Africa. Finally, our evidence also seems to suggest that direct knowledge/technology transfers are not more likely to occur via FDI than through trade—a result that is inconsistent with the view that tacit knowledge transfers are more likely to occur through localized linkages.

The paper is structured as follows. In Section 2 we provide an overview of the most recent literature. Section 3 presents our triangulation approach and describes the data used for the econometric analysis. Section 4 presents the results regarding direct horizontal transfers, and Section 5 investigates direct vertical linkages. Section 6 offers concluding remarks.

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[2] The data gathered for the 94 domestic firms vertically linked to MNEs via trade relies only on answers provided by one side of the node forming the relationship. We assume in the following that the information about direct knowledge spillovers provided by these firms is as accurate as the information provided by domestic firms linked to MNEs within the country.

2   Background and related literature

The empirical literature on the effects of indirect FDI spillovers/externalities in transition and developing countries is large and has been discussed in several reviews (e.g., Alfaro 2014; Blomström and Kokko 1998; Caves 1996; Görg and Greenaway 2004; Javorcik 2008; Javorcik and Spatareanu 2005; Markusen and Venables 1999; Moran 2007; Smeets 2008). This literature suggests that the potential for positive FDI technology externalities depends on the mechanism through which the knowledge transfers occur.

Analysis of whether FDI can help develop Africa's industrial capacity is typically pursued along two dimensions: (i) horizontal linkages, analysing whether the presence of foreign-owned firms within the same industry lead to knowledge/technology upgrading in local domestic firms, and (ii) vertical linkages, looking at foreign-owned firm effects on probabilities of knowledge transfers to local domestic input suppliers and/or customers of MNEs. As already noted, most literature measures linkages indirectly, by exploring the extent to which the dominance of foreign firms within and across sectors impacts on the productivity of domestic firms through externalities. Only a few studies have considered the extent to which self-reported knowledge moves between firms along the supply chain, and whether such transfers are directly related to interactions with foreign-invested firms. Thus, most studies do not separate out direct knowledge transfers from more indirect externalities associated with FDI. The distinction between indirect and direct effects is important, given that different industrial policy recommendations will emerge depending on which mechanism dominates. In economies with relatively high levels of intermediary competition and a relatively high degree of economic complexity, conditions for indirect spillovers are such that incoming knowledge and capabilities from FDI in a specific sector are highly likely to spread naturally, both horizontally and vertically. On the other hand, in economies characterized by low levels of competition and economic complexity, industry policies that facilitate direct knowledge transfers between specific partners may be necessary to ensure that knowledge and capabilities are transferred to industries that will subsequently have the largest opportunity gains (Hausmann et al. 2014).

Horizontal spillovers within sectors may arise when workers move from MNEs to local domestic firms, bringing knowledge with them. Similarly, domestic firms may observe MNEs operating in their sector and copy their technologies. Finally, within-sector competition between MNEs and domestic firms may force domestic firms to increase efficiency to survive, even though MNEs may have an incentive to prevent their embodied knowledge and technologies from leaking to local domestic competitors. These effects can also lead to the least efficient firms exiting, thereby improving overall productivity within sectors. This could lead to observed productivity improvements within sectors with a large dominance of MNEs, but should not automatically be interpreted as evidence of positive technology externalities/spillovers. In general, the empirical literature on intra-industry externalities has failed to find robust evidence for productivity gains accruing to local domestic firms through horizontal spillovers.

Effects through vertical spillovers/externalities, on the other hand, are more likely to be positive, since conflicts of interest between MNEs and their suppliers/customers are less likely. Positive spillovers through backward linkages occur when domestic firms that supply inputs to MNEs experience productivity improvements. This can happen through a number of different channels. First, it can increase possibilities for scale economies among domestic suppliers due to greater demand for intermediates produced by local domestic firms. Second, domestic suppliers may get better incentives to improve the quality of their inputs and increase the efficiency with which they are provided, due to increased requirements from MNEs and competition from other local firms for foreign customers. Third, there is also the direct effect, focusing on deliberate knowledge

transfers from MNEs to domestic input suppliers. However, in the literature this direct effect is generally not separated from indirect effects of MNE presence. It is also possible that backward linkages could have negative externalities, and the literature finds that a precondition for positive spillovers through backward linkages is that domestic input suppliers produce varieties that are similar to the input requirements of MNEs. This means that the absorptive capacity and adaptability of local domestic firms matter for the nature of spillovers through backward linkages.

Forward spillovers from MNE suppliers of inputs to downstream local domestic firms have been studied less in the literature. However, intermediates provided by an MNE may embody new advanced technologies from which local domestic firms can gain knowledge and improve efficiency. These inputs could be accompanied by services or other forms of support that impact upon the productivity of domestic users; and in contrast to imported intermediates, the tacit knowledge in these intermediates may only be realizable in localized settings through direct interactions (Arrow 1969). In addition, increased competition among input suppliers due to increased MNE presence may benefit downstream local domestic firms due to more efficiently produced inputs by all upstream firms.

Much of the recent empirical research investigates the existence of such FDI externalities with a focus on vertical linkages, particularly backward linkages. On average (according to the review papers cited above), studies support the presence of positive vertical FDI spillovers. In this literature, FDI spillovers are often inferred from associations between the intensity of presence of MNEs in a sector and productivity in local domestic firms in other sectors (using aggregate input-output information to support sector interlinkages). As highlighted in Javorcik and Spatareanu (2011), this standard approach assumes a positive linear relationship between the share of local inputs sourced by MNEs and the extent of non-pecuniary knowledge (or technology) externalities via backward linkages to domestic suppliers in linked industries. Giroud et al. (2012) highlight that more competitive and complex value chain relationships may limit direct transfers of knowledge along vertical dimensions. This is so even if they may facilitate indirect spillovers. Direct and indirect linkages should therefore be analysed separately, as also emphasized above.

Newman et al. (2015) try to overcome this by using self-reported firm information on knowledge/technology transfers to uncover whether vertical effects are more likely to emerge from direct (self-reported) MNE linkages, or whether effects are more likely to be driven by indirect FDI spillovers. In the case of Viet Nam, they find that indirect FDI spillovers are more likely to drive local domestic firm productivity improvements, as compared with knowledge transfers through direct linkages between MNEs and domestic firms. This finding is consistent with Hirschman (1958), and Viet Nam has a relatively complex industrial structure with well-established intersector linkages. However, in countries (in Africa) that lack economic complexity there will be less absorptive capacity and weaker industrial linkages, and so MNEs are less likely to generate positive indirect externalities. Instead, MNE presence is more likely to generate what Hirschman refers to as enclave economies. But given that location decisions by MNEs reflect location fundamentals, an MNE choosing to locate in a country with limited scope for indirect knowledge/technology externalities must do so on the basis that they (i) do not find the effects of externalities sufficiently important for their business (for example, where MNEs source inputs from abroad and focus primarily on export markets) or (ii) believe that they can facilitate via direct knowledge transfers the necessary initial technology upgrading of local suppliers/customers (and start a process for a future increase in local value chain dynamics).[3] In the latter case, we would

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[3] This is in line with the 2012 UNIDO study (see Amendolagine et al. 2013), which finds that foreign subsidiaries in Africa are aware of the lack of initial linkages, but that they seek through direct interactions with local domestic firms to increase economy-wide interlinkages with local firms over time.

expect that direct knowledge/technology transfers are more likely to occur in locations with fewer industrial linkages. This is what we test in the remainder of this study.

