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Learning-by-exporting in South Africa: The influence of global value chain (GVC) participation and technological capability*

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Using the South African Revenue Service and National Treasury firm-level panel data for 2009–2017, this paper investigates how trade related to the global value chain (GVC) affects the performance of manufacturing firms in South Africa. The paper uses extant classifications of internationally traded products to identify different categories of GVC-related products and compares the productivity premium of international traders for these different categories. Also, the paper investigates possible differences in learning-by-exporting effects across the identified categories of GVC-related products by estimating the effect of exporting before and after entry into foreign markets. The results confirm that GVC-related trade is associated with a higher productivity premium compared with traditional trade. However, within the categories of exporters, only the firms that trade in GVC-related products and simultaneously engage in research and development in the post-entry periods appear to learn from exporting. Our results underscore the gains of GVC integration in terms of the associated productivity premia and highlight the need for GVC-integrated firms to invest in building technological capacity.

Keywords: GVCs, parts and components, exporter premia, South Africa

JEL Codes: F14, F12, O33, O3

Introduction

Following Yeats (1999), empirical studies that use trade data to compute cross-border flows of 'parts and components' or intermediate capital products have proliferated (e.g., Jones, Kierzkowski, and Lurong 2005; Lall, Albaladejo, and Zhang 2004; Ng and Yeats 2001; Sturgeon and Memedovic 2010). Evidence from this literature points to important changes in the nature of cross-border flows of goods and services. In particular, trade in 'parts and components', a subset of intermediates mainly associated with machinery products, are found to represent a growing share of international trade (Athukorala 2010; Jones, Kierzkowski, and Lurong 2005; Schmidt and Ferrantino 2018; Yeats 1999), with electronics being responsible for most of this growth. In fact, anecdotal evidence suggests that about 60% of global trade consists of trade in intermediate products and is conducted via global value chains (GVCs) (Ndubuisi and Owusu 2021; Rabelloti, Lema, and Sampath 2018; UNCTAD 2013).

More recently, emerging firm-level literature has indicated that exporters of intermediate products benefit relatively more from participating in international markets when compared to firms that sell final products, although the latter still tend to maintain an overall superior performance (Accetturo and Giunta 2018; Agostino et al. 2015; Veugelers 2013). Underlying this empirical regularity is the idea that intermediate products, especially 'customized intermediates', are traded via GVCs, requiring outright knowledge transfer and exchange between upstream and downstream firms. This differs from the conventional learning-by-exporting hypothesis, wherein the exporter premia are explained by automatic knowledge spillovers in the international market (Wagner 2016).

The available evidence suggests that developing countries have been quickly gaining participation in overall trade, and this process has been even more intense in 'parts and components' and 'customized' intermediary products – a group of more complex intermediates that characterizes supplier-buyer relationships in GVCs (Foster-McGregor, Kaulich, and Stehrer 2015; Ndubuisi and Owusu 2022; 2023; Sturgeon and Memedovic 2010). Nevertheless, available studies examining the differential premia for exporters of intermediate products remain nascent and largely focused on developed economies, for which a richer set of firm-level surveys are available. Against this backdrop, the first objective of this paper is to examine the effects of GVC-related trade on the performance of exporters in South Africa. Further, the GVC literature has shown that gains from GVC participation are not automatic but frequently conditional on firms' investment in the development of their technological capabilities (Morrison, Pietrobelli, and Rabellotti 2008; Agostino et al. 2015; Agostino et al. 2020). In line with this, the second objective of this paper is to analyze the influence of firm capabilities, focusing on research and development (R&D) investments made after entry into export markets.

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To address our research objective, we follow the firm-level international trade literature and analyze both the productivity premia and the learning-by-exporting hypotheses associated with trading in the context of fragmented trade. However, rather than analyzing whether international traders outperform firms that are restricted to local markets, we look deeper into heterogeneities between exporters and the factors explaining these differences among firms in South Africa. We follow the GVC literature and concentrate on 'customized' intermediates as the product types that are most closely associated with fragmented trade. This allows us to compare the productivity of firms that trade these products with those that trade other types of products, and with those that do not trade at all, permitting us to detect the variations in performance connected to GVC participation.

Though our empirical approach does not establish a causal relationship, our empirical results show that exporters have a higher productivity premium compared with non-exporters. Comparing the productivity premium of firms trading GVC-related products and those that do not, we find that firms that trade GVC-related products have higher premium compared with those who are engaged only in traditional trade. Results on the learning-effect for the full population of firms in South Africa show evidence for learning, while when we consider the different subcategories, we do not find any such evidence that is specific to exporting only GVC-related products. However, once we consider firms that export GVC-related products and simultaneously engage in R&D in the post-entry period, we find evidence for learning.

Our paper adds to the literature in several ways. We contribute to the international firm-level trade literature by characterizing performance and learning in the context of fragmented trade. In the case of GVC studies, we advance the literature by characterizing performance differences before and after entry into foreign markets, thereby assessing learning effects related to GVC participation. As noted earlier, we attain this feat by identifying heterogeneous effects of trade on the performance of firms according to specific product characteristics associated with production fragmentation. Hence, our paper extends the analysis in Edwards, Sanfilippo, and Sundaram (2018) by estimating separate regressions for categories of traders according to the products traded by these firms and by testing the hypothesis of learning-by-exporting. Finally, we contribute to the firm-level trade and GVC literature by examining the role of firm capability in mediating the benefits of GVC participation and trade in general. Our study contributes further to this literature by identifying the heterogeneous effects of trade on firms' performance according to specific product characteristics associated with production fragmentation.

The remainder of the paper is as follows. The next section discusses the related literature. The section thereafter presents the research framework, describing the data and product classification used in identifying firms trading GVC-related product. This section also specifies the empirical model and the estimation strategy employed in the paper. The penultimate section presents and discusses the results, while the final section concludes the paper.

Related literature

The firm-level international trade literature has expanded dramatically since the pioneering work of Bernard and Jensen (1999). The primary evidence from this literature is that exporters perform better than non-exporters, particularly in terms of productivity (as well as other performance indicators) (Wagner 2016). Recently, however, a related micro-level research agenda in the context of the GVC approach has emerged (e.g., Gereffi, Humphrey, and Sturgeon 2005; Giovannetti and Marvasi 2016; Giuliani, Pietrobelli, and Rabellotti 2005; Humphrey and Schmitz 2002). While this literature is still in its infancy, the available evidence supports a positive association between supplying in GVCs and firms' performance. For instance, Giovannetti and Marvasi (2016) show that firms in Tuscany that participate in hierarchical global (as opposed to local) value chains are the best performing group, especially midstream producers (buyers and suppliers of intermediates). This result is confirmed by evidence indicating positive and significant premia for exporters of intermediate products (Accetturo and Giunta 2018; Veugelers 2013), while Brancati, Brancati, and Maresca (2017) show that Italian firms participating in specific types of GVCs experience a significant innovation, R&D, and productivity increase.

In the case of suppliers (i.e., enterprises that sell intermediates to other firms), the emerging evidence from this literature has been indicating the existence of a performance gap relative to firms that sell final goods. However, suppliers that integrate into foreign markets appear to benefit more from exporting and, when simultaneously investing in innovation, tend to reduce or completely close this gap relative to producers of final goods (Agostino et al. 2015; Agostino et al. 2020; Mazzi, Foster-McGregor, and de Sousa Ferreira 2021). This is compatible with previous evidence from the GVC literature, which originated from a wide variety of cases studies, indicating that learning in GVCs is not automatic but strongly influenced by firm's technological capabilities and by conscious investments by these firms to develop the capabilities that enable them to seize opportunities create by GVCs (Morrison, Pietrobelli, and Rabellotti 2008; Pietrobelli, Rabellotti, and Pietrobelli 2011).

While extant studies have offered important insights on the nexus between GVCs participation and firm performance, there has been little success in disentangling learning and self-selection as done in the international trade literature. In general, there is more emphasis on learning and upgrading, and the empirical evidence at the firm-level is mostly correlational. Only the studies of Brancati, Brancati, and Maresca (2017) and Agostino et al. (2015) offer evidence of GVC participation with ex-post-performance gains by suppliers. This literature tends to consider that GVC participation favours learning because the firms that lead value chains may promote – explicitly or tacitly – knowledge transfers and upgrading opportunities for their suppliers, especially in value chains where coordination is stronger and engagement by leaders higher (Giuliani, Pietrobelli, and Rabellotti 2005). A similar idea in the international trade literature, since Blalock and Gertler (2004) advocated the existence of learning-by-exporting in the case of firms in developing countries, involved supply relationships with higher degrees of customization or 'extended coordination'.

