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Trade, technology, and absorptive capacity

Firm-level evidence across geographical clusters in the Tanzanian textiles and apparel sector

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Abstract: Trade-linked technological change has potential to increase incomes in low-income countries (LICs). The most labour-intensive segments of the textiles and apparel global value chain are in LICs. However, gaps between available technologies and best practices make it difficult to adopt more efficient production processes or move into higher value-added functions. This paper examines current technology use in the Tanzanian textiles and apparel sector, using nationally representative secondary data, primary quantitative data, and qualitative information from semi-structured interviews. First, we examine whether firms' absorptive capacity mediates the effect of imported technology on firm productivity. Second, we look at differences across geographical clusters of firms in terms of local linkage types. Third, we assess current technology, gaps in firms' capabilities, and challenges in the sector to identify policy implications. Finally, we provide brief reflections on how firms in the Tanzanian textiles and apparel sector may adapt in the post-COVID-19 recovery phase.

Key words: absorptive capacity, firm productivity, global value chain, Tanzania, textiles and apparel

JEL classification: D22, D24, O14, O32

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1 Introduction

Low-income countries (LICs) have attracted the most labour-intensive segments of the textiles and apparel global value chain—cutting, making (sewing), and trimming. In these segments, upgrading takes place in terms of process, applying new technology or changes in existing production; or in terms of product, shifting into higher value-added product lines (Gereffi 1999). Therefore, participation in these parts of the value chain has been important for the pursuit of industrial development in LICs. However, severe gaps between the available technologies and what are known as best practices continue to present challenges for the adoption of more efficient production processes (Saha et al. 2019) or for a move up the chain into higher value-added functions, i.e. functional upgrades or organizational changes in distribution and production. Such gaps are apparent in the Tanzanian textiles and apparel sector, which lies at the lower end of the global technology frontier, and whose productivity differential continues to increase with respect to other economies at similar stages of development.

The main way forward for LIC firms in the buyer-driven textiles and apparel value chain (Gereffi 1999) is to adopt new technology and master the ability to produce patterns that can help to establish direct relationships with first-tier buyers. This is frequently the stepping stone to higher value addition (Whitfield and Staritz 2017). But such upgrading requires access to technology which often comes from abroad. The successful deployment of these technologies is dependent on different factors—the sum of which might even result in negative effects on functional upgrading (Fukunishi et al. 2013; Giuliani et al. 2005). These factors include gaps in capabilities, weak local linkages, inadequate access to finance, and low government support, which can impede firms' ambitions to adopt the technologies in a sustained manner and use them for future learning.

We investigate technology use in the textiles and apparel sector in Tanzania, a growing East African hub of textiles and apparel production, which is a representative case of an LIC struggling to move up the value chain due to inadequate technologies, lack of skilled labour, and insufficient resources. We especially examine the relationship between firms' productivity and imported technology from abroad. Our focus is threefold. First, we consider the role of a firm's absorptive capacity—the capacity of a recipient to assimilate value and use the knowledge transferred (Cohen and Levinthal 1990)—in mediating the effect of imported technology on the firm's productivity. Second, we consider differential effects across geographical clusters of firms, in terms of both local linkage types and absorptive capacities within the clusters. Third, we consider current technology, gaps in firms' capabilities, and challenges in the sector, in order to identify specific policy implications. In addition to these three main objectives, the paper also briefly reviews the role of technology from the Global South and its potential to bring LIC firms closer to the technological frontier.

Our analysis combines quantitative data from secondary and primary sources with qualitative semi-structured interviews. First, we use a panel data set that combines data from the Census of Industrial Production (CIP) for 2013 and data from the Annual Survey of Industrial Production (ASIP) for 2015 and 2016. Second, we use primary data from a structured survey with a sample of 20 firms that are representative of the Tanzanian textiles and apparel sector (Saha et al. 2019). Third, we use qualitative data from semi-structured interviews with the firms from the primary survey and a group of key policy stakeholders. Additionally, we reached out to key stakeholders to collect their reflections on how firms are responding to the consequences of the COVID-19 crisis.

The remainder of the paper is organized as follows. Section 2 presents a brief overview of Tanzania's textiles and apparel sector. Section 3 outlines the data sets we utilize and discusses the methods used in the analysis. Section 4 presents the results, highlighting their relevance for the literature and the Tanzanian context. Finally, section 5 summarizes our findings and draws targeted policy implications to conclude the paper.

2 Overview of the Tanzanian textiles and apparel sector

Strategically located in the East African Community (EAC), the Tanzanian textiles and apparel sector still lags behind in competitiveness, despite its growth in recent years. The sector contributes about four per cent of value added in total manufacturing (Trading Economics 2020); of total employment in agro-processing activities, the sector's share stands at about 27 per cent (Mazungunye 2019). Firms in this sector are at a lower tier in the global textiles and apparel value chain—primarily assembling pieces and selling them to foreign intermediaries, which then sell them on to global retailers and manufactures. This characterizes most LIC firms in the textiles and apparel sector, which is a typical buyer-driven value chain (Gereffi 1999).

The main activities in textiles and apparel can be subdivided into the following categories: weaving and spinning textiles (fabric and yarn); sewing, knitting, and production of textiles and apparel; sewing and production of apparel (finished clothing pieces). Cotton is the most important input for the sector, especially in sub-Saharan Africa. Tanzania has harvested cotton since the colonial era, albeit with relatively low agricultural yields, inadequate quality as a raw material, and insufficient amounts to meet the demands of the domestic industry. The total cotton output reached a peak of 580,000 bales in the harvest of 2005 to 2006, but went down to approximately 300,000 bales in 2015 to 2016 (USDA 2015), putting Tanzania far from the top 20 world producers; moreover, the country accounted for only 0.22 per cent of total cotton exports. However, productivity was also down to 163 kilos per hectare, 14 per cent lower than the peak achieved in 2005 to 2006.

Cotton exports are valued at US$29.5 million and amount to 0.53 per cent of total Tanzanian exports (Observatory of Economic Complexity 2020). Cotton exports are mostly in raw form, with over 75 per cent of the output being shipped overseas (Observatory of Economic Complexity 2020). Although there is evidence that among Tanzanian firms, the textile sector invests more than the national average in research and development (R&D), connectivity, and formal training (Goedhuys 2007), only 25 per cent of the cotton output is processed locally (according to ASIP and CIP data; see also Observatory of Economic Complexity 2020). This limited local value addition of the crop, scoring quite low in the Economic Complexity Index, reveals the relative underdevelopment of the local textile industry, which faces challenges in competing overseas.

Table 1 outlines the share of local sales and exports for the textiles and apparel sector as a whole. On average, only about 15 per cent of the sector's output was exported every year between 2013 and 2016. A large majority of production was sold to the domestic market, with a decline in export share over the years.

Table 1: Share of local sales and exports, by sector

	Manufacture of textiles				Manufacture of wearing apparel			
	2013	2015	2016	All years	2013	2015	2016	All years
Share of local sales	75.2%	85.2%	83.0%	82.1%	91.2%	92.3%	94.4%	92.8%
Share of exports	24.8%	14.8%	17.0%	17.9%	8.8%	7.7%	5.6%	7.2%

Source: authors' calculations based on data from ASIP and CIP.

There is an appetite for greater integration with external markets, which could in turn benefit local firms. However, this is impeded by several general challenges. For instance, investments into the textiles and apparel sector are made when a threshold demand consistent with a minimum efficient scale is reached, whether local or international. Further, export markets also demand stringent standard requirements for suppliers, in terms of not only quality control but also production lead times and delivery deadlines, cargo handling, and design specifications (Calignano and Vaaland 2017). Additionally, firms face an extensive list of minimum criteria for accessing global value chains—structured and diversified financing, integrated logistics, and labour and environmental standards (Staritz et al. 2017)—which are often either unaffordable or unknown to the majority of local firms in Tanzania.

The local network of Tanzanian firms is relatively homogeneous (Dantas et al. 2007). Few firms (about 25 per cent of all manufacturing firms) carrying out in-house R&D investments (Diyamett and Mutambla 2014). There is limited foreign direct investment (Calignano and Vaaland 2017), which mostly comes from the EAC-integrated consumer market, and is not due to any production efficiency gains. Furthermore, it is common for technological specializations and capabilities to be embedded within certain regions and places—an underlying factor that determines the strength of firms' networks (Murphy 2007). Limited linkages, both domestic and foreign, reduce the extent to which the Tanzanian textiles and apparel sector can learn via interactions, resulting in a less dynamic environment for firm innovation (Goedhuys 2007).

3 Data and methodology

We adopt a mixed methods approach, combining quantitative data from primary and secondary sources with qualitative data collected using semi-structured interviews. First, we present trends in technology use and outline summary statistics, focusing on the main variables of interest in determining firms' productivity—imported technology and absorptive capacity—along with a set of control variables. Second, we analyse the apparent geographical clusters of the textiles and apparel industry, and the network linkages among firms within two clusters across mainland Tanzania: North and South. Third, we undertake our empirical analysis using multiple regressions to explain the relationship between firms' productivity and imported technology, examining in particular the mediating role played by absorptive capacity.