3   Data and descriptive statistics

Data used in this study was collected using a data triangulation approach. Based on comparable semi-structured interviews with (i) each country's IPA, (ii) 102 MNEs, and (iii) 226 owners or managers of domestic firms, we obtained insights into the determinants of and cross-country differences in direct FDI spillovers. Structured interview guides ensured comparability of the information across sources and countries. For logistical reasons, the interviews were carried out in major cities only.

The sample of firms was selected as follows (purposive sampling combined with a sequential/snowball sampling technique). First, a semi-structured interview with the central government authorities in charge of attracting foreign investment was carried out. The investment agency targeted was the one that feeds into UNCTAD's *World Investment Report* with information for its annual survey. We therefore targeted institutions at the same level of responsibility. The identical semi-structured survey instrument provides systematic and comparable insights into government perceptions about possible FDI technology linkages from existing partnerships.[4] When asked about ways in which technology transfers from MNEs to domestic producers are likely to occur, the IPAs generally commented on the potential for generating direct linkages between MNEs and local domestic firms, and were less focused on describing policies to facilitate increasing FDI impact from externalities. Moreover, the country with the fewest identified direct linkages (Kenya) was the most optimistic about the potential for positive technology spillovers.

As part of the IPA interview, the enumerator in collaboration with the government FDI agency identified up to 20 MNEs in the manufacturing sector with majority foreign ownership to be subsequently interviewed; in most cases the government MNE agency was helpful in facilitating the interviews. In some countries, 20 manufacturing MNEs with majority foreign ownership could not be identified (or interviewed) in the chosen city. In such cases a broader industry definition was applied (including, in addition to manufacturing, mining, electricity and water, and construction). Even with this expanded industry definition, it was sometimes difficult to identify the targeted number of MNEs operating in the industrial sector. In countries/locations where

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[4] Most IPAs are part of traditional line ministries, with a mandate to promote investment by attracting and retaining MNEs. The IPA's core function is often to act as a 'one-stop shop' where any investor can obtain all necessary information to establish an enterprise, fully facilitated, without encountering any facilitation costs. Moreover, most countries have created documents that specify (to various degrees) the extent to which FDI is prohibited, restricted, allowed, or encouraged, and what FDI-related policy instruments the government intends to apply in the future. Currently the majority of FDI policy measures taken have been within liberalizing, facilitating, and promoting investments. Most countries in the sample have undertaken several policy measures directly affecting FDI, and countries are generally speeding up formal signings of international investment agreements (IIAs), albeit from a low base. Bilateral investment treaties are generally the preferred IIA, but double taxation treaties are becoming increasingly common. However, several countries highlight that they lack competent professionals in government that are specialized in international law in general and in IIAs in particular, which is slowing down the process. All countries in the sample have established special economic zones (SEZs) as a central part of their investment and industrial policy, and the location placement of MNEs is often an integral part of SEZ policies. According to the IPAs, the commonest method of MNE entry is through greenfield investments in SEZs. Most of these SEZs in the African sample have been established with a focus on lower-value-added sectors such as food and agro-processing, or textiles, garments, and leather products. All IPAs in the sample state that the creation of SEZs has been a success, but that the success is through export diversification and growth rather than employment generation. Only in the case of Viet Nam have the benefits and efficiency of SEZs begun to be questioned at this level.

there were numerous MNEs to select from, MNEs producing intermediates for the domestic market were preferred. In the end, information from a total of 102 industrial MNEs across the seven countries was available for analysis.

Second, based on this MNE identification, enterprises were interviewed using a predesigned interview guide, focusing on location choice determinants and local technology transfer. As part of the interview, the enumerator in collaboration with each MNE identified (i) up to three domestically owned industrial firms that are customers of the MNE, and (ii) up to three domestically owned industrial firms that are suppliers to the MNE. Moreover, each MNE was asked to mention whenever possible three in-country direct competitors to the MNE. With 102 MNEs this could in principle have resulted in 612 (3 x 2 x 102) interviews with domestic firms vertically linked to the MNEs as either customers or suppliers. However, only 132 vertically linked firms were identified.

Table 1: Sampling example, Viet Nam

FDI firm				Supplier		Customer		Competitor	
No.	City	Investor	Product	No.	Inputs	No.	Products	No.	Products
1	Hanoi	Japan	Porcelain products	1	Chemical	1	Porcelain products	x	Porcelain products
						2	Porcelain products		
						3	Porcelain products		
2	Hanoi	Japan	Furniture	2	Glass	4	Furniture	x	Furniture
				3	Wood	5	Furniture	x	Furniture
				4	Wood	6	Furniture		
3	Hanoi	Singapore	Tyres and tubes	5	Chemical	7	Tyres and tubes	x	Tyres and tubes
				6	Chemical	8	Tyres and tubes	1	Tyres and tubes
				7	Chemical	x	Tyres and tubes		
4	Hanoi	China	Electrical equipment	8	Copper wire	9	Transformers	x	Transformers
				9	Copper wire	10	Transformers	2	Transformers
5	Hanoi	Japan	Motor components	10	Steel/inox	11	Auto assembling	x	Auto spare parts
				11	Steel/inox	x	Auto assembling	3	Auto spare parts
				12	Steel/inox	x	Auto assembling		
6	Hanoi	Multiple	Rubber components	13	Rubber materials	12	Rubber products	x	Rubber products
				14	Raw rubber	13	Rubber products	x	Rubber products
				15	Raw rubber	14	Rubber products	x	Rubber products
7	Hanoi	Japan	Metal components	16	Steel	15	Locks	4	Metal products
				17	Steel	16	Miscellaneous mechanical products	x	Metal products
				18	Steel	17	Antennas	x	Metal products

	FDI firm			Supplier		Customer		Competitor	
No.	**City**	**Investor**	**Product**	**No.**	**Inputs**	**No.**	**Products**	**No.**	**Products**
8	Hanoi	Taiwan	Fibre optic cable	19	Decal, printing ink	18	Optic cable	5	Fibre optic cable
				20	Polypropylene bags	19	Optic cable		
						20	Optic cable		
9	Hanoi	Japan	Paint	21	Packing bags/boxes	21	Auto assembling	6	Paint
						22	Miscellaneous equipment	x	Paint
						23	Miscellaneous equipment		
10	Hanoi	Multiple	Paint	22	Chemical	24	Doors	x	Paint
				23	Chemical	25	Concrete	x	Paint
				24	Products for packing				
11	Hanoi	Multiple	Chemical products	25	Acid	26	Construction	7	Chemicals for construction
				26	Chemical	27	Concrete	x	Chemicals for construction
				27	Chemical	28	Construction		
12	Hanoi	Multiple	Carton products	28	Paper	29	Beer	8	Paper
				29	Paper	30	Milk	x	Carton
				30	Printing	31	Mechanical items	x	Paper bags
13	Hanoi	Japan	Plastic products	31	Ammoniac	32	Plastic door	9	Plastic products
						33	Plastic door	x	Plastic products
						34	Miscellaneous plastic products	x	Plastic products
14	Hanoi	Singapore	Electrical equipment	32	Electric wires	35	Transformers	10	Electric wires
				33	Miscellaneous electronic products	36	Transformers	x	Electric wires
				34	Miscellaneous electric equipment	37	Radios	x	Electric wires
15	Hanoi	Japan	Printing products	35	Printing paper	38	Miscellaneous printing products	11	Printing
				36	Printing paper	39	Miscellaneous printing products	x	Printing
				37	Printing paper	40	Miscellaneous printing products	x	Printing

Note: An additional three MNEs were interviewed in Dong Nai, but they did not provide sufficient customer/supplier/competitor details. Of the 88 domestic firms identified for interview, 13 refused to participate in the survey. None of the identified domestic suppliers/customers/competitors had any foreign involvement. In the Vietnamese case, MNEs were not asked to give joint venture company alternatives when unable to identify a domestic supplier/customer/competitor.