Nevertheless, learning is not the only relevant factor in the context of fragmented trade. First, trade in GVCs is characterized by higher transactional complexity, which entails higher relationship-specific investments, for example, in the development and adaptation of products and plants to the specific needs of buyers (Antràs and Chor 2013). Second, because these relationships involve higher quality standards and specification requirements, international buyers will tend to 'cherry-pick' the most capable suppliers to avoid production line delays and quality debasements caused by problems in the supply base. Third, some studies indicate that transactional frictions such as transportation and communication costs, and language and cultural differences, which are also directly linked to fixed and variable costs of exporting, can be more intense for trade in intermediates, parts, and components (Jones, Kierzkowski, and Lurong 2005; Kimura, Takahashi, and Hayakawa 2007; Kowalski et al. 2015; Sturgeon et al. 2017; UNIDO 2018).

In this paper, we take a step forward to characterize performance and learning in the context of fragmented trade, differentiating the productivity premium between exporting firms trading GVC-related products and those that do not. By distinguishing between the types of products that a firm exports when estimating the export premia and learning-by-exporting effects, we establish a fruitful connection between the international trade literature and the GVC approach. In that way, we demonstrate the existence of heterogeneous performance and learning trajectories for international traders related to their participation and position in GVC-related trade in South Africa.

Data and empirical model

Product classification

Products traded within GVCs are often complex intermediates that are either part of intra-firm trade or exchanged in networks that involve higher degrees of customization and coordination between firms. Hence, to identify GVC-related products we utilize the United Nations Broad Economic Categories classification (BEC5) which divide products into four categories according to their end-use (intermediates versus finals) and 'specification' type ('generic' versus 'specific'): 'specific' intermediates, 'generic' intermediates, final goods, and a residual group containing other exporters, especially exporters of unprocessed (primary) goods. We take a conservative approach by including in the residual category exports of products that have ambiguous classifications in terms of the 'specification' dimension and end-use. These are a small group, comprising about 9% of total HS codes. However, we do not have a consistent criterion to reassign them and therefore choose to focus the analysis on products that can be classified without ambiguity.

As a robustness check, we also depict results using a classification based on the complexity or 'contract-intensity' of products, as identified by the conservative version of the Rauch (1999) list of differentiated products, a taxonomy that has become popular in the economic literature (Andersson and Weiss 2012; Antràs and Chor 2013; Del Prete and Rungi 2015; Ndubuisi and Owusu 2023). This method consists of dividing products into three categories: traded in organized exchanges, reference priced in trade publications, and all others. The first two categories indicate homogeneous products traded in dense markets, while the residual identifies differentiated products more likely to be traded based on networks. We use the end-use classification to divide products into 'generic' intermediates (intermediates traded in organized exchanges or reference priced), 'specific' intermediates (intermediates classified in Rauch's 'others' group), finals, and the residual group.

In both classifications, Rauch and BEC5, exports of specific intermediates indicate GVC-related trade while generic intermediates indicate non-GVC trade, which are the main comparison groups of interest in our study. Exports of final goods do not necessarily relate to specific or generic products but indicate downstream trade in value chains and, therefore, are related to firms' positions. The residual group is not the focus of our analysis, but we maintain controls for exports of these products in all regressions as they are correlated with both performance and the other three export categories.

Data and descriptive statistics

The data used for our analysis are sourced from the South African Revenue Service and National Treasury (SARS-NT). The SARS-NT database is an unbalanced firm-level panel data compiled from four main sources: company income tax data, employee data, value-added tax data, and customs records. The data have an extensive timeframe covering the period 2009–2017. The company income tax data is the parent data set in the SARS-NT, and it covers tax returns of companies in a given financial year. The customs data contain detailed transaction-level information on the export and import activities of firms. The VAT data comprises indirect tax data on the consumption of goods and services charged either at the production and/or distribution stage of the product, while the employee tax data mainly covers individual employee tax information. However, the SARS-NT panel does not cover groups such as informal enterprises, or young and small firms (see Edwards, Sanfilippo, and Sundaram 2018; Kreuser and Newman 2016; Pieterse, Gavin, and Kreuser 2018, for a detailed description of the database).

To make the panel compatible across all four data sources, we restrict our sample to observations for which deflators, the value of sales, labour costs, employment, and fixed capital are available, resulting in the loss of a significant number of observations. Our final sample size comprises 120,635 firms. Due to cross-missing observations, we observe drops in the number of firms when we use additional co-variables such as fixed capital and R&D.

We deflate the fixed capital variables using a gross capital formation deflator, wages using the Consumer Price Index (CPI) and firms' remaining nominal variables using the Producer Price Index (PPI), all economy-wide deflators provided by Statistics South Africa. The average wage is calculated as total labour costs divided by the average number of employees. Capital is proxied by total assets or fixed assets (measured as plants, equipment, and other fixed assets), whereas R&D investments are self-declared values obtained from firms' tax returns. Finally, we measure labour productivity and capital per worker as value-added (sales minus the cost of intermediates) and capital divided by the average number of employees, respectively.

The basic descriptive statistics of all variables we use from the SARS-NT panel data in our model are presented in Tables 1–3. We present summary statistics for the entire sample and disaggregate by export and non-exporters.[1] More details about variable construction are presented in the notes to these tables. In Table 1, the data shows that exporters have higher values across all variables of interest compared with their non-exporting counterparts, in line with the literature (Edwards, Sanfilippo, and Sundaram 2018; Kreuser and Newman 2016). The data also suggest that exporters, on average, have more assets, employees, sell more, are more capital intensive, pay higher wages, import more, more innovative (higher investments in R&D and royalties), and invest more in training. Table 2 shows interesting insights related to the percentage of firms that undertake R&D, training, and pay royalties. For instance, 4.9% of all firms perform R&D, 8.8% pay royalties, and 43% invest in training on average. These values differ between exporting and non-exporting firms, with exporters having higher values on average compared with non-exporters. This confirms a hierarchy in knowledge-generating activities, where R&D seems to be the noblest and rare knowledge generation activity, followed by technology licensing and training. Table 3 reveals that firms in South Africa specialize mostly in the production and export of non-customized intermediates and primary (unprocessed) products. This reflects its pattern of comparative advantage and trade participation, based on commodity exports and natural resource insensitive manufactures. However, we do observe significant participation in customized intermediate exports in absolute numbers. This is in line with similar developing countries with a similar pattern of comparative advantage and size, such as Brazil.

Figure 1 shows the kernel density estimation for the four categories of exporters' labour productivity (log).[2] Two observations stand out. First, as expected, exporters' distribution dominates that of non-exporters. Second, exporters of non-customized intermediates appear to be the most productive, followed by customized intermediates, although the difference is not large. It is important to highlight, however, that these are unconditional results and therefore they do not control for other factors that might affect this distribution, such as sectors and size.

Econometric model

To estimate the export premia for different categories of firms classified according to their export destinations, we follow the methodology developed by Bernard and Jensen (1999), although with relevant adaptations. Importantly, our formulation estimates separate productivity premia for firms that export different types of products, as opposed to the single exported premium studied in Bernard and Jensen (1999) and other pioneering studies of this literature. This approach connects our study to the later works of this literature that use trade data at the transaction level and allow for the presence of

Table 1: Descriptive statistics of gross variables for all firms, exporters, and non-exporters.

	Total sample			Exporters			Non-exporters		
Variables	Obs.	Mean	Std.	Obs.	Mean	Std.	Obs.	Mean	Std.
ITR14 total assets (thousands)	90,652	70,030	1,027,000	29,181	174,900	1,684,000	61,471	20,260	448,100
k input (fixed assets, in thousands)	120,635	14,160	280,700	38,558	37,680	491,300	82,077	3,112	45,550
g sales (total sales, in thousands)	120,635	86,140	1,593,000	38,558	228,500	2,805,000	82,077	19,260	140,500
VA (total VA, in thousands)	120,635	23,120	407,800	38,558	59,030	717,300	82,077	6,245	42,350
g cos2 (prod. costs, in thousands)	120,635	63,030	1,388,000	38,558	169,500	2,448,000	82,077	13,010	105,400
x wages (wages paid, in thousands)	58,775	12,070	93,310	26,637	21,520	135,800	32,138	4,233	22,270
x labcost (labour costs, in thousands)	120,635	7,662	75,800	38,558	18,150	131,400	82,077	2,735	16,160
x rd (r&d expenditures)	52,753	100,332	3,167,318	24,599	197,543.35	4,600,646	28,154	15,395	537,298
x royalties (royalties expenditures)	52,914	726,147	15,540,000	24,659	1,478,289	22,690,000	28,255	69,731	1,535,792
# employees	120,635	43.52	301.8	38,558	85.75	450.1	82,077	23.69	193.5
ITR14_x_training	29,559	291,069	3,617	17,360	414,913.45	3,723,200	12,199	114,830	3,453,068
value exports (in thousands)	120,635	3,735	100,400	38,558	9,396	71,830	82,077	0	0
value imports (in thousands)	120,635	6,774	239,500	38,558	17,430	350,200	82,077	1,767	163,100

Notes: The variable 'k_input' is built by adding plants, equipment and other fixed assets (variables k_ppe and k_faother, respectively, in the original dataset). Variable 'VA' equals total sales (g_sales) minus production costs (g_cos2). Variable '# employees' is chosen from the original dataset as the total number of people with employment income supplied by firms weighted by the effective period of employment (irp5_empl_weight).
***Source*:** Authors' figure based on SARS-NT panel (National Treasury and UNU-WIDER 2019)

Table 2: Description of main variables across exporters and non-exporters.