3.1 Data

3.1.1 Secondary data

The secondary data comprises a representative sample of Tanzanian firms operating in the manufacture of textiles (International Standard Industrial Classification (ISIC) Division 13) and wearing apparel (ISIC Division 14). We extracted this data from a panel data set also used in Diao and McMillan (2018). The panel was created using the 2013 CIP and the 2015 and 2016 rounds of ASIP. ASIP is a nationally representative survey carried out by the Tanzanian National Bureau of Statistics (NBS) and periodically complemented by the CIP. The two samples analysed consist of 37 (2013), 60 (2015), and 57 firms (2016). The firms surveyed are roughly the same, although there are differences due to the closure of some firms and the new creation of others. Hence, we have an unbalanced panel of firms across the three years.

3.1.2 Primary data

The primary quantitative data in this paper was collected in mainland Tanzania between June and August 2019, using a carefully structured survey with a target sample of 30 firms for 2018 to 2019 (Saha et al. 2019).[1] The ASIP data set for 2016 from the NBS consists of 57 firms whose primary activity was related to textiles and apparel manufacturing; a random sample of 30 firms (57 per cent) from this population of 57 firms was targeted. Ultimately, the survey yielded a sample of 20 firms (a 67 per cent response rate) that responded to a structured set of questions. The interviews were conducted with managerial staff (at production control level or higher) and lasted one hour each. The responses were collected using tablets.

We use this structured primary data in this paper to identify two geographical clusters and map the linkages among firms within those clusters. The local linkages among firms are mapped for each cluster. Further, to distinguish between firms with high and low absorptive capacity in the clusters, we compute average measures over the past three years, and we create a dummy for higher capacity (taking the value of one) or capacity below the median value (zero). Later, we use this geographical identification to examine trends in the secondary data.

For five firms that we did not interview,[2] we infer their relationships—i.e. the edges of the network map—from the other firms' answers to the questionnaire. The edges are treated as undirected, and their width represents the frequency of the specific interaction. The two clusters are Cluster 1: North—Mwanza, Shinyanga, Arusha, and Kagera; and Cluster 2: South—Dar es Salaam, Morogoro, Tanga, and Pwani. We also use these clusters to control for differences in linkages within geographical clusters in our analysis of the panel data for 2013 to 2016.[3]

Based on the insights from this data, we argue that there are cluster-specific characteristics that may reflect firms' behaviour towards the use of imported technology and their absorptive capacity; thus, these differences may be correlated with our main variable of interest, i.e. productivity. Later, we outline the use of this information as a control variable in our empirical estimations using secondary data, with which we map the variable using the geographical identifier for firms.

3.1.3 Qualitative data

Aiming to draw policy implications, this paper also uses qualitative data collected between June and August 2019 with a semi-structured questionnaire. This questionnaire was conducted with the same firms from which we had collected quantitative data, but also with relevant policy stakeholders. The latter were government officials and industry associations, namely the Small Industries Development Organization, the Vocational Education and Training Authority, the Tanzania Industrial Research and Development Organization, the Textile Development Unit of the Ministry of Industry and Trade, the Textile and Garment Manufacturers Association of Tanzania (TEGAMAT), the Tanzania Cotton Board (TCB), the Confederation of Tanzania Industries (CTI), and the Gatsby Africa group.

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[1] Due to the limited size of the textiles and apparel industry in Tanzania, this number is quite close to the universe of firms.

[2] The five firms are Afritex (Tanga), Alliance Ginneries (Arusha), Nida Textile Mills (Dar es Salaam), Ruvu/China Tanzania Apparel Co. (Pwani), and Sunflag (T) (Arusha).

[3] The panel data is from 2013–14 to 2016–17, and the primary data is from interviews conducted in 2018–19. The network information is especially comparable for 2016–17, as there is only a very small lag. Further, the additional questions in our primary survey support the validity of this comparison.

First, we asked firms open-ended questions about four different areas: performance, value addition, government policy, and linkages with other firms. Second, we linked previous questions by asking government stakeholders about the current status and potential of the textiles and apparel industry in Tanzania, and the status and effectiveness of government policy for this sector. Third, we asked these officials about the levels of engagement and linkages with countries in the Global South.

All interviews were transcribed and analysed in NVivo, using the following themes: demand for and access to technology; constraints on access to raw materials; the nature of linkages among firms; operation below full capacity. The transcripts were analysed against specific questions related to the four areas of interest. The responses were read and coded according to themes and subthemes that provided answers and information on the queries. These codes were then reread to examine patterns across the answers. Finally, we conducted another round of key informant interviews in April 2020 to gather implications of COVID-19. Overall, the qualitative analysis helped us to contextualize the findings and identify directions for future research.

3.2 Methodology

3.2.1 Hypotheses

Differences in adoption lags and intensity of use regarding new technologies explain a large part of the income divergence among countries over the past two centuries (Comin and Mestieri 2018). We focus on two key hypotheses in relation to these differences.

> H1: The relationship between the adoption of new technologies and productivity is mediated by absorptive capacity—a firm's ability to learn from such technology from abroad.

First, in an environment of rapid technological change, firms demand technology in order to be able to innovate and stay connected to the global value chain. A firm's intellectual capital is an important source of competitive advantage that determines its ability to learn (Yeoh 2009). Firms can import new technology to improve productivity (Dearden et al. 2006); to promote skills transfer; for the imitation and/or improvement of engineering and managerial processes that lower costs, i.e. learning by doing (Gereffi, et al., 2005); or to work towards functional upgrades that entail the movement of the firm's production process towards more complex functions in a certain value chain. These can result in a firm's upwards movement along the value chain and a strengthening of backward linkages (Gereffi et al. 2005). However, a low absorptive capacity—measured by the firm's lack of human capital (Eaton and Kortum 1996) or of its own R&D—can reduce or even impede such learning from technology transfers.

> H2: Being in a geographical cluster with greater linkages among local firms is an important factor in explaining a firm's productivity.

Second, the existence of locally owned firms is an important differential in the retention of technologies in the recipient country, enabling further investments and ultimately embedding these local firms into global value chains. Local ownership of firms is evidenced as an important factor that drives profits and capabilities in several countries, including Ethiopia and Lesotho (Morris and Staritz 2017; Whitfield and Staritz 2017). Furthermore, local linkages among firms can bring easier access to sources of finance or capacity-building programmes, and can aid matchmaking with global buyers. We attempt to capture whether the differential effects between imported technology and productivity, mediated by absorptive capacity, are correlated with a firm's clustering with different forms of linkage—for instance, the sharing of information and awareness, or other complementarities in decision-making. To capture the role of such networks, we control for two different geographical clusters in mainland Tanzania, which are characterized by differences in local network linkages among firms and their absorptive capacities.

3.2.2 Empirical model

Our empirical model is based on Boothby et al. (2010), which examined the combined effects of the adoption of new technologies and training on productivity. We apply this model to investigate the role of imported technology and absorptive capacity (the latter captured as training or technology upgrade planning) in firm productivity in Tanzania, accounting especially for the geographical location of clusters. Table 2 summarizes the variables used for the quantitative analysis.

Table 2: Summary of variables of interest

Variable	Variable description
Productivity (PP)	
Value added	(Log) Value added: gross output minus intermediate consumption
Output per worker	(Log) Output per worker: gross output divided by number of workers
Imported technology (Imported Tech.)	
Imported technology	Use of imported technology—dummy variable with value 1 if the firm imports any technology from abroad in a given year
	% technology imported from abroad in a given year
Absorptive capacity (Abs.Cap)	
Training employees	Training for employees—dummy variable with value 1 for firms that provide training for employees in a given year, and 0 for firms that do not provide any training in that year
Technology upgrade	Technology upgrade/innovation—dummy variable with value 1 where firms report having a technology upgrade/innovation plan for the current year, and 0 otherwise
Control variables	
Firm size	(Log) Total persons engaged in the firm—number of employees on the permanent payroll, together with any temporary or seasonal workers
Age	Years since operations first started
Foreign	Foreign ownership—dummy variable with value 1 for firms with any foreign ownership, and 0 otherwise
Exporter	Exporting to foreign markets—dummy variable with value 1 where the firm is an exporter, and 0 otherwise
South	Being in the South cluster—dummy variable that identifies firms in the South cluster (1) relative to those in the North (0)

Source: authors' compilation based on data from ASIP and CIP, and primary data collected by the authors.

To explore the two hypotheses outlined above, we estimate the following specification:

$$PP_{it} = \beta_0 + \beta_1 \, Imported\ Tech._{it} + \beta_2 \, Abs.Cap_{it} + \beta_3 \, Imported_{it} * Abs.Cap_{it} + \rho x + v_t + \varepsilon_{it} \quad [1]$$

where PP is a productivity measure for firm i at time t; $Imported\ Tech.$ measures a firm's reliance on technology from abroad; $Abs.Cap$ reflects a firm's absorptive capacity, using two proxy measures; $Imported*Abs.Cap$ is the interaction term; x is a vector of control variables that may affect productivity; v_t is the year fixed effect; ε is an error term. β_1, β_2, β_3, and ρ are coefficients and vectors of coefficients to be estimated.