Source: authors' compilation.

Table 2: Sampling example, Kenya

	FDI firm			Supplier		Customer		Competitor	
No.	**City**	**Investor**	**Product**	**No.**	**Inputs**	**No.**	**Products**	**No.**	**Products**
1	Nairobi	India	Packaging	1	Tissue/hygiene products	1	Dairy/ food processing	x	Carton packaging
				#	Paper	x	Dairy/ food processing	1	Packaging
				#	Fibres	#	Dairy/ food processing/ fast-moving consumer goods	x	Packaging
2	Nairobi	Switzerland	Footwear	x	Textiles			x	Miscellaneous rubber products
				#	Petroleum-based materials			2	Food and footwear
				#	Textiles			#	Footwear
3	Nairobi	USA	Automotive industry	#	Used car parts	2	Cement trucks	3	Automotive industry
						#	Food industry	#	Automotive industry
						#	Cement trucks	#	Automotive industry
4	Nairobi	UK	Pharma- ceuticals	#	Packing materials			4	Pharmaceuticals
								#	Pharmaceuticals
								#	Pharmaceuticals
5	Nairobi	Mauritius	Iron and steel industry	#	Paint			5	Steel/roofing materials
				#	Fuel/petroleum			x	Aluminium/ roofing materials
				#	Electrical devices			#	Roofing materials
6	Nairobi	Taiwan	Textile	2	Carton manufacturer			#	Textiles
				#	Packaging material			#	Textiles
				#	Packaging material			#	Textiles
7	Nairobi	UK	Tobacco	3	Printers			6	Tobacco
				#	Packaging material				
				#	Glue				
8	Nairobi	Netherlands	Petroleum	4	General plastics	x	Sugar	#	Petroleum
				x	Miscellaneous products	#	Food	#	Petroleum
				#	Packaging material	#	Cement	#	Petroleum
9	Nairobi	USA	Beverages	#	Sugar			7	Beverages/ fresh juice
				#	Packaging material			#	Beverages/ fresh juice
				#	Packaging material				

FDI firm				Supplier		Customer		Competitor	
No.	City	Investor	Product	No.	Inputs	No.	Products	No.	Products
10	Nairobi	France	Cement	#	Packaging material	#	Construction	8	Cement
				#	Packaging material			x	Cement
								x	Cement

Note: One additional MNE was interviewed, but did not provide sufficient customer/supplier/competitor details. Of the 14 domestic firms identified for interview, nine refused to participate in the survey. Domestic suppliers/customers with majority foreign involvement are highlighted with #.
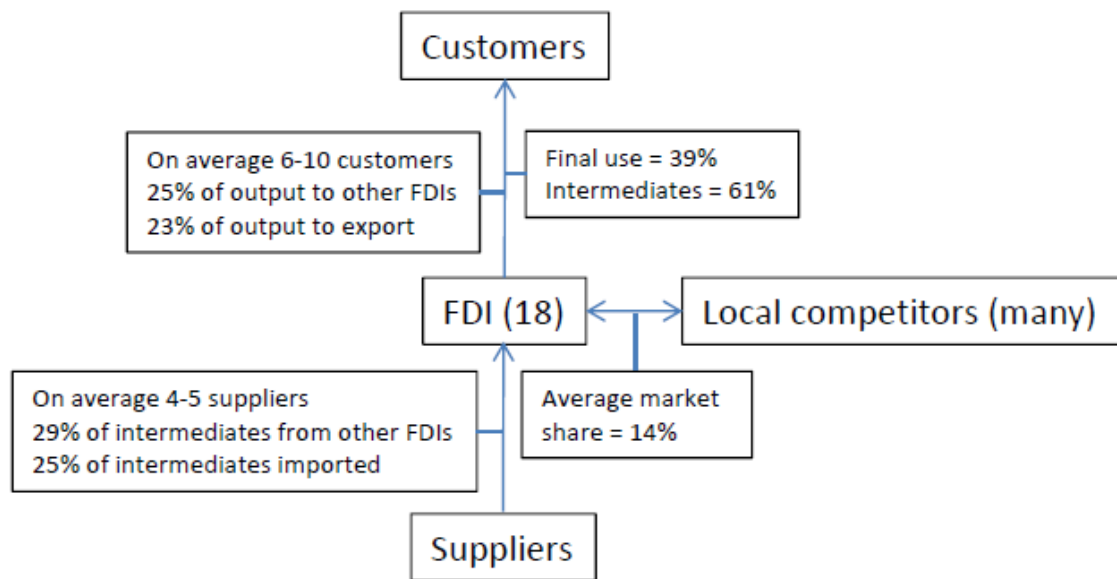
Source: authors' compilation.

The explanation for this can be found in Tables 1 and 2, which provide examples of the MNE responses for Kenya and Viet Nam (firm-identifying details have been removed from the tables to ensure anonymity). Take FDI firm number 1 in Table 1 as an example. It is located in Hanoi, produces porcelain, and has a Japanese company as its main shareholder. According to the information obtained from the interview, this MNE has only one domestic supplier (of chemicals used as an intermediate), but numerous customers of its (final-use) products. When asked about its competitors, the MNE responded that it only has one 'real' competitor, although many porcelain producers are located within the Hanoi perimeter. To compare, take MNE number 4 in Table 2. Located in Nairobi, this company produces pharmaceuticals and is UK-owned. It has no domestic input suppliers, and has only listed another majority foreign-owned company located in Kenya as a main within-country input provider. Moreover, it has no domestic or MNE customers in-country. All output is exported directly. Finally, it has one major domestic and two other MNE competitors located in the area. Key differences between Tables 1 and 2 are (i) the noteworthy difference in MNE-domestic firm linkages, and (ii) the relatively few domestic customers for MNE-produced output in Kenya.

To distinguish possible vertical MNE spillover effects from backward and forward linkages stemming from international trade, additional domestic firms not directly linked to the identified MNEs were purposely included in the sampling frame if they engaged (i) in supplier relationships with a foreign company outside the country (direct export) in another sector (defined at the four-digit International Standard Industrial Classification (ISIC) code level), or (ii) in purchaser relationships with a foreign company outside the country (direct import) in another sector. To identify these firms, assistance from the country IPAs was relied upon. Combined with domestic firms identified as having direct links with MNEs within the country, a total of 226 domestic firms across the seven countries were ultimately available for analysis. Of these, 132 were directly vertically linked (supplier or customer) to an MNE with a branch within the country.

