Firms Characteristics, Global Value Chains and Development

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1. Abstract

This paper provides a set of stylized facts on developing nations firms engaging in global value chains (GVCs), using the World Bank Enterprise Surveys. The paper shows that developing nation firms engaged in GVCs are more likely to use training programs, foreign-licensed technology, quality certification and the internet for communicating with customers and suppliers. The underlying thesis is that with the fragmentation of production processes firms are required to share a common set of characteristics in order to be able to produce and supply predictable, reliable and on time intermediate inputs and final goods. In addition, this paper uses the same dataset to see whether developing country firms both importing and exporting transfer their know-how and technology to their upstream local suppliers, and whether these transfers depend upon foreign ownership.

2. Introduction

World trade and production are increasingly structured around GVCs, in which different stages of the production process are located in different economies. The creation of GVCs mainly takes place through a mix of outsourcing and offshoring strategies by MNEs, aiming to find access to cheaper, more differentiated, and better quality inputs. UNCTAD (2013) estimates that 70 to 80 percent of global trade is linked to such international production networks of MNEs. The main implication is that a significant share of the volume of international trade, possibly up to two-thirds, is accounted for by shipments of intermediate inputs (see Johnson and Noguera, 2012).

The fragmentation of production is not new, production sharing has been going on within Western European countries and between the US and Canada since the 1960s. Contrary to the past, firms in developing economies are not just required to assemble intermediate inputs for local sales. They are exporting parts and components that are used in some of the most sophisticated products on the planet. Nowadays, through GVCs, countries trade more than products; they trade know-how, integrating networks of subsidiaries and local suppliers along stages of production (Taglioni and Winkler, 2015).

When MNEs offshore or outsource stages of their production processes in developing economies, they do not rely on local know-how. Rather, MNEs import their technology, management, logistics, and any other bits of know-how not available in the local economy since the intermediate inputs produced abroad have to fit with parts made around the world. As a result, for developing nation firms became vital to produce and supply predictable, reliable and on time intermediate inputs. A day of delay in exporting has a tariff equivalent of 1 percent or more for time-sensitive products (Hummels, 2007). Slow and unpredictable land transport keeps most of Sub-Saharan Africa out of the electronics value chain (Christ and Ferrantino, 2011).

For instance, a global manufacturing producer as Toyota uses third parties intermediate inputs, handing over the production of leather seats, steering wheel, tires, etc. to local suppliers. Toyota transfers its technology to the local suppliers in order to maintain the quality standards necessary to assemble the intermediate inputs in the final product.

This behavior is not only associated to MNEs, since every firm leading GVCs (hereafter GVC lead firm) strives to minimize coordination and monitoring costs involved with the production and incorporation of inputs in final goods. This paper using a dataset of firm level data, based on the World Bank's Enterprise surveys, extends the empirical literature on firm heterogeneity showing that developing nation firms engaged in GVCs (i.e. both importing and exporting) are more likely to use training programs, foreign-licensed technology, quality certification and the internet for communicating with customers and suppliers. Two-way traders are identified as firms participating in GVCs based on the assumption that their imported inputs are then re-exported as final products or intermediate inputs.

In turn, these characteristics may be transferred to local suppliers that indirectly participate in GVCs providing intermediate inputs to direct participants. The underlying idea is that along the supply chains even firms not directly trading must possess some common characteristics in order to be able to supply predictable, reliable and on time intermediate inputs. Using the same dataset of firms, the paper looks at whether developing country firms participating in GVCs transfer their know-how and technology to their upstream local suppliers, and whether these transfers depend upon foreign ownership.

The tested hypothesis is that GVC lead firms have an incentive to transfer specific know-how and technology to make the flows of inputs and final goods as efficient as possible. The empirical literature on MNEs spillovers is mixed. We know that foreign affiliates typically invest more in R&D than domestic firms. But linkages between MNEs and domestic firms may suffer as MNEs often develop protective mechanisms to prevent their knowledge from spilling over to local competitors and local firms often lack the absorptive capacity for the advanced technology and skills of MNEs. This paper argues that within GVCs, MNEs have higher incentives to transfer know-how and technology to their local suppliers, necessary for efficiently trading intermediate inputs and final goods.

3. Related Literature

This paper relates to the empirical literature on firm heterogeneity and FDI spillovers.