Productivity is measured using two variables: first, value added of the firm (in logs), following the definition provided in the 2013 CIP as gross output (value of goods produced, receipts from services rendered, and non-industrial services) minus intermediate consumption (electricity, water and fuels, raw materials and supplies, industrial and non-industrial services); second, output per worker (in logs), measured following the definition provided in the 2013 CIP as gross output divided by number of workers.

The key explanatory variables include *imported technology*. This comprises manual, semi-automated, and fully automated technology that is not locally manufactured. This classification is based on the current status of the plant technology being used by the firms. Again, we use two measures: first, a dummy variable that identifies the use of imported technology; second, the share imported from abroad.

The measurement of absorptive capacity for Tanzania's manufacturing sector has met with limitations. Using our panel data, we construct two proxy measures: first, *training employees*—a dummy variable that captures whether firms provided training in a given year; second, *technology upgrade*—a dummy variable that captures whether the firm is currently spending on any new technology/innovation. In addition, we add an interaction term between imported technology and absorptive capacity, to investigate whether the effect of imported technology is mediated by the absorptive capacity of the firm. Our measures are in line with those described in the literature to capture absorptive capacity in terms of a firm's knowledge base, usually identified in terms of human resources (skills, training, experience, etc.) and in-house knowledge creation efforts (Giuliani and Bell 2005).

We also include a set of control variables, as follows. First, *firm size* is proxied by the total number of employees (in logs) to account for size-related characteristics that affect productivity. Second, the *age* of the firm is measured from the year the firm started operations until the year in which the information was collected, to account for the role of firms' experience. Third, *foreign* is a dummy variable that identifies foreign owners, examining whether foreign-owned firms are more productive than purely domestic firms. Fourth, and similarly to Boothby et al. (2010), the *exporter* dummy identifies whether a firm exports, which is considered an important incentive to innovate due to exposure to international competition (Baldwin and Gu 2004).

Finally, we include a dummy variable for *South* that takes the value of one for firms located in southern Tanzania, and zero for firms in northern Tanzania; the grouping is also based on linkages among firms in each cluster. This measure is based on our primary data, and to the best of our knowledge is applied here for the first time in the context of the relationship between productivity and technology for Tanzanian textiles and apparel.

We recognize that there may be two main limitations, given the scope of our econometric analysis. First, on account of the small number of observations, we cannot account for possible endogeneity. Second, there may be an omitted variable bias, as the possibility to control for variables is driven to a certain extent by data availability. However, the sectoral focus of the analysis in combination with an in-depth qualitative enquiry allows us to better contextualize the findings in the Tanzanian economy, as well as to identify variables that can be considered in future research.

4 Results

We begin by presenting trends in technology use between 2013 and 2016. Then we discuss the differences in network structures across the two geographical clusters in our study. To examine the role of absorptive capacity in the technology-productivity relationship, we estimate the model presented in section 3.2.2. Finally, we link these findings with the semi-structured data analysis to draw a set of key policy implications.

4.1 Descriptive analysis

Table 3: Types and sources of technology

Variable	2013	2015	2016	All years
Manual				
Number of firms	22	39	34	95
Percentage of firms	(61.1%)	(65.0%)	(59.6%)	(62.1%)
Local	68.2%	61.5%	55.9%	
Imported	18.2%	30.8%	41.2%	
Both	13.6%	7.7%	2.9%	
Semi-automated				
Number of firms	22	30	30	82
Percentage of firms	(61.1%)	(50.0%)	(52.6%)	(53.6%)
Local	68.2%	83.3%	80.0%	
Imported	18.2%	6.7%	10.0%	
Both	13.6%	10.0%	10.0%	
Fully automated				
Number of firms	5	12	13	30
Percentage of firms	(13.9%)	(20.0%)	(22.8%)	(19.6%)
Local	80.0%	91.7%	84.6%	
Imported	20.0%	8.3%	7.7%	
Both	0.0%	0.0%	7.7%	
Number of firms	**37**	**60**	**57**	**154**

Source: authors' calculations based on data from ASIP and CIP.

Table 3 presents trends in technology use: by type—the percentages of firms that use manual, semi-automated, or fully automated technology; and by source—the percentages of firms that source locally, from imports, or both. Firms may use technology across different types as well as from different sources. While the majority of firms report having used either manual or semi-automated technology consistently over the years, only a limited number of firms report the use of fully automated technology. The majority of these technologies are sourced from the local market—as second-hand machinery, due to the absence of a machinery industry in-country.[4] Moreover, while we observe an increase in the share of imported manual technology, we do not observe similar trends for imported semi-automated or fully automated technology.

A breakdown of technology use types by disaggregated sectors—the manufacture of textiles, and the manufacture of wearing apparel (Appendix Table A1)—indicates the following. First, in textiles, the firms appear to increase their share of imported manual machinery over the three

[4] However, from our primary data, we find that by 2018–19 many firms were purchasing new machinery (55 per cent) or equipment (80 per cent), which was largely imported (91 per cent and 63 per cent respectively).

years; however, there is a decline in imported semi-automated and fully automated machinery. Second, in apparel, most machinery is procured from local sources over the three years.

Table 4: Firms' main characteristics

	2013	2015	2016	All years
Dependent variables				
Value added (000 TZS)	3374.1	9649.1	8787.0	7822.4
	(4993.8)	(41274.9)	(41520.1)	(36058.8)
(Log) Value added	13.5	12.6	12.5	12.8
	(2.3)	(3.1)	(2.9)	(2.8)
Output per worker (000 TZS)	46.8	414.6	399.1	320.5
	(80.0)	(2677.8)	(2747.8)	(2356.7)
(Log) Output per worker	9.9	9.7	9.5	9.7
	(1.3)	(2.2)	(1.9)	(1.9)
Explanatory variables				
Imported technology (dummy)	29.7%	28.3%	31.6%	29.9%
	(46.3%)	(45.4%)	(46.9%)	(45.9%)
Imported technology (%) if >0	99.1%	92.9%	90.0%	93.3%
	(3.0%)	(22.6%)	(29.1%)	(22.7%)
Training employees (dummy)	21.6%	23.3%	22.8%	22.7%
	(41.7%)	(42.7%)	(42.3%)	(42.0%)
Training employees (000 TZS) if >0	4.4	14.4	4.8	8.6
	(5.5)	(37.9)	(8.5)	(24.6)
Technology upgrade	51.4%	23.3%	19.3%	28.6%
	(50.7%)	(42.7%)	(39.8%)	(45.3%)
Control variables				
Firm size	375.2	204.0	212.1	248.1
	(630.5)	(481.6)	(512.9)	(533.3)
Age	10.6	13.1	12.2	12.2
	(10.0)	(14.8)	(10.4)	(12.2)
Foreign	29.7%	26.7%	22.8%	26.0%
	(46.3%)	(44.6%)	(42.3%)	(44.0%)
Exporter (%)	21.6%	26.7%	19.3%	22.7%
	(41.7%)	(44.6%)	(39.8%)	(42.0%)
Exported value (000 TZS) if >0	13123.8	13059.4	9534.9	11966.4
	(11490.7)	(15267.3)	(9584.1)	(12642.2)
Additional information				
Total production (000 TZS)	9514.1	19311.8	13475.6	14797.6
	(15788.7)	(60842.8)	(53977.9)	(50675.2)
Total sales (000 TZS)	8735.9	18679.7	12708.3	14080.4
	(15625.1)	(59852.4)	(52981.5)	(49821.4)
Number of firms	**37**	**60**	**57**	**154**

Note: standard deviations in parentheses.

Source: authors' calculations based on data from ASIP and CIP.

Table 4 reports firms' characteristics for all years of analysis (Appendix Table A2 reports firms' main characteristics by foreign ownership status). We begin by examining the dependent variables. On average across all three years, firm value added is 7,822,000 TZS, with some fluctuations across the years. The same is true for output per worker, with an average across the years of 320,000 TZS, and a huge jump from 2013.

In terms of imported technology, only about 30 per cent of firms make use of any type of imported technology. The same picture emerges in our interviews, as firms report primarily using local machinery, with limited imports from abroad. However, among those reporting the use of imported technology, the share of utilization on average is above 90 per cent of the firm's total technology use.

For absorptive capacity measured as training, we find that only a fifth of the firms in our sample have provided any form of training for their employees, with the amount of financial resource for training purposes being equal to about six per cent of the firm's sales. The second measure of absorptive capacity suggests that only about 30 per cent of firms have implemented technology upgrade plans across the three years. These results are indicative of insufficient absorptive capacity.

