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**E-COMMERCE AND DEVELOPING COUNTRY-SME
PARTICIPATION IN GLOBAL VALUE CHAINS**

by

Rainer Lanz, Kathryn Lundquist, Grégoire Mansio, Andreas Maurer and Robert Teh[^]

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ABSTRACT

Two far-reaching developments have increased the trade opportunities for SMEs in developing countries. Firstly, the rise of the internet and advances in ICT have reduced trade-related information and communication costs. Secondly, the international fragmentation of production has increased the opportunities for SMEs to specialize in narrow activities at various stages along the production chain. Using firm-level data from the World Bank's Enterprise Survey, we test whether digital connectivity, as captured by whether a firm has a website or not, facilitates the participation of manufacturing SMEs from developing countries in global value chains (GVCs). We find robust evidence that digital connectivity facilitates the participation of manufacturing SMEs in GVCs in terms of both backward and forward linkages. SMEs with a website tend to import a higher share of their inputs used for production and export a higher share of their sales as compared to SMEs without a website. Furthermore, the findings indicate that the effect of having a website on GVC participation is stronger for SMEs than for large firms. Beyond digital connectivity at the firm level, we also assess the role of a country's ICT infrastructure in facilitating GVC participation of SMEs. We find that SMEs tend to participate more in GVCs in countries where a higher share of the population has fixed broadband subscriptions. This result also holds if we control for other country-level factors such as the quality of logistics services, rule of law and access to finance. Our findings can provide guidance for policy makers in developing countries about the importance of investing in ICT infrastructure, creating a regulatory and policy environment conducive to e-commerce, and providing SMEs and workers with the digital skills and knowledge to use ICT technologies efficiently.

JEL classification: F14, F63

Keywords: E-commerce, developing countries, small and medium-sized enterprises, global value chains

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1 INTRODUCTION

With the ubiquity of the Internet and the explosive growth of e-commerce, why aren't more SMEs, particularly from developing countries, participating in global value chains (GVCs)? Parts of this question have been answered extensively in other studies, identifying in particular the issues of digital infrastructure, access to information, and policy reform for developing countries. We provide a summary of this literature addressing how e-commerce has generally affected SMEs' participation in international trade; why SMEs throughout the world have had challenges entering GVCs, particularly as it relates to e-commerce; and a discussion of the hurdles faced by developing country SMEs to enter GVCs in the digital era.

The literature finds that e-commerce adoption has a significant positive effect on SME performance, including a higher average sales growth rate for SMEs. (Abebe, 2014) and a stimulating effect on international trade generally (Freund and Weinhold, 2004; Clarke, 2008). Further, SMEs with an online presence are more likely to export (Lendle and Olarreaga, 2014; UPS, 2017). This is partly due to the fact that the internet facilitates information dissemination, removes intermediaries, increases business outreach, and helps create a global reputation, all of which reduces SME costs and increases international competitiveness (Fernandes, Mattoo, Nguyen, and Schibbauer, 2017; IADB, 2014a; ITC 2016; Lendle and Olarreaga, 2014).

However, SMEs who have an e-commerce presence may not immediately make their entry into GVCs as a supplier or exporter. There are studies that show SMEs often enter international trade as an importer and that these imports, particularly of intermediates, increase a firm's productivity eventually leading to exports (European Commission, 2010; ITC, 2015c; Bas and Strauss-Kahn, 2014). In fact, a recent study has demonstrated that imports are not only linked to SME competitiveness, but also that these imports are strong predictors of GVC trade (Boffa, Jansen, and Solleder, 2017), all of which shows the interlinkages between e-commerce adoption, GVCs, and SME competitiveness.

Although e-commerce can make it easier for SMEs to trade, there are still significant obstacles that they face which arise because of their size and the specific requirements of GVC trade. To be able to participate in GVCs, firms need to be a reliable source of supply of products of a consistent quality and of a sufficient volume (ADB, 2015). Services SMEs, which are also often involved in e-commerce, face their own hurdles related to cross-border data flows and different national laws that apply to international licensing requirements, intellectual property rights, and copyrights (Nordås, 2015). Given that GVC participation can be a first step to accessing international markets (IADB, 2014a; ITC, 2015a; ITC, 2015c), an important take-away is that the lack of participation by SMEs in GVCs could continue to limit SME participation in trade.

In terms of the infrastructure constraints faced by developing countries in e-commerce, they range from the most basic, such as access to a steady supply of electricity, to the more complex, such as not having access to electronic payment systems or a lack of high speed internet cables (ITC, 2016; Darsinouei, 2017). This is a particular problem, not only because information communication technology (ICT) is necessary for e-commerce, but also because ICT is now considered a pre-requisite for joining most GVCs (ADB, 2015). However, a recent study by the World Bank claims that the most important technological requirement is still basic access to the internet. No matter the internet's functionality, regardless of lacking features such as broadband connection and e-commerce platforms, e-commerce can develop if the internet is present (Fernandes, Mattoo, Nguyen, and Schiffbauer, 2017). This is in line with empirical studies that have shown that access to the internet improves export performance in developing

countries across manufacturing and services sectors through reduced search costs and decreased distance barriers (Clarke, 2008, Freund and Weinhold, 2004; Hortaçsu et al, 2009; Ahn et al, 2011; and Lendle et al, 2016). Further the internet has also been shown to increase firm productivity, especially of smaller and less innovative firms (Clarke and Wallsten, 2006; Lin, 2015; Osnago and Tan, 2016; Paunov and Rollo, 2016).

However, the internet alone does not mean automatic integration into the international marketplace and developing countries face a number of specific problems integrating into GVCs. On top of inadequate ICT infrastructure, businesses in developing countries may not have access to international banking and may be excluded from international e-marketplaces (ITC, 2015b). The country may not have an effective system of disseminating trade marketing information, or it may lack a credible source of corporate credit information or does not have a credit guarantee system. National policy in these countries may also be inadvertently preventing successful internationalization of SMEs via GVCs. The countries may be members of overlapping or duplicative FTAs that complicate export and import procedures (Lim and Kimura, 2010). All of these issues pose challenges to developing country SME participation in GVCs, despite the opportunities provided by e-commerce.