The literature on firm heterogeneity has pointed to the fact that firms can be ranked in terms of their performances, ultimately related to their productivity. In particular, as reviewed by Bernard et al. (2011), firms that are both importing and exporting are rarer, larger and more productive than the ones that serve only domestic markets. Seker (2012) also found that two-ways traders (both importing and exporting) are the most innovative, in terms of product and process innovation, than any other group of firms.

From the FDI literature the results are mixed, and suggest that the postulated spillover effects often do not materialize automatically in developing nations. There are many transmission channels to take into consideration and MNEs have different incentives in sharing their know-how and technology with domestic firms. Evidence supporting the presence of FDI spillovers to upstream sectors in developing nations have been found in Javorcik (2004) and Blalock and Gertler (2008). This paper claims that these spillovers may be amplified in a GVC-setting, given the need to integrate locally produced inputs into a global production network. As suggested by Javorcik (2008), sharing information about new technologies or business practices (such as quality control processes or inventory management techniques) to suppliers reduces input costs, increases input quality, and thus benefits multinationals. Survey data also reveals that firms operating in GVCs receive higher pressure from MNEs which impose higher standards for product quality, technological content, or on-time delivery (Javorcik, 2008). MNEs thus may induce local producers in upstream sectors to make improvements. In addition multinationals often offer assistance to their suppliers, such as personnel training, advance payment, leasing of machinery and help with quality assurance and organization of production line.

The GVC-related measures discussed in this paper are based on survey evidence on Czech firms in Javorcik (2008). In the Czech Republic, more than a quarter of all suppliers surveyed (49 of 190) report that multinationals required them to make specific improvements. Specifically, to the question "which are the types of changes required from multinational?", the most frequent requirements were improvements to the quality assurance process, acquisition of a quality certification (such as an ISO 9000), improvements to the timeliness of deliveries, use of a new technology, or purchase of new equipment. In addition, the survey data reveals that local suppliers in order to receive a contract from a multinational undertake improvements on their own. Thirty-six percent of Czech suppliers reported making improvements with the explicit purpose of finding a multinational customer. These improvements included investing in new machinery and equipment, improving product quality, conducting staff training increasing production volume, reducing the share of defective units produced, and reorganizing manufacturing lines.[1] Finally, forty percent of Czech companies with ISO 9000 certification reported obtaining it in order to be able to supply multinational companies.

The recent theoretical literature on GVCs emphasizes that technology, the engineering of the production process, dictates the way in which different stages of production are linked. Baldwin and Venables (2013) introduced the concepts of "snakes" and "spiders" as two arch-type configurations of production systems. The snake refers to a production chain organised as a sequence of production stages, whereas the spider refers to an assembly process on the basis of simultaneously delivered components and parts. However, the conclusion of this paper may apply to both production structures, since every GVC lead firm has to deal with the monitoring and coordination costs associated to the supply and incorporation of inputs.

The related literature on firms' boundaries emphasizes that firms in order to minimize production costs have to answer a two-dimensional decision problem: whether to source intermediate inputs from within the firm or not, i.e. the vertical integration decision; and whether to locate an economic activity in the country of origin or abroad, i.e. the offshoring decision (see, for

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[1] So far due to data limitation I couldn't use as GVC-related measures any proxy for the purchase of new equipment or machinery, improvement/ introduction of a new process or product.

example, Antras (2013); Antras and Yeaple (2014), for an overview). Although the literature has identified two distinct sets of necessities for firms that countries are asked to address: connecting factories and protecting assets. It has largely left opened the question of which are the implications of such trade-offs for local firms.

4. Data and Variables of Interest

The dataset is built on the World Bank's Enterprise surveys[2]. The surveys for 131 developing and emerging economies, from 2006 to 2015 are used to build a cross-sectional dataset. There are 44'521 manufacturing firms included in the analysis. Even though firms may be observed in more than one year the time dimension is not considered in this exercise. The dataset covers all the 2-digit manufacturing industries listed by ISIC rev 3.1 (from 15 to 37).

Firms which are not trading are the largest group and account for 41% of observations. Among trading firms, the ones participating in GVCs, identified as firms both importing and exporting, represent 19% of the sample. Interesting, importer-only is the largest group among trading firms, and exporter-only[3] the smallest, accounting for 35% and 5% respectively. This is may due to the fact that fixed costs for importers are lower than for exporters in developing and emerging economies.

