10th AIEAA Conference

*Agriculture, food and global value chains:
Issues, methods and challenges*

"Mapping global value chain participation and positioning in agriculture and food"

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What I am going to speak about

General aim:

- to overview the body of empirical work on GVCs in international production and trade mainly from a "macro" angle, measuring and mapping GVCs using trade in value added data, with special attention to the agriculture and food sectors.

Specific aims:

- reviewing developments in methods and data;
- presenting GVC indicators - at the country and sectoral level - computed using trade in value added data;
- showing some stylized facts on GVC participation and positioning in agriculture and food;
- providing recent empirical evidence of the economic impact of the GVCs on these sectors;
- concluding with some critical issues and speculative thoughts regarding the future of GVCs.

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A collective work…

"Mapping global value chain participation and positioning in agriculture and food"

Silvia Nenci*, Ilaria Fusacchia*, Anna Giunta*, Pierluigi Montalbano♣, Carlo Pietrobelli*
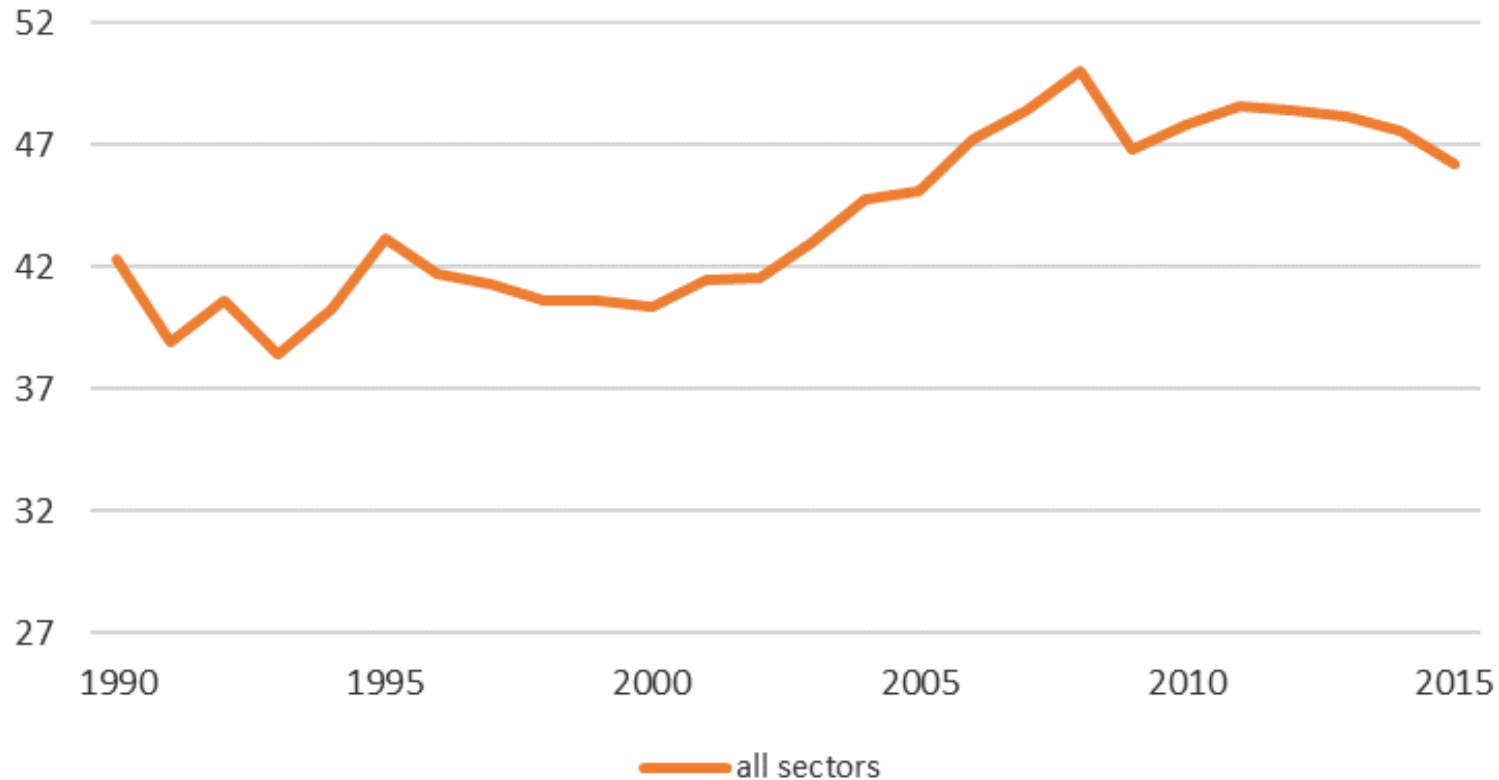
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forthcoming in "Biobased and Applied Economics"