Variables	Total sample			Exporters			Non-exporters		
	Obs.	Mean	Std.	Obs.	Mean	Std.	Obs.	Mean	Std
VAE (labour productivity)	120,334	598,001	26,630,000	38,523	995,109	46,750,000	81,811	411,011	3,724,670
KE (K Intensity)	120,334	243,962	9,055,764	38,523	373,023	15,660,000	81,811	183,190	2,268,086
wage (average wage)	120,334	238,151	7,591,037	38,523	360,191	13,190,000	81,811	180,685	1,666,773
assets per employee	90,416	1,365,437	30,260,000	29,155	2,068,353	49,738,747	61,261	1,030,909	13,180,000
red (r&d/sales)	52,180	0.0007	0.042	24,599	0.00089	0.03	27,581	0.000640	0.050
p red (R&D binary)	52,180	0.049	0.220	24,599	0.078	0.27	27,581	0.024	0.15
train (training/sales)	29,244	0.0008	0.005	17,360	0.00084	0.0028	11,884	0.00076	0.0075
p train (training binary)	29,244	0.430	0.49	17,360	0.47	0.50	11,884	0.36	0.48
roy (royalties/sales)	52,342	0.0014	0.027	24,659	0.0018	0.026	27,683	0.0011	0.028
p roy (roylaty dummy)	52,342	0.088	0.28	24,659	0.12	0.320	27,683	0.062	0.24
p exp (exporter dummy)	120,635	0.32	0.47	38,558	1	0	82,077	0	0
p imp (importer dummy)	120,635	0.32	0.47	38,558	0.72	0.45	82,077	0.12	0.33

Notes: Labour productivity equals value added/employees, capital intensity (KE) equals fixed assets/employees, assets per employee equals total assets/employees, and wage equals labour costs/employees.
Source: Authors' figure based on SARS-NT panel (National Treasury and UNU-WIDER 2019)

heterogeneity between exporters (see Wagner 2007, 2012, 2016 for a thorough reviews of these studies). Moreover, we include firm fixed effects to account for unobserved firm characteristics correlated with the firm's export status or the control variables, which has become a common concern in this literature. We also control for the effect of importing similar product categories, as most studies indicate importing is frequently associated with higher productivity (Foster-McGregor, Isaksson, and Kaulich 2014a). Therefore, the productivity premia are defined as the difference in productivity between firms that export (import) a positive value of a given type of product and those that do not export (import) the same product type, conditional on firm-level controls that include other export and import behaviours. We assume that different trade behaviours are not mutually exclusive: firms can – and frequently do – export and/or import more than one product category. We adopt the following semi-logarithmic equation:

$$lnLP_{it} = \alpha_0 + \boldsymbol{\beta X_{it}} + \boldsymbol{\Phi Z_{it}} + \alpha_i + \alpha_t + \varepsilon_{it} \quad (1)$$

where LP_{it} indicates labour productivity, $\boldsymbol{X_{it}}$ designates the vector of dummies indicating if firm i exports one of the product categories at time t. Following the empirical literature (Foster-McGregor et al. 2014a; Edwards, Sanfilippo, and Sundaram 2018), $\boldsymbol{Z_{it}}$ is a vector of controls which also includes different import behaviours of firms, the number of employees, capital per labour, and wages. α_i and α_t are firms and year fixed effects.

We evaluate the learning-by-exporting hypothesis using a leads-and-lags approach. Inspired by Autor (2003), the method has also been explored elsewhere in the learning-by-exporting literature (e.g., Mazzi, Foster-McGregor, and de Sousa Ferreira 2021; Pisu 2008; Schwarzer 2017) as opposed to the conventional approach of using matching techniques. This method explores two main aspects of the panel. First, it allows us to estimate a long-term 'learning curve' for firms, tracking their productivity premium trajectory across years before and after entry into the export market, which provides a picture of longer trends. Second, it also maximizes the number of observations for export entries in each export category due to the fact we can keep starts from different years in the sample in the same regression. The estimated equation is formulated as follows:

$$LnLP_{it} = \alpha_0 + \sum_{s=-n}^{n} \boldsymbol{\beta_s X_{is}} + \boldsymbol{\Phi Z_{it}} + \alpha_i + \alpha_t + \varepsilon_{it} \quad (2)$$

where all variables and vectors have the same meaning as in (1), except for $\boldsymbol{X_{is}}$ which indicates if firm i is an exporter in time t and takes value one if, and only if, $s = t - K_i$, where K_i indicates the year firm i started exporting each product category and n is the range of the learning curve, which depends on the total periods of the panel. The SARS-NT panel ranges from 2009 to 2017, but the sample is better populated from 2013 onwards. Therefore, we use the complete panel to estimate equation (1) but focus on the firms present in the final 5 years of the

Table 3. Exports and imports by product category across years (in 1000s).

Year	Customized intermediates (b5_spcf)	Finals (b5 finals)	Non-customized (b5 nspcs)	Primary and residual (b5 others)
Exports				
2009	611,416	515,668	462,701	299,766
2010	5,743,630	5,138,611	18,596,285	9,684,517
2011	3,541,288	3,767,819	3,953,806	3,667,013
2012	12,563,479	11,418,007	24,589,027	17,614,349
2013	14,268,567	12,359,209	31,531,125	21,336,659
2014	8,547,839	7,465,717	28,441,578	11,768,18
2015	16,801,805	14,742,870	19,802,807	17,647,488
2016	8,179,19	7,563,348	10,326,569	7,756,878
2017	17,154,478	14,581,521	34,023,008	24,210,282
Imports				
2009	817,539	515,668	292,369	263,974
2010	6,699,844	5,138,611	17,774,586	9,550,001
2011	3,867,995	3,767,819	3,840,254	3,453,858
2012	16,056,760	11,418,007	21,753,011	16,957,084
2013	17,166,748	12,359,209	29,396,224	20,573,380
2014	9,989,098	7,465,717	27,556,472	11,212,034
2015	19,884,959	14,742,870	17,755,833	16,611,309
2016	10,162,776	7,563,348	8,963,561	7,136,307
2017	21,333,138	14,581,521	30,823,402	23,231,229

Source: Authors' figure based on SARS-NT panel (National Treasury and UNU-WIDER 2019)

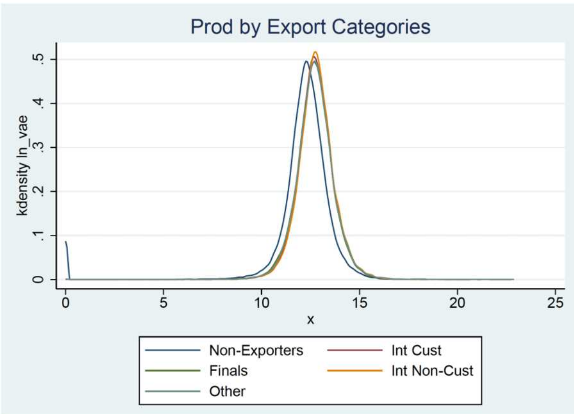

Figure 1: Kernel densities for the export categories and non-exporters.
Source: Authors' figure based on SARS-NT panel (National Treasury and UNU-WIDER 2019)

sample for the estimation of equation (2) to observe export starters for longer periods either before or after entry. We also drop firms that start exporting in their first two years in the sample (2013, 2014) when estimating equation (2) to be as sure as possible that the remaining exporters are export starters and not permanent or intermittent exporters. As a result, we look at three cohorts of starters (2014, 2015, 2016, 2017) and the maximum range *n* of the learning curve will be 8, i.e., 4 periods before the last entry (2017) and 3 periods after the earliest (2014)[3], totalling with the year of entry 8 binary variables for each GVC export category ($s \in [-4, 3]$).