Table 1. Variable descriptions

Variable	Description	Obs.	Mean	Std Dev.
Imp & Exp	= 1 if the firm exports and imports	44521	0.19	0.39
Import only	= 1 if the firm only imports	44521	0.35	0.48
Export only	= 1 if the firm only exports	44521	0.05	0.22
None	= 1 if the firm does not trade	44521	0.41	0.49
Foreign	= 1 if foreign ownership >= 10%	43917	0.10	0.30
Training	= 1 if the firm runs training programs in the previous year	42871	0.39	0.49
For tech	= 1 if the firm uses technology licensed from a foreign-owned company	43982	0.16	0.36
Quality cert	= 1 if the firm has an internationally-recognized quality certification	43204	0.27	0.44
Internet	= 1 if the firm communicates with clients and suppliers via email or website	44409	0.74	0.44

Here we distinguish foreign affiliates by trade orientation. A foreign affiliate is a firm having more or equal than 10% of foreign ownership. There are 4'494 foreign affiliates, accounting for 10% of the sample. They span all manufacturing sectors and there are 120 countries with at least one foreign firm. Almost 50% of foreign affiliates are both importing and exporting and 85% are trading somehow. The share of exporter-only and importer-only is similar between domestic firms and foreign affiliates.

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[2] For more information see http://www.enterprisesurveys.org/Data.
[3] This definition includes only direct exporters, excluding indirect exporters that can also be identified in the dataset.

Table 2. Firms distribution

All manufacturing firms	Obs.	Mean	Std. Dev.
Importer & exporter	44521	0.19	0.39
Only importer	44521	0.35	0.48
Only exporter	44521	0.05	0.22
None	44521	0.41	0.49
Only foreign affiliates (>10% foreign ownership)			
Importer & exporter	4494	0.47	0.50
Only importer	4494	0.33	0.47
Only exporter	4494	0.06	0.24
None	4494	0.14	0.35
Only domestic firms			
Importer & exporter	39423	0.16	0.37
Only importer	39423	0.35	0.48
Only exporter	39423	0.05	0.22
None	39423	0.44	0.50

Table 3 shows the share of adoption by trade orientation and ownership of the GVC-related measures identified in this paper, which are the use of: training program in the previous year, technology licensed from a foreign company, internationally recognized quality certification, and website and emails to communicate with clients and suppliers. Interesting, the table highlights two findings: first, the presence of a hierarchy of adoption in GVC-related measures, with trading firms characterized by higher shares than non-traders; second, the hierarchy being consistent across foreign affiliates and domestic firms, with larger premia for the former. This evidence may indicate the presence of some fixed costs in adopting the GVC-related measures identified in this paper, which only the most productive firms can incur.

Table 3. Share of GVC-related measures by trade orientation and ownership

All firms	Non-trader	Only importer	Only exporter	Importer & exporter
Training	0.27	0.40	0.50	0.61
Foreign technology	0.09	0.16	0.19	0.28
Quality certification	0.18	0.20	0.49	0.53
Internet	0.56	0.78	0.93	0.97
Foreign affiliates				
Training	0.35	0.52	0.59	0.67
Foreign technology	0.21	0.37	0.32	0.42
Quality certification	0.33	0.40	0.64	0.61
Internet	0.70	0.88	0.93	0.96
Domestic firms				
Training	0.26	0.38	0.48	0.59
Foreign technology	0.09	0.14	0.17	0.23
Quality certification	0.17	0.18	0.47	0.50
Internet	0.55	0.77	0.92	0.97

The table below shows that the characteristics induced by the participation in GVCs are ultimately related to firm performance. Firms using training programs, foreign technology, quality certification and internet to communicate with customers and suppliers share higher labor productivity[4] premium. The coefficients of level of employment and foreign ownership are coherent with the literature on firm-heterogeneity indicating that bigger firms and foreign affiliates are more productive. (I do not want to draw any conclusion about causality from this analysis)

VARIABLES	(1) lab prod	(2) lab prod	(3) lab prod	(4) lab prod
training	0.231***			
	(0.0149)			
for_tech		0.262***		
		(0.0200)		
quality_cert			0.368***	
			(0.0168)	
internet				0.511***
				(0.0194)
empl	0.117***	0.128***	0.0977***	0.0906***
	(0.00560)	(0.00534)	(0.00564)	(0.00552)
foreign	0.403***	0.371***	0.372***	0.396***
	(0.0258)	(0.0256)	(0.0256)	(0.0253)
Observations	37,185	38,321	37,692	38,602
R-squared	0.784	0.779	0.781	0.783

Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1
Countries-year and industry FEs are included