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The importance of Global Value Chains: past and present

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The rise of GVCs

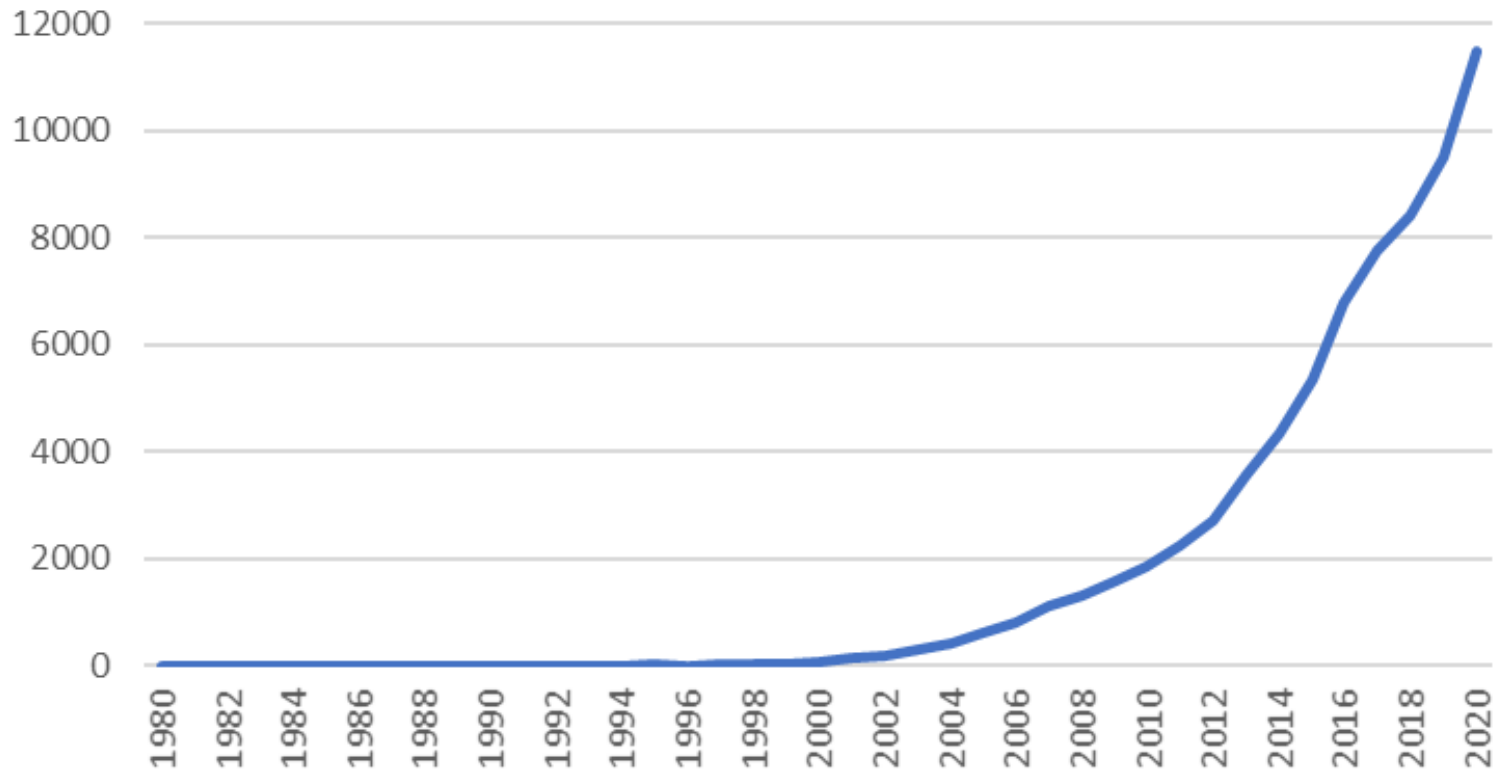## GVC Trade as percentage of world trade