It should be highlighted that this sampling approach was highly ambitious, and in itself gave some important insights. First, it was confirmed that many MNEs (especially in the five African countries) are not linked with any domestic manufacturing firms, i.e. that they only have links to other MNEs within the country. Several MNEs are sole producers of particular/niche products, and thus have no competitors; others rely solely on imports, and thus do not source intermediate inputs from the domestic market. A large majority of MNEs produce wholly for the export market, implying that direct domestic forward linkages will be non-existent for these firms. Second, and more surprisingly, MNEs engaged with domestic suppliers and/or customers identified those on a day-to-day basis, and very few had long-term relationships with domestic suppliers/customers. Consequently, limited information about names, locations, and other contract details were available.

Figure 1: Composition of sampled firms and their relations, Viet Nam

Source: authors' illustration.

Figure 2: Composition of sampled firms and their relations, Kenya
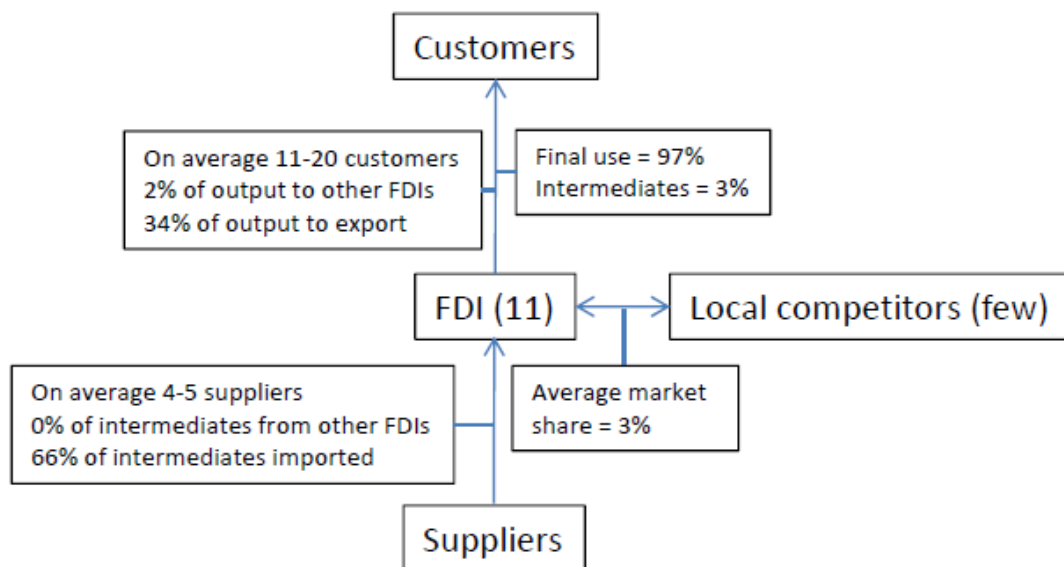
Source: authors' illustration.

Taking again the cases of Kenya and Viet Nam, Figures 1 and 2 illustrate country differences in the composition of sampled firms and their relations. The 18 selected Vietnamese MNEs have on average six to 10 customers.[5] Some 25 per cent of output is sold to other MNEs within Viet Nam, and 23 per cent is exported. This means that a large share of production is never 'linked' with

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[5] Besides requesting information on the three main domestic customers, suppliers, and competitors, each MNE was independently asked for its total number of customers, suppliers, and competitors within the country.

domestic firms (thereby limiting the scope for vertical spillovers). In the Kenyan case, we observe on average more customers (many of them foreign, however), higher export shares, and only limited within-country interactions between MNEs and domestic firms. In addition, in Kenya the MNEs face few but often large local competitors, as compared with Viet Nam, where foreign-invested firms often dominate the market but face many local smaller niche competitors. Moran (2007) highlights that vertical technology spillovers are more likely to occur when one is engaging in the intermediate goods market compared with trading final-use goods. Here we observe that 61 per cent of the Vietnamese MNEs sell for intermediate use, compared with only three per cent in the Kenyan case. Turning to backward linkages, Figures 1 and 2 show that 29 and 25 per cent of intermediates are sourced from other MNEs and imports respectively in the Vietnamese case, as compared with an average of zero and two thirds for Kenya. These figures are representative of the regional differences, which indicate that the spillover externalities through complex intermediate linkage structures are less likely to be present in our African sample than in Cambodia and Viet Nam, confirming the illustration in Tables 1 and 2.

Tables 3 and 4 document selected summary statistics by country, obtained from the semi-structured interviews with the 102 MNEs (Table 3) and 226 domestic firms with links to an MNE (Table 4).

As expected, MNEs are large firms, but the sampled domestic firms are also relatively large. The average numbers of employees across the seven countries are 850 (MNE) and 275 (domestic), with the majority of these being full-time employed. Moreover, most MNE employees are 'local'. In terms of ownership structure, we find that most MNEs in the sample are wholly foreign-owned. We note that this does not mean that joint ventures between foreign and domestic firms are not a growing part of the enterprise population. Most MNEs entered through greenfield investments (76 per cent), while the remaining firms have either acquired or merged with existing businesses. There is an indication that MNEs in Africa use mergers and acquisitions (M&A) more frequently as an entry mode than in the two Asian countries.

Interestingly, we observe major cross-country differences in the main reasons for the location choices of MNEs. Resource-seeking FDI (a host country rich in minerals, raw materials, lower labour costs, etc.) is highlighted as the main reason in Ethiopia, Uganda, and Viet Nam, whereas market-seeking FDI is mentioned as a main determinant of location choice in Ghana, Kenya, and Mozambique. We note that very few MNEs chose their location due to expectations of improving production efficiency.

Tables 3 and 4 also show that around 40 per cent of the MNEs and 28 per cent of domestic firms with MNE links are located in special economic zones (SEZs). This SEZ average masks major cross-country differences (Cambodia, Ghana, and Kenya have very few firms located in SEZs, while Ethiopia and Viet Nam have more focused SEZ policies). In addition, we also asked more specific questions about firms' reasons for choosing their current production site. Again, a lot of variation is observed cross-country. In some countries, several firms state that the production site was allocated by the government (Ethiopia), whereas a location close to its customers is the dominating location criterion in other cases (Viet Nam). Good infrastructure is also highlighted as one of the main drivers of location choice, for both domestic and foreign-owned firms.