Furthermore, firms in the Tanzanian textile and wearing apparel sectors employ on average about 248 individuals, with a marginal decrease in the number of workers from 2013 to 2015. In terms of total production, we observe a sharp increase from 2013 to 2015, and a decrease in 2016. Finally, only 34 firms (22.7 per cent) report exports over the three years, with a gradual decline in exports over the years. Additional information on total production and sales is reported to provide context.

4.2 Geographical clusters

Figure 1 presents the network linkages[5] for the Tanzanian textiles and apparel sector, split according to the two geographical clusters in this study. Panel A is the North cluster—Mwanza, Shinyanga, Arusha, and Kagera; panel B is the South cluster—Dar es Salaam, Morogoro, Tanga, and Pwani. On the left of each panel, the nodes are also identified by absorptive capacity measured (using the primary data) as employee training; on the right, the nodes reflect technology upgrade/innovation plans. The numbers represent specific firms in the primary data sample.

In terms of activities, firms in both clusters conduct some or all of the following: weaving and spinning textiles, sewing, knitting, and production of apparel. Among our sample firms, ginning is concentrated in the North (57 per cent), while most knitting/weaving, dyeing/printing, and sewing is done in the South (54 per cent).

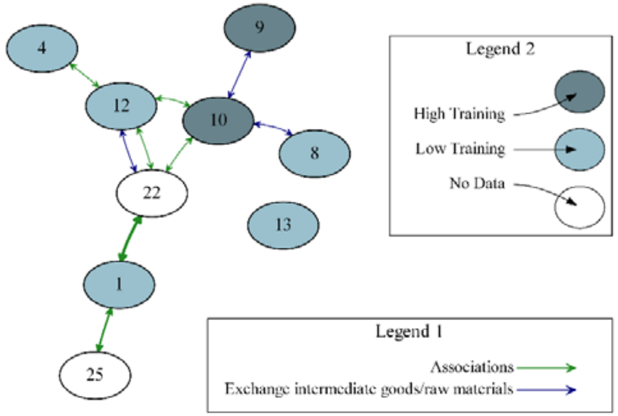
The network in the North is characterized by relationships based on common membership of associations (67 per cent), and the interactions are quite infrequent overall (78 per cent occur less than once a month). The network in the South shows a more diversified pattern of relationships, predominantly exchanges of intermediate goods and raw materials (50 per cent), followed by exchanges of technical expertise (22 per cent), with the former not occurring very often (89 per cent occur less than once a month). In addition, firms in the South appear to be more connected on average: the average degree (i.e. the average number of links for each node) is 2.25, against two in the North (+12.5 per cent). This is also true when we look at the weighted degree distribution (the weights are the frequencies of the interactions). The average weighted degree is 0.78 in the South, compared with 0.67 in the North (+16 per cent).

[5] Prepared using NEATO visualization software. The geometric distance in the layout between any two nodes approximates their path distance in the network.

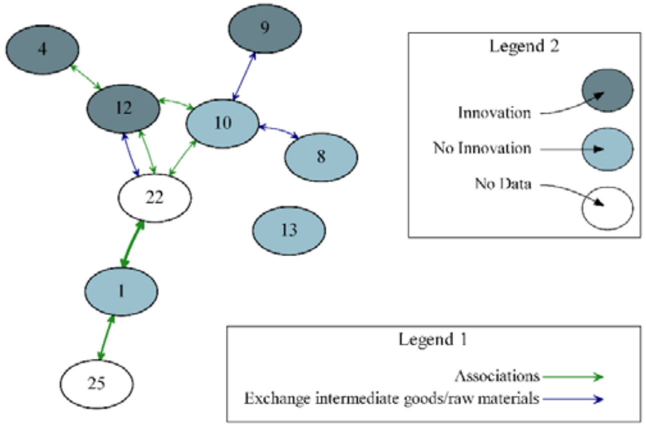
Figure 1: Local network linkages in Tanzania, North and South

Panel A: Cluster 1: North

Absorptive capacity: high and low training

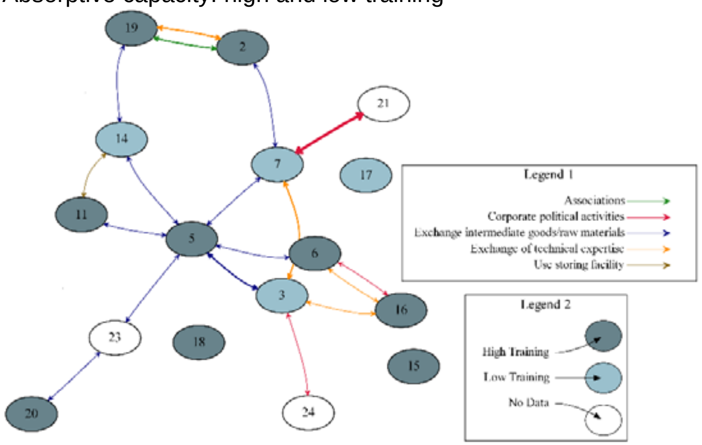


Absorptive capacity: innovation/no innovation

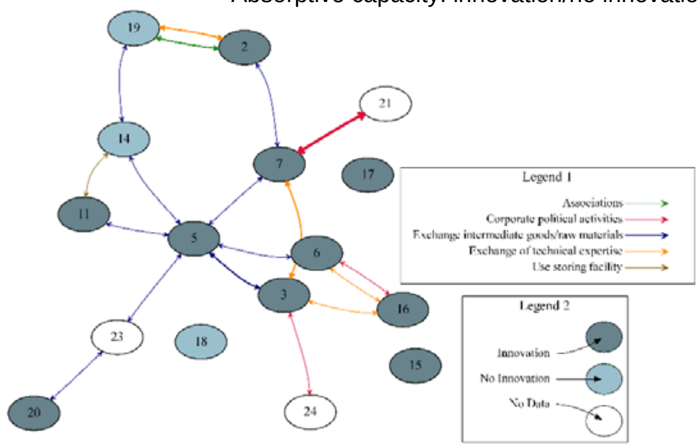


Panel B: Cluster 2: South

Absorptive capacity: high and low training



Absorptive capacity: innovation/no innovation



Note: the numbers represent anonymized firms from the primary survey of 30 target firms in Tanzania's textiles and apparel sector. Legend 1 lists the nature of the interactions. Legend 2 lists absorptive capacity.

Source: authors' illustration.

In terms of absorptive capacity, using our primary data, we observe that the South cluster is characterized not only by more diversified and frequent interactions, but also by a larger proportion of firms with greater absorptive capacity (proxied by employee training)[6]—69 per cent, compared with 28 per cent in the North. Hence, the two geographical clusters are characterized by different proportions of firms with high absorptive capacity. This difference between the two clusters persists when we use the alternative measure of absorptive capacity—a dummy variable that captures whether the firm is currently spending on any new technology upgrades or new knowledge, i.e. innovation. The South cluster is again characterized by a higher proportion of firms that spend on innovation: 77 per cent, against 43 per cent in the North.

Additionally, we examine relationships across the two clusters (Appendix Figure A1).[7] We observe that in both cases, firms that belong to one cluster tend to interact with two main hubs in the other. In particular, when we look at the top right, we notice that node 22 plays a pivotal role in terms of the exchange of intermediate goods and raw materials between the two clusters.

Table 5: Types and sources of technology, by geographical cluster

	Cluster: North				Cluster: South			
Variable	**2013**	**2015**	**2016**	**All years**	**2013**	**2015**	**2016**	**All years**
Manual								
Number of firms	11	20	16	47	11	19	18	48
Percentage of firms	(79%)	(83%)	(76%)	(80%)	(50%)	(53%)	(50%)	(51%)
Local	54.5%	50.0%	43.8%		81.8%	73.7%	66.7%	
Imported	27.3%	45.0%	56.3%		9.1%	15.8%	27.8%	
Both	18.2%	5.0%	0.0%		9.1%	10.5%	5.6%	
Semi-automated								
Number of firms	9	6	8	23	13	24	22	59
Percentage of firms	(64%)	(25%)	(38%)	(39%)	(59%)	(67%)	(61%)	(63%)
Local	55.6%	83.3%	75.0%		76.9%	83.3%	81.8%	
Imported	33.3%	16.7%	12.5%		7.7%	4.2%	9.1%	
Both	11.1%	0.0%	12.5%		15.4%	12.5%	9.1%	
Fully automated								
Number of firms	1	6	4	11	4	6	9	19
Percentage of firms	(7%)	(25%)	(19%)	(19%)	(18%)	(17%)	(25%)	(20%)
Local	100.0%	100.0%	75.0%		75.0%	83.3%	88.9%	
Imported	0.0%	0.0%	0.0%		25.0%	16.7%	11.1%	
Both	0.0%	0.0%	25.0%		0.0%	0.0%	0.0%	

Source: authors' calculations based on data from ASIP and CIP.

Next, we use this geographical identification to examine trends in the secondary data. Table 5 outlines the trends in technology types across the two geographical clusters. In the North cluster, on average, 80 per cent of firms report the use of manual technology; only 40 per cent and 20 per cent report the use of semi-automated or fully automated technology respectively. In the South cluster, we observe that only 50 per cent of firms report the use of manual technology, while more

[6] We do not consider firms for which we are able to infer linkages from the survey but that we did not interview, as we do not have data on their average level of training.

