TRADE4SD
Fostering the positive linkages between trade and sustainable development

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Deliverable 1.5: Taxonomy of GVCs

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About TRADE4SD Project

Trade is a central factor in shaping not only global, but also regional and local development. Trade policy has an especially important part to play in achieving the UN Sustainable Development Goals (SDGs). The premise of the TRADE4SD project is that trade has the power to produce positive outcomes when the policies which define the rules of the game are framed and designed in a way to promote access to markets, fair prices and standards of living for farmers, as well as alleviating rural poverty and ensuring sustainable farming practices. Addressing the relation between trade and SDGs requires an integrated approach to policy-making and inclusive governance.

The main objective of the TRADE4SD project is to contribute to build new opportunities for fostering the positive sustainability impacts of trade supported by improved design and framing of trade policy at national, EU and global level, including WTO modernisation, increased policy coherence at different domains including agricultural, energy, climate, environmental and nutritional policies.

To meet this objective, the project will develop an integrated and systematic approach that combines quantitative models from different perspectives, and several qualitative methods recognising that SDGs and trade are highly context-related. On the one hand, a robust analysis of economic, social and environmental impacts is given by using diverse but integrated modelling techniques and qualitative case studies. On the other hand, a wide consultation process is implemented involving stakeholders both in the EU and in partner countries as well as those with a wide international scope of activity, providing opportunities for improved understanding, human capital building, knowledge transfer and dissemination of results. To this extent, the consortium involves, as co-producers of knowledge, a number of research and stakeholder participants with different backgrounds who will use their networks to facilitate the civil society dialogue and build consensus on the subject of gains from trade in view of sustainability.

Project Consortium

No.	Participant Organisation Name	Country
1	Corvinus University of Budapest (CORVINUS)	HU
2	University of Kent (UNIKENT)	UK
3	Consiglio per la Ricerca in Agricoltura e l'Analisi dell'Economia Agraria (CREA)	IT
4	Johann Heinrich von Thünen-Institut, Bundesforschungsinstitut für ländliche Räume, Wald und Fischerei (THUENEN)	DE
5	The University of Sussex (UOS)	UK
6	University of Ghana (UG)	GH
7	Luonnonvarakeskus (LUKE)	FI
8	Centrum Analiz Spoleczno-Ekonomicznych-Fundacja Naukowa (CASE)	PL
9	Food and Agriculture Organization of the United Nations (FAO)	IT
10	Institut national de recherche pour l'agriculture, l'alimentation et l'environnement (INRAE)	FR
11	Confederazione Generale Dell'Agricoltura Italiana (CONFAGRICOLTURA)	IT
12	Truong Dai Hoc Kinh Te Thanh Pho Ho Chi Minh (UEH)	VN
13	Luminaconsult Sprl (LUMINA)	BE

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Argentina	ARG
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Belgium	BEL
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Brunei	BRN
Bulgaria	BGR
Cambodia	KHM
Cameroon	CAM
Canada	CAN
Chile	CHI
China	CHN
Colombia	COL
Costa Rica	CRC
Cote d'Ivoire	CIV
Croatia	HRV
Cyprus	CYP
Czech Republic	CZE
Denmark	DNK
Egypt	EGY
Estonia	EST
Finland	FIN
France	FRA
Germany	DEU
Greece	GRC
Hong Kong	HKG
Hungary	HUN
Iceland	ICE
India	IND
Indonesia	IDN
Ireland	IRL
Italy	ITA
Japan	JPN
Jordan	JOR
Kazakhstan	KAZ
Laos	LAO
Latvia	LVA
Lithuania	LTU
Luxembourg	LUX
Malaysia	MYS
Malta	MLT
Mexico	MEX
Morocco	MOR
Myanmar	MYA
Netherlands	NLD
New Zealand	NZL
Nigeria	NIG
Norway	NOR
Pakistan	PAK
Peru	PER
Philippines	PHL
Poland	POL
Portugal	PRT
Romania	ROU
Russian Federation	RUS
Senegal	SEN
Singapore	SGP
Slovak Republic	SVK
Slovenia	SVN
South Africa	ZAF
South Korea	KOR
Spain	ESP
Saudi Arabia	SAU
Sweden	SWE
Switzerland	CHE
Switzerland	CHE
Taiwan, China	TWN
Thailand	THA
Tunisia	TUN
Turkey	TUR
Ukraine	UKR
United Kingdom	GBR
United States	USA
Viet Nam	VNM

1 INTRODUCTION

Since the WWII, the role of global value chains (GVCs) has been continuously increasing as the main driver of global production and trade patterns. With the continuous rise of globalisation, at least until 2008, GVCs have brought increasing specialisation and vertical integration to the global economy, thereby connecting different parts of the world. Unbundling of tasks and business activities as well as functions has provided new opportunities for developing countries to continuously increase their participation in global production and trade flows without having to develop a completely new product or value chain.

GVC participation plays a crucial role in economic development as the ability of countries to prosper highly depends on their level of participation in the global economy (Ignatenko et al., 2019, Montalbano and Nenci, 2020). Even small countries with limited resources can benefit from global trade through GVC participation with significant variation across countries and sectors. As evident from the majority of the existing literature in the field (Montalbano and Nenci, 2020), GVC participation represent a perfect opportunity for supporting local agri-food markets to become more commercialised and productive, thereby increasing local incomes as well as their stability together with food security. It is also evident that agricultural sectors participate in value chains predominantly as suppliers of raw materials, whereas food sectors participate mainly in terms of sourcing inputs from global markets (Greenville et al., 2017).

At the same time, many poorer countries faced serious challenges in integrating to these GVCs for a number of reasons, including low educated human capital, poor infrastructures, low capital endowments, versatile political and business climates or poor institutions (Bamber et al., 2014, OECD, 2015). For local and regional as well as global policymakers, the question is therefore what the key determinants of developing countries in GVC participation are and how can targeted policies help fostering better integration.

This deliverable provides an empirical analysis of the determinants of agri-food GVC participation of countries standing at different levels of economic development, especially focusing on developing countries. This analysis is particularly relevant for developing countries helping them to better understand the overall context and the key determinants of success and thereby increasing their involvement in global agri-food GVCs. In doing so, the deliverable starts with identifying the determinants of participation by descriptive statistics (Chapter 2) and economic models (Chapter 3), followed by the analysis of how different kinds of shocks can affect the resilience of agriculture (Chapter 4). The deliverable then provides a taxonomy of global agri-food value chains (Chapter 5), followed by policy recommendations to increase participation (Chapter 6). The last Chapter concludes. The deliverable highly builds on results of Deliverable 1.4.

2 DETERMINANTS OF PARTICIPATION

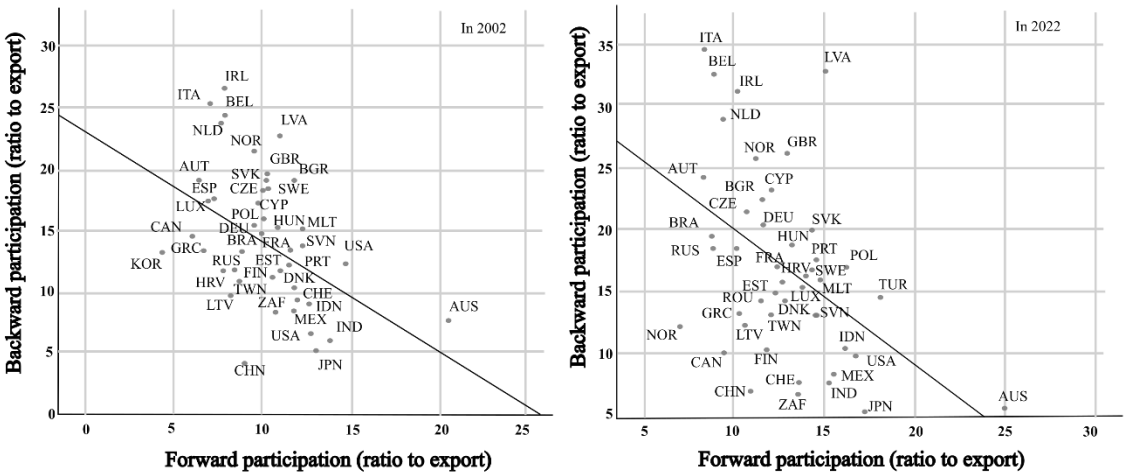
There are many ways how countries and firms can participate in agri-food GVCs. Different activities include, but are not limited to, extraction of natural resources, farming, processing, managing, distributing or packaging agri-food products. These activities may not mean direct trading of good and services across borders but may be linked to such activities through value creation. The type of participation in the global unbundling of production activities is determined by the nature of the value creation process. Depending on the type of product and the geographical location, value chains will remain regional or will become global in nature.

Based on these grounds, there has been considerable efforts during the past decades to better understand the complex nature of GVCs and decompose gross trade flows into various types of domestic and foreign value added by country and sector. Chapter 2 of Deliverable 1.4. summarises the major advances in this process, while Chapter 4 describes the different measurement methods available. Here we just recall the essential parts to create the framework for the upcoming analysis.

Value chain participation is defined in terms of the country of origin of the value added embedded in exports and hence looking forward and backward from the country of origin: backward participation means foreign value added in the "incoming" exports, while forward participation stands for domestic value added used as inputs to produce exports to a destination country (OECD, 2015). In other words, backward participation identifies to what extent domestic firms use foreign value added in their exports, while the forward participation index checks to what extent a country's exports are used by firms in destination countries as inputs for their intermediate production and their associated exports activities.

Although all countries engage in both types of GVC participation to some extent, countries with relatively high backward participation seems to have lower forward participation and vice versa. As Figure 2.1 suggests, correlation between backward and forward participation was also negative for our sample (-0.19 in 2002 and -0.22 in 2022), in line with OECD (2015). Consequently, determinants of participation are different for the two types of integration. This chapter analyses backward and forward participation against a number of factors, suggested by the literature, affecting the degree and type of GVC integration.