Table 3: Summary statistics, MNEs

	Total	Cambodia	Ethiopia	Ghana	Kenya	Mozambique	Uganda	Viet Nam
Average number of employees (in country)	850	2814	389	347	1116	321	286	598
Share full-time permanent employees (%)	82	99	84	87	87	79	74	68
Share local employees (%)	81	98	96	64	99	93	89	50
Sectors best represented in the sample	..	Textiles	Food	Food	Mixed	Mixed	Mixed	Mixed
	..	Garments	Textiles	Rubber	..	..	..	..
	..	..	Garments	Plastics	..	..	..	..
Share 100% foreign ownership (%)	84	100	80	78	73	89	80	89
Mode of entry								
M&A	21	7	40	25	18	56	13	0
Greenfield	76	93	60	50	82	44	81	100
Other/not specified	3	0	0	25	0	0	6	0
Main reason for choosing country (%)								
Resource-seeking	37	27	58	11	9	33	42	50
Market-seeking	36	13	32	44	46	56	37	39
Efficiency-seeking	9	7	5	22	0	0	21	6
Capabilities/strategic assets	4	0	0	0	18	11	0	5
Other/not specified	14	53	5	22	27	0	0	0
Firms with more than one production facility in the country (%)	32	40	20	33	36	56	40	17
Main production facility located in an SEZ (%)	40	20	40	11	18	44	42	78
Main reason for choosing production location within country (%)								
Allocated by authorities	18	0	35	0	27	11	15	17
Availability of cheap labour	12	27	10	0	0	0	15	11
Good infrastructure	24	60	0	66	36	22	15	17
Location close to input suppliers	10	13	15	0	18	0	15	0
Location close to customers	25	0	25	0	0	45	30	50
Location close to competitors	2	0	5	0	10	0	0	0
Other reasons/not specified	9	0	10	33	9	22	10	5
Number of MNEs	102	15	20	9	11	9	20	18

Note: Based on a total 102 interviews.

Source: authors' compilation.

Table 4: Summary statistics, domestic firms

	Total	Cambodia	Ethiopia	Ghana	Kenya	Mozambique	Uganda	Viet Nam
Average number of employees (in country)	275	444	248	296	317	2,702	200	165
Full-time permanent employees	213	443	208	193	296	1,453	177	123
Share single ownership (%)	37	47	21	45	15	60	14	49
Firms with more than one production facility in the country (%)	24	16	20	14	38	20	11	33
Main production facility located in an SEZ (%)	28	0	53	0	15	0	47	26
Main reason for choosing production location within country (%)								
Allocated by authorities	17	0	38	23	15	0	14	12
Availability of cheap labour	7	5	10	5	0	20	6	9
Good infrastructure	20	5	35	23	8	0	22	18
Location close to input suppliers	16	32	5	9	23	40	11	19
Location close to customers	23	11	3	14	15	0	22	40
Location close to competitors	4	0	3	9	0	0	6	3
Other reasons/not specified	13	47	8	18	38	40	19	0
Number of domestic firms	226							

Note: Based on a total 226 interviews.

Source: authors' compilation.

Table 5: Technology and innovation

MNEs	Total	Cambodia	Ethiopia	Ghana	Kenya	Mozambique	Uganda	Viet Nam
Share that would characterize the technological level/capacity of the firm's existing machinery and equipment above the level of its main competitors	49	67	45	44	64	78	35	33
Share that would be able to increase production by more than 25% using existing equipment/machinery only	39	27	65	0	45	71	40	22
Share that introduced a new technology/production process within the past two years	63	80	55	67	55	86	70	44
Share that obtain machinery and equipment from local suppliers	16	0	20	13	0	..	40	6
Share that undertake in-house research and development	50	20	40	78	45	88	65	39
Share that hold internationally recognized patents	43	0	30	33	73	89	65	6
Share that introduced a new product (at the ISIC four-digit level) within the past two years	25	0	5	63	27	44	40	22

Domestic firms	Total	Cambodia	Ethiopia	Ghana	Kenya	Mozambique	Uganda	Viet Nam
Share that would characterize the technological level/capacity of the firm's existing machinery and equipment above the level of its main competitors	26	42	28	35	69	0	31	10
Share that would be able to increase production by more than 25% using existing equipment/machinery only	31	58	43	38	50	40	39	10
Share that introduced a new technology/production process within the past two years	46	58	58	62	38	60	67	24
Share that obtain machinery and equipment from local suppliers	25	0	10	35	8	25	20	42
Share that introduced a new product (at the ISIC four-digit level) within the past two years	30	11	25	40	46	20	59	22

Note: MNE and domestic firm information based on 102 and 226 observations respectively.

Source: authors' compilation.

Table 5 documents summary statistics about firm-level technology and the modes through which this new technology is acquired for both MNEs and domestic firms. The first row of each panel in the table shows the firms' self-evaluations of their technology in comparison with their competitors. Some 49 per cent of MNEs and 26 per cent of domestic firms claimed to have a technology advantage compared with their competitors. At the same time, only around 30 per cent of both types of firm stated that they would be able to increase capacity by more than 25 per cent using existing production structures. Moreover, two thirds of MNEs and almost half of domestic firms mentioned that they had introduced new technology or production processes in the last two years.[6] Thus both MNEs and domestic firms seem highly dynamic in terms of technological upgrading, and most are utilizing their capacity fairly well. The table also shows that these dynamic technological features translate into relatively high levels of innovative capacity. Some 25 per cent of MNEs and 30 per cent of domestically owned firms have introduced new product groups (defined at the four-digit ISIC code level) in the last two years.

The focus of this study is on how these dynamic features come about, and whether the domestic firms get 'additional' technology that is directly transferred from linked MNEs or whether technology upgrading continues to be driven through other mechanisms.[7] An observation that could lead one to question whether technology spillovers between 'linked-in' MNEs and domestic firms are likely to lead to direct production technology upgrading is that very few firms source new technology locally/domestically (16 per cent of MNEs and 25 per cent of domestic firms). Most firms acquire their technology through direct import, and a significant number of MNEs acquire technology from headquarters located abroad. Indeed, learning new production technologies and processes from abroad seems critical in building greater firm-level technological capability.

4   Direct technology transfers through horizontal spillover channels

One mechanism through which domestic firms may experience a direct technology transfer is via horizontal mechanisms, as described in Section 2. Table 6 illustrates the presence or absence of potential direct technology transfers along the horizontal dimension from MNEs to linked domestically owned firms. Some 57 per cent (49 out of 86) of MNEs reported that they observed that main domestic competitors had changed production techniques and processes as a direct result of the competitive pressure from the MNE. This share was 37 per cent (81 out of 221) when the question was posed to linked domestic firms. However, when we zoom in on linked domestic firms listed as competitors, there is almost perfect correspondence between the answers for the linked MNE and the domestic firm listed as competitor. Take Table 1 (Viet Nam) as an example: it documents that FDI firm number 3 (location: Hanoi; investor: Singapore; sector: tyres and tubes) named a domestic competitor (competitor number 1), which the survey team approached for an interview. If the MNE and the domestic competitor gave answers in accordance with each other to similar questions, we label this as corresponding link information.

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[6] Some two thirds of the MNEs that had introduced new technologies/production processes had found it necessary to carry out technical adaption of the equipment/machinery to fit local conditions. Adaption was primarily done in order to facilitate the use of local inputs or to adjust to the skill level of employees.

[7] For example, improvements in technology may take the form of transfer of technological progress via imports through imitation, reverse engineering, reconditioning, and modification of machinery and equipment, rather than through supplier/customer links to local MNEs.