Although there has been extensive research on SMEs and trade, with some empirical support found on the role of digital technology in SME trade (WTO, 2016), there has been little empirical work investigating its role in facilitating SME participation in GVCs. This study contributes to the literature by empirically testing whether digital connectivity increases the participation of small firms in GVCs, particularly in developing countries. This question is especially important given that ICT has been shown to be a pre-requisite for joining most GVCs and that GVC participation can be a first step to accessing international markets.

2 DATA

Our main data source is the World Bank Enterprise Surveys (WBES), which provide firm-level data for developing and middle-income countries. These data comprise representative samples of an economy's private sector and cover a wide span of years. However, the data are not panel data and the individual businesses surveyed are not necessarily consistent between surveys. Although there are some slight differences in the survey questions between countries and years, a standard methodology is used across surveys and the main questions addressing business environment topics from infrastructure availability to finance remain consistent. Surveys are conducted by private contractors and questions are asked to business owners and top managers from various manufacturing and services sectors.

The data used in this study have been carefully constructed, spanning the years 2006 to 2017 and covering 111 countries. While countries have been surveyed one to three times during that period, it is not possible to determine whether or not a firm appears several times in the dataset. To ensure the robustness of our results, we run regressions using both the full sample and a sample where only the latest survey of each country is included.

Besides those considerations, the data also needed some processing before it could be used. For example, the World Bank codes non-responses such as "I don't know" with a negative value in the database, so these responses were changed to "missing" instead. Additionally, the survey contains information relating to the perceived accuracy of the figures given by the respondent. Only observations where the "Estimates computed with some precision" and "Figures taken directly from establishment records" data were kept. Further, only manufacturing firm responses were included in this study. This is because WBES differ slightly

for manufacturing and services firms. For example, questions relating to capacity utilization and production are not relevant to many services firms, meaning that the two samples are not fully comparable. Given these discrepancies, it made more sense to focus solely on manufacturing firms for this analysis. After this cleaning process, 55,904 observations over 111 countries were left.

To capture digital connectivity, we use measures at both the firm and country level. At the firm level, we use the WBES to construct a dummy variable indicating whether a firm has a website, thereby providing a proxy for digital technology.¹ At the country level, national digital connectivity is measured using the share of fixed broadband subscriptions in the population from the International Telecommunication Union's ICT database².

Two different firm size variables are used in the regressions. Firstly, we use a dummy variable to denote whether a firm is an SME or a large firm. Following the WBES definition, – SMEs have 0-99 employees (SME=1) and large firms have 100 or more employees (SME=0). Besides using a dummy, we use a continuous firm-size variable as our second measure, calculating the number of employees of a firm in a particular year. The number of employees is calculated by the World Bank and includes temporary employees. Table 1 provides descriptive statistics on the number of employees for both SMEs and large firms.

Table 1 - Size of Firm (number of employees)

	Observations	Mean	Std. Dev.	Min	Max
SMEs	42,512	27	23	0	99.8
Large \geq 100	13,392	492	2,323	100	167,667
Total	55,904				

We use two separate dependent variables to capture backward and forward linkages in GVCs. Firstly, to measure backward linkages, we use the share of inputs of foreign origin in a firm's total material inputs, where inputs of foreign origin can be imported either directly or indirectly. Secondly, to proxy for international forward linkages, we use the share of total exports in a firm's total sales. Total exports include both direct exports, where the immediate recipient is abroad, as well as indirect exports, which are sales to a trader or third party who then exports the product without modifications.³ Since total exports cover exports of intermediate inputs and final products, it is important to note that the share of exports in total sales is only a broad proxy for international forward-linkages in GVCs. Table 2 provides descriptive statistics of these GVC variables.

¹ Other questions related to digital processes, or technology, are available from the WBES. However, many had very few associated records or did not have a smooth response rate, such as the questions “Is an internet connection used to order purchases for this establishment” or “does the firm use email”.

² <https://www.itu.int/en/ITU-D/Statistics/Pages/publications/wtid.aspx>

Although the database also comprises other variables such as Mobile Broadband, our results show that a solid internet network is more important overall for our survey's time-period and population.

³ Hence, sales of inputs to domestic manufacturing that are exported after further processing are captured by domestic sales.

Table 2 - Backward- and Forward-Linked GVC Variables

	Observations	Mean	Std. Dev.	Min	Max
Share of imports in total inputs (%)	48,024	28.6	36.2	0	100
Share of total exports in sales (%)	49,960	14.7	30.2	0	100

To control for firm heterogeneity (or differences in firm productivity), we use the following variables based on the WBES: 1) foreign ownership of the firm (a dummy variable indicating if the firm is more than 50% owned by foreigners); 2) capacity utilization (expressed as a share of total capacity); 3) manager's years of experience and 4) capital intensity (net book value of machinery, vehicles, equipment, land and buildings divided by the number of employees). Appendix Table A provides the name, definition and source of variables.

Table 3 and Table 4 provide illustrative evidence of the relationship between firm size and digital connectivity for firms that participate in GVCs: 51.8% of firms that use inputs of foreign origin have a website (Table 3), while 61.5% of those who export have one (Table 4). However, there is a substantial difference between large and small firms. Around 75% of importing large firms have a website, compared to only 42% of importing SMEs. The gap for exports is slightly less pronounced but still substantial: whereas 76.8% of large exporting firms have a website, only 51.2% of small exporters do. Our regressions will look more closely at these differences and try to determine whether having a website has a differential impact on SMEs and large firms in terms of GVC participation.