5. Empirical Analysis

5.1 GVCs-Linked Premia

This section provides evidence supporting the fact that firms importing and exporting at the same time share a variety of positive premia which so far have not been investigated in the literature. Following Bernard et al. (2011), the estimation results are based on this specification:

$$Y_{ijc} = \beta_0 + \beta_1 \, Imp\&Exp_{ijc} + \beta_2 Imp_{ijc} + \beta_3 Exp_{ijc} + \beta_4 Foreign_{ijc} \qquad (1)$$
$$+ \beta_5 Z_{ijc} + \mu_j + \sigma_{ct} + \varepsilon_{ijc},$$

where i denotes the firm, j the industry and c the country. The variable "*Imp&Exp*" equals 1 if the firm is both exporting and importing, "*Exp*" equals 1 if the firm is only exporting, "*Imp*" equals 1 if the firm is only importing, "Foreign" equals 1 if the firm has a foreign ownership higher or

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[4] Labor productivity is calculated as value added per employee, where value added is the difference between sales and cost of raw materials and intermediate goods used in production.

equal than 10%. "Y_{ijc}" denotes one of the following GVC-related measures: use of training programs, foreign-licensed technology, quality certification and the internet for communicating with clients and suppliers. In addition the specification uses industry and country-year fixed effects, and control for firms' level of employment. Country fixed effects allow isolating potential differences across countries in GVC participation and technology adoption. Industry fixed effects account for differences in factors such as the level of competition, technology use, market demand, and trade intensity. Finally year-fixed effects control the changes in macroeconomic environment and international trade over time. All the estimation results are based on robust standard errors clustered by year, country and industry. Standard errors are clustered to allow for correlations in measures across firms within the same country, industry, and year.

The results are based on the logit method and the discrete differences in probability are reported. In other words, the coefficient of "*Exp&Imp*" indicates the difference in probability for "Y_{ijc}" being equal to 1 between two-way traders and non-trading firms. For instance, two-way traders are 14% more likely to run training programs than non-trading firms.

Table 4. Trade orientation and GVC-related premia: all manufacturing firms

	Training	Foreign lic.	Quality cert.	Internet
Export&Import	**0.139**	**0.08**	**0.14**	**0.174**
	(0.008)**	**(0.007)****	**(0.007)****	**(0.009)****
Export only	0.081	0.029	0.118	0.14
	(0.011)**	(0.010)**	(0.009)**	(0.013)**
Import only	0.08	0.07	0.046	0.072
	(0.007)**	(0.006)**	(0.005)**	(0.004)**
Foreign	0.042	0.098	0.071	0.048
	(0.007)**	(0.005)**	(0.006)**	(0.008)**
N	42,119	43,149	42,504	43,274
Pseudo R2	0.224	0.142	0.307	0.460
p-Values for Tests on Marginal Effects				
Exp/Imp = Exp	0.00	0.00	0.01	0.03
Exp/Imp = Imp	0.00	0.03	0.00	0.00

Note: Marginal effects of the discrete difference in probability are reported.
Robust standard errors clustered by country-year and industry are in parentheses. * p<0.05; ** p<0.01
The regressions include log firm employment, 2-digit industry and country-year fixed effects.

In addition at the bottom of the table, for each specification, an analysis of whether traders significantly differ from each other in the use of GVC-related measures is presented. The p-value for these tests show that two-way traders perform significantly better than exporters-only and importer-only in all measures.

Fact 1: developing nation firms both importing and exporting share significantly higher probabilities to run training programs, use foreign-licensed technology, quality certification and the internet for communicating with suppliers and customers than any other group of firms.

The results highlight that firms participating in GVCs possess superior tangible and intangible GVC-related assets. The GVC-related premia follow a hierarchy, with two-way traders being the most likely to possess these premia. Coherently with the literature on firm heterogeneity, this hierarchy of premia is expected to be driven by firms' productivity, with low productivity firms not able to bear the fixed-costs necessary to participate in GVCs.

The table also shows that the coefficients of the indicator of foreign ownership are highly significant. Firms with foreign ownership tend to use more all the GVC-related measures than domestic firms. Consistent results are presented in the annex, table A.2 shows that including additional controls, such as firm's age, labor productivity and skill intensity does not affect table our conclusions.