Table 6: Horizontal spillovers

MNE responses: competition/demonstration spillovers

	Yes	No
FDI observed domestic firms (competitors within the same ISIC four-digit code) changing production techniques/processes as a direct result of competitive pressure from the firm?	49 (57)	37 (43)

	Yes	No	NA	
FDI observed domestic firms trying to directly adopt production techniques/processes (by observing or copying) from the FDI?	29 (59)	17 (35)	3 (6)	

MNE responses: labour spillovers

	Yes	No
Experienced employees leaving to set up a local enterprise directly connected to the FDI?	33 (33)	67 (67)
Share as competitors	15 (45)	
Share as customers	19 (58)	
Share as suppliers	18 (56)	

Domestic firm responses: competition/demonstration spillovers

	Yes	No
Firm changed production techniques/processes due to competitive pressure from MNEs within the same sector?	81 (37)	140 (63)

	Yes	No
Directly adopted production techniques/processes from these MNE competitors?	34 (46)	47 (54)

Domestic firm responses: labour spillovers

	Yes	No
Firm hired employees initially trained in an MNE?	57	154
	(27)	(73)

	Yes	No	
Engagement of these employees directly resulted in changes in production techniques/processes?	30	27	
	(53)	(47)	

Note: Percentages in parentheses.

Source: authors' compilation.

These numbers indicate that the presence of MNEs indirectly acts as a technology 'push' factor for domestic firm technology upgrading. This is confirmed in the second row of Table 6, which documents that 59 per cent of the MNEs that had observed changed production techniques in other firms due to competitive pressure had also observed the direct adoption of production techniques/processes (by observing or copying) from the MNE. Again, there is consistency between corresponding links. Regional differences do exist (not documented in the table for reasons of exposition), with the African firm sample experiencing competition- and demonstration-related spillovers more frequently than firms in Cambodia and Viet Nam. Especially in the Vietnamese case, MNEs 'feel' the competition pressure from domestic firms and state that they have every incentive to prevent their embodied knowledge and technologies from leaking to these domestic competitors, a feature also found in the manufacturing sector in Eastern Europe (Javorcik 2004).

Table 6 also explores direct linkages between MNEs and domestically owned firms, manifested in terms of labour market competition and the importance of spin-offs (former employees of FDI firms) in the domestic firms. Some 33 per cent of MNEs report that they have experienced employees leaving to set up local enterprises directly connected to the FDI. However, not all former employees have set up competing businesses. They have instead exploited existing opportunities (and local information) and become either customers or suppliers of the MNE. Corresponding link consistency is weaker in this case, which is also illustrated by the relatively low share (27 per cent) of linked domestic firms reporting that they have hired employees initially trained in MNEs. Contrary to the demonstration/competition effects, the data does not show any immediate cross-country differences in horizontal spillovers along the labour mobility dimension. An interesting observation occurred when the survey teams enquired of domestically owned firms whether hiring spin-offs had resulted in any meaningful impact on the firm's production processes or techniques. Some 53 per cent reported that the recruitment of former employees of MNEs had had such an impact.

To summarize: domestic firm technology choice decisions seem to be influenced by MNEs' technology levels and dynamics along the highlighted horizontal dimensions (demonstration/competition and labour/spin-off effects). However, this type of analysis does not provide insights into whether these horizontal influences from MNEs are more pronounced than influences from local domestic competitors, an issue to which we now turn.

5   Direct technology transfers through vertical spillover channels

In the previous section, we documented that horizontal spillovers (within sectors) to some degree arise when workers move from MNEs to domestic firms, bringing with them acquired knowledge that influences firm technology choices. Similarly, domestic firms observe and copy/adapt MNE technologies, and it also seems that competition from MNEs forces domestic firms to increase efficiency to survive (especially in the sample of African firms).

According to our literature review, direct technology spillovers between sectors are more likely to bring productivity-improving benefits to domestic firms through vertical spillover mechanisms. However, the literature has focused on vertical spillovers through externalities, rather than studying direct links, which are in focus here. Figure 3 shows how technology spillovers from MNEs to domestic firms in other sectors are defined.

Spillovers through backward linkages occur when domestic firms that supply inputs to MNEs experience significant productivity changes (positive/negative) due to the interaction between the two parties. Most of the literature on backward linkages is only suggestive about how these backward linkages happen, and direct technology transfers—i.e. deliberate knowledge/technology transfers from MNEs to domestic input suppliers—have to our knowledge only been studied in a few cases.[8]

Figure 3: Definition of vertical linkages/technology transfers

Domestic firm

| Forward linkage/technology transfer | Supplies goods and/or inputs | Backward linkage/technology transfer |

Foreign firm

Note: Direction of linkages is defined from the perspective of foreign firms.

Source: authors' illustration.

Grossman and Helpman (1991) document that forward linkages also have the potential to lead to direct positive knowledge/technology spillovers from MNEs supplying inputs to downstream domestic firms. The idea is that intermediates provided by MNEs embody new and more advanced technologies from which domestic firms can learn. In contrast to imported intermediates, these inputs are accompanied by services (or other forms of support) that impact on the productivity of domestic users (Javorcik 2004).

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[8] Moran (2001) uses a number of different case studies to show that deliberate technology transfers are relatively common. This happens through MNEs offering technical assistance, management experience, or quality assurance systems to their suppliers.

Table 7: Vertical spillovers

Panel A: MNE responses—vertical spillovers

		Customers (forward linkages) %	Suppliers (backward linkages) %
Produces mainly for final consumption		53	..
100% sales to or import from other FDIs or through direct exports/imports		24	33
Share with five or fewer customers/suppliers		27	60
Relations with domestic customers/suppliers required a direct technology transfer from the FDI to the customer/supplier	All	21	18
	Kenya	50	30
	Viet Nam	6	6
Transfer stipulated directly in contract	All	47	36
	Kenya	50	67
	Viet Nam	0	0

Panel B: domestic firm responses—vertical spillovers

		Suppliers (forward linkages) %	Customers (backward linkages) %
Produces mainly for final consumption		..	46
Customer/supplier relations with MNEs either domestic links or through direct exports/imports		85	84
Share with five or fewer customers/suppliers		53	15
Relations with customers/suppliers required additional investments in order to obtain contract	All	19	30
	Kenya	31	38
	Viet Nam	9	21
Relations with customers/suppliers resulted in direct technology transfer from customer/supplier to the firm	All	76	41
	Kenya	75	80
	Viet Nam	14	5
Share of firms receiving the technology transfer from an MNE		56	27

Note: Numbers based on 102 MNEs and 226 linked local domestic firms.

Source: authors' compilation.

In what follows we aim to disentangle the characteristics of domestic firms experiencing direct vertical spillovers. Table 7 summarizes some of these characteristics, combining information from MNEs and linked domestic firms. Around 25 per cent of the MNEs interviewed do not have any interactions with domestic firms. This corresponds fairly well with the observation that 15 per cent of the domestic firms report having no customer/supplier relations with MNEs (either domestic links or through direct exports/imports). Focusing on the variables of interest, we asked MNEs directly whether their relations with domestic customers/suppliers required a direct technology transfer from the MNE to the customer/supplier. It can be seen from Table 7 (Panel A) that on average 18 per cent of interviewed MNEs reported experiencing backward linkages. Of these, 36 per cent stated that the knowledge/technology transfers were directly stipulated in the contracts with their domestic customers. In addition, 21 per cent of firms experienced forward linkages, with 47 per cent of these stating that transfers of capabilities were stipulated directly in formal contracts. This supports the case study findings by Moran (2001). Moreover, the summary statistics show

that direct forward linkages are more frequently observed than direct backward linkages. As illustrated with the Kenya versus Viet Nam cases, and the spline plots of the fraction of direct technology transfers by country (Figure 4), we see that direct technology transfers are more likely to take place among the sample of African MNEs than in the Asian region. The same patterns are generally found from the interviews with linked domestic firms (Table 7, Panel B).