Figure 2.1 Correlation between forward and backward participation in 2002 and 2022

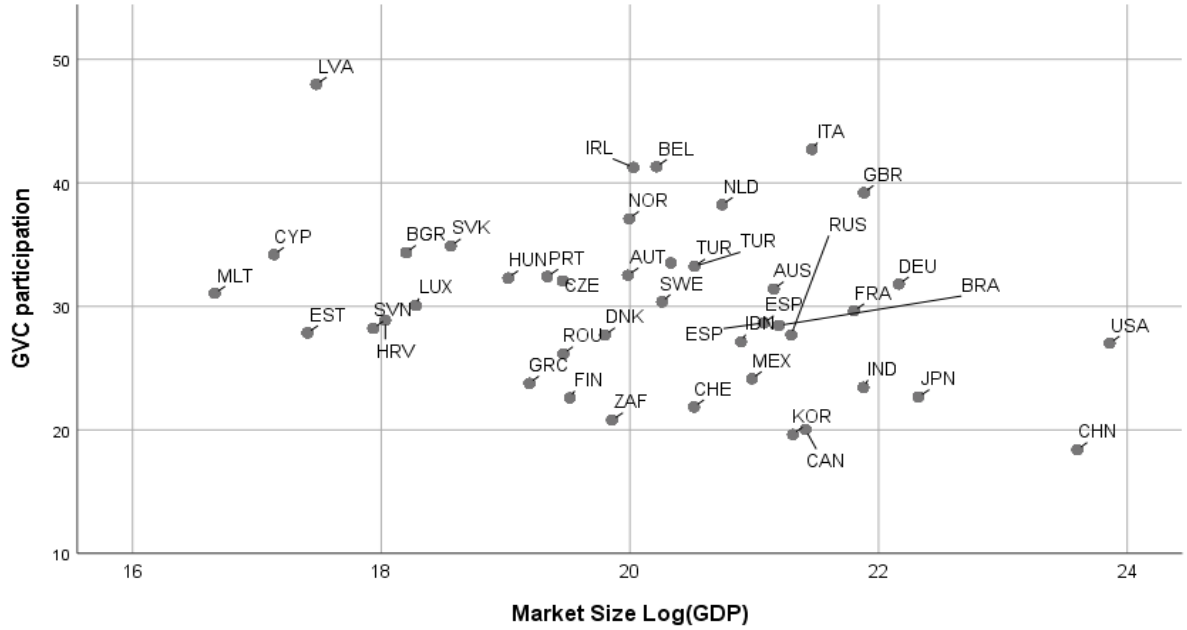


Source: own composition based on EXIOBASE (2023)

2.1 Market size

As the classic gravity theory suggests, trade volumes are positively related to the magnitude of trading partners and negatively to the distance between them. Proxied by GDP, market size is expected to be a strong determinant of GVC participation. Figure 2.2 confirms this expectation, clearly showing that the size of economy and market highly determines the level of integration in agri-food value chains. The vast majority of the countries analysed had a considerable market size with a relatively high GVC participation rate, with some exceptions like Baltic countries or Cyprus and Malta. Interestingly, the economies of the USA and China had relatively lower GVC participation in agri-food markets than originally expected.

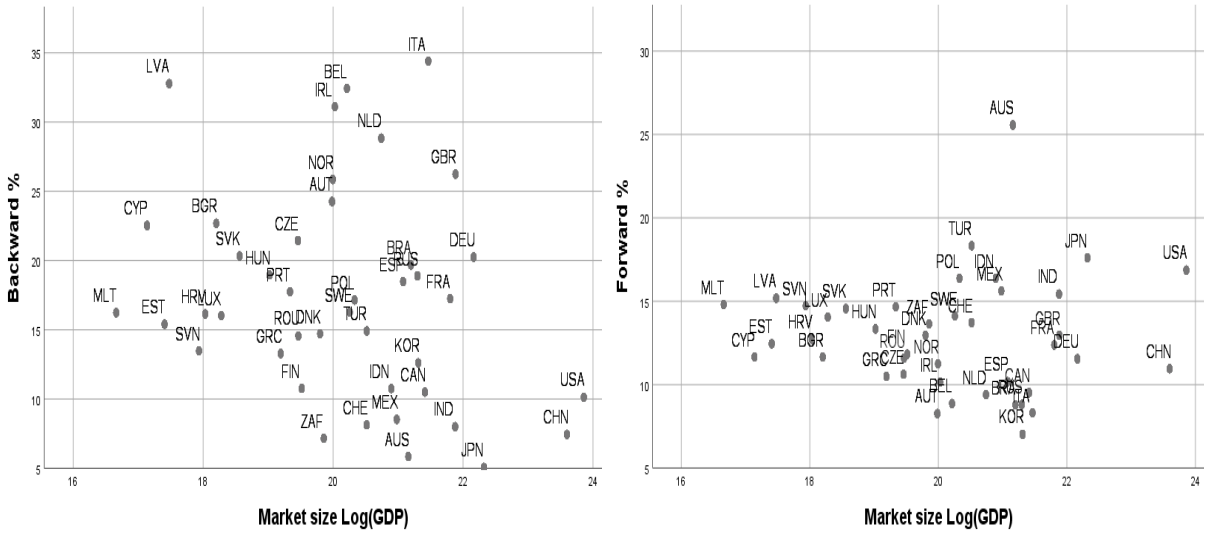
Figure 2.2 Correlation between market size and GVC participation in 2022



Source: own composition based on EXIOBASE (2023)

As to the relationship between market size and types of GVC participation, Figure 2.3 suggests that countries with larger markets seem to source a relatively low share of foreign inputs for producing their agri-food exports, especially valid for agricultural raw materials. This is because larger domestic markets are associated with a larger pool of domestic intermediaries to source from (OECD, 2015). At the other end, market size and forward participation are positively linked, suggesting that larger domestic markets are associated with a larger share in exports of domestic inputs used by other countries.

Figure 2.3 Correlation between market size and forward as well as backward participation in 2022



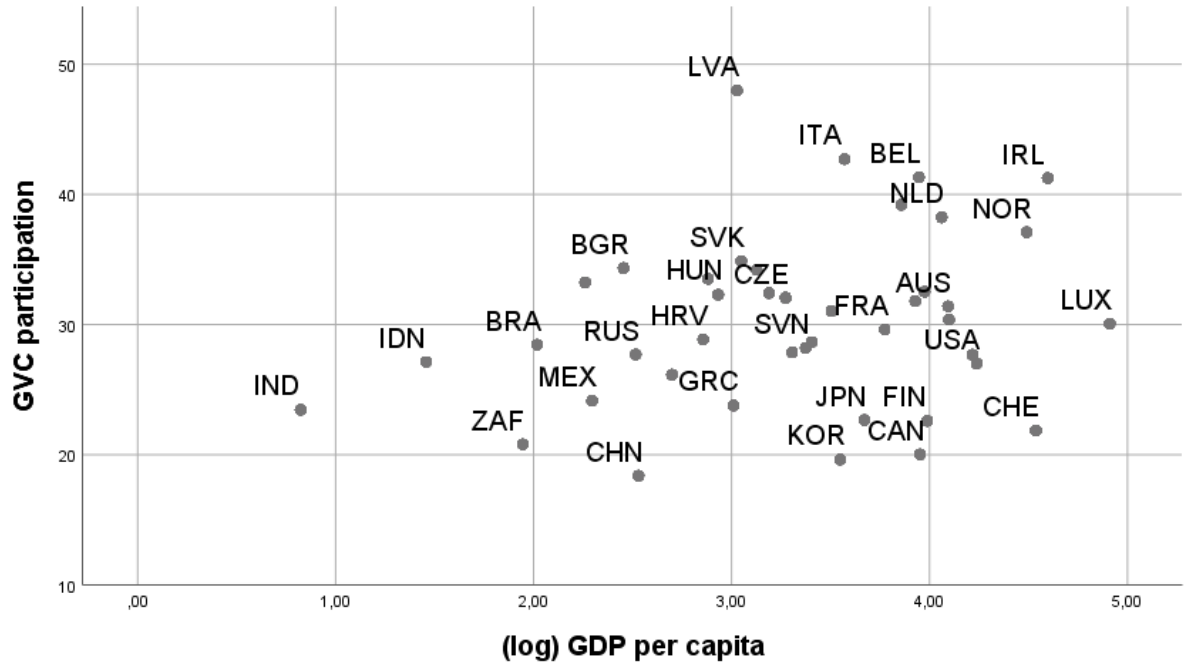
Source: own composition based on EXIOBASE (2023)

2.2 Level of development

The level of development of a country can also be a major determinant of GVC participation as suggested by the literature. The structure of the economy changes along the development path and such changes are expected to be highly reflected in GVC participation rates. Countries at an early stage of economic development usually specialise in primary products serving as inputs into further production processes, suggesting higher forward participation rates. As a next step of economic development, backward participation linkages are also developing along with industrialisation patterns, followed by more forward orientation at a higher level of development (OECD, 2015).

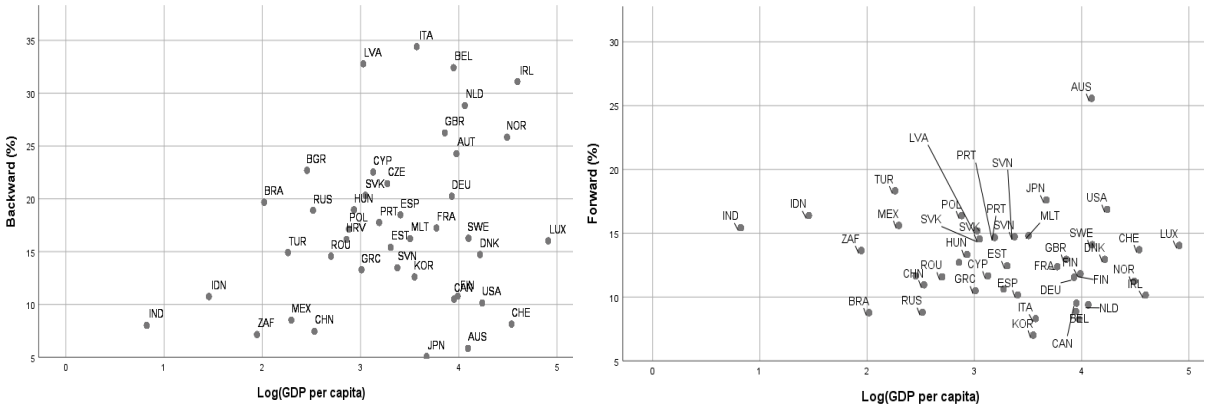
Figure 2.4 underlines the arguments above suggesting a positive relationship between level of development and GVC participation. Figure 2.5 confirms this relationship for backward participation but not for forward participation, suggesting that level of economic development does not automatically mean higher forward GVC participation in agri-food markets.