In line with these findings, we test to what extent being involved in GVCs adds to foreign affiliates and domestic firms. This exercise is performed using a linear probability model, given the complexity of evaluating an interaction term between two dummy variables in the logit model[5].

$$Y_{ijc} = \beta_0 + \beta_1 Imp\&Exp_{ijc} + \beta_2 Imp_{ijc} + \beta_3 Exp_{ijc} + \beta_4 Foreign_{ijc} \qquad (2)$$
$$+ \beta_5 Foreign \ x \ Imp\&Exp + \beta_6 Z_{ijc} + \mu_j + \sigma_{ct} + \varepsilon_{ijc},$$

Adding an interaction term between "*Imp&Exp*" and "*Foreign*" implies that the premium of participating in GVCs among foreign affiliates is expressed by

$$E[y \ | Imp\&Exp = 1, Foreign = 1] - E[y \ | \ Imp\&Exp = 0, Foreign = 1] =$$

$$= [\beta_1 + \beta_4 + \beta_5] - [\beta_4] = \beta_1 + \beta_5 \ ;$$

and among domestic firms by β_1. As reported by the table below, the t-test on the sum of the coefficients of "*Imp&Exp*" and interaction term is always significantly different from zero.

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[5] Table A.1 in the annex shows how the linear probability model does not produce different conclusions than the logit model.

Table 5. Trade orientation and GVC-related premia: all manufacturing firms

	Training	Foreign lic.	Quality cert.	Internet
Interaction	**-0.0321****	**0.0189**	**-0.0691*****	**-0.107*****
	(0.0141)	**(0.0172)**	**(0.0157)**	**(0.0117)**
Export&Import	0.160***	0.0800***	0.184***	0.148***
	(0.00987)	(0.00802)	(0.00911)	(0.00896)
Export only	0.0776***	0.0155	0.136***	0.151***
	(0.0126)	(0.0103)	(0.0122)	(0.0121)
Import only	0.0772***	0.0586***	0.0328***	0.119***
	(0.00696)	(0.00526)	(0.00483)	(0.00657)
Foreign	0.0578***	0.145***	0.128***	0.0727***
	(0.00970)	(0.0106)	(0.0109)	(0.00871)
N	42,194	43,291	42,524	43,704
R-squared	0.265	0.130	0.324	0.436
	p-Values for Tests on Coefficients			
Exp&Imp + Interaction = 0	0.00	0.00	0.00	0.00

Note: The OLS method is applied in all the estimation results. "Interaction" denotes the product between "Exp&Imp" and "Foreign". The regressions include log firm employment, 2-digit industry and country-year fixed effects. Robust standard errors clustered by country-year and industry are in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$

Fact 2: being involved in GVCs benefits more domestic firms than foreign affiliates in terms of running training program, and using quality certification and internet for communicating with suppliers and customers.

Now, the analysis assesses whether foreign affiliates differ by trade orientation. Importantly, we would expect that two-way trader and exporter-only foreign affiliates, i.e. vertical FDI, differ from importer-only foreign affiliates, i.e. horizontal FDI. The underlying argument is that vertical FDI for its nature is more relevant in the GVC context than horizontal FDI. Table 6 shows that non-trading foreign affiliates, which account for 15% of our sample, are the worst performing group across all the GVC-related measures.

Fact 3: among foreign affiliates, two-way traders and exporter-only, accounting for half of the sample, are more likely than non-trading firms and importer-only to run training programs, use quality certification and the internet for communicating with customers and suppliers.

Table 6. Trade orientation and GVC-related premia: foreign affiliates

	Training	Foreign lic.	Quality cert.	Internet
Export&Import	**0.155**	**0.18**	**0.154**	**0.108**
	(0.023)**	**(0.028)****	**(0.023)****	**(0.016)****
Export only	0.113	0.06	0.183	0.1
	(0.033)**	(0.040)	(0.035)**	(0.024)**
Import only	0.102	0.165	0.069	0.068
	(0.023)**	(0.026)**	(0.023)**	(0.011)**
N	4,308	4,330	4,230	3,292
Pseudo R2	0.249	0.122	0.259	0.344
p-Values for Tests on Coefficients				
Exp/Imp = Exp	0.14	0.00	0.37	0.75
Exp/Imp = Imp	0.00	0.50	0.00	0.01

Note: Marginal effects of the discrete difference in probability are reported.

Robust standard errors clustered by country-year and industry are in parentheses. * p<0.05; ** p<0.01

The regressions include log firm employment, 2-digit industry and country-year fixed effects.

Finally, using the econometric specification in equation (1) considering only exporting firms, we test whether two-way traders share higher premia than exporter-only. Table 7 shows that two-way traders have higher premia than exporter-only, supporting further the idea that firms participating in GVCs must possess some superior assets. Interestingly, the premia associated with foreign affiliates is not significantly different than firms participating in GVCs, except for the use of foreign licensed technology.