[7] But we do not include this in our regression analysis.

than 60 per cent report the use of semi-automated technology; the share of firms reporting fully automated technology is similar to the share in the North cluster. If we look at the source of the technologies, while the manual technology in the North cluster is almost equally split between local and imported technology, in the South cluster the share of local technology is greater than the imported share, albeit with a decreasing trend over the years. If we look at semi-automated and fully automated technology, a greater share in both clusters comes from the local market, with a relatively higher share of imported technology in the North cluster.

Table 6: Firms' main characteristics, by geographical cluster

	Cluster: North				Cluster: South			
	2013	**2015**	**2016**	**All years**	**2013**	**2015**	**2016**	**All years**
Dependent variables								
Value added (000 TZS)	3026	4457	4175	4017	3586	13110	11477	10185
	(5795)	(12662)	(11765)	(10916)	(4565)	(52303)	(51565)	(45034)
Value added (ln)	12	12	12	12	14	13	13	13
	(3)	(3)	(3)	(3)	(2)	(3)	(3)	(3)
Output per worker (000 TZS)	25	86	35	54	60	633	611	486
	(26)	(218)	(60)	(145)	(98)	(3455)	(3457)	(2992)
Output per worker (ln)	9	9	9	9	10	10	10	10
	(1)	(2)	(2)	(2)	(1)	(2)	(2)	(2)
Explanatory variables								
Imported technology (dummy)	50%	42%	48%	46%	17%	19%	22%	20%
	(52%)	(50%)	(51%)	(50%)	(39%)	(40%)	(42%)	(40%)
Imported technology (%) if >0	100%	91%	91%	93%	98%	96%	89%	93%
	(0%)	(29%)	(29%)	(24%)	(5%)	(11%)	(32%)	(21%)
Training employees (dummy)	21%	25%	19%	22%	22%	22%	25%	23%
	(43%)	(44%)	(40%)	(42%)	(42%)	(42%)	(44%)	(42%)
Training employees (000 TZS) if >0	1.1	1.1	4.1	2.0	6.4	24.4	5.2	12.4
	(0.8)	(1.1)	(4.3)	(2.7)	(6.2)	(49.0)	(10.0)	(30.5)
Technology upgrade	50%	21%	10%	24%	52%	25%	25%	32%
	(52%)	(42%)	(30%)	(43%)	(51%)	(44%)	(44%)	(47%)
Control variables								
Firm size	370	206	188	238	379	203	226	254
	(749)	(547)	(545)	(594)	(564)	(441)	(501)	(495)
Age	10.9	7.7	9.5	9.1	10.5	16.7	13.7	14.1
	(13.4)	(8.7)	(9.2)	(10.1)	(7.5)	(16.9)	(10.9)	(13.0)
Foreign	36%	29%	24%	29%	26%	25%	22%	24%
	(50%)	(46%)	(44%)	(46%)	(45%)	(44%)	(42%)	(43%)
Exporter	21%	25%	19%	22%	22%	28%	19%	23%
	(43%)	(44%)	(40%)	(42%)	(42%)	(45%)	(40%)	(42%)
Exported value (000 TZS) if >0	23690	21760	13208	19574	6784	7839	7436	7471
	(9513)	(18781)	(13567)	(15106)	(7200)	(10572)	(6850)	(8448)
Total production (000 TZS)	11081	15914	8611	12168	8560	21577	16313	16431
	(23618)	(36566)	(24171)	(29451)	(8705)	(73133)	(65616)	(60312)
Total sales (000 TZS)	10869	15613	8422	11928	7437	20724	15209	15417
	(23539)	(36582)	(24340)	(29488)	(8212)	(71753)	(64306)	(59152)
Number of firms	**14**	**24**	**21**	**59**	**23**	**36**	**36**	**95**

Source: authors' calculations based on data from ASIP and CIP.

Table 6 presents the main firm characteristics from the secondary data by geographical cluster. Firms in the South cluster report higher average value added compared with the North, with a sharp increase registered in 2015. Further, while 50 per cent of the firms in the North report the use of imported technology, the majority (80 per cent) of firms in the South rely on local technology. While we note some differences at cluster level in terms of the share of utilization of imported technology, the number of employees, and the share of firms providing training for employees, the significant differences are in terms of financial resources for training activity: the quality and extent of employee training is greater in the South cluster. Finally, firms in the North are on average younger than their southern counterparts, and report a higher value of exports and lower total production and sales.

4.3 Role of absorptive capacity

Table 7: Firms' main characteristics, by imported technology status

	Without imported technology				**With imported technology**			
	2013	**2015**	**2016**	**All years**	**2013**	**2015**	**2016**	**All years**
Dependent variables								
Value added (000 TZS)	4449	12169	10693	9778	834	3274	4657	3232
	(5566)	(48199)	(49594)	(42451)	(1488)	(11122)	(12432)	(10251)
Value added (ln)	14	13	13	13	12	11	11	12
	(2)	(3)	(3)	(3)	(2)	(3)	(3)	(3)
Output per worker (000 TZS)	59	567	567	444	19	30	36	30
	(93)	(3161)	(3322)	(2809)	(18)	(49)	(63)	(49)
Output per worker (ln)	10	10	10	10	9	9	9	9
	(1)	(2)	(2)	(2)	(1)	(2)	(2)	(2)
Imported technology (dummy)	0%	0%	0%	0%	100%	100%	100%	100%
	(0%)	(0%)	(0%)	(0%)	(0%)	(0%)	(0%)	(0%)
Imported technology (%) if >0					99%	93%	90%	93%
					(3%)	(23%)	(29%)	(23%)
Explanatory variables								
Technology upgrade	46%	26%	26%	31%	64%	18%	6%	24%
	(51%)	(44%)	(44%)	(46%)	(51%)	(39%)	(24%)	(43%)
Training employees (dummy)	19%	30%	28%	27%	27%	6%	11%	13%
	(40%)	(47%)	(46%)	(45%)	(47%)	(24%)	(32%)	(34%)
Training employees (000 TZS) if >0	6.7	15.4	5.6	10.2	0.6	1.0	0.6	0.6
	(5.9)	(39.2)	(9.0)	(26.8)	(0.2)	(0.0)	(0.6)	(0.3)
Control variables								
Firm size	12	14	12	13	8	11	12	11
	10	16	11	13	11	13	10	11
Age	497	255	267	318	87	74	94	85
	(718)	(555)	(605)	(618)	(113)	(145)	(161)	(142)
Foreign	35%	30%	23%	29%	18%	18%	22%	20%
	(49%)	(47%)	(43%)	(45%)	(41%)	(39%)	(43%)	(40%)
Exporter	23%	35%	26%	29%	18%	6%	6%	9%
	(43%)	(48%)	(44%)	(45%)	(41%)	(24%)	(24%)	(29%)
Exported value (000 TZS) if >0	17103	13927	9814	13215	1185	46	6739	2289
	(10409)	(15390)	(10055)	(12886)	(1568)	(0)	(0)	(3148)
Total production (000 TZS)	12866	23973	15656	18296	1592	7521	8750	6584
	(17821)	(69771)	(63125)	(58505)	(2276)	(25804)	(25617)	(22228)
Total sales (000 TZS)	11857	23109	14716	17369	1358	7477	8358	6359
	(17771)	(68570)	(61888)	(57470)	(2041)	(26099)	(25612)	(22341)
Number of firms	**26**	**43**	**39**	**108**	**11**	**17**	**18**	**46**

Source: authors' calculations based on data from ASIP and CIP.

In this section, we investigate the relationship between technology and firm productivity, focusing on the role played by absorptive capacity. We estimate a model of the type proposed by Boothby et al. (2010), and apply it to imported technology for the Tanzanian textiles and apparel sector.

Table 7 reports the firms' main characteristics by imported technology status: without imported technology, and with imported technology. Only 30 per cent of firms have used any imported technology. Interestingly, firms that have not used any imported technology across the three years report on average higher value added, higher shares and levels of expenditure on training for employees, higher shares and total values of exports, and higher levels of production and sales.

During our semi-structured interviews, firms stated a preference for local, older machinery. Three reasons were given for this. First, spare parts are easily and cheaply available. Second, frequent power cuts mean that the seasonal availability of cotton results in inconsistency in production plans—plant closures occur during part of the year, and costs from depreciation of non-operational machinery are high. Third, access to long-term finance is still limited and expensive. Hence, it appears that a mismatch between other available inputs and lack of access to higher-quality capital may be affecting firms' decisions regarding the sourcing of technology, which will also likely affect productivity. Additionally, none of the firms reported having production plant in any type of special economic zone. This may be a potential solution to problems related to infrastructure and access to inputs and raw materials.