Figure 2.4 Correlation between level of development and GVC participation in 2022



Source: own composition based on EXIOBASE (2023)

Figure 2.5 Correlation between level of development and forward as well as backward participation in 2022



Source: own composition based on EXIOBASE (2023)

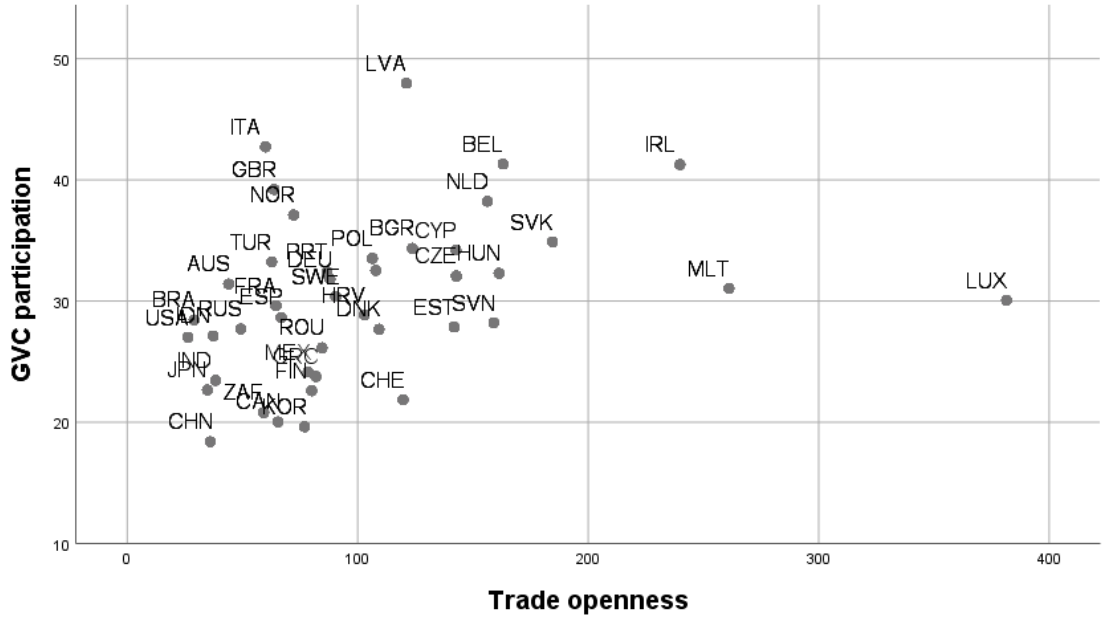
2.3 Trade openness

According to many studies (e.g., OECD, 2015), trade openness is also treated as a central determinant of GVC participation. Access to foreign inputs is crucial in global production and trade activities and when production processes include multiple border crossings as they do with GVCs trade, trade costs are amplified. Referring to the outward and inward orientation of a given country's economy and measured as the sum of a country's exports and imports as a share of that country's GDP, the general assumption is that countries more open to trade have

generally higher GVC participation rates. This assumption holds for agri-food trade flows as evident from Figure 2.6, suggesting that liberalised open countries tend to have higher shares in global agri-food trade production and trade flows than closed economies.

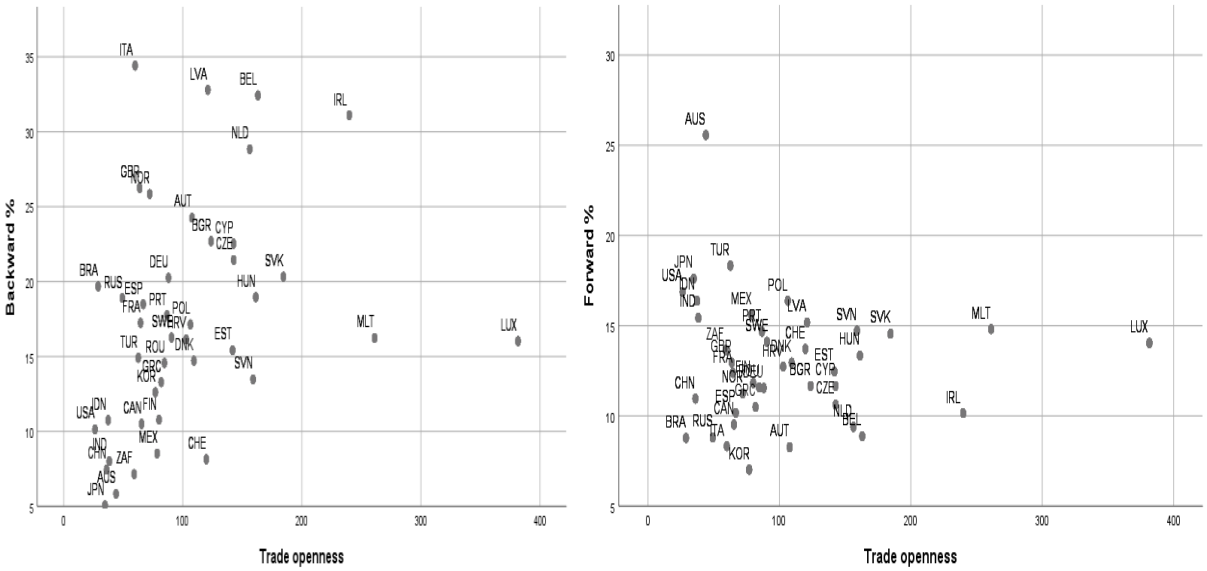
Going more into detail, when analysing the relationship between trade openness and backward and forward participation, the magnitude of effects become more visible. It seems evident from Figure 2.7 that the generally positive relationship becomes more positive and significant for backward participation than for forward participation, implying that open trade is more beneficial for incoming than outgoing value added. This is also in line with the argument that backward participation is generally expected to be more sensitive to the country's tariff policies it involves import into the country levying the tariff, while forward participation confronts producers with barriers in export markets (OECD, 2015).

Figure 2.6 Correlation between trade openness and GVC participation in 2022



Source: own composition based on EXIOBASE (2023)

Figure 2.7 Correlation between trade openness and forward as well as backward participation in 2022

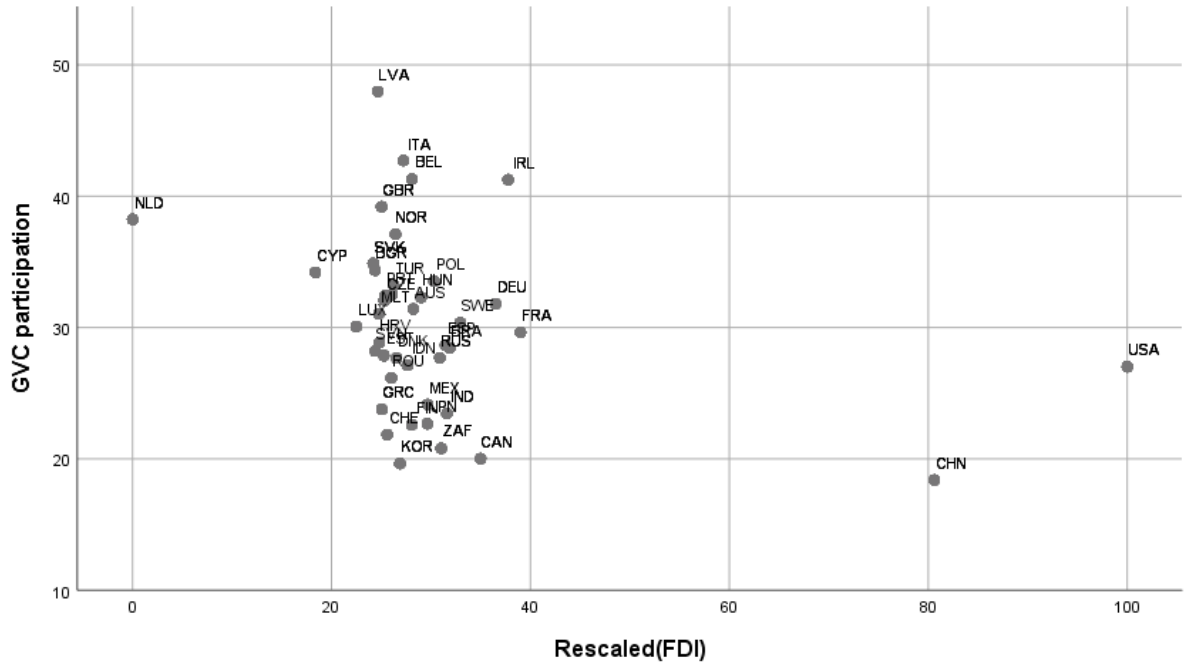


Source: own composition based on EXIOBASE (2023)

2.4 FDI

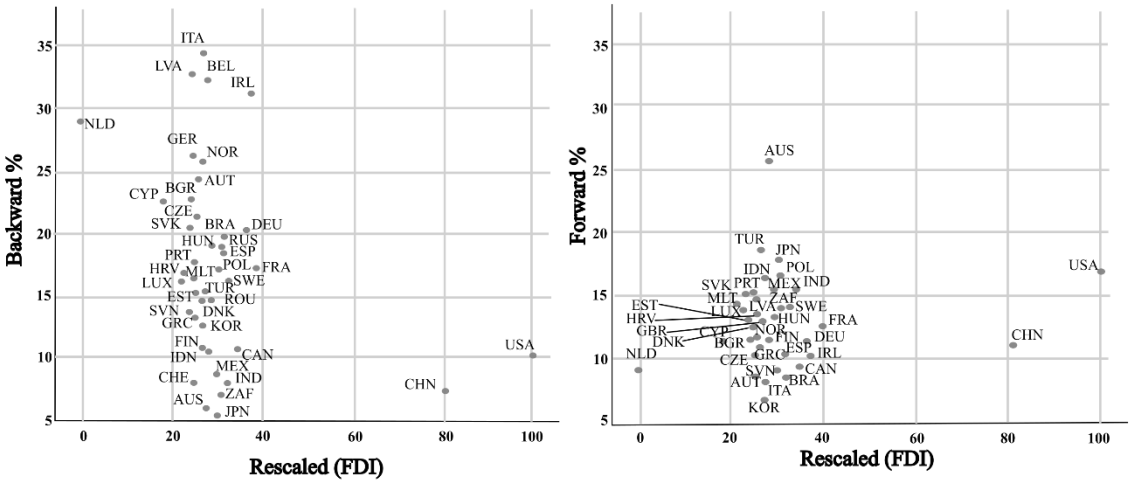
Multi-National Enterprises (MNEs) played a central role in the globalisation of production and trade flows or as OECD (2015) puts it, the "GVC revolution". Therefore, it is expected that openness to FDI inflows is strongly related to all types of GVC participation. Foreign capital inflows boost participation in global trade flows at all levels, suggesting higher backward and forward participation rates. Mergers and acquisitions are also frequent ways for developing country firms to integrate into global agri-food trade flows. This assumption also seems to hold as Figure 2.8 and Figure 2.9 suggest, especially for forward participation.