Fact 4: two-way traders are more likely than exporter-only to run training programs, use foreign-licensed technology, quality certification and internet for communicating with suppliers and customers than exporter-only.

Table 7. Trade orientation and GVC-related premia: only exporting firms

	Training	Foreign lic.	Quality cert.	Internet
Export&Import	**0.069**	**0.08**	**0.045**	**0.026**
	(0.013)**	**(0.022)****	**(0.012)****	**(0.006)****
Foreign	0.043	0.136	0.065	0.005
	(0.012)**	(0.033)**	(0.012)**	-0.008
N	10,407	10,464	10,238	7,590
Pseudo R2	0.192	0.119	0.232	0.327

Note: Marginal effects of the discrete difference in probability are reported.

Robust standard errors clustered by country-year and industry are in parentheses. * p<0.05; ** p<0.01

The regressions include log firm employment, 2-digit industry and country-year fixed effects.

To further support these results we implement a matching strategy, where the "treatment group" includes all firms involved in GVCs and the "control group" exporter-only. The firms are matched within survey and by sector, ownership, level of employment, age, labor productivity measured as the log difference between sales and employment and skill intensity measured as the share of non-production workers over total workers. The estimated average treatment effects reported in table 8 confirms the previous conclusion, except for the use of quality certification.

Table 8. Propensity score matching: treatment is being a two-way trader

	Training	Foreign lic.	Quality cert.	Internet
ATE: Exp&Imp (1 vs 0)	**0.0501***	**0.0538***	**-0.0450***	**0.0248***
	(0.0162)	**(0.0140)**	**(0.0153)**	**(0.00646)**
N	8,814	8,923	8,692	8,983

Note: Robust Abadie-Imbens standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.
Estimates based on the logistic treatment model on the sample of exporting firms; minimum number of matches per observations required is 1.

5.2 Transfer of know-how and technology in GVCs

The previous section provided evidence supporting the fact that firms participating in GVCs possess superior tangible and intangible assets including foreign-licensed technology, quality certification, trained labor and internet. This section uses firm-level data to see whether developing country firms that participate in GVCs transfer their know-how and technology to their upstream local suppliers, and whether these transfers depends upon foreign ownership.

The underlying hypothesis is that GVC lead firms, given the need to integrate locally produced inputs into a global production network, benefit from sharing their know-how and technology to suppliers reducing monitoring and coordination costs, and increasing input quality. The upstream transfer can occur directly, when the GVC lead firm imposes higher standards for product quality, technological content, or on-time delivery to the local suppliers, and indirectly through the movement of highly trained and skilled staff from firms participating in GVCs to local suppliers. In addition, local suppliers may take improvements on their own with the explicit purpose of finding a multinational customer. The latter can be also considered as an indirect transfer of know-how and technology, since it would bring up local suppliers to global standards, ultimately increasing their international competitiveness.

The empirical analysis builds up on the methodology used in Javorcik (2004) and Blalock and Gertler (2008). First, a proxy for GVC horizontal transfer is calculated as the ratio of labor employed by firms participating in GVCs (i.e. both importing and exporting) to total labor in the sector.

$$GVC - Horizontal_{jc} = \frac{\sum_{\forall i \ in \ j} GVC_{ijc} * Y_{ijc}}{\sum_{\forall i \ in \ j} Y_{ijc}}$$

where "GVC_{ijc}" equals 1 if the firm i is participating in GVCs (i.e. both importing and exporting), "Y_{ijc}" is firm i's level of employment.

Then a proxy for GVC upstream transfer is calculated as the proportion of output produced by upstream sectors and supplied to downstream sectors weighted by the share of employees accounted by firms participating in GVCs to total employees in the downstream sector.

$$GVC - Upstream_{jc} = \sum_{k \neq j} s_{jkc} * GVC - Horizontal_{kc}$$

where "s_{jkc}" is the proportion of sector j's intermediate inputs supplied to sector k taken from US's input-output table from the World Input-Output Database (WIOD)[6]. The analysis focuses on 14 manufacturing sectors available from the WIOD. The proportion is calculated excluding output supplied for final consumption and as intermediate inputs to primary and services sectors.