To examine the productivity effects between the two groups of firms differentiated by their reliance on imported technology, Table 8 presents the benchmark results of ordinary least squares regressions using value added as the dependent variable (Appendix Table A3 presents the results using output per worker as the dependent variable). Panel A reports the results using the first absorptive capacity measure—training employees (dummy); panel B presents the same results using the second measure for absorptive capacity—technology upgrade. In both panels, columns (1) to (4) present the results for the model with all variables of interest specified as binary variables (Model 1), while results in columns (5) to (8) present the results for the model with the inclusion of imported technology expressed in shares (Model 2).

We begin by discussing the results in panel A. If we focus on the results presented in columns (1) to (3), it is interesting to note that imported technology has a consistently negative and statistically significant coefficient. Absorptive capacity measured by employee training alone is positive and statistically significant in column (2). With both of the aforementioned variables together in column (3), the coefficient for absorptive capacity turns insignificant. However, when we introduce the interaction term in column (4), we find a positive and statistically significant coefficient that affirms the mediating role played by absorptive capacity in the productivity-imported technology relationship.[8] These results are robust to the use of different measures for imported technology (as percentages) in columns (5) to (8).

In panel B, where we use the alternative proxy for absorptive capacity, we find similar results to those above, which suggests that our findings are robust to the alternative measurement. One difference is that having a technology upgrade plan has no significant effect on productivity on its own. These results are also robust to the second measure of imported technology in percentage terms, and confirm the findings described above.

[8] The interaction effect is significant at 10 per cent, so while our results provide support for the association between the main variables of interest, given the low significance levels, we conduct a set of robustness checks.

Table 8: Imported technology, absorptive capacity, and firm productivity: benchmark

Panel A: Absorptive capacity measure: training employees (dummy)								
	Model 1				**Model 2**			
	Imported technology (dummy)				**Imported technology (%)**			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Imported technology	-0.710**		-0.638*	-0.898**	-0.909**		-0.835**	-1.044***
	(0.339)		(0.340)	(0.365)	(0.349)		(0.351)	(0.369)
Abs.Cap.		0.660*	0.575	0.259		0.660*	0.547	0.268
		(0.353)	(0.353)	(0.390)		(0.353)	(0.350)	(0.383)
Interaction				1.634*				1.681*
				(0.892)				(0.967)
Firm size (ln)	0.649***	0.681***	0.666***	0.690***	0.642***	0.681***	0.659***	0.674***
	(0.133)	(0.133)	(0.133)	(0.132)	(0.132)	(0.133)	(0.132)	(0.131)
Age	0.039***	0.036***	0.037***	0.037***	0.037***	0.036***	0.036***	0.035***
	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)
Foreign	1.820***	1.752***	1.762***	1.792***	1.767***	1.752***	1.716***	1.772***
	(0.430)	(0.433)	(0.429)	(0.426)	(0.427)	(0.433)	(0.426)	(0.424)
Exporter	0.611	0.661	0.542	0.425	0.590	0.661	0.524	0.469
	(0.419)	(0.418)	(0.419)	(0.420)	(0.415)	(0.418)	(0.415)	(0.414)
South	0.904***	1.075***	0.913***	0.919***	0.876***	1.075***	0.885***	0.935***
	(0.322)	(0.311)	(0.320)	(0.318)	(0.318)	(0.311)	(0.316)	(0.316)
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	154	154	154	154	154	154	154	154
R-squared	0.619	0.616	0.626	0.634	0.625	0.616	0.631	0.639
Panel B: Absorptive capacity measure: technology upgrade (dummy)								
	Model 1				**Model 2**			
	Imported technology (dummy)				**Imported technology (%)**			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Imported technology	-0.710**		-0.709**	-1.245***	-0.909**		-0.914**	-1.557***
	(0.339)		(0.340)	(0.380)	(0.349)		(0.351)	(0.392)
Abs.Cap.		0.103	0.093	-0.429		0.103	0.135	-0.422
		(0.358)	(0.354)	(0.389)		(0.358)	(0.351)	(0.380)
Interaction				2.130***				2.399***
				(0.737)				(0.730)
Firm size (ln)	0.649***	0.659***	0.646***	0.675***	0.642***	0.659***	0.637***	0.666***
	(0.133)	(0.135)	(0.134)	(0.131)	(0.132)	(0.135)	(0.133)	(0.129)
Age	0.039***	0.038***	0.039***	0.044***	0.037***	0.038***	0.037***	0.041***
	(0.013)	(0.014)	(0.013)	(0.013)	(0.013)	(0.014)	(0.013)	(0.013)
Foreign	1.820***	1.796***	1.799***	1.671***	1.767***	1.796***	1.736***	1.546***
	(0.430)	(0.444)	(0.439)	(0.430)	(0.427)	(0.444)	(0.436)	(0.426)
Exporter	0.611	0.763*	0.616	0.624	0.590	0.763*	0.596	0.614
	(0.419)	(0.420)	(0.421)	(0.411)	(0.415)	(0.420)	(0.417)	(0.403)
South	0.904***	1.077***	0.898***	0.860***	0.876***	1.077***	0.866***	0.828***
	(0.322)	(0.316)	(0.324)	(0.316)	(0.318)	(0.316)	(0.320)	(0.310)
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	154	154	154	154	154	154	154	154
R-squared	0.619	0.607	0.619	0.640	0.625	0.607	0.625	0.651

Note: standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Source: authors' calculations based on data from ASIP and CIP.

Our finding—that imported technology alone may have a negative impact on firm-level productivity—aligns with the literature, which identifies that the successful adoption and integration of new technologies requires the acquisition of new skills or the upgrade of the existing workforce's skill levels. Moreover, Okafor et al. (2017) and Yasar (2013) found similar results for the cases of Ghana and China respectively: absorptive capacity mediates the effect of imported technology on productivity. The meta-analysis employed by Zou et al. (2018) also found similar results: absorptive capacity mediates the effect of innovation and knowledge transfer on financial performance, which is largely positively correlated with firm productivity.

Additionally, in our semi-structured interviews, while the majority of firms that imported new technology stated that increasing production capacity and improving production quality were their main motivations, a binding constraint on higher productivity levels appears to have been associated with the lack of skilled labour, corroborating the crucial role of absorptive capacity in mediating the effect of imported technology on productivity. Indeed, foreign technical experts are also hired to train local staff on the correct usage of machinery.

Girma (2005) found an analogous result for the United Kingdom regarding the mediating role of absorptive capacity on productivity. When developing countries are considered, the expected positive correlation between imported technology and firm-level productivity is actually much more nuanced (Habiyaremye 2013), and even negative for some industries and sectors (López 2008). However, even in the case of developed countries, a negative correlation holds in some cases (Fagerberg and Verspagen 2000). Our results contrast with some other findings in the literature, mostly for either developed countries (Mendi 2007; Vuori 1997) or countries with a well-established industrial park (Hasan 2002; Jacob and Meister 2005; Kim 1980; Parameswaran 2009; Zhao 1995). Furthermore, the results are also different from general evidence regarding Tanzania's manufacturing sector, such as Nyantakyi and Munemo (2016).

Notwithstanding caveats regarding the interpretation of the trade indices in the *Doing Business* reports (DBRs) (Sharafeyeva and Shepherd 2020; World Bank 2020), Tanzania is ranked 141 out of 190 countries, the lowest among its East African peers (World Bank 2020). However, our qualitative interviews differed slightly. In contrast with its fair score in the DBRs, all the firms we interviewed stated that electricity was the main barrier, not only because of its high cost in general (and the high costs of acquiring back-up generators), but also because of the frequent power cuts, which bring plants grinding to a halt. Several respondents also indicated an oligopolistic local market for textile raw materials, dominated by a couple of large firms that often set input prices high, rendering smaller companies less competitive—an issue not covered by the DBRs. While we do not model them directly, we also find that a number of firms cannot increase production levels due to a lack of access to finance and the high costs of borrowing for the purchase of machinery and raw materials, once again in contrast with the DBRs, which give credit the highest score of all topics for Tanzania (although it is still low compared with more developed countries). Further research that compiles qualitative data on factors such as electricity and sources of finance would therefore add value to the modelling of productivity effects for Tanzanian firms.

Among the control variables, the only non-significant coefficient is related to the status of firms as exporters. This probably suggests that firms export products with low value addition; thus, being an exporter does not have a significant impact on value addition. The coefficients for number of employees, age, and foreign ownership are positive and statistically significant, as expected. We find a positive and statistically significant relationship between productivity and foreign ownership. This aligns with the firms' responses during the semi-structured interviews. While sample firms reported that they could compete on quality, they were unable to compete on price with international firms, mostly those from South and South-East Asia. The exception were firms with some foreign ownership, which reported being competitive with overseas products. However, most firms expressed the need for interim protection from textile and garments imports. This is not surprising, as these firms simultaneously reported linkages with a number of other firms, including foreign ones—importing inputs from the Global South, especially China and India.