Figure 2.8 Correlation between FDI and GVC participation in 2022



Source: own composition based on EXIOBASE (2023)

Figure 2.9 Correlation between FDI and forward as well as backward participation in 2022



Source: own composition based on EXIOBASE (2023)

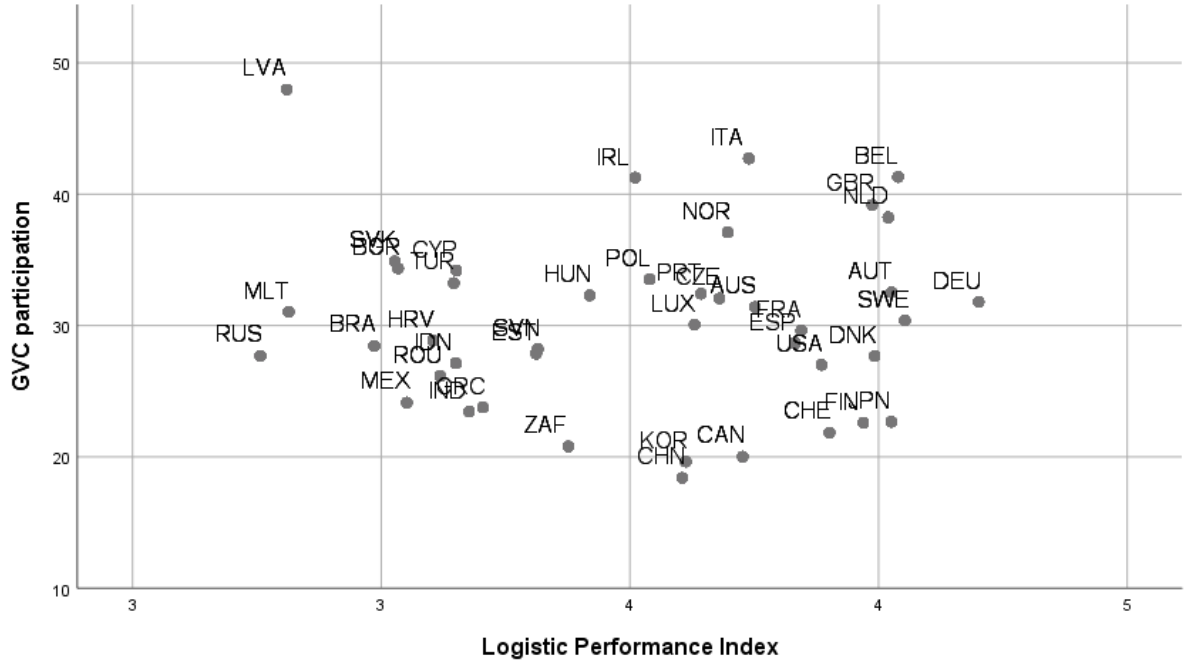
2.5 Logistics performance

Complex production systems crossing borders multiple times requires efficient logistic systems and similarly to trade openness, logistics costs can be amplified through the value chain. Access

to good quality roads, ports, railway networks and airports is a must in modern trade. All these factors are measured by a relatively new Logistics Performance Index (LPI), elaborated by the World Bank.

It is evident from Figure 2.10 that the higher the LPI of a country, the higher its GVC participation rate is, with some exceptions. Developed countries generally have higher LPI, while developing countries still seem to face logistics-related burdens in their agri-food trade flows.

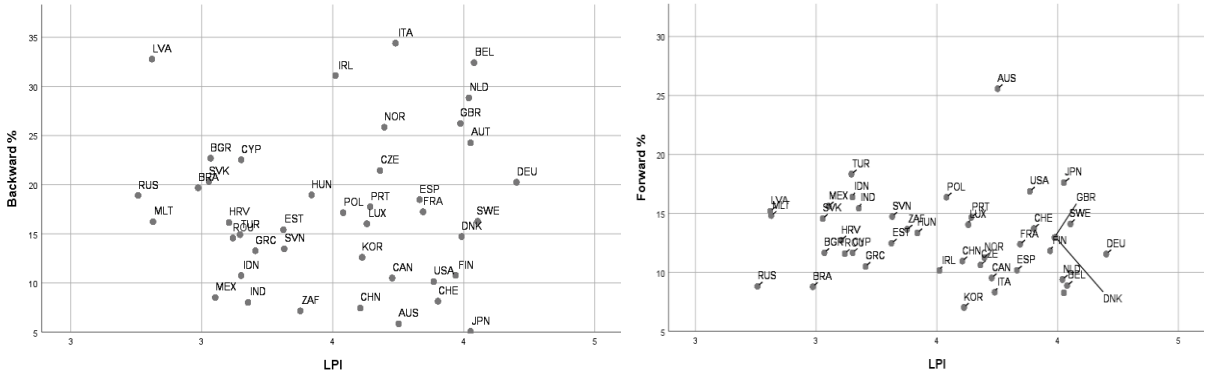
Figure 2.10 Correlation between LPI and GVC participation in 2022



Source: own composition based on EXIOBASE (2023)

However, by differentiating between backward and forward participation, a more diverse picture becomes visible suggesting that logistics performance and GVC participation are not always interrelated – in many cases, correlation are minimal (Figure 2.11). This may come from the diverse nature of agri-food trade flows and their different logistics needs.

Figure 2.11 Correlation between LPI and forward as well as backward participation in 2022



Source: own composition based on EXIOBASE (2023)

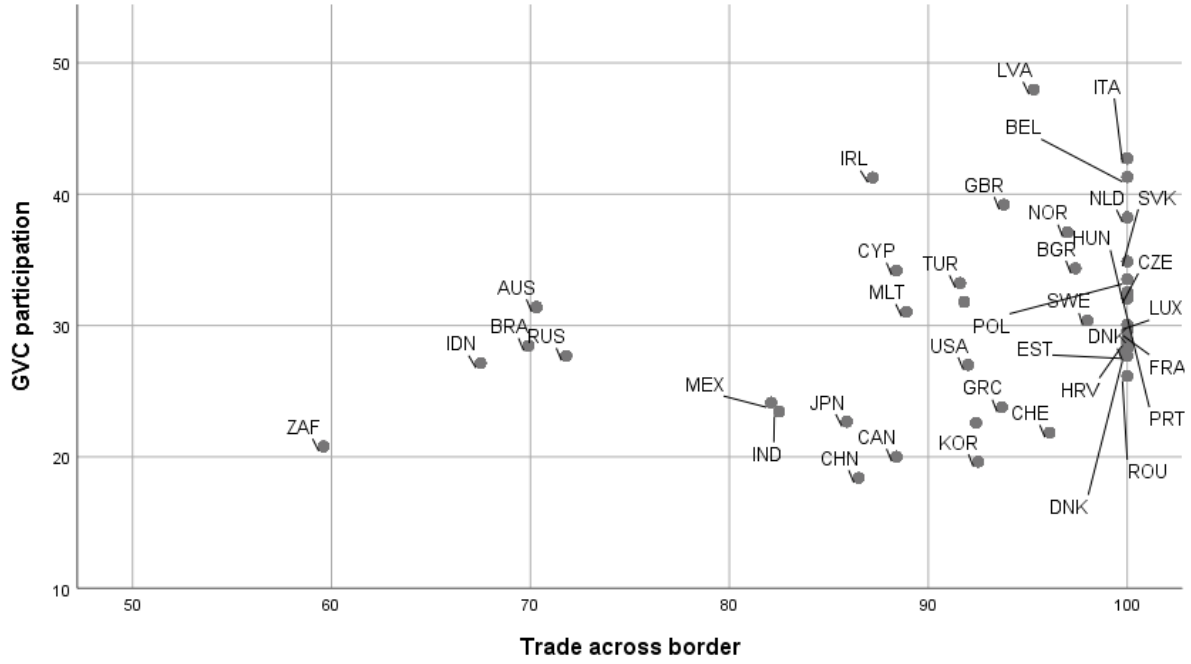
2.6 Ease of doing business

The World Bank also provides some estimations on the ease of doing business by country. Proxied by several indicators, a high ease of doing business means that the regulatory environment is conducive to the starting and operation of a firm (World Bank, 2017). As we can expect, the easier to establish and run a new business, the higher the chances a company participates in GVCs as well.

This is exactly what we see from both indicators (proxies) attempting to catch the ease of doing business: trade across borders and contract enforcement. In the former case, it records the time and cost associated with the logistical process of exporting and importing goods, while in the latter, it records the time and cost for resolving a commercial dispute through a local first-instance court, and the quality of judicial processes index.