In addition the upstream transfer indicator is divided by ownership, distinguishing whether the transfer of know-how comes from domestic or foreign firms in downstream sectors:

$$GVC - Upstream - Foreign_{jc} = \sum_{k \neq j} s_{jkc} * GVC - Horizontal_{kc} - Foreign$$

$$GVC - Upstream - Domestic_{jc} = \sum_{k \neq j} s_{jkc} * GVC - Horizontal_{kc} - Domestic$$

These measures are based on the cross-section dataset retrieved from the World-Bank Enterprise Surveys (the same dataset used in section 5.1). While the GVC – Upstream indicator is available for 125 countries, the GVC – Upstream – Foreign and GVC – Upstream – Domestic indicators are available for 112 countries. One limitation is that the indicators' sectoral coverage varies across surveys.

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[6] http://www.wiod.org/new_site/database/niots.htm

Table 9. GVC-related transfers variables by sector, average across surveys

Sector	Description	GVC - Upstream	GVC - Upstream - Foreign	GVC - Upstream - Domestic	GVC - Horizontal
c3	Food, Beverages and Tobacco	33%	12%	22%	33%
c4	Textiles and Textile Products	36%	11%	25%	47%
c5	Leather, Leather and Footwear	34%	8%	26%	40%
c6	Wood and Products of Wood and Cork	23%	6%	17%	21%
c7	Pulp, Paper, Paper , Printing and Publishing	24%	8%	16%	19%
c8	Coke, Refined Petroleum and Nuclear Fuel	23%	9%	15%	21%
c9	Chemicals and Chemical Products	38%	14%	25%	44%
c10	Rubber and Plastics	29%	11%	19%	31%
c11	Other Non-Metallic Mineral	24%	10%	16%	23%
c12	Basic Metals and Fabricated Metal	29%	10%	20%	31%
c13	Machinery, Nec	32%	12%	19%	39%
c14	Electrical and Optical Equipment	30%	14%	16%	40%
c15	Transport Equipment	28%	11%	16%	28%
c16	Manufacturing, Nec; Recycling	26%	10%	15%	23%

The measure of upstream transfer, "$GVC - Upstream_{jc}$, is included in the following specification:

$$Y_{ijc} = \beta_0 + \beta_1\, GVC - Upstream_{jc} + \beta_2 \ln Z_{ijc} + \delta_j + \delta_c + \delta_t + \varepsilon_{ijc} \qquad (3)$$

where *i* denotes the firm operating in sector *j* and country *c*. The dependent variable "Y_{ijc}" stands for one of the following GVC-related measures: use of training programs, foreign-licensed technology, quality certification and the internet for communicating with clients and suppliers; "Z_{ijc}" denotes the firm level of employment. The specification is estimated using a logit model with robust standard errors clustered by year, country and industry.

In table 10, the first set of regressions (on the left) includes all firms, instead, the second set (on the right) only non-trading domestic firms. The coefficient of interest is β_1, which is expected to be positive and significant. In other words, we expect that firms in sectors that supply larger share of inputs to firms participating in GVCs are more likely to being equipped with the GVC-related measures considered.

The second specification tests if the transfer depends upon ownership:

$$Y_{ijc} = \beta_0 + \beta_1\, GVC - Up{-}Domestic_{jc} + \beta_2\, GVC - Up{-}Foreign_{jc} + \beta_3 \ln Z_{ijc} \qquad (4)$$
$$+ \delta_j + \delta_c + \delta_t + \varepsilon_{ijc}$$

Overall the results do not contradicts the hypothesis that GVC lead firms have higher incentives to share their know-how and technology with their upstream suppliers. However, the only evidence consistent across all specifications is that suppliers are more likely to run training programs for higher presence of domestic two-way traders in downstream sectors.

Table 10. Logit model with transfer variables: all firms and only non-trading domestic firms (the coefficients are not the marginal effects)

VARIABLES	All firms				Non-trading domestic firms			
	(1) training	(2) for tech	(3) quality cert	(4) internet	(1) training	(2) for tech	(3) quality cert	(4) internet
GVC - Up	0.302**	0.133	0.651***	0.667***	0.226	0.296	0.259	0.652***
	(0.152)	(0.154)	(0.149)	(0.206)	(0.258)	(0.321)	(0.282)	(0.247)
Empl (log)	0.596***	0.484***	0.785***	1.105***	0.526***	0.461***	0.778***	0.998***
	(0.0128)	(0.0132)	(0.0152)	(0.0287)	(0.0241)	(0.0342)	(0.0304)	(0.0323)
Observations	47,831	48,021	49,308	50,449	15,832	16,329	16,288	16,714
Pseudo R2	0.194	0.112	0.271	0.418	0.216	0.131	0.31	0.41

Robust standard errors clustered by year, country and industry in parentheses. *** p<0.01, ** p<0.05, * p<0.1
Regressions include year, country and industry fixed effects.