We find that being located in the South cluster with diversified linkages is correlated with higher productivity, corroborating the summary statistics presented in Table 6. However, generally we find that the scope of local networks in the Tanzanian textile and garments industry is still limited. Only a few domestic firms report working with other domestic firms—mostly smaller firms collaborate to increase their production capacity and meet orders during demand spikes. Moreover, only a few smaller firms purchase inputs, mostly fabrics, from larger firms (three in total). Two firms stated that they purchased second-hand foreign machinery and parts from other domestic firms, whereas such purchases from abroad are common. Even in these two firms, the domestic transfer of technology took place because of the closure of companies and the subsequent sale of machinery and equipment.

Despite the limited extent of the local network of firms more generally, the domestic market is very important for many Tanzanian firms. Using an average from the ASIP and CIP data, we find that approximately 85 per cent of the sectoral output is sold locally, with the rest being exported. Most of these firms turn to the local market due to a lack of capacity or awareness to supply first-tier international buyers, even though firms recognize that growth based on the domestic market is structurally limited by chronically low purchasing power. In contrast, some Ethiopian firms use the local market as a springboard from which they tap into global value chains; in these cases, the local market cross-subsidizes operations with international markets, such as testing branded product lines and controlling production to meet stringent requirements (Whitfield and Staritz 2017), evidence of which our survey did not find in Tanzania.

Overall, our results reveal that to benefit from imported technology, firms need to invest in building their absorptive capacities. Imported technology can have a detrimental impact on a firm's productivity if it is not combined with training or technology upgrade plans. Access to foreign technologies does not necessarily translate into higher productivity, due to firms' limited ability to identify and develop such technologies. The crucial role of absorptive capacity in determining the effect of imported technology on firms' productivity highlights the need for a combination of foreign technology and investment in capacity for local firms.

Furthermore, low labour productivity has been an issue. While we do not model this, our semi-structured interviews found evidence of high rates of labour turnover and absenteeism in the industry. Firms reported that besides being unpunctual and inconsistent in going to the factory floor, workers often tended not to stay at the same firm for long periods of time, and to change firms quite often. Firms may therefore not only be disincentivized to offer training, but also have to adopt costly measures to manage the high labour turnover. Additionally, there is limited availability of workers for managerial and supervisory positions, which are then filled by expatriates, mostly from South Asia. However, labour regulations regarding the hiring of foreign workers remain fairly stringent. In this respect, easing immigration policy for skilled workers in relevant predetermined sectors and activities would address a key constraint for firms. This would also be in line with the role that absorptive capacity plays in mediating the effect of imported technology on firms' productivity.

Where firms in LICs may lack the means to build these capabilities, development practitioners can provide support—especially facilitating the exchange of knowledge from other partners in the Global South that already have a presence in these markets. One route to fix this gap could be to facilitate the inflow and exchange of knowledge and technology from partners in the Global South, especially by means of South-South cooperation, which can bring in cost-effective and adaptable technologies with other South partners (Mohanty et al. 2019; Saha et al. forthcoming).

Finally, as firms deal with the consequences of COVID-19, three broad groupings of firms are visible in the market. First, large firms that are engaged in cut, make, and trim, with offices in Mauritius and Hong Kong, are facing hits to capacity utilization, with lower foreign demand and changes in purchasing behaviour. Second, firms that export primarily to regional markets have had order cancellations, and as a response are swiftly shifting to the production of face masks using different fabrics, in an initiative spearheaded by TEGAMAT and coordinated with the Ministry of Industry and Trade. However, these firms face difficulties in accessing inputs that are imported from abroad. Third, smaller firms that produce a local fabric called *kanga kitenge* for mainly local markets (mostly farmers) expect to face depressed demand. Several firms expect to cut hours, grant extended leave, and furlough half of their workforce.

5 Conclusions and policy implications

This section summarizes our findings and draws attention to critical policy implications for the Tanzanian textiles and apparel sector. We discuss the implications of our core results: the need to combine imported technology with investment in absorptive capacity; differences by geographical cluster; and finally, responses to COVID-19.

Absorptive capacity plays a mediating role in the effect of imported technology on productivity. Where firms introduced new products or processes between 2013 and 2016, those products and processes were new to the firm only, not to the domestic market; this highlights the inadequate access to technology and the low levels of upgrading. The majority of firms that purchased either new machinery or equipment largely imported them from India or China. In this regard, although machinery is largely exempt from import duty under the EAC Common External Tariff, bureaucracy around imports is still problematic. Firms in our sample reported that customs procedures, and value-added tax (VAT) refunds for the import of capital inputs such as machinery, are cumbersome, and significant human resources have to be allocated specifically for this long process.

Next, we find that firms faced several issues regarding the availability of raw materials in 2018 to 2019, when the local price of cotton was fixed above market prices. It appears that high raw material costs coupled with import restrictions on raw cotton prevented smaller firms from increasing their production capacity. Some firms even shut down production entirely in the period between cotton harvests, due to a lack of raw materials, because of both low domestic production and unaffordable imported inputs due to high tariffs. In addition to facing high cotton prices, many firms have to import certain processed inputs that are subject to import duties, such as yarn, due to the low quality of locally available inputs. In this context, firms demand a more candid dialogue among all parties—farmers, industry, and government—to discuss the scope for the government, via the TCB, to purchase raw materials from farmers at higher subsidized prices in order to meet industry needs at lower subsidized prices.

We also found clear geographical differences: the southern region of Tanzania is characterized by diversified linkages among local firms, which is correlated with higher firm productivity. However, northern Tanzania lags behind. Firms in the latter region especially expressed the need for government support to effectively build local capacity as a stepping stone to link into global value chains, facilitating easier access to sources of finance and capacity-building programmes, or to aid matchmaking with global buyers. Although all firms are members of sectoral and industry associations (TEGAMAT and the CTI), which are good networks for coordinating interests with the government, it appears that few firms know how to actually accrue effective and tangible benefits, and hence firms need support to access such institutions.

In light of COVID-19, immediate policy action is needed. The government has taken some measures already (i.e. redirecting industrial capacity towards the production of face masks and other personal protective equipment). However, textiles and apparel firms, as well as industrial organizations, are looking for the government to take more concrete steps forwards in response to the pandemic. There exist other, potentially more effective ways to alleviate the impact of the price and demand shocks on Tanzanian companies coming from outside. For instance, there is a call for support for the clearance of outstanding debts, the waiving of interest charges on overdrafts and short-term loans, the reduction of payroll taxes, VAT, and corporate tax rates, and a restriction on imports of second-hand clothing.

Finally, firms mentioned that despite the willingness to improve networks among local firms, government institutions may not have the requisite capabilities to effectively assist different firms. The same may hold with regard to dealing with shocks from the current pandemic. One way forwards would be for the government to engage more with firms and strengthen institutions, with support from regional and international development practitioners, and also from the Global South.

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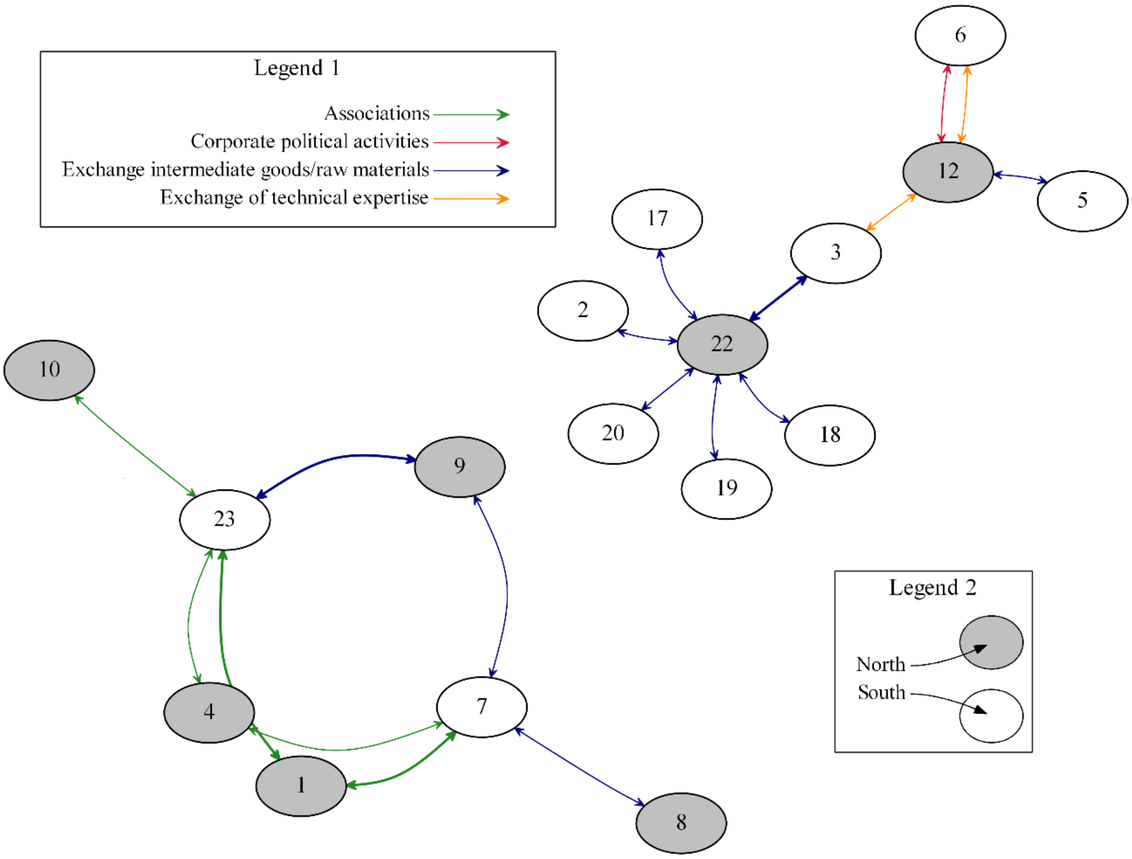
Appendix

Figure A1: Firms' networks across Tanzania: North and South



Source: authors' illustration.