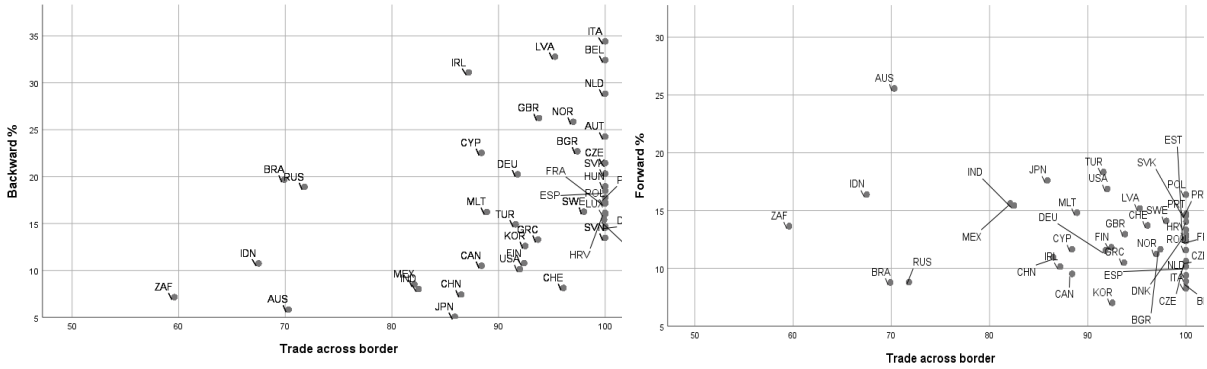
As for trade across borders, Figure 2.12 suggests some relationship with GVC participation in general, but as Figure 2.13 puts it, this relationship is stronger for backward participation, implying that at the company level, ease of doing business counts more for incoming value added in terms of GVC participation.

Figure 2.12 Correlation between trade across borders and GVC participation in 2022



Source: own composition based on EXIOBASE (2023)

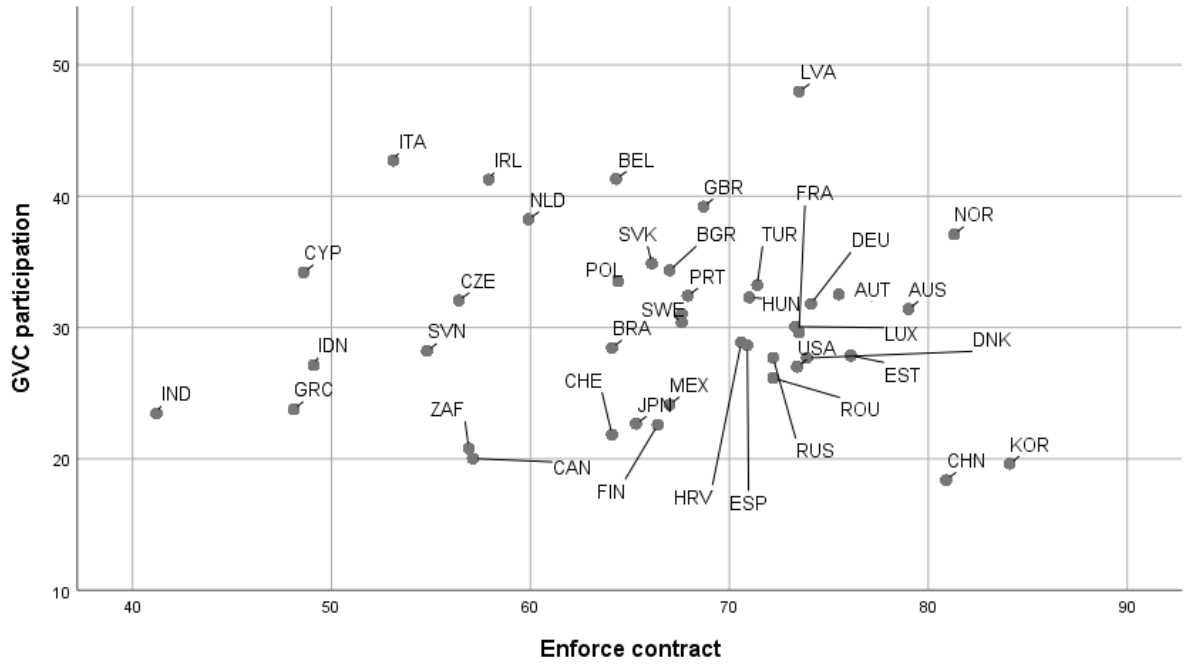
Figure 2.13 Correlation between trade across borders and forward as well as backward participation in 2022



Source: own composition based on EXIOBASE (2023)

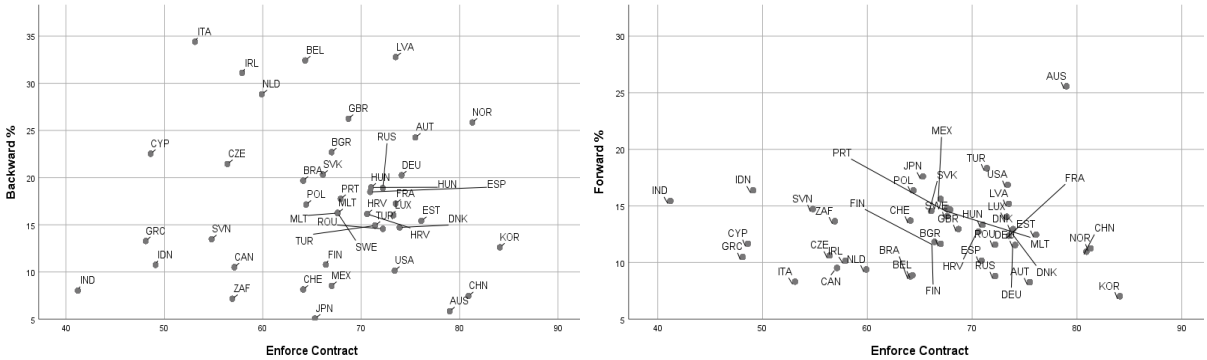
In the case of contract enforcement, it seems that the pattern is exactly the same: no clear signs of relationship in general but a clear sign of strong relationship exists with backward participation, suggesting that contract enforcement counts more in GVC participation mainly for incoming value added (Figure 2.14 and Figure 2.15).

Figure 2.14 Correlation between contract enforcement and GVC participation in 2022



Source: own composition based on EXIOBASE (2023)

Figure 2.15 Correlation between contract enforcement and forward as well as backward participation in 2022



Source: own composition based on EXIOBASE (2023)

3 Modelling major determinants

After having a first impression on the determinants of GVC participation, this section aims to provide a model-based assessment of the drivers based on the different indicators described above.

3.1 Data

In line with Deliverable 1.4, all GVC time series data come from the OECD (TiVA) dataset. Data for the independent variables comes from various sources as evident from Table 3.1. Note that a few more variable was added according to stakeholder consultations as potential determinants: harmful and liberalising interventions, number of standards and eurozone membership.

Table 3.1 Data sources for the variables

Variable name	Description	Source	Applied transformation	time span
Market size	Market size is proxied by GDP, which is measured in million USD PPP	Word Bank WDI[1]	natural logarithm	1960-2022
Level of development	Level of development is proxied by GDP per capita, which is measured in USD	Word Bank WDI[1]	natural logarithm	1960-2022
Trade openness	Share of exports/imports in GDP at current prices	Our World in Data, National accounts[2]	-	1950-2020
Openness to inward FDI	FDI net inflaws (BoP, million USD)	Word Bank WDI[1]	min/max*	1960-2021
Logistics Performance Index (LPI)	composite measure of the speed of trade with indicators derived from big datasets tracking shipments	Word Bank WDI[1]	-	2007-2022
Ease of doing business (Trade across borders)	composite measure of the time and cost of export and import	World Bank Doing Business archive[3]	-	2005-2020
Ease of doing business (Contract enforcement)	composite measure of the time and % of claims and the	World Bank Doing Business archive[3]	-	2005-2020

[1] https://databank.worldbank.org/source/world-development-indicators
[2] https://ourworldindata.org/grapher/trade-as-share-of-gdp
[3] https://archive.doingbusiness.org/en/data

Variable name	Description	Source	Applied transformation	time span
	quality of judicial process			
Harmful interventions	export/import quota, export/import ban, anti-dumping,anti-subsidy, licensing	Global Trade Alert[4]	-	2009-2021
Liberalising interventions	(tariff measures, subsidies, quotas, credits, import licensing, internal taxes and charges)	Global Trade Alert[4]	-	2009-2021
Number of standards	review of 300+ standards by product, sector, area or focus	International Trade Center[5]	-	2002-2022
Eurozone membership	Eurozone membership	Statistisches Bundesamt (DESTATIS)[6]	-	2002-2022

Source: own composition based on OECD (2023) data

Table 3.2. present the basic descriptive statistics of the variables used in the analysis, showing high diversity in the dataset. Standard deviations are quite high in general, suggesting that our database includes a wide diversity of different country cases.

[4] www.globaltradealert.org
[5] https://standardsmap.org/en/identify?origin=
[6] https://www.destatis.de/Europa/EN/Country/EU-Member-States/_EU_EZ_Zeitverlauf_en.html

Table 3.2 Basic descriptive statistics of the variables

Variable name	Min	Max	Mean	Standard deviation
Market size (million US$)	10 993	24 255 796	1 355 921	3 044 756
Level of development (current US$)	600.93	123 678.7	24 727.29	24 631.73
Trade openness	20.72	442.62	99.31	72.93
Openness to inward FDI (million US$)	-330 339	511 434	23 943	61 217
Logistics Performance Index (LPI)	2.07	4.23	3.29	0.52
Ease of doing business (Trade across borders)	2.6	100	81.14	16.66
Ease of doing business (Contract enforcement)	31.7	89.1	63.41	12.17
Harmful interventions	0	1523	56.91	101.75
Liberalising interventions	0	211	18.08	18.34
Number of standards	1	30	19.13	5.3
Eurozone membership	0	1	-	-

Source: own composition based on OECD (2023) data

3.2 Econometric specification

Although the empirical literature on the determinants of GVC trade is developing rapidly, there is still no "gold standard" for investigation (OECD, 2015). The following fixed effect panel regression model for the GVC participation as the dependent variable was used to measure individual country characteristics by using a set of influential factors between 2009 and 2020. The equation of the economic model is as follows:

$$Y_{it} = \sum_{j=1}^{M} \beta_j X_{it}^{(j)} + \alpha_i + \varepsilon_{it},$$

where i $(1 \leq i \leq 76)$ indicates a given country, t $(1 \leq t \leq 12)$ denotes a given year from 2009 to 2020. The given policy variable is denoted by j $(1 \leq j \leq M)$, where M is the total number of factors (policy and market related factors). The following trade policy related variables were used in the analysis: number of standards, harmful and liberalising interventions and FDI. Market (non-policy) related variables are: eurozone membership, market size, level of development, LPI, trade openness, trade across border and contract enforcement. Backward and

forward participation were also used in the second and third model as dependents (Y_{it}) for the *i*-th country in the *t*-th year. β_j is the regression coefficient for the *j*-th variable and $X_{it}^{(j)}$ is the value of the *j*-th variable for the *i*-th country in the *t*-th year. The individual country characteristics were represented by α_i, while ε_{ij} denotes the error term for the *i*-th country in the *t*-th year. Development indicators were downloaded from the World Bank's database. The dataset then was completed with GVC, forward and backward participation ratios from the WITS dataset.