The learning curve provides an insightful visualization tool but also allows us to identify more formally the existence of learning-by-exporting. The learning hypothesis is tested by comparing productivity premia before and after entry into exporting, i.e., by checking if $\beta_{0-1} = \beta_{0+f}$, where *l* and *f* are, respectively, the periods chosen before and after entry for comparison. We call these tests 'Test 1', 'Test 2', and 'Test 3' in the empirical section, depending on the values we choose for *l*. Additionally, we check for differences in the *change* of the productivity premium before and after entry into exporting, in this case, if $\beta_{-1} - \beta_{-1-m} = \beta_{-1+m} - \beta_{-1}$. This is equivalent to testing if $\beta_{-1} = 0.5*(\beta_{-1+m} + \beta_{-1-m})$, where *m* is the interval of periods before and after entry chosen to evaluate the change in the productivity premium. Intuitively, the test checks if the mean of coefficients β_{-1+m} and β_{-1-m} is significantly different from β_{-1}. This holds only when the productivity premium increases by a higher (or lower) amount after entry. Implicitly, this latter test checks if the entry into export markets affects previously existing trends in the *growth* of firms' productivity premium. We choose $m = 2$ in the empirical section and call this test 'Test 4'.

Estimation

Our empirical analysis proceeds in two steps. First, we estimate equation (1) and evaluate the export premia for firms according to the three categories of products described above.[4] In this step, we are interested in comparing productivity differentials associated with different categories of products, focusing especially on customized intermediates. Next, we estimate equation (2) and evaluate export premia for starters in the same categories of products before, during, and after entry in international markets. In this case, we test whether productivity differentials were built after entry in international markets – which we consider supportive of learning- by-export.

Empirical results

Analysis of GVC related export premia

Table 4 reports the initial results from the fixed effect estimation of GVC related trade on labour productivity. We sequentially introduce controls to test the robustness of our results. The estimation results are consistent across all specifications, with trade-related dummies

Table 4: GVC-related trade and firm productivity premium.

	Ln of value-added per employee				
	(1)	(2)	(3)	(4)	(5)
Customized intermediates	0.1938	0.1592	0.1541	0.0332	0.0620
	(0.0176)***	(0.0143)***	(0.0161)***	(0.0095)***	(0.0082)***
Finals	0.1332	0.1123	0.0951	0.0171	0.0442
	(0.0162)***	(0.0134)***	(0.0149)***	(0.0092)*	(0.0081)***
Non-customized intermediaries	0.1156	0.1039	0.0866	−0.0077	0.0226
	(0.0170)***	(0.0139)***	(0.0159)***	(0.0088)	(0.0075)***
Others	0.2000	0.1635	0.1696	0.0323	0.0568
	(0.0181)***	(0.0150)***	(0.0170)***	(0.0092)***	(0.0079)***
Ln employment		−0.3479			−0.6427
		(0.0217)***			(0.0106)***
Ln capital intensity		0.0807			0.0282
		(0.0035)***			(0.0014)***
Ln wages		0.2863			0.0964
		(0.0107)***			(0.0039)***
BEC5 specific products imports			0.2283		
			(0.0209)***		
BEC5 final products imports			0.1518		
			(0.0162)***		
BEC5 non-specific products imports			0.1909		
			(0.0202)***		
BEC5 primary and non-specified products imports			0.1736		
			(0.0174)***		
exported value/sales ratio BEC5 specific products				−0.2227	−0.3673
				(0.1692)	(0.1573)**
exported value/sales BEC5 final products				−0.1432	−0.0823
				(0.0988)	(0.0872)
exported value/sales BEC5 non-specific products				−0.3355	−0.3933
				(0.1536)**	(0.1475)***
exported value/sales BEC5 primary and non-specified products				−0.0664	−0.1892
				(0.2221)	(0.2123)
Observations	120,334	120,334	120,334	118,271	118,271
Number of clusters	28,504	28,504	28,504	28,077	28,077
R-squared	0.0357	0.219	0.0446	0.105	0.314
F	65.28	132.4	60.10	167.9	367.5

Notes: Robust standard errors in parentheses; *** *p < 0.01*, ** *p < 0.05*, * *p < 0.1*.

having positive and significant labour productivity effects. This confirms that exporting is associated with higher labour productivity in firms. A further look at the results shows that the size of the estimated coefficient of customized intermediaries is larger, followed by final goods and non-customized intermediaries. This suggests that GVC-related trade is associated with higher productivity premium compared to non-GVC intermediates and downstream exporters of final goods. The result is robust to different covariates and classifications. The result is, therefore, consistent with extant results in the GVC firm-level literature (Accetturo and Giunta 2018; Agostino et al. 2015; Avenyo et al. 2022; Veugelers 2013), and indicates that GVC participation is associated with higher productivity premia. The result is also consistent with findings in the GVC literature suggesting that GVC participation reduces the performance gap between downstream and upstream, which in our case is captured by an inverted hierarchy between final goods and intermediate producers that are in GVCs (Agostino et al. 2015; Brancati, Brancati, and Maresca 2017; Giuliani, Pietrobelli, and Rabellotti 2005). These results also corroborate recent findings by Mazzi, Foster-McGregor, and de Sousa Ferreira (2021) in the Brazilian manufacturing sector. In Table A1 in the Appendix, we also report results for the Rauch (1999) classification for robustness, which remains compatible.

Next, we consider export intensity as reported in columns 4 and 5 of Table 4. The results suggest that productivity premia reduce as export intensity increases, especially when we control other covariates (column 5). However, it is important to note that the intensive margin effect is quite small for most firms. For example, for exporters of customized intermediates reported in column 5, the entry effect is $[\exp(0.0620)-1]*100 = 6.39\%$. On the other hand, the median effect of export intensity is only $[\exp(-0.3673*0.0021)-1]*100 = -0.07\%$, where $p50 = 0.0021$, which amounts to an overall premium of 6.32% for the median intensity exporter of customized intermediates. This is in line with the firm heterogeneity trade models (e.g., Melitz 2003), suggesting that the fixed costs of exporting are strongly responsible for the performance premia of exporters.

Existing studies suggest that importing firms acquire technical knowledge and superior inputs that offer some performance gains compared to firms that do not import (e.g., Edwards, Sanfilippo, and Sundaram 2018; Foster-McGregor, Isaksson, and Kaulich 2014a). We tested this conjecture, and the results are reported in Column 3. The results show that importing firms have higher productivity premiums than non-importing firms, with the import of customized intermediaries having the highest productivity gains. Our import variables' coefficients that are greater in size than those of our export variables is in line with the empirical literature suggesting that imports generate higher productivity premiums than exports (Foster-McGregor et al. 2014; Edwards, Sanfilippo, and Sundaram 2018). Edwards, Sanfilippo, and Sundaram (2018) for instance found that access to imported intermediate inputs is critical for firms' productivity, which is in line with our results.

Other control variables in Table 4 include employment, capital per worker, and wages (columns 2, 5, 7, and 8). Our results are in line with the extant literature showing that higher wages are positively correlated with labour productivity, indicating that higher wages are likely connected to increases in the quality of the firm's labour pool, while increases in capital intensity per worker tend to complement labour and lead to higher labour productivity. Regarding employment, we observe a negative point estimate, indicating that increases in the number of employees lead to less than proportional increases in total value-added, reducing value-added *per employee*, although the size of the coefficient still points to an overall positive effect on *total* value-added.

Analysis of GVC-related learning-by-Exporting

Figure 2 shows the productivity premia (%) for export starters based on equation (2). Period $t = 0$ indicates the first year of exporting, periods to the left of $t = 0$ represent estimates for periods before entry, while periods to the right of $t = 0$ indicate periods after entry. Since the model is in log-linear form, we transform the estimated coefficients using the equation $e^{\beta} - 1$ to obtain export premia as percentages. Each curve represents a different regression with different samples or controls as reported in Table 5. The first curve (All Entry, No Contr.) shows the model with all export entrants and no time-varying controls, only firm and time fixed effects. The next curve (All Entry, Contr.) includes the full set of time-varying controls. The remaining curves follow the same logic, except now only continuous exporters (i.e., firms that continue to export for at least two consecutive years) are considered as export starters. Continuous exporters remain involved in foreign markets for a longer period and in theory, are more likely to experience learning effects.

Figure 2 shows that the productivity premia of export starters increase sharply in the year of entry relative to pre-entry levels. For instance, the productivity premium of continuous exporters jumps from around -5% to 5% between $t = -1$ to $t = 0$ in the model without time-varying controls. While the subsequent two periods do not show a clear trend, they, however, remain above those in the pre-entry period. The two curves for continuous exporters appear to continue a slow-growth trend.

Turning to Table 5, we observe that the estimated productivity premia are small, and most are not statistically different from zero. These results are because the average effect of being an export starter is captured by the firm fixed effects and does not mean the effect of exporting is zero.[5] We have seen in the previous section that the export premia we estimate are positive and significant, and this is confirmed by estimations of equation (2) without firm fixed effects (not depicted, but available upon request). The firm fixed effects also make it necessary to omit one of the terms of the learning curve, for which we chose the last coefficient $(X_{i3})X_{in}Starter_i$. Despite these disadvantages, we chose to keep the firm fixed effects to control for unobserved firm characteristics, which is highly important.