Notes: GVC trade in total international trade is the share of trade that flows through at least two borders (see Borin and Mancini, 2015, 2019)

Sources: Author's elaboration using EORA data

A growing scientific interest

Papers in Google scholar on the GVC topic

Notes: Number of entries as a result of a Google Scholar search of the exact phrase "global value chains". Search conducted on 4 June 2021

Source: Nenci, 2021

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GVCs as a skeleton of the economic system

Why do they matter?

GVCs have become the world economy's backbone and central nervous system (Cattaneo, Gereffi, & Staritz, 2010).

They can significantly affect competitiveness and macroeconomic developments.

A deep impact in many sectors with implications in terms of production, global trade, and employment, for both developed and developing countries.

➢ For industrialized economies, GVCs ensure *access to lower priced inputs, wider variety and economies of scale*.

➢ For developing economies, GVCs represent a *valid shortcut to structural transformation* since they allow them to join existing supply chains instead of building them or acquiring a comparative advantage in a broad range of production stages domestically.

GVCs can boost growth and reduce poverty (WDR, 2020)

Agriculture and food GVCs: involvement in GVCs is a *key driver of economic transformation* and *growth in both the agricultural and non-agricultural sectors* with evidence that jobs associated with GVCs have higher productivity levels (Lopez-Gonzalez, 2016; Jouanjean, Gourdon and Korinek, 2017; OECD, 2015).

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Different approaches and levels of analysis of GVCs

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GVCs: a complex and multidisciplinary issue
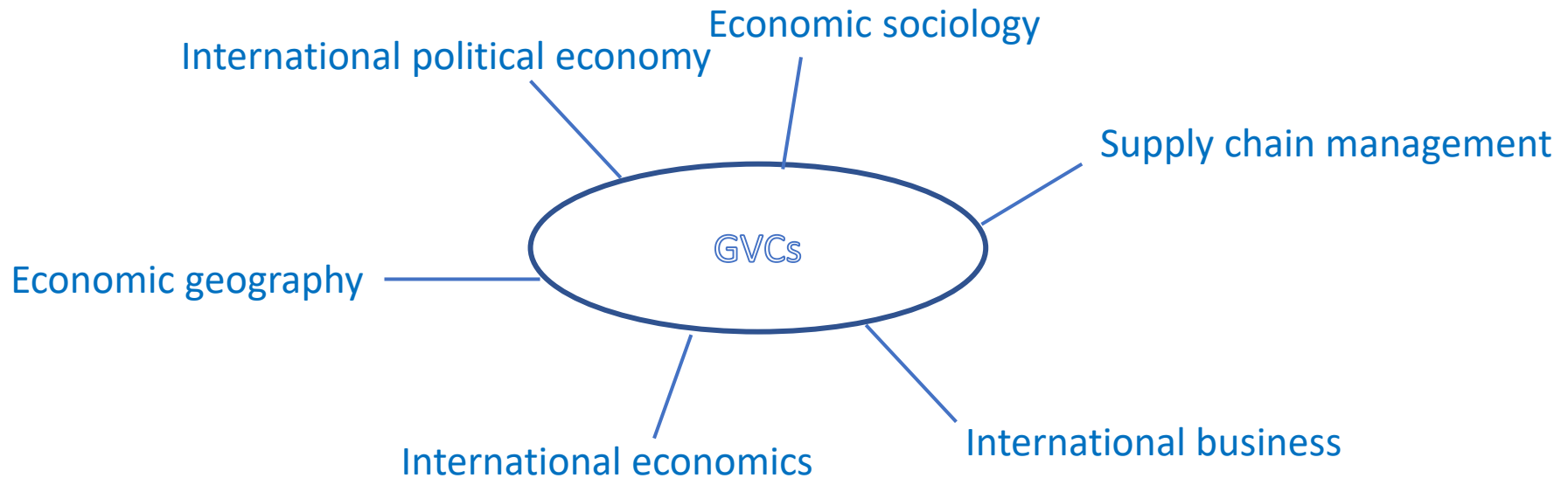
The origin of the concept of GVCs traces back to the old tradition of Marxian scholars and to the dependency and structuralist school in Latin America (Ponte, Gereffi, Gaj-Reichert, 2019 GVC Handbook Ch.1)