3.3 Identifying country clusters

In the first step we performed a Principal Component Analysis (PCA) for GVC, backward and forward participation and all the influential (policy and market related) factors. The purpose of the analysis was to graphically represent the data matrix in a two-dimensional space and determine the interrelationships between the factors by creating two latent components.

Table 3.3 PCA results for the sample

Factor name	Component weights	
	Component 1 Market related factors	Component 2 Trade policy related factors
GVC %	**0.73**	-0.16
Forward %	-0.13	0.01
Backward %	**0.73**	-0.16
Standards	-0.08	**0.68**
Liberal Interventions	0.21	**0.48**
Harmful Interventions	0.04	**0.76**
Eurozone	**0.56**	0.05
Market Size	**0.80**	-0.15
Level of development	**0.74**	0.36
Trade Openness	**0.62**	-0.27
Trade Across Border	**0.70**	0.21
FDI	0.03	**0.67**
LPI	**0.65**	0.06
Contract Enforcement	**0.66**	0.27
Explained variance(%)	28%	23%

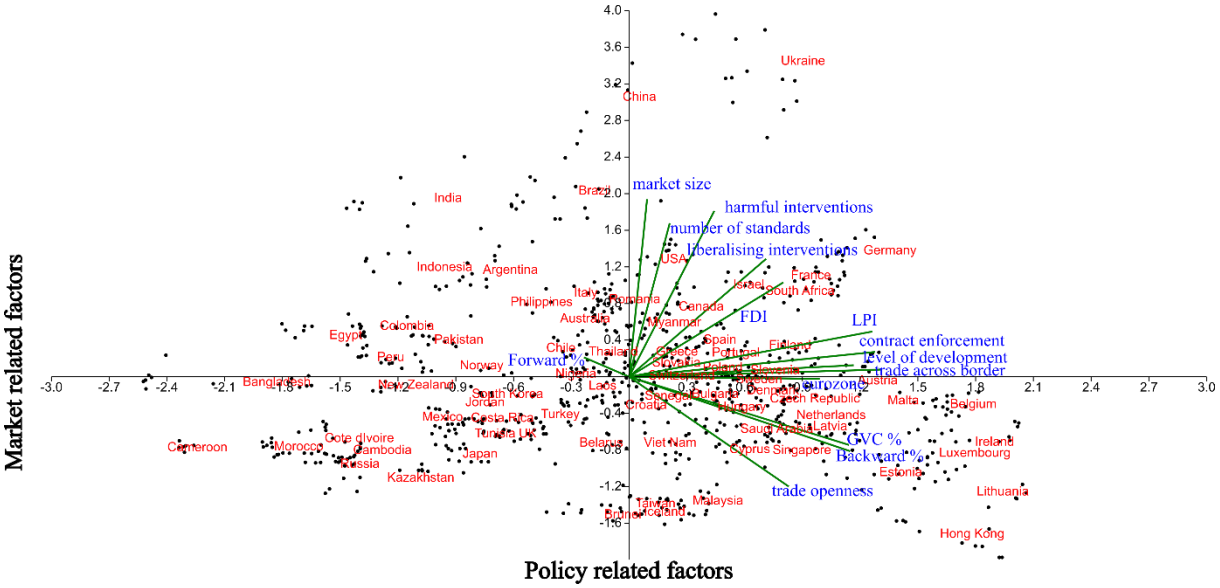
Note: Overall Measure of Sampling Adequacy =0.6
Bartlett test was significant at 5% level ($p<0.001$)

Table 3.3. presents the components and the weights of the factors. Generally speaking, PCA analysis was adequate and satisfied the minimum conditions (Kaiser-Meyer-Olkin's measure of factor adequacy should be larger than 0.5) and the Bartlett test is also significant indicating that the data were appropriate for the analyses. The explained variance by the first two Principal Components (PCs) is larger than 50% and the first Principal Component (PC) contributes to 28% of the explained variance. All the PCAs were performed on the correlation matrix and Varimax rotation was used. For all the calculations R 3.4.4 was used with psych package for KMO and Bartlett test and principal function was used for calculating PCA. The first latent

component is the major one. It describes the relationship between GVC and backward participation and mostly the market related factors, while the second component is comprised of mostly trade policy related variables (standards, harmful and liberalising interventions, FDI).

A biplot (Figure 3.1.) was created enabling us to study the connections between the countries and influential factors and also to identify country groups and factor groups as well.

Figure 3.1 PCA biplot of the studied factors and countries



Source: own composition based on OECD (2023) data

The green vectors present how much weight each factor has on a given PC. These weights can be determined by projecting each vector to the given PCs. For example, Component 2 separates standards, harmful and liberalising interventions and FDI from the other factors (market factors). The first component describes the GVC % and the level of development and contract enforcement and also correlates well with trading across the border (trade policy related factors). Countries located to the right participating most in Global Value Chains, most of them are from the eurozone and the level of contract enforcement and development is rather high here. Countries located to the left of the first axis are just the opposite (less GVC and backward participation, low level of contract enforcement and development).

We can also observe that backward and GVC participation is the closest to the trade openness which is the main determinant of GVC participation**.** Also being in the eurozone and the level of development helps trade across the border and makes it easier to enforce contracts and improves the logistic performance. PCA is also useful to capture cluster structures of the data. The following cluster structures can be obtained from the biplot of the PCA (Table 3.4.).

Table 3.4 Categorisation of agri-food GVC participation engagement by country

High engagement countries	Average engagement	Low engagement countries
Austria, Belgium, Czech Republic, Denmark, Estonia, Finland, France, Germany, Hong Kong, Ireland, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Saudi Arabia, Singapore	Argentina, Australia, Belarus, Brazil, Brunei, Bulgaria, Canada, Chile, China, Costa Rica, Croatia, Cyprus, Greece, Hungary, Iceland, Israel, Italy, Japan, Jordan, Kazakhstan, Laos, Malaysia, Myanmar, Nigeria, Norway, Philippines, Poland, Portugal, Romania, Senegal, Slovakia, Slovenia, South Africa, South Korea, Spain, Sweden, Switzerland, Taiwan, Thailand, Tunisia, Turkey, UK, Ukraine, USA, Vietnam	Bangladesh, Cambodia, Cameroon, Colombia, Cote d'Ivoire, Egypt, India, Indonesia, Kazakhstan, Morocco, Mexico, New Zealand, Pakistan, Peru, Russia

Source: own composition based on OECD (2023) data

As evident from Table 3.4., high engagement countries are mainly developed eurozone countries with open markets and liberal trading policies, while low engagement ones are mainly developing countries with protectionist trade policies. Level of development, trade openness, trade across borders and LPI are key for success, as well as contract enforcement, while market size, standards, FDI and market interventions play only a limited role. In other words, market related factors are more important than trade policy related factors in pursuing GVC participation, at least in agri-food markets.

3.4 Determinants of agri-food GVC participation

First an F test was performed to test whether the individual fixed effect panel model is better than the simple OLS regression. We found that the fixed effect panel regression fitted the data better ($F(73,258)=84.21;p<0.001$). A Hausman Test was also performed to compare fixed effect panel model to the random effect model. We reject the null hypothesis ($Chi2(df=10)=48.84;p<0.001$) that the random effect model is better, therefore we used the fixed effect model. Augmented Dickey Fuller test ($ADF=-6.416;p=0.01$) was also performed with lag order 2 to show that the series have no unit roots (stationary). Breusch-Godfrey/Wooldridge test showed serial correlation in the time series ($Chi2(df=2)=34.31;p<0.001$) and Breusch-Pegan test ($BP=259.11,p<0.001$) showed presence of heteroskedasticity. Therefore, we applied a robust covariance matrix estimation using Arellano's method to control for heteroskedasticity and serial correlation. In order to estimate the fixed effect panel model, R 3.4.4 was used with plm package.

Table 3.5 Fixed effect panel and OLS regression model estimations for the whole dataset (2009-2020)

Policy factor	**OLS**	**Fixed-effect**
Eurozone	**11.804*** **	-1.573
	(1.149)	(0.985)
No. of Standards	0.170	not
	(0.115)	applicable
Liberal Interventions	-0.015	**0.040***
	(0.030)	**(0.024)**
Harmful Interventions	0.005	0.002
	(0.009)	(0.003)
Market size	**-0.806***	**2.939***
	(0.478)	**(1.597)**
Level of development	**-1.749****	-1.275
	(0.732)	(1.559)
FDI	-9.092	-0.051
	(8.430)	(1.233)
LPI	2.293	0.272
	(1.902)	(0.658)
Trade openness	**0.038*** **	**0.073*** **
	(0.008)	**(0.020)**
Trade across border	-0.001	-0.021
	(0.036)	(0.021)
Contract enforcement	**0.182*** **	0.043
	(0.047)	(0.045)
Constant term	**44.715*** ** **(12.02)**	not applicable
R-squared	0.403	0.178
F-statistic	20.32***	5.65***

Note: *p<0.1; **p<0.05; ***p<0.01
Source: own composition based on OECD (2023) data

The result of the OLS regression differs from the fixed effect panel. Eurozone membership has a significantly positive effect on GVC participation, however, only in the case of the OLS model. Liberal trade interventions seems to have some positive effect in the fixed effect panel model. Interestingly, the effect of market size is different, depending on the model specification, though the level of development seems to negatively influence GVC participation, at least in the agri-food sector. Contract enforcement has some positive effect in both cases as well as trade openness, which is significantly positive in both models.