However, productivity premia before and after entry, which is our main concern in this section, tend to be statistically different from each other. In the bottom part of Table 5, we report the p-value for three different Wald tests for simple and composite linear hypotheses. Test 1 checks if $\beta_{-3} = \beta_2$, i.e., if the productivity premium the three years before entry equals the productivity premium two years after the year of entry. Test 2 checks if $\beta_{-2} = \beta_2$, while Test 3 checks if

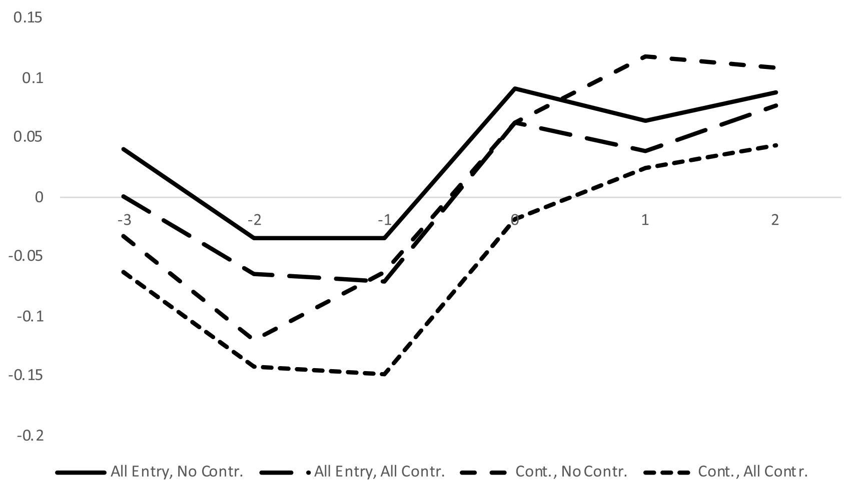

Figure 2: Learning curves for export starters across different samples (all starters, and continuers).
Source: Authors' figure based on SARS-NT panel (National Treasury and UNU-WIDER 2019)

Table 5: Productivity premia for export starters divided by different samples (all starters, continuers).

Ln of value-added per employee				
Sample	All entry (1)	All entry (2)	Continuers (3)	Continuers (4)
Export t-4	0.0254	−0.1086		
	(0.0976)	(0.0833)		
Export t-3	0.0152	−0.0324	−0.0339	−0.0654
	(0.0835)	(0.0754)	(0.1191)	(0.1082)
Export t-2	−0.0801	−0.0896	−0.1281	−0.1543
	(0.0854)	(0.0746)	(0.1306)	(0.1119)
Export t-1	−0.0678	−0.1406	−0.0660	−0.1613
	(0.0838)	(0.0718)*	(0.1284)	(0.1092)
Export t	0.0656	−0.0059	0.0597	−0.0193
	(0.0688)	(0.0576)	(0.0995)	(0.0824)
Export t + 1	0.0500	−0.0115	0.1115	0.0238
	(0.0663)	(0.0562)	(0.0966)	(0.0802)
Export t + 2	0.0624	0.0120	0.1020	0.0414
	(0.0643)	(0.0541)	(0.0957)	(0.0795)
Ln employees		−0.5899		−0.5865
		(0.0348)***		(0.0374)***
Ln capital intensity		0.0439		0.0442
		(0.0056)***		(0.0058)***
Ln wages		0.1959		0.2031
		(0.0241)***		(0.0256)***
Importer		0.2291		0.2428
		(0.0441)***		(0.0511)***
Observations	26,631	26,631	24,477	24,477
R-squared	0.0411	0.1741	0.0406	0.1742
Year FE	YES	YES	YES	YES
Test 1	43%	44%	8%	15%
Test 2	3.1%	8.6%	1.9%	2.0%
Test 3	2.4%	0.3%	4.5%	0.4%
Test 4	0.8%	0.0%	9.1%	1.1%
F	18.24	47.11	17.82	43.75

Notes: Robust standard errors in parentheses; *** *$p < 0.01$*, ** *$p < 0.05$*, * *$p < 0.1$*.

$\beta_{-1} = \beta_2$, therefore covering all periods before entry and comparing them with the last estimated period after entry. Although for Test 1 differences are not significant at 5%, we can observe that in all but one case the null hypothesis is rejected at 5%[6] for Tests 2 and 3, and more strongly for continuous exporters, indicating statistically different productivity premia after entry in export markets.

Differences between these coefficients might result from the continuation of productivity trajectories that were already present before entry into export markets. Test 4, therefore, checks if $\beta_{-1} - \beta_{-3} = \beta_1 - \beta_{-1}$, i.e., if the change in productivity premia is equal before and after firms enter export markets. We find supportive evidence for this in all the models at a conventional statistical significance level. This result is consistent with Figure 2, where we observed that export premia are mostly stable or reducing before entry (between $t = -3$ and $t = -1$) and start increasing from the period of the entry ($t = 0$).

The above findings provide suggestive evidence of *learning-by-exporting* for the population of South African firms in our sample, corroborating findings in other developing countries' context. For instance, Foster-McGregor, Isaksson, and Kaulich (2014b) found similar *learning-by-exporting* evidence for manufacturing firms in 19 sub-Saharan African countries. One of our paper's objectives is to check if this *learning-by-exporting* is related to a firm's participation in GVCs. Hence, Figure 3 shows the curves for export starters based on our categorization of exported products i.e., customized, non-customized, and final products. We show results only for the model including the complete set of time-varying controls and for all starters, although results are similar for continuous exporters.

As can be seen in Figure 3, for the different categories, we do not observe any growth trends. Exporters of customized and non-customized intermediates appear quite stable, while exporters of final goods show more variation but no clear trend. Table 6 reports the regression results for the learning-by-exporting effects. It is important to observe that all columns of Table 6 reproduce results of the same regression, therefore the results for the control variables and regression statistics are equal in all columns. What we depict in separate columns are the estimates for each type of export behaviour obtained from the same regression. It is important to estimate all coefficients in the same model because firms export more than one product category and therefore, we need to control for the effect of each product type separately. The dearth of empirical evidence on the learning-by-exporting effects across the product subgroups we observed in Figure 3 is confirmed further by the Wald tests we report at the bottom of Table 6.

The result shown in Figure 3 suggests that exporting GVC-related intermediates separately is not related to

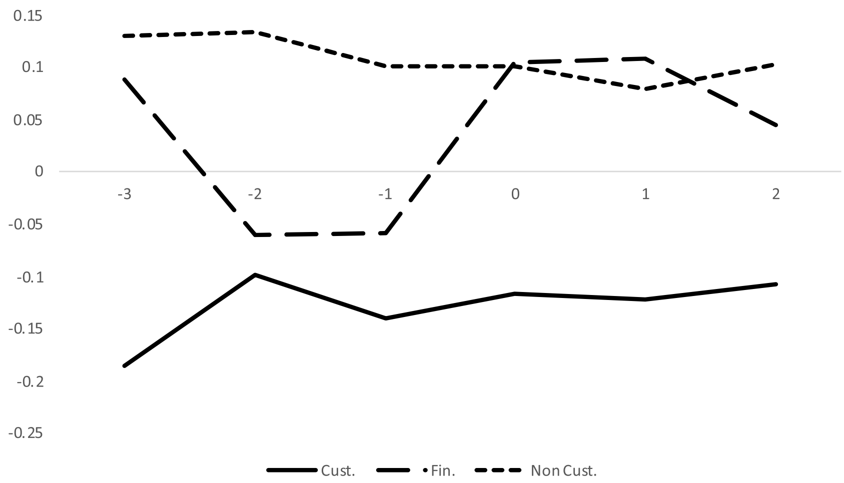

Figure 3: Learning curves for export starters divided by different product types, sample of all starters and complete set of controls. ***Source***: authors' figure based on SARS-NT panel (National Treasury and UNU-WIDER 2019)

the learning effects we observed for overall exporters or any other separate product categories. One of the potential reasons for this is that successful exporters tend to diversify their exports in more than one product category, thereby accumulating the learning effects from different product categories, which cannot be captured

Table 6: Productivity premia for export starters divided by different product types, sample of all starters and complete set of controls.