Figure 4: Spline plots of direct vertical linkages
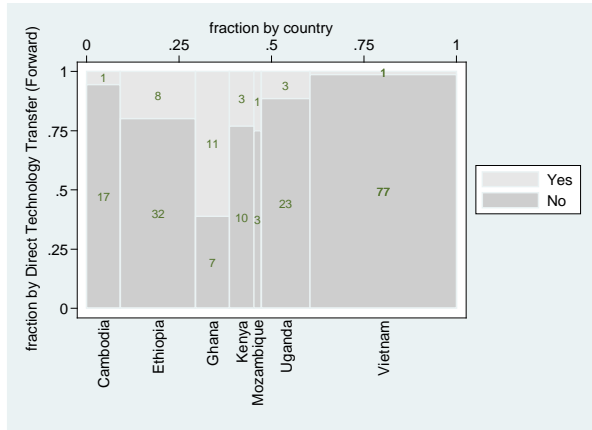
Direct forward linkages   Direct backward linkages
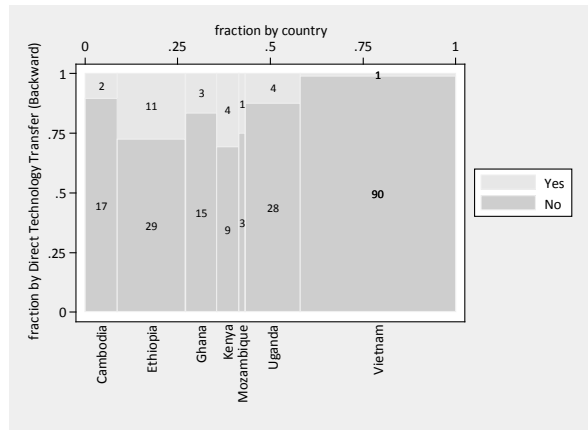
Note: Spline plots for direct forward and backward linkages. Illustrates the fraction of linked (to MNEs) domestic firms where both sides of the 'nodes' forming the relationship state that a transfer of technology and/or knowledge has taken place. As an example, we have 78 nodes from Viet Nam, but one node confirms that a direct transfer has taken place between the MNE and the linked domestic firm. In Ghana, we observe 18 nodes, and in 11 cases a direct transfer has been confirmed by both parties.

Source: authors' compilation.

We now proceed to take a closer look at the association between region and the probability of receiving a direct knowledge/technology transfer either upstream or downstream, using a traditional probability model and controlling for firm size and age, customer/supplier relations, production characteristics and location. Hence, we estimate log odds ratios from a logit specification describing the probability of a domestic firm receiving a direct technology transfer. The model is formulated as

$$\Pr(y_{ic} = 1 \mid x_{ic}, c) = \Lambda(\beta' x_{ic} + \alpha_c), \ i,...,N_c, c = 1,...,7.$$

[1]

where y_{ic} equals one if firm i in country c receives a knowledge/technology transfer; x_{ic} are the firm-specific technology linkage determinants; α_c is the country-specific term; and Λ is the logistic distribution function. Controls more specifically include firm size (log employees), firm age (establishment year in logs), ownership structure (indicator for single-owner firm), production characteristics (indicator for production for final goods use), location (indicator for only one production facility, indicators for SEZ, country), and customer/supplier relations (size of customer/supplier base, and indicators for engagements with MNEs both within and/or outside the country). Based on the above, we are especially interested in establishing whether direct vertical spillovers are more likely to occur in our sample of African countries as compared with our sample of Asian countries.

Table 8: Vertical spillover determinants

	Panel A: backward linkages			Panel B: forward linkages		
	1	2	3	4	5	6
Firm size	0.030**	0.025**	0.020*	0.006	-0.003	-0.005
(Number of employees, log)	(2.19)	(2.11)	(1.73)	(0.36)	(0.25)	(0.36)
Firm age	0.032	0.018	0.032**	0.061*	0.030	0.019
(Years, log)	(1.54)	(1.17)	(2.05)	(1.70)	(1.20)	(0.58)
MNE/FDI customer/supplier	-0.126***	-0.042	-0.005	-0.144***	0.043	0.012
(Yes = 1, No = 0)	(2.56)	(0.90)	(0.17)	(2.75)	(0.76)	(0.21)
Africa		0.110**	0.123**		0.287***	0.279***
(Yes = 1, No = 0)		(2.20)	(2.12)		(3.24)	(2.76)
Other controls	No	No	Yes	No	No	Yes
Observations	189	189	170	171	171	164
Pseudo R2	0.170	0.218	0.322	0.103	0.200	0.208

Note: The dependent variable is the indicator of firms receiving a direct knowledge/technology transfer. Robust t-statistics. * Significant at 10%; ** significant at 5%; *** significant at 1%.

Source: authors' compilation.

Table 8 reports the regression results, dividing the table into transfers from backward linkages (Panel A) and forward linkages (Panel B). The results in Column 1 indicate that, conditional on firm size and age, local domestic firms are less likely to receive a direct knowledge/technology transfer if they have an MNE (within the country) as a customer than if they have a foreign firm abroad, or a domestic firm, as a customer. This result is rather striking given the purposive sampling approach applied, where results are expected to be biased towards overestimating vertical transfers occurring through within-country firm linkages. Adding a regional control in Column 2 shows that the negative coefficient on the MNE customer relations indicator is driven by differences across the African and Asian samples. African firms are generally more likely to receive direct knowledge/technology transfers, and less likely to have an MNE as a customer, than Asian firms. Including the additional controls described above does not change this result (Column 3).

A similar pattern is found for forward linkages. This suggests that when local domestic firms are being supplied with inputs by an MNE within the country, this is negatively associated with an increase in the likelihood of receiving a direct knowledge transfer through forward linkages. At the same time, operating in Africa (*ceteris paribus*) increases this probability compared with firms in Asia. These results are consistent with the information obtained from the 102 interviews with MNEs, and it suggests that MNEs in Africa are more likely to engage in direct contractual arrangements, both upstream and downstream, regarding transfers of technology and know-how as compared with Asian MNEs. However, it should be highlighted that even in our African sample of domestic firms purposively selected to have a higher likelihood of being vertically integrated with an MNE, direct technology/knowledge transfers through FDI are not more likely to be observed than direct technology/knowledge transfers through trade (results available as supplementary material on request).

The differential size effect for African and Asian firms may be a sign of general differences in the parameters. If so, the total regional effect on the probability of receiving an MNE knowledge transfer cannot be estimated by simply adding country dummies in the non-linear regression. We therefore estimate the total regional effect using a generalized Oaxaca-Blinder decomposition.[9] The generalized Oaxaca-Blinder decomposition can identify two components of the unconditional vertical knowledge/technology transfer gap by region (i.e. the difference between the probability of firms receiving a vertical technology transfer in Africa and Asia). The first component is a measure of the importance of differences in observable characteristics between African and Asian firms. We refer below to this component as the 'characteristics effect'. The second component is a measure of the importance of differences in parameters for the two regions, capturing variation in the returns to the characteristics between African and Asian firms. We refer to this as the 'regional effect', because this is the estimated average effect on probabilities of receiving a direct vertical knowledge/technology transfer for African firms.