Table 3 - Number of firms with a website and imports of inputs

Firm Category	Website Yes/No		
	Yes (share in total)	No (share in total)	Total
SME <100	42%	58%	23,192
Large 100+	75%	25%	9,772
All Firms	51.8%	48.2%	32,964

Table 4 - Number of firms with a website and exports

Firm Category	Website Yes/No		
	Yes (share in total)	No (share in total)	Total
SME <100	51.2%	48.8%	12,404
Large 100+	76.8%	23.2%	8,315
All Firms	61.5%	38.5%	20,719

3 EMPIRICAL MODEL

The purpose of this paper is to analyse how digital connectivity affects GVC participation of SMEs. Our two regression models distinguish between digital connectivity of the firm and digital connectivity at the country level, and are specified as follows:

- Firm level:

$$GVC_{ijt} = \alpha + \beta_1 SME_{ijt} + \beta_2 web_{ijt} + \beta_3 (SME_{ijt}) * (web_{ijt}) + \beta X_{ijt} + \delta_{jt} + \theta_{kt} + \mu_{jk} + \varepsilon_{ijt}$$

GVC_{ijt} measures the imports or the exports of firm i in country j in year t and represents the measure of GVC participation; SME_{ijt} characterises firm size through a dummy that takes the value of one if firm i is an SME (this variable can also be replaced by $size_{ijt}$, a continuous variable measuring the firm's number of employees); web_{ijt} characterises a dummy representing whether or not firm i has a website; $SME_{ijt} * web_{ijt}$ denotes the interaction term between the size variable and the website dummy; X_{ijt} represents a set of control variables including manager's experience in years, capacity utilization, capital intensity, and foreign ownership; δ_{jt} , θ_{kt} , and μ_{jk} are country, industry and year fixed effects respectively; and finally ε_{ijt} denotes the error term.

- Country level:

$$GVC_{ijt} = \alpha + \beta_1 SME_{ijt} + \beta Z_{ijt} + \beta_3 (SME_{ijt}) * (Z_{jt}) + \beta X_{ijt} + \delta_{jt} + \theta_{kt} + \mu_{jk} + \varepsilon_{ijt}$$

In this second model, the only difference from the first resides in Z_{jt} which is a set of four country-level variables that capture possible constraints to GVC participation of firms, and SMEs in particular: Firstly, to capture digital connectivity at the country level, we use the share of fixed broadband internet subscriptions in the population (*Fixed Broadband*) from the World Telecommunication/ICT Indicators database of the International Telecommunication Union (ITU). Secondly, we use the World Bank logistic performance index (*lpi*) to measure the overall efficiency of the country's logistics. Thirdly, the *rule of law* indicator from the World Bank Governance Indicators captures economic agents' confidence in, and adherence to, national

rules of law, in particular the quality of contract enforcement, property rights, the police, and the courts. Fourthly, to measure access to finance, we use the variable *Private credit* from the World Bank Financial Structure Database, which indicates the amount of credit granted to the country's private sector (as a share of GDP).

Because our dependent variables are proportions (which can take on any value from 0 to 1), we use a fractional logit model assuming *a priori* that it has a binomial distribution. Following Papke and Woolridge (1996), we use the generalized linear models (GLM) framework to estimate the equations. To check for robustness, we also use OLS methods for comparison (see Appendix).

4 RESULTS

4.1 Digital connectivity at the firm level

Throughout this section, the following format will be used to present our findings. The first three columns (1)-(3) show results when firm size is measured using the SME dummy (*Size: SME dummy*), while columns (4)-(6) show results when using the logarithm of a firm's number of employees (*Size: Number of employees*). The only difference between columns (1) and (2), as well as between columns (4) and (5), is whether or not capital intensity is included as a control variable. Data on capital intensity is only available for a little more than half of the sample, leading to a significant drop in the number of observations when it is included in regressions. Continuing further, columns (3) and (6) only take into account the last survey available for each country, again serving the purpose of verifying the consistency of the results between samples of different sizes.

Table 5 presents the results when using the share of imported inputs as dependent variable and measuring digital connectivity at the firm level. The positive and significant coefficients of the website dummy indicate that firms with a website tend to use a higher share of inputs of foreign origin in total inputs. Being an SME has a statistically significant negative impact on the share of imported inputs used by a firm as can be seen from the negative coefficients of the *Size* variable in columns (1)-(3). This finding is consistent with results in columns (4)-(6), which show that firms with more employees tend to source a bigger share of their inputs from abroad (positive coefficient of *Size*).

Table 5 - Digital connectivity at the firm level and imported inputs – GLM regressions

Dep. Variable	Share of imported inputs					
	(1)	(2)	(3)	(4)	(5)	(6)
	Size: SME dummy			Size: Number of employees		
Website	0.172*** (0.037)	0.117*** (0.045)	0.152* (0.078)	0.905*** (0.055)	0.883*** (0.074)	0.973*** (0.122)
Size	-0.749*** (0.035)	-0.732*** (0.043)	-0.750*** (0.078)	0.288*** (0.011)	0.301*** (0.014)	0.346*** (0.025)
Size x Website	0.402*** (0.042)	0.402*** (0.053)	0.395*** (0.091)	-0.142*** (0.013)	-0.150*** (0.017)	-0.175*** (0.029)
Foreign ownership	0.734*** (0.032)	0.754*** (0.040)	0.868*** (0.068)	0.665*** (0.033)	0.677*** (0.040)	0.780*** (0.069)
Capacity utilization	-0.033" (0.021)	0.010 (0.028)	-0.012 (0.043)	-0.060*** (0.021)	-0.018 (0.028)	-0.043 (0.044)
Manager experience	0.078*** (0.013)	0.089*** (0.016)	0.054** (0.027)	0.064*** (0.013)	0.075*** (0.016)	0.037 (0.027)
Capital intensity		0.030*** (0.006)	0.019** (0.009)		0.030*** (0.006)	0.021** (0.009)
Observations	44,003	26,715	12,084	43,924	26,715	12,084
Country f.e.	yes	yes	yes	yes	yes	yes
ISIC f.e.	yes	yes	yes	yes	yes	yes
Year f.e.	yes	yes	yes	yes	yes	yes
Standard errors	robust	robust	robust	robust	robust	robust
Robust standard errors in parentheses	All surveys		Last survey	All surveys		Last survey

*** p<0.01, ** p<0.05, * p<0.1, " p<0.15

Our main variable of interest is the interaction term between firm size and website. The positive and significant interaction terms between the SME dummy and website indicate that having a website has a larger impact on SMEs than on large firms in increasing the share of imported inputs (columns (1)-(3)). Further corroboration of this result can be found in the negative sign of the interaction term for the variables website and number of employees in columns (4)-(6). This suggests that the bigger a firm grows, the weaker the effect of having a website is on the share of imported inputs.