Table 3.6. goes further and identifies determinants of GVC participation by the different country engagament. It appears that market size and level of development increases GVC participation for only those countries having anyway high GVC participation rates, while FDI fosters GVC participation but only for the low engagers. Trade openness seems to have some positive effect in all cases, while trade across borders are negatively related to GVC participation. Interestingly, level of different trade policy interventions does not seem to have a modest role in shaping GVC participation rates.

Table 3.6 Fixed effect panel regression model estimations for the high, low and average engagement countries for agri-food GVC participation between 2009-2020

Factors	High	Low	Average
Eurozone	-0.606	not	not
	(0.944)	applicable	applicable
Liberal Interventions	0.007	0.073	**0.054****
	(0.048)	(0.059)	**(0.024)**
Harmful Interventions	0.003	**0.023***	0.002
	(0.027)	**(0.013)**	(0.003)
Market size	**11.752*****	0.456	82.078
	(4.093)	(1.535)	(62.945)
Level of development	**13.181*****	1.008	-10.907
	(4.802)	(1.66)	(19.113)
FDI	-6.137	**127.518****	0.086
	(9.752)	**(60.507)**	(1.123)
LPI	-0.654	0.095	0.443
	(1.469)	(1.009)	(0.834)
Trade openness	**0.064***	0.030	**0.088*****
	(0.035)	(0.022)	**(0.018)**
Trade across border	**-0.163***	-0.001	-0.028
	(0.095)	(0.021)	(0.030)
Contract enforcement	0.137	-0.104	0.049
	(0.099)	(0.097)	(0.044)
R-squared	0.308	0.275	0.219
F-statistics	2.50**	1.59	4.56***

Note: *p<0.1; **p<0.05; ***p<0.01
Source: own composition based on OECD (2023) data

3.5 Determinants of agri-food backward GVC participation

We extended our analysis by running the same models to forward and backward participation as well. First an F test was performed to test whether the individual fixed effect panel model is better than the simple OLS regression. We found that the fixed effect panel regression fitted the data better ($F(73,258)=82.23;p<0.001$). A Hausman Test was also performed to compare fixed effect panel model to the random effect model. We should reject the null hypothesis ($Chi2(df=10)=31.66;p<0.001$) that the random effect model is better, therefore we used the fixed effect model. Augmented Dickey Fuller test ($ADF=-6.709;p=0.01$) was also performed with lag order 2 to show that the series have no unit roots (stationary). Breusch-Godfrey/Wooldridge test showed serial correlation in the time series ($Chi2(df=2)=38.27;p<0.001$) and Breusch-Pegan test ($BP=408.35,p<0.001$) showed presence of heteroskedasticity. Therefore, we applied a robust covariance matrix estimation using Arellano's method to control for heteroskedasticity and serial correlation.
In order to estimate the fixed effect panel model, R 3.4.4 was used with plm package.

As evident from Table 3.7, the same determinants of GVC participation applies than observable in Table 3.5, though the signs are different. Eurozone, market size, level of development, trade openness and contract enforcement all have a positive and significant impact on backward GVC

participation, suggesting that these market and policy related factors can shape how countries add value to the whole value chain when importing from other countries.

Table 3.7 Fixed effect panel and OLS regression model estimations for the whole dataset (2009-2020) for backward GVC participation

Policy factor	**OLS**	**Fixed-effect**
Eurozone	**9.958*** **	**0.852***
	(0.993)	**(0.483)**
No. of Standards	0.095	not
	(0.099)	applicable
Liberal Interventions	-0.042	0.025
	(0.026)	(0.022)
Harmful Interventions	-0.005	0.001
	(0.008)	(0.003)
Market size	**0.750***	0.035
	(0.413)	(1.416)
Level of development	**1.160****	-0.874
	(0.633)	(1.313)
FDI	0.627	-0.206
	(7.285)	(1.045)
LPI	-4.858	0.380
	(1.643)	(0.653)
Trade openness	**0.046*** **	**0.039*** **
	(0.007)	(0.014)
Trade across border	0.004	-0.016
	(0.032)	(0.022)
Contract enforcement	**0.115*** **	0.009
	(0.040)	(0.033)
Constant term	-15.282*** (10.389)	not applicable
R-squared	0.391	0.082
F-statistic	19.32***	2.298***

Note: *p<0.1; **p<0.05; ***p<0.01

Source: own composition based on OECD (2023) data

As to the determinants of backward GVC participation by engagement, Table 3.8. echoes what we have seen in Table 3.6. for determinants of overall GVC participation with a marked difference in terms of eurozone membership – this definitely plays a positive role for backward GVC participation. It is also evident that developed countries with bigger markets tend to have higher backward GVC participation levels.

Table 3.8 Fixed effect panel regression model estimations for the high, low and average engagement countries for agri-food GVC backward participation between 2009-2020

Policy factor	High	Low	Average
Eurozone	**1.617*** **	not	not
	(0.535)	applicable	applicable
Liberal Interventions	0.008	0.005	**0.042** **
	(0.045)	(0.034)	**(0.019)**
Harmful Interventions	-0.036	**0.012***	0.002
	(0.023)	**(0.006)**	(0.003)
Market size	**9.560** **	**-2.786***	7.394
	(3.592)	(1.379)	(61.095)
Level of development	**-10.509** **	-0.159	-1.119
	(4.433)	(1.320)	(17.392)
FDI	1.386	**76.650*** **	-0.053
	(5.206)	**(23.328)**	(0.907)
LPI	1.871	**-2.043*** **	0.430
	(1.595)	(0.619)	(0.682)
Trade openness	0.017	0.029	**0.066*** **
	(0.013)	(0.027)	**(0.019)**
Trade across border	**-0.153***	0.001	-0.018
	(0.075)	(0.013)	(0.032)
Contract enforcement	0.144	-0.001	-0.019
	(0.035)	(0.042)	(0.047)
R-squared	0.269	0.417	0.160
F-statistics	2.07*	3.01***	3.08***

Note: *p<0.1; **p<0.05; ***p<0.01

Source: own composition based on OECD (2023) data

3.6 Determinants of agri-food forward GVC participation

Again, when analysing the determinants of forward GVC participation, an F test was performed first to test whether the individual fixed effect panel model is better than the simple OLS regression. We found that the fixed effect panel regression fitted the data better ($F(73,258)=46.054; p<0.001$). The fitted random model was not significant but the fixed effect model fitted the data better. Augmented Dickey Fuller test ($ADF=-6.637; p=0.01$) was also performed with lag order 2 to show that the series have no unit roots (stationary). Breusch-Godfrey/Wooldridge test showed serial correlation in the time series ($Chi2(df=2)=32.696; p<0.001$) and Breusch-Pegan test ($BP=66.29, p<0.001$) showed presence of heteroskedasticity. Therefore, we applied White's correction for the covariance matrix. In order to estimate the fixed effect panel model, R 3.4.4 was used with plm package.

As to the determinants of forward agri-food GVC participation, a different pattern of factors emerges. Eurozone membership does not seem to foster forward GVC participation at all, neither do market size (OLS model) and level of development as well as trade openness (OLS model). However, LPI seems to have a significantly positive role (OLS model). All this

suggests that developing countries with relatively smaller markets and good logistics performance have higher chances to participate in forward GVC.

Table 3.9 Fixed effect panel and OLS regression model estimations for the whole dataset (2009-2020) for forward GVC participation

Policy factor	**OLS**	**Fixed-effect**
Eurozone	-0.424	**-2.046*** **
	(0.585)	**(0.737)**
No. of Standards	0.043	not
	(0.058)	applicable
Liberal Interventions	0.023	0.008
	(0.015)	(0.012)
Harmful Interventions	0.008	0.001
	(0.005)	(0.004)
Market size	**-1.399*** **	**2.622*** **
	(0.243)	**(0.697)**
Level of development	**-2.302*** **	-0.279
	(0.373)	(0.751)
FDI	-6.545	0.452
	(4.289)	(1.504)
LPI	**6.102*** **	-0.040
	(0.968)	(0.498)
Trade openness	**-0.017*** **	**0.015***
	(0.004)	**(0.008)**
Trade across border	-0.007	-0.003
	(0.019)	(0.009)
Contract enforcement	0.024	0.023
	(0.024)	(0.021)
Constant term	54.087***	not applicable
	(6.117)	
R-squared	0.178	0.104
F-statistic	6.51***	3.006***

Note: *p<0.1; **p<0.05; ***p<0.01

Source: own composition based on OECD (2023) data

As to determinants of forward GVC participation by engagement, similar patterns show up than in Table 3.8., though with different signs (Table 3.10). Eurozone membership has a significantly negative effect on high engagement of forward agri-food GVC participation, while market size mainly have positive effects for average and low engagement. LPI is negative for those with high engagement, while positive for those with low engagement, while trade policy related factors have only minor roles.

Table 3.10 Fixed effect panel regression model estimations for the high, low and average engagement countries for agri-food GVC forward participation between 2009-2020

Policy factor	**High**	**Low**	**Average**
Eurozone	**-1.879*** **	not	not
	(0.493)	aplicable	aplicable
Liberal Interventions	-0.003	**0.067***	0.002
	(0.025)	**(0.040)**	(0.013)
Harmful Interventions	0.037	0.008	0.001
	(0.024)	(0.009)	(0.002)
Market size	-0.292	**3.708***	**65.346****
	(1.619)	**(1.899)**	**(32.612)**
Level of development	0.068	0.813	-9.757
	(2.745)	(2.005)	(10.532)
FDI	-5.237	37.033	0.428
	(7.284)	(52.716)	(1.201)
LPI	**-1.988*** **	**2.322****	-0.190
	(0.722)	**(1.076)**	(0.452)
Trade openness	**0.024***	-0.012	0.009
	(0.013)	(0.027)	(0.016)
Trade across border	0.022	-0.003	-0.006
	(0.034)	(0.028)	(0.015)
Contract enforcement	-0.036	-0.100	**0.053***
	(0.047)	(0.071)	**(0.030)**
R-squared	0.189	0.487	0.09
F-statistics	1.30	4.01***	1.61

Note: *p<0.1; **p<0.05; ***p<0.01

Source: own composition based on OECD (2023) data

4 GVCs and shock transmission

Production linkages serve as important transmitters of shocks between countries. Intermediate goods cross the border many times, also transmitting economic disturbances across countries even if they do not directly trade with each other. If a significant share of imports are used as inputs in the production process that is further re-exported, changes in third country demand represent an important determinant of a country's imports. Similarly, a country's exports may also be sensitive to changes in third country demand due to production and re-export linkages. All this contradicts classic trade theories arguing that imports are solely a function of domestic demand and exports are a function of foreign demand.