	Ln of value-added per employee			
Type of exporter	Customizers	Finals	Non-customizers	Others
Sample	All entry	All entry	All entry	All entry
	(1)	(2)	(3)	(4)
Export t-4	−0.2693	0.0829	0.1663	−0.0686
	(0.1541)*	(0.1317)	(0.1863)	(0.1233)
Export t-3	−0.2056	0.0851	0.1217	−0.0734
	(0.1212)*	(0.1189)	(0.1739)	(0.1140)
Export t-2	−0.1037	−0.0615	0.1254	−0.1246
	(0.1044)	(0.1220)	(0.1658)	(0.1166)
Export t-1	−0.1511	−0.0604	0.0965	−0.1559
	(0.0961)	(0.1108)	(0.1636)	(0.1135)
Export t	−0.1231	0.1000	0.0965	−0.0378
	(0.0836)	(0.0888)	(0.1471)	(0.0955)
Export t + 1	−0.1291	0.1031	0.0760	−0.0165
	(0.0760)*	(0.0847)	(0.1388)	(0.0946)
Export t + 2	−0.1139	0.0441	0.0985	0.0127
	(0.0857)	(0.1032)	(0.1390)	(0.0963)
Ln employees	−0.5945	−0.5945	−0.5945	−0.5945
	(0.0347)***	(0.0347)***	(0.0347)***	(0.0347)***
Ln capital intensity	0.0437	0.0437	0.0437	0.0437
	(0.0056)***	(0.0056)***	(0.0056)***	(0.0056)***
Ln wages	0.1960	0.1960	0.1960	0.1960
	(0.0240)***	(0.0240)***	(0.0240)***	(0.0240)***
Importer customers	0.1179	0.1179	0.1179	0.1179
	(0.0382)***	(0.0382)***	(0.0382)***	(0.0382)***
Importer final	0.1012	0.1012	0.1012	0.1012
	(0.0296)***	(0.0296)***	(0.0296)***	(0.0296)***
Importer non-customers	0.1139	0.1139	0.1139	0.1139
	(0.0347)***	(0.0347)***	(0.0347)***	(0.0347)***
Importer others	0.1073	0.1073	0.1073	0.1073
	(0.0350)***	(0.0350)***	(0.0350)***	(0.0350)***
Observations	26,631	26,631	26,631	26,631
R-squared	0.1762	0.1762	0.1762	0.1762
Year FE	YES	YES	YES	YES
Test 1	39.2%	73.8%	81.7%	29.3%
Test 2	91.2%	42.3%	77.2%	12.8%
Test 3	63.6%	34.2%	97.9%	3.4%
Test 4	77.6%	0.2%	95.6%	2.4%
F	31.20	31.20	31.20	31.20

Notes: Robust standard error in parentheses; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

by the model reproduced in Table 6. However, an important insight from the broader GVC-related literature suggests that learning will frequently depend on firms' own internal innovation efforts. Firms need to 'invest in learning and building technological capabilities to innovate effectively' in value chains (Morrison, Pietrobelli, and Rabellotti 2008, 51). Among others, this is because lead firms will rarely sustain the development of core capabilities by local firms. Hence, the productivity trajectories of exporters that invest in capabilities and innovation may be different from those that do not, especially for those involved in GVCs, where the learning potential, in theory, is higher.

Analysis of GVC-related learning-by-Exporting: the role of technological capability

In line with the argument in the preceding section, Figure 4 shows the learning curves for exporters that perform R&D after entering export markets for at least one period, i.e., either in $t = 0$, $t = 1$or $t = 2$. Formally, the empirical model that leads to this Figure is expressed in the following way:

$$\begin{aligned} LnLP_{it} = {} & \alpha_0 + \sum_{s=-n}^{n} \beta_s X_{is} \\ & + \sum_{s=-n}^{n} \gamma_s X_{is} * R\&D\_entry_i + R\&D_{it} \\ & + \boldsymbol{\Phi Z_{it}} + \alpha_i + \alpha_t + \varepsilon_{it} \end{aligned} \quad (3)$$

where $R\&D\_entry_i$ is a dummy variable taking value 1 if the firm performed R&D after entering the exports of products, therefore separating these firms' entire learning curves from those of exporters that do not perform R&D investments after entry. We use this variable to signal firms that perform internal investments in capabilities and innovation after entry, and not to capture the effect of R&D itself. The latter is captured by the variable $R\&D_{it}$, which is a dummy taking value one if the firm performs R&D in period t and complements the vector of controls $\boldsymbol{Z}$.

Figure 4 shows the same learning curves shown in Figure 2, but this time only for firms that invest in R&D after entry. As the Figure indicates, these firms appear to experience sharp learning trajectories after entry. In Table 7 we report the associated regression results and observe the Wald tests that indicate significant differences in coefficients immediately before (β_{-1}) and two years after entry (β_2), called 'Test_R&D 3' for these firms in the regressions without time-varying controls at the 5% significance levels, therefore partially confirming the impressions observed on the graph. Despite the apparent growth trend observed after entry in Figure 4, the tests for changes in the productivity premia (Test_R&D 4) do not depict significant values in any of the columns. Table 7 also confirms that the learning trajectories for firms that do not perform R&D after entry indicate no signs of learning.

Could these results be connected to GVC-related intermediates? Figure 5 shows an affirmative answer to this conjecture. Figure 5 shows that the learning curves of firms exporting GVC-related products and performing R&D after entry present a clear increase after period $t = 0$ for all starters and stable growth trend from period $t = -3$ for export continuers, suggesting that this growth trend was already present before exporting for these firms. Similar growth trends are not observed for firms exporting GVC-related products but that do not perform R&D after entry. Table 8 shows the coefficients have high standard errors; however, we see that the Test_R&D 1 presents a p-value of 6.8% in the case of export continuers in column (2), therefore significant at the 10% level.

The results above partially explain the learning effects observed for the overall population of exporters. The evidence for learning-by-exporting for the overall population of South African firms is strong, and this appears to be connected to firms that invest in capabilities after entry in foreign markets. Although this effect is also likely related to a process of diversification of export products to more than one of the export categories we classify,

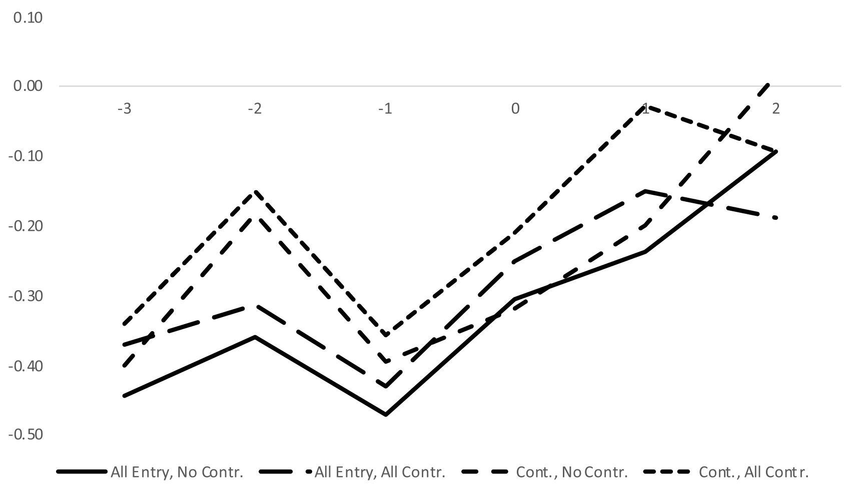

Figure 4: Learning curves for export starters that invest in capabilities (R&D) after entry divided by different samples (all starters, continuers) and different sets of controls (no time-varying controls, complete set of controls).
Source: Authors' figure based on SARS-NT panel (National Treasury and UNU-WIDER 2019)

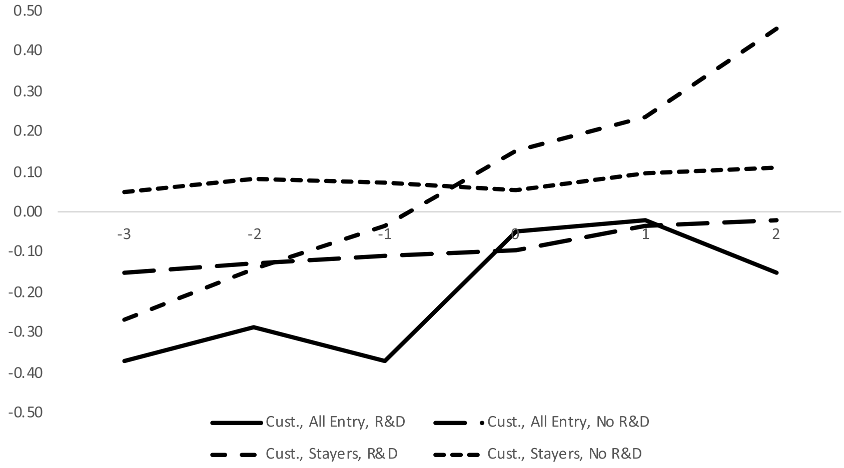

Figure 5: Learning curves for export starters of customized intermediates according to investment in R&D after entry and by different samples (all starters, continuers).
***Source*:** Authors' figure based on SARS-NT panel (National Treasury and UNU-WIDER 2019)

exporters of GVC-related intermediates that invest in the development of their internal technological capabilities are also partially responsible for these trends, although in the case of export continuers these trends appear to precede entry into foreign markets.