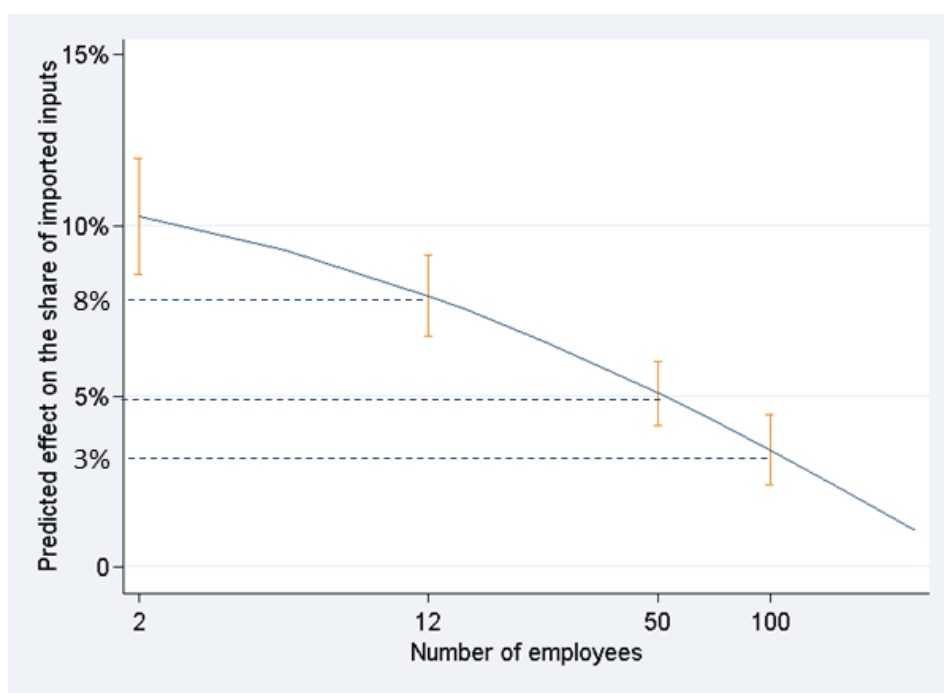
Hence, the findings support the hypothesis that the effect of having a website on GVC participation through backward linkages is stronger for SMEs than for large firms. An analogous interpretation is that having a website helps firms mitigate size-related disadvantages related to the participation in GVCs.

Other control variables have the expected sign. Foreign ownership is found to have a positive and significant impact on the share of imported inputs in all specifications. Similarly, a manager's experience and a firm's capital intensity are also associated with significantly stronger backward linkages. In contrast, capacity utilization is not found to be a significant determinant of a firm's share of imported inputs.

Figure 1 illustrates the magnitude of how the effect of having a website on backward linkages differs for firms of different size. This figure shows the marginal effect of having a website on the share of imported inputs, depending on firm size. Small firms that have a website display a higher marginal effect on imported inputs. For example, firms with 12 employees (i.e., those

around the 25th percentile) that have a website have a predicted mean share of imported inputs that is 8 percentage points higher than firms of that size without a website. In contrast, for large firms of 100 employees (i.e., the 75th percentile), the marginal effect of having a website is only 3 percentage points. Again, this confirms that having a website is more important for SMEs than for big firms in terms of using a larger share of foreign inputs in the production.

Figure 1 - Predicted effect of having a website on the share of imported inputs, depending on the firm size (number of employees)



The vertical orange capped lines represent a 95% confidence interval.

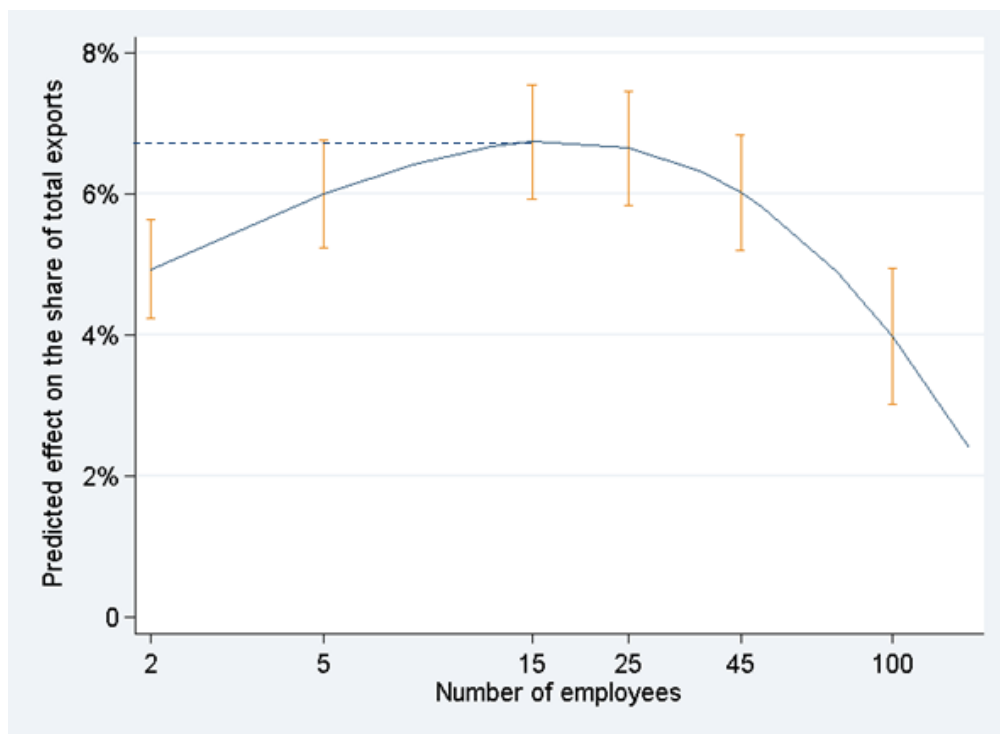
Table 6 contains the estimation results when we use the share of total exports (direct plus indirect exports) in total sales as the dependent variable to proxy forward linkages. Results are similar to Table 5 where we used the share of imported inputs as the dependent variable. Firms with a website as well as bigger firms are associated with a significantly higher share of exports in sales. Furthermore, the coefficients for the interaction terms between website and firm size variables show that the positive effect of a website on forward linkages is stronger for SMEs ((1)-(3)) and firms with less employees ((4)-(6)). Figure 2 shows that the marginal effect of having a website on the export share is highest for firms between 8 and 25 employees. With respect to the other explanatory variables, the manager's experience does not appear to help firms to sell abroad in contrast with the result found for the share of imported inputs.