Algebraically, the direct vertical knowledge/technology transfer gap between African and Asian firms can be described by decomposition into two components:

$$\Delta = \frac{1}{n}\sum_{i=1}^{n}(\Lambda(\hat{\beta}'_{SSA,i}\, x_{SSA,i} + \hat{\alpha}_{SSA}) - \Lambda(\hat{\beta}'_{SSA,i}\, x_{A,i} + \hat{\alpha}_{SSA})) +$$

$$\frac{1}{n}\sum_{i=1}^{n}(\Lambda(\hat{\beta}'_{SSA,i}\, x_{A,i} + \hat{\alpha}_{SSA}) - \Lambda(\hat{\beta}'_{A,i}\, x_{A,i} + \hat{\alpha}_{A,i}))$$

[2]

where Δ is the gap between the probability of receiving a vertical technology transfer for African and Asian firms. The first term on the right-hand side is an estimate of the difference in probabilities of receiving a direct vertical technology transfer for African (*SSA*) and Asian (*A*) firms where the expectation is evaluated under the African parameters (β_{SSA}, α_{SSA}). This is the characteristics effect, as it extracts the importance of differences in firm characteristics and aggregates these differences using equal weights. The second term is an estimate of the difference in expected probability of a direct vertical knowledge/technology transfer for African firms when the expectation is evaluated under the Asian and African parameters respectively. This is the regional effect.

Table 9 shows the results of generalized Oaxaca-Blinder decompositions by region. Panel A reports the results without additional controls, while Panel B controls for all firm attributes described above. Samples are divided into three categories: (i) full sample—Column 1; (ii) sample excluding domestic firms vertically linked via trade—Column 2; (iii) sample excluding firms vertically linked to MNEs (within country)—Column 3. In all columns, the reported direct vertical knowledge transfer differences in means are positive; direct vertical transfers are more likely to be observed in Africa than in Asia, independently of whether the knowledge transfer comes from within the country or via trade relations. In Column 1, Panels A and B, the differences in firm characteristics are small and statistically insignificant. This indicates that there should not be regional differences in probabilities of receiving direct vertical knowledge transfers, based on information about differences in firm attributes. The positive and statistically significant regional effect is driving the differences in means. Accordingly, it would appear that the probability of vertical linkages depends on differences in underlying regional characteristics, and is not due to

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[9] Kline (2011, 2014) has documented the close link between the decomposition and estimation of average treatment effects. He shows that the Oaxaca-Blinder decomposition is equivalent to a reweighting impact estimator in which the odds of treatment is a linear function of the control variables.

differences in firm-specific attributes. Comparing results in Columns 2 and 3, we see that the conclusion using all firms is consistent with results considering only within-country linkages (Column 2). In contrast, differences in trade-related vertical knowledge transfers are explained by differences in firm characteristics (Column 3). This result suggests that we should expect differential regional effects (for 'identical' firms) of direct vertical knowledge transfers via FDI, whereas the probability of receiving technology transfers through the trade channel is likely to be driven by individual firm-level attributes.

Table 9: Generalized Blinder-Oaxaca decomposition of the regional vertical knowledge/technology transfer gap

	All firms		Only MNE linkages		Only trade linkages	
	Coefficient	T-stat	Coefficient	T-stat	Coefficient	T-stat
Panel A: without controls						
Difference in means	0.406***	(6.70)	0.393**	(2.18)	0.278**	(2.10)
Characteristics effect	0.048	(0.53)	-0.015	(0.54)	0.616	(1.40)
Regional effect	0.358***	(3.17)	0.408**	(2.18)	-0.339	(0.79)
Panel B: with controls						
Difference in means	0.425***	(6.32)	0.464***	(2.65)	0.288**	(2.35)
Characteristics effect	0.009	(0.08)	-0.033	(0.39)	0.495**	(2.40)
Regional effect	0.416***	(3.44)	0.497**	(2.44)	-0.207	(1.01)

Note: 'Only MNE linkages' and 'only trade linkages' restricts the sample to firms with direct relations with either a foreign firm outside the country or a foreign firm within the country. 'Only MNE linkages' restricts the sample to firms with direct relations with a foreign firm within the country. Panel A reports regressions without additional controls, while Panel B includes controls. T-statistics (in parentheses) based on bootstrapped standard errors (500 replications). * Significant at 10%; ** significant at 5%; *** significant at 1%.

Source: authors' compilation.

6   Discussion and conclusion

A common feature of the FDI spillover literature is that an indirect approach is used to measure the effect of knowledge spillovers. Associations between increased presence of MNEs and productivity improvements in local domestic firms are interpreted as a result of technology transfers from foreign affiliates to domestic firms. The mechanisms through which these transfers happen are many, but they all depend on interindustry linkages and underlying industrial structures. Lack of economic complexity limits the scope for knowledge/technology diffusion of FDI, i.e. sets a limit on the extent of spillover externalities. We hypothesize that FDI spillover externalities (*ceteris paribus*) are less likely to occur in countries where enterprise interlinkages are weak (in Africa) as compared with countries with more complex industrial structures (in Asia).

Knowledge diffusion is not an automatic process, and it often requires direct interaction between involved parties. In this study, we have argued that in order to come to grips with the complete potential of MNE knowledge/technology transfers, we need to better understand the direct linkages associated with MNE presence. Due to data limitations, only a few studies have focused on the nature and existence of direct FDI linkages. To our knowledge, no study has so far tried to

verify information about direct FDI linkages using information from both MNEs and linked local domestic firms. This is the challenge we have addressed here, triangulating information from seven countries (Cambodia, Ethiopia, Ghana, Kenya, Mozambique, Uganda, and Viet Nam) to establish whether there is systematic evidence of the relationship between FDI and the existence of knowledge/technology transfers from MNEs to domestic firms.

Combining evidence from interviews with MNEs and linked local domestic firms, we identified whether direct relations between MNEs and domestic firms lead to recognized direct transfers of knowledge/technology. Our results confirm that there are relatively few linkages between MNEs and domestic firms in sub-Saharan Africa as compared with Asia. However, when these linkages are present, they are more likely to lead to direct knowledge/technology transfers from MNEs to domestic firms compared with linked-in firms in Asia, where competition effects are more likely to erode possibilities for direct spillovers. However, when controlling for traditional firm attributes, we do not find that direct knowledge/technology transfers are more likely to occur through FDI than through trade. Thus our results are not consistent with the view that tacit knowledge transfers are more likely to occur through localized linkages. However, we do find that a large proportion of direct vertical transfers of knowledge are made by formal contractual arrangements. This signals that IPAs' legal assistance to domestic firms could help to facilitate increases in direct knowledge transfers from MNEs to domestic firms. Finally, our results could indicate that the lack of economic complexity in African industry makes direct linkages a non-negligible aspect of MNE presence, in the absence of the industrial structures that normally facilitate externalities from FDI technology spillovers. A deeper analysis of this aspect would no doubt move the literature forward, and coming to grips with these characteristics is in our assessment critically important for formulating effective industrial policy in the years to come.

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