It is interesting to observe that we do not find similar trends for other export categories, i.e., the learning curves do not show any indication of learning for exporters of non-customized and final goods (Appendix Table A2). A related paper by Mazzi, Foster-McGregor, and de Sousa Ferreira (2021) also did not find evidence of learning effect in trade in customized intermediates in Brazil. Conversely, the authors found evidence of leaning in trade in final products, contrary to our evidence of no learning effect in South Africa. While South Africa and Brazil have an apparently similar economic structure, largely built around the exploration, processing and exports of natural resources, there are also important differences in the structure of the manufacturing sector of the two countries that may be driving some of the differences in the results. Moreover, we do not find any evidence of learning-by-exporting for other firm expenditures connected to capability development, such as investments in training and payments of royalties (available upon request). Only R&D investments appear to influence firms' capacity to learn through export relationships.

Conclusion

The emergence of GVCs – whereby goods that used to be produced within one country are now fragmented and distributed across global networks of production – has offered developing countries new opportunities to integrate into the global economy. Following the firm-level literature that identifies GVC participating firms as those trading 'parts and components' or 'customized intermediate products', this paper examines the performance implications of GVC participation among firms in South Africa. Our paper examines the existence of export premia differentials and the presence of learning-by-exporting between GVC and non-GVC participating firms in South Africa using the South African Revenue Service and National Treasury firm-level panel data covering the period 2009–2017.

Evaluating the export premia for firms in an econometric model, our findings are consistent with the wider empirical literature suggesting that exporters have a higher productivity premium compared with non-exporters. However, firms that trade GVC-related products tend to have a higher premium compared with traditional trade, suggesting the positive benefits of GVC participation that have been underscored in the broader GVC literature. For the learning effect, while we find evidence of a learning effect in the full population of firms in South Africa, this is not the case when we consider firms that trade GVC-related products. However, we find evidence of a learning effect for firms that trade in GVC-related products and engage in R&D investment after entry, especially export continuers. This latter result is consistent with the broader idea that successful learning and capability building in GVC frequently depend on firms' own internal innovation efforts (Morrison, Pietrobelli, and Rabellotti 2008, 51), partly due to the hierarchical constraints and skill intensity of advanced tasks in international value chains.

Put together, our results underscore the gains from integration into GVC in terms of the associated productivity premia and highlight the need for GVC participating firms to invest in building technological capacity. Technological capabilities enable such firms to innovate, learn in GVC by identifying and exploiting knowledge spillovers as well as avoid captive value chains. Among others, this is very important in the contest of African countries where how to attain economic and social upgrading in GVCs remains highly debated. From a policy perspective, therefore, our result suggest that national policies aimed at increasing integration of domestic firms into GVCs, say by liberalizing tariffs and non-tariffs barriers (NTBs), should be accompanied by policies that enhance the technological capabilities of domestic firms. In line with our result, one such examples could entail granting R&D tax credits to GVC participating firms. However, it could also extend more broadly to national industrial policies targeted at skill upgrading say educational curriculum reforms that

Table 7: Productivity premia for export starters that invest in capabilities (R&D) after entry divided by different samples (all starters, continuous exporters) and different sets of controls (no time varying controls, complete set of controls).

Dep. variable	Ln of value-added per employee			
Sample	All entry (1)	All entry (2)	Continuers (3)	Continuers (4)
Export t-4	0.0484	−0.1172		
	(0.1134)	(0.0908)		
Export t-3	0.0769	−0.0085	−0.0183	−0.0778
	(0.0862)	(0.0766)	(0.1062)	(0.0922)
Export t-2	0.0389	0.0185	0.0252	−0.0429
	(0.0756)	(0.0648)	(0.0863)	(0.0742)
Export t-1	0.0666	0.0105	0.0800	−0.0151
	(0.0699)	(0.0586)	(0.0774)	(0.0677)
Export t	0.0835	0.0537	0.0464	−0.0134
	(0.0644)	(0.0562)	(0.0714)	(0.0644)
Export t + 1	0.1080	0.0691	0.1006	0.0297
	(0.0587)*	(0.0482)	(0.0679)	(0.0557)
Export t + 2	0.0156	0.0111	−0.0147	−0.0249
	(0.0474)	(0.0428)	(0.0574)	(0.0529)
Export t-4 * R&D_entry	−0.6572	−0.3612		
	(0.2210)***	(0.2748)		
Export t-3 * R&D_entry	−0.5879	−0.4648	−0.5095	−0.4174
	(0.1686)***	(0.2333)**	(0.1507)***	(0.2470)*
Export t-2 * R&D_entry	−0.4438	−0.3761	−0.2017	−0.1637
	(0.1753)**	(0.2215)*	(0.1645)	(0.2094)
Export t-1 * R&D_entry	−0.6368	−0.5603	−0.5019	−0.4410
	(0.2443)***	(0.3408)	(0.2096)**	(0.3697)
Export t * R&D_entry	−0.3661	−0.2875	−0.3839	−0.2355
	(0.1538)**	(0.1753)	(0.1887)**	(0.1908)
Export t + 1 * R&D_entry	−0.2714	−0.1626	−0.2210	−0.0279
	(0.1293)**	(0.1686)	(0.1386)	(0.1562)
Export t + 2 * R&D_entry	−0.0990	−0.2081	0.0161	−0.0965
	(0.1866)	(0.1652)	(0.2133)	(0.1722)
R&D	−0.0765	−0.0881	−0.0642	−0.0646
	(0.0828)	(0.0796)	(0.0847)	(0.0837)
Ln employees		−0.7123		−0.7028
		(0.0418)***		(0.0470)***
Ln capital intensity		0.0292		0.0282
		(0.0067)***		(0.0073)***
Ln wages		0.0492		0.0472
		(0.0176)***		(0.0193)**
Importer		0.1236		0.1262
		(0.0360)***		(0.0390)***
Observations	6,050	6,050	5,339	5,339
R-squared	0.0952	0.2997	0.0973	0.2876
Year FE	YES	YES	YES	YES
Test 1	42%	77%	97%	53%
Test 2	72%	89%	60%	78%
Test 3	38%	99%	17%	86%
Test 4	62%	65%	51%	84%
Test 1_R&D	1%	16%	0%	12%
Test 2_R&D	7%	33%	24%	70%
Test 3_R&D	1%	15%	1%	21%
Test 4_R&D	28%	24%	49%	38%
F	94.28	42.05	91.13	36.54

Notes: Robust standard errors in parentheses; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

targets specific value chains based on the country's comparative advantage and/or subsidies to GVC participating firms that invest a certain percentage of their annual profit in upgrading the skills of their workforce. Our findings also hold some practical implications for AfCFTA, especially concerning liberalizing tariffs and in providing the requisite infrastructure for trade promotion in and for Africa. Attaining these fits would help the further integration of firms into GVC, while increasing the opportunities of reaping the gains thereof.

Going forward, future empirical research could consider and provide insights into specific manufacturing industries engaged in fragmented trade, and how these trade activities affect trade and industrial policy designs in South Africa and developing countries. Our results need to be interpreted with the caveat that our use of leads and lags of exports may not fully account for endogeneity between GVC participation and labour productivity given the high level of serial correlation. Future studies could focus on resolving the issue of

Table 8: Productivity premia for export starters of customized intermediates according to investment in R&D after entry and by different samples (all starters, continuers).

Dep. variable	Ln of value-added per employee	
Type of exporter	Customizers	Non-customizers.
Sample	All entry	Continuers
	(1)	(2)
Export t-4	−0.2294	
	(0.1348)*	
Export t-3	−0.1644	0.0457
	(0.1132)	(0.1433)
Export t-2	−0.1389	0.0763
	(0.1035)	(0.1130)
Export t-1	−0.1160	0.0698
	(0.0983)	(0.1166)
Export t	−0.1013	0.0517
	(0.0866)	(0.1028)
Export t + 1	−0.0347	0.0914
	(0.0740)	(0.0854)
Export t + 2	−0.0221	0.1037
	(0.0637)	(0.0852)
Export t-4 * R&D_entry	−1.3458	
	(1.1624)	
Export t-3 * R&D_entry	−0.4641	−0.3151
	(0.9208)	(0.4508)
Export t-2 * R&D_entry	−0.3379	−0.1536
	(0.8547)	(0.4469)
Export t-1 * R&D_entry	−0.4617	−0.0383
	(0.7850)	(0.5637)
Export t * R&D_entry	−0.0507	0.1394
	(0.6318)	(0.3587)
Export t + 1 * R&D_entry	−0.0219	0.2105
	(0.4469)	(0.3009)
Export t + 2 * R&D_entry	−0.1669	0.3734
	(0.4336)	(0.2505)
R&D	−0.0785	−0.0645
	(0.0825)	(0.0858)
Observations	6,050	5,339
R-squared	0.3044	0.2915
Year FE	YES	YES
Test 1	13%	63%
Test 2	16%	74%
Test 3	23%	70%
Test 4	78%	99%
Test 1_R&D	63%	6.8%
Test 2_R&D	77%	17%
Test 3_R&D	56%	36%
Test 4_R&D	25%	98%
F	21.29	19.33

Notes: Robust standard errors in parentheses; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

endogeneity by identifying and using a valid instrument. Our analysis could also be extended by controlling for possible heterogeneity in labour productivity generated by different export destinations, a variable we lacked in the data set we used in our analysis.