Table 6 - Digital connectivity at the firm level and exports – GLM regressions

Dep. Variable	Share of total exports					
	(1)	(2)	(3)	(4)	(5)	(6)
	Size: SME dummy			Size: Number of employees		
Website	0.145*** (0.042)	0.188*** (0.052)	0.414*** (0.081)	1.819*** (0.089)	1.868*** (0.114)	1.769*** (0.167)
Size	-1.721*** (0.045)	-1.701*** (0.055)	-1.525*** (0.090)	0.737*** (0.017)	0.758*** (0.021)	0.661*** (0.034)
Size x Website	0.831*** (0.054)	0.802*** (0.067)	0.696*** (0.103)	-0.336*** (0.020)	-0.341*** (0.025)	-0.274*** (0.038)
Foreign ownership	1.131*** (0.042)	1.147*** (0.051)	1.222*** (0.084)	0.964*** (0.042)	0.974*** (0.052)	1.074*** (0.086)
Capacity utilization	0.012 (0.032)	0.103** (0.042)	0.058 (0.053)	-0.052" (0.032)	0.041 (0.042)	-0.003 (0.053)
Manager experience	0.018 (0.018)	0.012 (0.022)	0.022 (0.033)	-0.009 (0.018)	-0.018 (0.022)	-0.009 (0.034)
Capital intensity		0.019** (0.009)	-0.002 (0.011)		0.025*** (0.009)	0.009 (0.012)
Observations	44,569	28,399	14,428	44,520	28,399	14,428
Country f.e.	yes	yes	yes	yes	yes	yes
ISIC f.e.	yes	yes	yes	yes	yes	yes
Year f.e.	yes	yes	yes	yes	yes	yes
Standard errors	robust	robust	robust	robust	robust	robust
Robust standard errors in parentheses	All surveys		Last survey	All surveys		Last survey

*** p<0.01, ** p<0.05, * p<0.1, " p<0.15

Figure 2 - Predicted effect of having a website on the share of exports, depending on the firm size (number of employees)



The vertical orange capped lines represent a 95% confidence interval.

4.2 Digital connectivity at the country level

In Tables 7 and 8, we replace the indicator of digital connectivity — the firm having its own website — with the concentration of broadband subscribers in a country. This use of a country-level measure of digital connectivity allows us to say something about the role of public policy in telecommunications and the ICT sector in facilitating SME participation or integration into GVCs.

In line with previous findings, Table 7 confirms that being a small firm has a negative impact on the share of imported inputs used by the firm, i.e. negative coefficient of a SME dummy in columns (1)-(3) and positive coefficient of the number of employees in columns (4)-(6). Regarding digital connectivity at the country level, we find that a higher share of fixed broadband internet subscriptions mitigates the negative effect of firm size. The interaction terms between firm size and fixed broadband also remain significant if we interact firm size with other country-level factors of SME participation in GVCs (i.e., LPI, rule of law and private credit/access to finance). Hence, results for digital connectivity at the country level are in line with results at the firm level — the smaller the firm, the more important the effect of digital connectivity on the share of imported inputs used by the firm.

Table 7 - Digital connectivity at the country level and imported inputs – GLM regressions

Dep. Variable	Share of imported inputs					
	(1)	(2)	(3)	(4)	(5)	(6)
	SME dummy			Size: number of employees		
Size	-0.736*** (0.032)	-0.611** (0.258)	-0.201 (0.425)	0.304*** (0.011)	0.265*** (0.084)	0.202" (0.131)
Size x Fixed Broadband	0.029*** (0.004)	0.030*** (0.005)	0.032*** (0.006)	-0.013*** (0.001)	-0.015*** (0.002)	-0.016*** (0.002)
Size x lpi		-0.026 (0.096)	-0.298* (0.161)		0.011 (0.032)	0.084* (0.050)
Size x Rule of law		0.040 (0.064)	-0.011 (0.098)		0.016 (0.021)	0.051" (0.031)
Size x Private credit in country		-0.001 (0.001)	0.004*** (0.002)		0.000 (0.000)	-0.001** (0.001)
Foreign ownership	0.776*** (0.041)	0.771*** (0.044)	0.946*** (0.079)	0.688*** (0.041)	0.687*** (0.044)	0.847*** (0.080)
Capacity utilization	0.017 (0.028)	0.001 (0.030)	-0.046 (0.048)	-0.020 (0.029)	-0.032 (0.030)	-0.082* (0.049)
Manager experience	0.095*** (0.016)	0.103*** (0.018)	0.077** (0.031)	0.075*** (0.017)	0.084*** (0.018)	0.054* (0.031)
Capital intensity	0.037*** (0.006)	0.041*** (0.007)	0.033*** (0.011)	0.036*** (0.006)	0.040*** (0.007)	0.036*** (0.011)
Observations	25,676	23,093	9,859	25,676	23,093	9,859
Country f.e.	yes	yes	yes	yes	yes	yes
ISIC f.e.	yes	yes	yes	yes	yes	yes
Year f.e.	yes	yes	yes	yes	yes	yes
Standard errors	robust	robust	robust	robust	robust	robust
Robust standard errors in parentheses	All surveys		Last survey	All surveys		Last survey