Table 11. Logit model with transfer variables by ownership: all firms and only non-trading domestic firms (the coefficients are not the marginal effects)

VARIABLES	All firms				Non-trading domestic firms			
	(1) training	(2) for tech	(3) quality cert	(4) internet	(1) training	(2) for tech	(3) quality cert	(4) internet
GVC - Up - Domestic	0.551***	-0.137	0.334	0.874***	1.047***	0.806*	0.0204	0.566
	(0.197)	(0.217)	(0.208)	(0.293)	(0.343)	(0.418)	(0.392)	(0.396)
GVC - Up - Foreign	0.105	0.435**	0.932***	0.475*	-0.382	-0.0586	0.531	0.738***
	(0.206)	(0.191)	(0.193)	(0.263)	(0.324)	(0.431)	(0.421)	(0.273)
Empl (log)	0.597***	0.483***	0.787***	1.109***	0.534***	0.458***	0.788***	1.013***
	(0.0129)	(0.0133)	(0.0154)	(0.0295)	(0.0246)	(0.0348)	(0.0307)	(0.0330)
Observations	46,545	46,792	48,013	49,134	15,279	15,788	15,728	16,153
Pseudo R2	0.192	0.112	0.27	0.418	0.216	0.131	0.311	0.409

Robust standard errors clustered by year, country and industry in parentheses. *** p<0.01, ** p<0.05, * p<0.1
Regressions include year, country and industry fixed effects.

6. Annex

Table A.1 provides the OLS results of the specification in equation 1, allowing for a comparison with the estimates of the logit model in table 4. The OLS coefficients are similar to the logit model, importantly the hierarchy of the GVC-related premia is consistent between the two methods, except for the last column.

Table A.1. Trade orientation and GVC-related premia: all manufacturing firms

	Training	Foreign lic.	Quality cert.	Internet
Export&Import	**0.155*****	**0.0830*****	**0.200*****	**0.130*****
	(0.00944)	**(0.00785)**	**(0.00894)**	**(0.00838)**
Export only	0.0786***	0.0149	0.154***	0.154***
	(0.0126)	(0.0103)	(0.0124)	(0.0121)
Import only	0.0779***	0.0582***	0.0435***	0.122***
	(0.00699)	(0.00527)	(0.00501)	(0.00661)
Foreign	0.0438***	0.153***	0.112***	0.0261***
	(0.00792)	(0.00905)	(0.00888)	(0.00693)
N	42,194	43,291	42,621	43,704
Pseudo R2	0.265	0.130	0.313	0.435
p-Values for Tests on Marginal Effects				
Exp/Imp = Exp	0.00	0.00	0.00	0.02
Exp/Imp = Imp	0.00	0.00	0.00	0.20

Note: The OLS method is applied in all the estimation results.

Robust standard errors clustered by country-year and industry are in parentheses. *** p<0.01, ** p<0.05, * p<0.1

The regressions include log firm employment, 2-digit industry and country-year fixed effects.

Table A.2 replicates the results in table 4 adding as controls age of the firm, firm's labor productivity measured as the log difference between sales and employment and firm's skill intensity measured as the share of non-production workers over total workers. The results

Table A.2. Trade orientation and GVC-related premia: all manufacturing firms

	Training	Foreign lic.	Quality cert.	Internet
Export&Import	**0.124**	**0.08**	**0.124**	**0.145**
	(0.009)**	**(0.009)****	**(0.008)****	**(0.009)****
Export only	0.067	0.028	0.103	0.116
	(0.013)**	(0.011)**	(0.011)**	(0.013)**
Import only	0.074	0.068	0.038	0.057
	(0.007)**	(0.007)**	(0.006)**	(0.004)**
Foreign	0.028	0.093	0.063	0.036
	(0.008)**	(0.006)**	(0.007)**	(0.008)**
N	33,080	33,881	33,177	33,435
Pseudo R2	0.226	0.140	0.316	0.471
p-Values for Tests on Marginal Effects				
Exp/Imp = Exp	0.00	0.00	0.03	0.06
Exp/Imp = Imp	0.00	0.04	0.00	0.00

Note: Marginal effects of the discrete difference in probability are reported.

Robust standard errors clustered by country-year and industry are in parentheses. * $p<0.05$; ** $p<0.01$

The regressions include log firm employment, age, labour productivity, skill intensity, 2-digit industry and country-year fixed effects as controls.