GVCs are a relevant channel of transmission of supply-side shocks (Cigna et al., 2022) as evidenced by many recent crisis events (COVID-19, Russia-Ukraine war, etc.). The role of GVCs in the transmission of shocks is mainly associated with their sticky nature (Antràs, 2020), reflecting the irreversible nature of investments made in the organisation of GVCs. Complex goods requiring a high number of different production processes are more difficult to substitute and a single failure of one supplier can affect the entire chain, leading to higher costs or even supply shutdowns.

The impact of a shock is magnified through a chain due to the well-known "bullwhip effect". In terms of inventories, crisis times also bring forecast errors, to which the typical business response is the building of stocks of inventories. The further a company is in the chain, the higher the bullwhip effect is, as forecast errors are magnified, as well as associated inventories.

On this basis, it seems we need to re-think conventional trade definitions. As imports are widely used to produce exports in many cases through a value chain, countries are competing each other at many stages, especially as they do not sell products based only on the use of domestic inputs. With GVCs, countries intensively trade intermediate inputs, challenging classic exchange rate definitions and calling for the use of input-output real effective exchange rates (Cigna et al., 2022). Moreover, traditionally defined export market shares computed with gross trade flows may also be misleading in reflecting a country's contribution to global production.

The global economy has been hit by many different shocks recently. Different waves of trade tensions between the USA and China, the Brexit, COVID-19 and the Russia-Ukraine war has all pushed our world towards slowbalised, regionalised and more protected trade, also evident from Deliverable 1.4. This has important implications also for the determinants of GVC participations.

Trade openness, for instance, is a significant determinant of GVC participation, implying the vital role of tariffs and non-tariff measures in the global trade of goods and services. In a world of extensive supply and demand linkages, these impacts are cumulated, implying that higher trade costs coming from increased tariffs change the quantity and price of traded goods, especially for intermediate goods crossing the borders several times. On the chain level, these impacts are magnified, ending up in significantly higher costs for the final products.

On the whole, demand and supply shocks generate different supply chain dynamics. Demand can be passed upstream to input suppliers, while supply disruptions can be transmitted down

the chain. Firms hit by a shock generally produce fewer goods, thereby raising product prices. In GVC terms, these effects cancel each other for upstream firms, while downstream ones feel the increase of prices, lowering their overall production. Conversely, increased demand is associated with increased production at the industry level, implying increased input production by upstream firms, while leaving downstream firms unaffected (Cigna et al., 2022).

5 Taxonomy of GVCs

As evident from Deliverable 1.4 and the above, GVC studies explore the relationships between value distribution mechanisms and organisation of the cross-border production and consumption patterns. Gereffi et al. (2005) were the first to create a framework of global value chains by aiming at categorising them based on their governance structures and the different forms of transactions between stakeholders.

Figure 5.1. illustrates the framework which is also in line with the preliminary results of the TRADE4SD project. The rectangles represent the boundaries of the firms, while their size indicates the strength of their bargaining power. Arrows stand for the direction and extent of business interventions, which can be supportive or predatory. Toward the right of the diagram, clients possess greater bargaining powers and stronger influence on the distribution of the value added. The figure also highlights three parameters as ones playing an important role in the categorisation: complexity of transactions, ability to codify transactions, and capabilities in the supply base. On this basis, Gereffi et al. (2005) classified GVCs into five different categories.

In a **market-type** global value chain, generic commodity production does not require any specific investments or product descriptions so producers and consumers have endless choices for alternative partners. Key information is mostly given by price and transaction costs are close to zero, implying high price elasticity. Identical to the model of "perfect markets", buyers and sellers are connected through open spot market transactions.

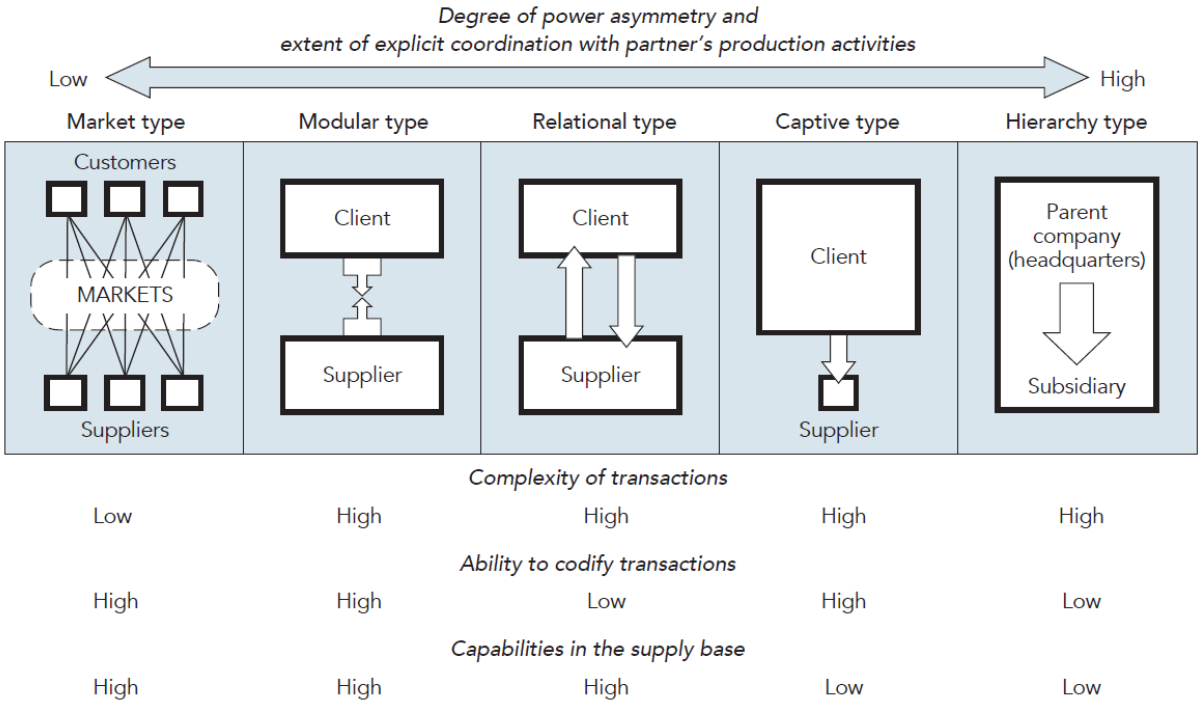
The **modular-type** of global value chains represent some higher degree of power asymmetry with decreased number of clients and suppliers who are playing against each other. Compared to the market-type chains, complexity of transactions is much higher due to the complexity of the products. Much more product-related information needs to be given related to a specific transaction, though transaction costs for changing partners remain relatively low.

As a next step, when manufacturing process involves specialised equipment with limited scope for alternative uses, transactions become asset-specific with contracting parties becoming mutually dependent, ending up in a **relational-type** chain. Suppliers are not motivated to search for other potential buyers in this model, while clients are also not eager to change their suppliers due to the specificity of the products and services. Compared to the modular-type model, ability to codify transactions remain low in this case.

With further increasing the degree of power asymmetry between buyers and sellers, we end up in the **captive-type** value chain. Compared to the modular-type, capabilities in the supply base are definitely lower here due to the overwhelming power of the client over its supplier. Suppliers need to follow the instructions of their clients and while facing serious product quality and delivery time requirements. Suppliers have captive positions here due to their limited scale and/or specialisation patterns.

Last but not least, the **hierarchy-type** global value chains represent the highest degree of power asymmetry. They are the exact opposites of market-type chains with high complexity of transactions, low ability of codifications and low capabilities in their supply base. This is a typical type of a vertically integrated firm such as many multinational corporations.

Figure 5.1 Taxonomy of global value chains



Source: Gereffi et al. (2005) and World Bank (2017)

The framework above can be applied to the different value chains analysed later in the project. As they are highly case-specific and complex, a single and one size fits all solution can not be given to all agri-food value chains. However, the taxonomy and the determinants described above may help to better understand the different dynamics behind GVC participation at the case level.

6 Conclusions and policy recommendations

Deliverable 1.5. analysed the determinants of participation in GVCs for countries at different levels of economic development. This report is particularly important in understanding how the involvement of developing countries in GVCs can be increased in order to create better integration for them to the global economy.

The report makes it clear what the key determinants are of GVC participation by (1) analysing simple correlation statistics; (2) by running econometric models for all countries and (3) by identifying determinants by engagement. **Overall, our results suggest that structural characteristics of the countries are the key determinants of GVC participation and that market and trade policy related determinants drive engagement in forward and backward GVC participation.** The most important determinants are as follows.

1. **Trade openness:** Trade openness proved to be one of the most important factors in GVC participation in all models and by all means (backward and foreward types as well). Opening borders and actively trading with other countries should be a key policy for countries aiming to increase their GVC participation levels.
2. **Level of economic development:** As expected, the general level of economic development definitely plays a role in enhancing GVC participation at all levels and especially for backward participation. Developed countries are most active in GVCs than developing ones. Economic policies aimed to improving economic development is also beneficial for better GVC integration.
3. **Logistics performance:** The quality and speed of logistics activities appear to be major determinants of GVC participation, especially for forward participation. Economic policies should focus on investing in logistics infrastructure.
4. **Ease of doing business:** The ease of doing business was proven to be another key factor in all terms of GVC participation – governments should focus on providing a conducive business environment.
5. **Eurozone membership:** Being part of a common market with a common currency definitely fosters GVC participation, especially backward participation.
6. **Market size:** Market size per se does not seem to play a major role in boosting GVC participation – countries with smaller markets can also be important beneficiaries of global economic integration.
7. **Trade interventions:** Liberal trade interventions play some role in enhancing GVC participation, though this does not seem to be the most important factor. Trade intervention policies seem to play a limited role in GVC participation growth.

On the whole, it seems **that market related factors are more important than trade policy related factors** in pursuing GVC participation, at least in agri-food markets. Future policies in pursuing higher GVC participation should take these results into account.

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