*** p<0.01, ** p<0.05, * p<0.1, " p<0.15

Finally, Table 8 presents the results for the share of exports on total sales. The negative sign of the coefficient on the dummy variable suggests that small firms tend to export less than large firms, although the positive sign of the interaction term suggests that in countries with relatively more broadband subscriptions this effect is partially offset. Similarly, the negative interaction terms in columns (4)-(6) indicate that fixed broadband can reduce the size-related advantage of firms with more employees in terms of forward linkages.

Furthermore, as one could expect, better logistics performance tends to benefit small firms more than large firms when it comes to exports, as can be seen in the positive interaction term between the SME dummy and the LPI ((1)-(3)) as well as the negative interaction between the number of employees and LPI ((4)-(6)). This additional finding supports the important role of trade facilitation measures in helping SMEs connect to global markets and to GVCs.

Table 8 - Digital connectivity at the country level and exports – GLM regressions

Dep. Variable	Share of total exports					
	(1)	(2)	(3)	(4)	(5)	(6)
	SME dummy			Size: number of employees		
Size	-1.590*** (0.041)	-3.073*** (0.311)	-2.969*** (0.481)	0.666*** (0.014)	1.164*** (0.113)	1.065*** (0.174)
Size x Fixed Broadband	0.041*** (0.004)	0.029*** (0.006)	0.023*** (0.007)	-0.015*** (0.002)	-0.012*** (0.002)	-0.010*** (0.002)
Size x Ipi		0.596*** (0.117)	0.596*** (0.176)		-0.187*** (0.043)	-0.161** (0.064)
Size x Rule of law		-0.083 (0.076)	-0.144 (0.105)		0.047* (0.027)	0.105*** (0.037)
Size x Private credit in country		-0.002* (0.001)	-0.002" (0.002)		0.000 (0.000)	0.000 (0.001)
Foreign ownership	1.186*** (0.051)	1.206*** (0.053)	1.351*** (0.087)	1.005*** (0.052)	1.022*** (0.054)	1.187*** (0.090)
Capacity utilization	0.115*** (0.042)	0.127*** (0.045)	0.073 (0.058)	0.037 (0.042)	0.047 (0.045)	-0.005 (0.058)
Manager experience	0.025 (0.022)	0.023 (0.023)	0.032 (0.036)	-0.017 (0.022)	-0.014 (0.023)	-0.002 (0.036)
Capital intensity	0.029*** (0.009)	0.027*** (0.009)	0.001 (0.012)	0.035*** (0.009)	0.033*** (0.009)	0.014 (0.012)
Observations	27,380	25,264	12,230	27,380	25,264	12,230
Country f.e.	yes	yes	yes	yes	yes	yes
ISIC f.e.	yes	yes	yes	yes	yes	yes
Year f.e.	yes	yes	yes	yes	yes	yes
Standard errors	robust	robust	robust	robust	robust	robust
Robust standard errors in parentheses	All surveys		Last survey	All surveys		Last survey

*** p<0.01, ** p<0.05, * p<0.1, " p<0.15

5 CONCLUSION

SMEs participate less in international trade compared to large firms as they are typically less productive and face size-related disadvantages. Two far-reaching developments have shown to increase the trade opportunities for SMEs. Firstly, the rise of the internet and advances in ICT have reduced trade-related information and communication costs. Secondly, the international fragmentation of production has increased the opportunities for SMEs to specialize in narrow activities at various stages along the production chain.

This paper analyses the nexus between SMEs, digital connectivity and global value chains in developing countries. Using firm-level data for 111 countries from the World Bank's Enterprise Surveys, we test whether digital connectivity, as captured by whether a firm has a website or not, increases the participation of manufacturing SMEs in GVCs.

We find robust evidence that digital connectivity facilitates the participation of manufacturing SMEs in GVCs in terms of both international backward and forward linkages. SMEs with a website tend to import a higher share of their inputs used for production and export a higher share of their sales as compared to SMEs without a website. Furthermore, the findings indicate that the effect of having a website on GVC participation is stronger for SMEs than for large firms.

The economic importance of these findings is underlined by the magnitude of the relationship. Having a website is associated with an 8-percentage point higher predicted mean share of imported inputs for firms with 12 employees (which would be firms at the 25th percentile of the distribution) as compared to only about a 3-percentage point difference for firms with 100 employees (for firms that would be at the 75th percentile).

In addition to digital connectivity at the firm level, we also assess the role of digital connectivity in terms of a country's ICT infrastructure for GVC participation of SMEs. We find that SMEs tend to participate more in GVCs in countries where a higher share of the population has fixed broadband subscriptions. This result also holds if we control for other country-level factors such as the quality of logistics services, rule of law and access to finance.

Our findings can provide guidance for policy makers in developing countries. Given the important role that digital connectivity, both at the firm and country level, plays in connecting SMEs to GVCs, policy makers may consider actions in a number of areas.

Firstly, it is vital that governments provide their business sector with affordable, high-quality access to the internet. Key policy aspects include the mobilization of investment in ICT infrastructure, both public and private, as well as the creation of a regulatory environment that provides for sound competition in the telecommunications sector.