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Notes

1. See Appendix II for the definition of all variables.
2. We log transform the variable to reduce skewness in the data.
3. We also drop intermittent exporters, since the pre- and post-effects of exporting are confounded for these firms. We initially classify intermittent exporters as firms that return to exporting after having stopped exporting for one period but also test with longer intervals of two and three periods.
4. We estimate all models including the residual category ('others') to control for other export behaviours.
5. One can note that for overall exporters $\sum_{s=-n}^{n} X_{is} = Starter_i$, where $Starter_i$ is a binary taking value 1 if the firm is an export starter and zero otherwise. It follows that $\sum_{s=-n}^{n} \beta_s X_{is} = \beta_{-n} Starter_i + \sum_{s=-n+1}^{n} \gamma_s X_{is}$, where $\gamma_s = (\beta_s - \beta_{-n})$. The estimates we observe in Table 5 are equivalent to γ_s and therefore can be seen as expressing time-related *deviations* of the export premium from an average for export starters given by β_{-n}. This coefficient (β_{-n}), however, is subsumed by the firm fixed effects and cannot be identified in equation (2); and therefore, we are unable to recover the *real* premia given by β_s in model (2).
6. In column (2), Test 2 depicts a p-value of 8.6%.

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Appendices

Appendix 1

Table A1: GVC-related trade and firm productivity premium for the Rauch classification.

Ln of value-added per employee	(1)	(2)	(3)
*p*_rch_spcf_int_exports	0.2216	0.1880	0.0689
	(0.0190)***	(0.0152)***	(0.0082)***
*p*_rch_finals_int_exports	0.1358	0.1146	0.0445
	(0.0164)***	(0.0135)***	(0.0081)***
*p*_rch_nspcf_int_exports	0.1230	0.1071	0.0293
	(0.0186)***	(0.0152)***	(0.0078)***
*p*_rch_others_exports	0.1934	0.1556	0.0526
	(0.0178)***	(0.0146)***	(0.0076)***
r_rch_spcf_int_exports			−0.3559
			(0.1197)***
r_rch_finals_int_exports			−0.0804
			(0.0872)
r_rch_nspcf_int_exports			−0.4033
			(0.2090)*
r_rch_others_exports			−0.1902
			(0.2350)
Log Employment		−0.3484	−0.6429
		(0.0217)***	(0.0106)***
Ln Capital Intensity		0.0807	0.0282
		(0.0035)***	(0.0014)***
Ln Wages		0.2863	0.0965
		(0.0106)***	(0.0039)***
Observations	120,334	120,334	118,271
Number of clusters	28,504	28,504	28,077
R-squared	0.0359	0.219	0.314
F	65.63	132.5	368.5

Note: robust standard errors in parentheses; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.
***Source*:** Authors' calculations based on SARS-NT panel.

Table A2: Productivity premia for export starters of different export categories.

Ln of value-added per employee				
	(1)	(2)	(3)	(4)
Type of exporter	Customizers	Finals	Non- Customizers	Others
Sample	All Entry	All Entry	All Entry	All Entry
Export t-4	−0.2294	−0.0499	0.0482	0.1037
	(0.1348)*	(0.1587)	(0.1234)	(0.1362)
Export t-3	−0.1644	0.0215	0.0430	0.0977
	(0.1132)	(0.1420)	(0.1156)	(0.1224)
Export t-2	−0.1389	−0.0446	0.1250	0.0527
	(0.1035)	(0.1200)	(0.0973)	(0.1099)
Export t-1	−0.1160	0.0418	0.0782	−0.0342
	(0.0983)	(0.1076)	(0.0895)	(0.1052)
Export t	−0.1013	0.0808	0.0886	−0.0089
	(0.0866)	(0.1072)	(0.0866)	(0.0993)
Export t + 1	−0.0347	0.0849	0.0187	−0.0255
	(0.0740)	(0.0901)	(0.0778)	(0.0904)
Export t + 2	−0.0221	0.0100	0.0688	−0.0613
	(0.0637)	(0.0904)	(0.0727)	(0.0744)
Export t-4 * R&D_entry	−1.3458	1.1877	0.9887	−1.7260
	(1.1624)	(1.0191)	(0.6502)	(0.6791)**
Export t-3 * R&D_entry	−0.4641	0.6520	0.2319	−0.7854
	(0.9208)	(0.8925)	(0.5368)	(0.4529)*
Export t-2 * R&D_entry	−0.3379	0.6695	0.3433	−1.1919
	(0.8547)	(0.9426)	(0.4926)	(0.5538)**
Export t-1 * R&D_entry	−0.4617	0.5982	0.0934	−0.7971
	(0.7850)	(0.8614)	(0.5584)	(0.3709)**
Export t * R&D_entry	−0.0507	0.2819	−0.0627	−0.5072
	(0.6318)	(0.6327)	(0.4656)	(0.3195)
Export t + 1 * R&D_entry	−0.0219	0.0820	0.4157	−0.4861
	(0.4469)	(0.5025)	(0.3609)	(0.3031)
Export t + 2 * R&D_entry	−0.1669	0.1593	0.2148	−0.2714
	(0.4336)	(0.4651)	(0.3084)	(0.3058)
R&D	−0.0785	−0.0785	−0.0785	−0.0785
	(0.0825)	(0.0825)	(0.0825)	(0.0825)
Observations	6,050	6,050	6,050	6,050
R-squared	0.3044	0.3044	0.3044	0.3044
Year FE	YES	YES	YES	YES
Test 1	13%	92%	79%	10%
Test 2	16%	53%	46%	15%
Test 3	23%	68%	88%	71%
Test 4	78%	83%	34%	19%
Test 1_R&D	63%	34%	81%	25%
Test 2_R&D	77%	34%	17%	32%
Test 3_R&D	56%	96%	2%	39%
Test 4_R&D	33%	71%	4%	42%
F	21.29	21.29	21.29	21.29

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

Appendix II

Table A3: Definitions of variables.

Created variables	Definition
Customized intermediates	binary BEC5 or Rauch specific products exports
Finals	binary BEC5 or Rauch final products exports
Non-customized intermediaries	binary BEC5 or Rauch non-specific products exports
Others	binary BEC5 or Rauch primary and non-specified products exports
Ln Emp	log 1 + employees
Ln_Cap. Intensity	log 1 + capital/employees
Ln Wages	log 1 + wages
value_imports	imported value
Importers	binary importers
*p*_b5_spcf_int_imports	binary BEC5 specific products imports
*p*_b5_finals_int_imports	binary BEC5 final products imports
*p*_b5_nspcf_int_imports	binary BEC5 non-specific products imports
*p*_b5_others_imports	binary BEC5 primary and non-specified products imports
r_b5_spcf_int_imports	imported value/sales ratio BEC5 specific products
r_b5_finals_int_imports	imported value/sales BEC5 final products
r_b5_nspcf_int_imports	imported value/sales BEC5 non-specific products
r_b5_others_imports	imported value/sales BEC5 primary and non-specified products
r_b5_spcf_int_exports	exported value/sales ratio BEC5 specific products
r_b5_finals_int_exports	exported value/sales BEC5 final products
r_b5_nspcf_int_exports	exported value/sales BEC5 non-specific products
r_b5_others_exports	exported value/sales BEC5 primary and non-specified products
value_exports	exported value
r_rch_spcf_int_exports	ratio Rauch specific products exports
r_rch_finals_int_exports	ratio Rauch final products exports
r_rch_nspcf_int_exports	ratio Rauch non-specific products exports
r_rch_others_exports	ratio Rauch other non-specified products exports
Ln Vae	Ln of value added per employee
VA	Total value added
assets per employee	Total assets/employees
VAE	VA/employees
CIT-IRP5 panel variables	Description
ITR14_k_total assets	Total assets
k_input	Total capital
g_sales	total sales
g_cos2	total cost of sales
x_wages	total wage costs
x_labcost	total labour costs
x_rd	total r&D costs
x_royalt	Total roylaties costs
Employees	Total employment (irp5_empl_weight)
ITR14_x_training	Total training costs

***Source*:** Authors' illustration.