Table A1: Key firm characteristics by subsector, textiles and apparel

		Division 13: manufacture of textiles			Division 14: manufacture of wearing apparel		
		2013	**2015**	**2016**	**2013**	**2015**	**2016**
Manual	**N Manual**	**16**	**31**	**26**	**8**	**9**	**11**
	Local	68.8%	58.1%	57.7%	62.5%	66.7%	54.5%
	Imported	25.0%	32.3%	38.5%	12.5%	33.3%	45.5%
	Both	6.3%	9.7%	3.8%	25.0%	0.0%	0.0%
Semi-automated	**N Semi-automated**	**19**	**28**	**24**	**6**	**5**	**8**
	Local	78.9%	78.6%	83.3%	50.0%	100.0%	75.0%
	Imported	10.5%	10.7%	8.3%	33.3%	0.0%	12.5%
	Both	10.5%	10.7%	8.3%	16.7%	0.0%	12.5%
Fully automated	**N Fully automated**	**4**	**11**	**9**	**2**	**3**	**4**
	Local	75.0%	90.9%	88.9%	100.0%	100.0%	75.0%
	Imported	25.0%	9.1%	11.1%	0.0%	0.0%	0.0%
	Both	0.0%	0.0%	0.0%	0.0%	0.0%	25.0%

Source: authors' calculations based on data from ASIP and CIP.

Table A2: Firms' main characteristics, by ownership status

	Domestic				Foreign			
	2013	**2015**	**2016**	**All years**	**2013**	**2015**	**2016**	**All years**
Dependent variables								
Value added (000 TZS)	1796	7770	7835	6433	7104	14817	12008	11783
	(3496)	(46725)	(46733)	(40877)	(6119)	(20086)	(14305)	(15417)
Value added (ln)	13	11	12	12	15	16	16	15
	(2)	(3)	(3)	(3)	(2)	(2)	(1)	(1)
Output per worker (000 TZS)	36	503	496	394	71	172	70	111
	(46)	(3128)	(3129)	(2736)	(130)	(261)	(78)	(187)
Output per worker (ln)	10	9	9	9	10	11	10	11
	(1)	(2)	(2)	(2)	(1)	(2)	(1)	(1)
Imported technology (dummy)	35%	32%	32%	33%	18%	19%	31%	23%
	(49%)	(47%)	(47%)	(47%)	(41%)	(40%)	(48%)	(42%)
Imported technology (%) if >0	99%	98%	100%	99%	100%	70%	55%	70%
	(3%)	(8%)	(0%)	(5%)	(0%)	(52%)	(52%)	(45%)
Explanatory variables								
Technology upgrade	42%	16%	14%	21%	73%	44%	39%	50%
	(50%)	(37%)	(35%)	(41%)	(47%)	(51%)	(51%)	(51%)
Training employees (dummy)	23%	18%	21%	20%	18%	38%	31%	30%
	(43%)	(39%)	(41%)	(40%)	(41%)	(50%)	(48%)	(46%)
Training employees (TZS) if >0	5	3	3	4	3	30	8	18
	(6)	(3)	(4)	(4)	(1)	(57)	(15)	(41)
Control variables								
Firm size	11	12	11	11	11	16	15	14
	(9)	(14)	(11)	(12)	(12)	(17)	(10)	(13)
Age	195	44	83	94	802	644	648	689
	(340)	(77)	(274)	(245)	(926)	(784)	(832)	(821)
Foreign								
Exporter	12%	16%	11%	13%	46%	56%	46%	50%
	(33%)	(37%)	(32%)	(34%)	(52%)	(51%)	(52%)	(51%)
Exported value (000 TZS) if >0	1568	1847	4935	2821	20057	21780	13368	18826
	(1292)	(2878)	(7925)	(4913)	(8366)	(15339)	(9730)	(12355)
Total production (000 TZS)	5665	10390	11492	9738	18611	43847	20188	29218
	(8615)	(59372)	(59645)	(52122)	(24132)	(59832)	(28032)	(43757)
Total sales (000 TZS)	4783	9866	10791	9064	18080	42918	19198	28378
	(7828)	(58298)	(58444)	(51110)	(24270)	(59101)	(28299)	(43424)
Number of firms	**26**	**44**	**44**	**114**	**11**	**16**	**13**	**40**

Source: authors' calculations based on data from ASIP and CIP.

Table A3: Imported technology, absorptive capacity, and firm productivity: robustness, output per worker as dependent variable

	Panel A: Absorptive capacity measure: training employees (dummy)							
	Model 1				**Model 2**			
	Imported technology (dummy)				**Imported technology (%)**			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Imported technology	-0.504		-0.464	-0.573*	-0.685**		-0.644**	-0.734**
	(0.312)		(0.314)	(0.341)	(0.322)		(0.325)	(0.345)
Abs.Cap.		0.384	0.322	0.189		0.384	0.296	0.178
		(0.325)	(0.327)	(0.365)		(0.325)	(0.325)	(0.358)
Interaction				0.686				0.716
				(0.834)				(0.904)
Firm size (ln)	-0.229*	-0.209*	-0.219*	-0.210*	-0.235*	-0.209*	-0.226*	-0.219*
	(0.122)	(0.123)	(0.123)	(0.124)	(0.122)	(0.123)	(0.122)	(0.123)
Age	0.048***	0.046***	0.047***	0.047***	0.047***	0.046***	0.046***	0.045***
	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)
Foreign	1.416***	1.375***	1.383***	1.396***	1.375***	1.375***	1.348***	1.371***
	(0.396)	(0.399)	(0.397)	(0.398)	(0.394)	(0.399)	(0.395)	(0.397)
Exporter	0.653*	0.701*	0.615	0.566	0.631	0.701*	0.596	0.572
	(0.386)	(0.385)	(0.388)	(0.393)	(0.383)	(0.385)	(0.385)	(0.387)
South	0.744**	0.867***	0.750**	0.752**	0.716**	0.867***	0.721**	0.742**
	(0.296)	(0.287)	(0.297)	(0.297)	(0.293)	(0.287)	(0.293)	(0.295)
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	154	154	154	154	154	154	154	154
R-squared	0.277	0.271	0.282	0.285	0.286	0.271	0.290	0.293
	Panel B: Absorptive capacity measure: technology upgrade (dummy)							
	Model 1				**Model 2**			
	Imported technology (dummy)				**Imported technology (%)**			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Imported technology (dummy)	-0.504		-0.502	-0.747**	-0.685**		-0.690**	-1.013***
	(0.312)		(0.313)	(0.357)	(0.322)		(0.323)	(0.371)
Abs.Cap.		0.113	0.106	-0.132		0.113	0.137	-0.143
		(0.327)	(0.326)	(0.366)		(0.327)	(0.324)	(0.359)
Interaction				0.972				1.207*
				(0.693)				(0.691)
Firm size (ln)	-0.229*	-0.223*	-0.232*	-0.219*	-0.235*	-0.223*	-0.239*	-0.225*
	(0.122)	(0.124)	(0.123)	(0.123)	(0.122)	(0.124)	(0.122)	(0.122)
Age	0.048***	0.047***	0.048***	0.050***	0.047***	0.047***	0.046***	0.049***
	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)
Foreign	1.416***	1.389***	1.392***	1.333***	1.375***	1.389***	1.344***	1.248***
	(0.396)	(0.406)	(0.404)	(0.405)	(0.394)	(0.406)	(0.402)	(0.403)
Exporter	0.653*	0.763**	0.659*	0.663*	0.631	0.763**	0.638*	0.646*
	(0.386)	(0.384)	(0.388)	(0.386)	(0.383)	(0.384)	(0.384)	(0.382)
South	0.744**	0.865***	0.738**	0.720**	0.716**	0.865***	0.705**	0.686**
	(0.296)	(0.289)	(0.298)	(0.297)	(0.293)	(0.289)	(0.295)	(0.293)
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	154	154	154	154	154	154	154	154
R-squared	0.277	0.265	0.278	0.287	0.286	0.265	0.287	0.302

Note: standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Source: authors' calculations based on data from ASIP and CIP.