Secondly, governments need to put in place laws and regulations that allow both businesses and consumers to benefit from opportunities provided by e-commerce, including on digital payment systems, digital signatures, consumer protection and data protection.

Thirdly, policy makers need to ensure that SMEs and workers have the digital skills and knowledge to use ICT technologies efficiently in the different business functions such as market research, product development, sourcing, production, sale, or after-sale services.

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APPENDIX

Table A		
Firm-level Data Set Description		
<i>Variable</i>	<i>Definition</i>	<i>Source</i>
Fixed Broadband	Number of internet subscriptions for one hundred inhabitants.	International Telecommunication Union, ICT indicators database.
Foreign ownership	Dummy variable equal to unity for firms that were more than 50% owned by foreign private individuals, companies or organizations.	World Bank Enterprise Surveys question b2b.
Ln (capacity utilization)	Natural logarithm of the firm's share of capacity utilization.	World Bank Enterprise Surveys question f1.
Ln (capital intensity)	Share of capital per full-time employee of a given firm.	Derived from World Bank Enterprise Surveys questions n6a and n6b (for total capital) and "size_num" for total employment.
Ln (manager experience)	Natural logarithm of the number of years of experience the company's top manager has.	World Bank Enterprise Surveys question b7.
Ln (number of employees)	Natural logarithm of the variable listing a firm's full-time employees.	World Bank Enterprise Surveys "size_num" variable.
LPI (logistic performance index)	Comprehensive indicator including customs, infrastructure, international shipments, logistics quality and performance, tracking, tracing, and timeliness.	World Bank Logistics Performance Index database.
Private Credit in Country	Private credit by deposit money banks and other financial institutions to GDP	World Bank Financial Structure database
Rule of Law	Aggregate and individual governance indicators for six dimensions of governance: Voice and Accountability; Political Stability and Absence of Violence/Terrorism; Government Effectiveness; Regulatory Quality; Rule of Law; Control of Corruption.	World Bank Worldwide Governance Indicators database.
Share of direct exports	Share of a firm's sales that were known to be exported by a third party.	World Bank Enterprise Surveys question d3c.

Share of indirect exports	Share of a firm's sales that were known to be exported by a third party.	World Bank Enterprise Surveys question d3b.
Share of inputs imported directly	Share of inputs of a product that was imported directly.	World Bank Enterprise Surveys question d13.
Share of total exports	Share of a firm's sales that were known to be exported.	Derived from World Bank Enterprise Surveys question d3b & d3c.
Rule of Law	Aggregate and individual governance indicators for six dimensions of governance: Voice and Accountability; Political Stability and Absence of Violence/Terrorism; Government Effectiveness; Regulatory Quality; Rule of Law; Control of Corruption.	World Bank Worldwide Governance Indicators database.
Private Credit in Country	Private credit by deposit money banks and other financial institutions to GDP	World Bank Financial Structure database
SME	Dummy variable equal to unity if the establishment has less than 100 employees.	Derived from World Bank Enterprise Surveys "size" variable.
Website	Dummy variable equal to unity if the establishment has its own website.	World Bank Enterprise Surveys question c22b.

Table 9 - Digital connectivity at the firm level and imported inputs – OLS regressions

Dep. Variable	Share of imported inputs					
	(1)	(2)	(3)	(4)	(5)	(6)
	Size: SME dummy			Size: Number of employees		
Website	2.348*** (0.708)	1.198 (0.869)	1.319 (1.254)	14.129*** (0.947)	13.689*** (1.250)	11.762*** (1.685)
Size	-12.811*** (0.661)	-12.748*** (0.812)	-10.580*** (1.214)	4.667*** (0.181)	4.941*** (0.233)	4.651*** (0.348)
Size x Website	7.022*** (0.789)	7.147*** (0.980)	5.546*** (1.395)	-2.187*** (0.236)	-2.364*** (0.304)	-2.180*** (0.426)
Foreign ownership	16.084*** (0.670)	16.226*** (0.823)	17.633*** (1.323)	14.971*** (0.671)	14.955*** (0.824)	16.354*** (1.323)
Capacity utilization	-0.482 (0.359)	0.285 (0.470)	0.031 (0.675)	-0.902** (0.359)	-0.180 (0.470)	-0.463 (0.673)
Manager experience	1.294*** (0.207)	1.465*** (0.271)	0.793** (0.384)	1.073*** (0.207)	1.214*** (0.271)	0.558" (0.383)
Capital intensity		0.468*** (0.102)	0.240* (0.135)		0.472*** (0.102)	0.289** (0.134)
Observations	44,003	26,715	12,084	43,924	26,715	12,084
R-squared	0.284	0.288	0.319	0.290	0.294	0.327
Country f.e.	yes	yes	yes	yes	yes	yes
ISIC f.e.	yes	yes	yes	yes	yes	yes
Year f.e.	yes	yes	yes	yes	yes	yes
Standard errors	robust	robust	robust	robust	robust	robust
No. of countries	111	105	83	111	105	83
Robust standard errors in parentheses	All surveys		Last survey	All surveys		Last survey

*** p<0.01, ** p<0.05, * p<0.1, " p<0.15

Table 10 - Digital connectivity at the firm level and exports – OLS regressions

Dep. Variable	Share of total exports					
	(1)	(2)	(3)	(4)	(5)	(6)
	Size: SME dummy			Size: Number of employees		
Website	0.004 (0.008)	0.011 (0.009)	0.050*** (0.013)	0.067*** (0.008)	0.063*** (0.011)	0.046*** (0.015)
Size	-0.210*** (0.007)	-0.215*** (0.009)	-0.164*** (0.013)	0.070*** (0.002)	0.074*** (0.002)	0.057*** (0.003)
Size x Website	0.073*** (0.008)	0.070*** (0.010)	0.037** (0.014)	-0.009*** (0.002)	-0.008*** (0.003)	0.002 (0.004)
Foreign ownership	0.181*** (0.007)	0.175*** (0.008)	0.189*** (0.013)	0.162*** (0.007)	0.154*** (0.008)	0.171*** (0.013)
Capacity utilization	0.003 (0.003)	0.013*** (0.004)	0.010* (0.006)	-0.004 (0.003)	0.006 (0.004)	0.003 (0.006)
Manager experience	-0.000 (0.002)	-0.001 (0.002)	0.002 (0.003)	-0.004** (0.002)	-0.005** (0.002)	-0.001 (0.003)
Capital intensity		0.001" (0.001)	-0.001 (0.001)		0.002** (0.001)	0.001 (0.001)
Observations	44,569	28,399	14,428	44,520	28,399	14,428
R-squared	0.271	0.292	0.279	0.290	0.312	0.295
Country f.e.	yes	yes	yes	yes	yes	yes
ISIC f.e.	yes	yes	yes	yes	yes	yes
Year f.e.	yes	yes	yes	yes	yes	yes
Standard errors	robust	robust	robust	robust	robust	robust
No. of countries	111	104	83	111	104	83
Robust standard errors in parentheses	All surveys		Last survey	All surveys		Last survey

*** p<0.01, ** p<0.05, * p<0.1, " p<0.15

Table 11 - Digital connectivity at the country level and imported inputs – OLS regressions

Dep. Variable	Share of imported inputs					
	(1)	(2)	(3)	(4)	(5)	(6)
	Size: SME dummy			Size: Number of employees		
Size	-0.131*** (0.021)	-0.256*** (0.089)	-0.214" (0.134)	0.053*** (0.007)	0.106*** (0.032)	0.105** (0.048)
Size x Fixed Broadband	0.006*** (0.002)	0.004** (0.002)	0.003** (0.002)	-0.002*** (0.001)	-0.002*** (0.001)	-0.002*** (0.001)
Size x Ipi		0.051" (0.033)	0.030 (0.048)		-0.022* (0.012)	-0.020 (0.018)
Size x Rule of law		0.011 (0.019)	0.003 (0.023)		0.000 (0.008)	0.006 (0.010)
Size x Private credit in country		-0.000 (0.000)	0.000 (0.000)		0.000 (0.000)	-0.000 (0.000)
Foreign ownership	0.165*** (0.016)	0.163*** (0.018)	0.185*** (0.024)	0.150*** (0.016)	0.149*** (0.018)	0.172*** (0.024)
Capacity utilization	0.004 (0.006)	0.002 (0.006)	-0.005 (0.009)	-0.002 (0.006)	-0.003 (0.006)	-0.010 (0.009)
Manager experience	0.015*** (0.004)	0.016*** (0.004)	0.010* (0.006)	0.012*** (0.004)	0.013*** (0.004)	0.008 (0.006)
Capital intensity	0.006*** (0.002)	0.006*** (0.002)	0.004* (0.002)	0.006*** (0.002)	0.006*** (0.002)	0.004* (0.002)
Observations	25,676	23,093	9,859	25,676	23,093	9,859
R-squared	0.285	0.295	0.347	0.295	0.304	0.355
Country f.e.	yes	yes	yes	yes	yes	yes
ISIC f.e.	yes	yes	yes	yes	yes	yes
Year f.e.	yes	yes	yes	yes	yes	yes
Standard errors	cluster	cluster	cluster	cluster	cluster	cluster
No. of countries	98	89	67	98	89	67

*** p<0.01, ** p<0.05, * p<0.1, " p<0.1

All surveys

Last survey

All surveys

Last survey

Country-clustered standard errors in parentheses

Table 12 - Digital connectivity at the country level and exports – OLS regressions

Dep. Variable	Share of total exports					
	(1)	(2)	(3)	(4)	(5)	(6)
	Size: SME dummy			Size: Number of employees		
Size	-0.204*** (0.047)	-0.487*** (0.145)	-0.419*** (0.149)	0.077*** (0.015)	0.154*** (0.049)	0.128** (0.053)
Size x Fixed Broadband	0.003 (0.004)	0.000 (0.003)	-0.000 (0.002)	-0.001 (0.001)	0.000 (0.001)	0.000 (0.001)
Size x Ipi		0.112** (0.052)	0.094* (0.056)		-0.031* (0.017)	-0.021 (0.019)
Size x Rule of law		-0.010 (0.031)	-0.030 (0.028)		0.004 (0.011)	0.017* (0.010)
Size x Private credit in country		-0.000 (0.000)	-0.000 (0.001)		0.000 (0.000)	-0.000 (0.000)
Foreign ownership	0.187*** (0.028)	0.194*** (0.030)	0.223*** (0.043)	0.161*** (0.029)	0.169*** (0.031)	0.200*** (0.043)
Capacity utilization	0.015** (0.006)	0.016** (0.007)	0.011 (0.011)	0.006 (0.006)	0.007 (0.006)	0.002 (0.011)
Manager experience	0.001 (0.004)	0.000 (0.004)	0.003 (0.006)	-0.004 (0.004)	-0.004 (0.004)	-0.000 (0.007)
Capital intensity	0.002 (0.003)	0.002 (0.002)	-0.001 (0.002)	0.002 (0.003)	0.002 (0.002)	0.000 (0.002)
Observations	27,380	25,264	12,230	27,380	25,264	12,230
R-squared	0.281	0.279	0.243	0.308	0.305	0.264
Country f.e.	yes	yes	yes	yes	yes	yes
ISIC f.e.	yes	yes	yes	yes	yes	yes
Year f.e.	yes	yes	yes	yes	yes	yes
Standard errors	cluster	cluster	cluster	cluster	cluster	cluster
No. of countries	97	89	67	97	89	67
*** p<0.01, ** p<0.05, * p<0.1, " p<0.1!		All surveys	Last survey	All surveys	Last survey	

Country-clustered standard errors in parentheses