> *…. With a new focus on specific industries rather than countries, on the role of power in economic transactions, and on Multinational Corporations (MNCs).*

The concepts of Global Commodity Chains (GCC) and Global Value Chains (GVC) developed in the early 1990s (Gereffi, 1993)

GVCs scholars from social sciences focused on the configuration of GVCs (*governance, locations decisions, geographic scope, level of coordination*)

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Different levels of analysis

Different approaches and different **levels of analysis** (Antràs and Chor, 2021)

Macro (country- and industry-level) and **micro** (firm-level) approaches to measuring GVCs have advanced *on parallel tracks*, headed towards the same direction and with the same aim, yet with limited overlap (Johnson, 2018; Giunta, Montalbano & Nenci, 2021)

Micro: It is undeniable that it is not countries or industries that participate in GVCs, but rather firms. Conversely, the analysis of GVC at the firm-level is still at an "infant stage" (Antràs, 2021) mainly because of *lack of good quality firm-level data*

Recently, a few papers, mostly relying on general firm-level surveys, have carried out empirical analyses to investigate the firms' involvement in GVCs and their impact on performance (Inferrera, 2021; Lopez-Garcia and di Mauro, 2015; Altomonte et al., 2020; Barba Navaretti et al., 2011; Accetturo and Giunta, 2011; Cainelli et al., 2018; Meliciani et al., 2019; Giunta, Montalbano and Nenci, 2021; Montalbano, Nenci and Pietrobelli, 2018; Del Prete and Rungi, 2017; Alfano et al., 2017; Brancati et al., 2017; Agostino et al., 2020; Giovannetti et al., 2015; Giovannetti and Marvasi, 2016).

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Measuring GVCs at the country and sectoral level: data, methods and indicators

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The Global Input-Output Tables

A strand of work has combined information from bilateral trade data with national input-output tables to construct global I-O tables (see Hummels et al., 2001; Johnson and Noguera, 2012; Miroudot and Ragousssis, 2009; Koopman et al., 2011, 2014; Foster Mc Gregor and Stehrer, 2013)

			Input use & value added							Final use			Total use
			Country 1			$\cdots$	Country J			Country 1	$\cdots$	Country J	
			Industry 1	$\cdots$	Industry S	$\cdots$	Industry 1	$\cdots$	Industry S				
Intermediate	Country 1	Industry 1	Z_{11}^{11}	$\cdots$	Z_{11}^{1S}	$\cdots$	Z_{1J}^{11}	$\cdots$	Z_{1J}^{1S}	F_{11}^{1}	$\cdots$	F_{1J}^{1}	Y_{1}^{1}
		$\cdots$	$\cdots$	Z_{11}^{rs}	$\cdots$	$\cdots$	$\cdots$	Z_{1J}^{rs}	$\cdots$	$\cdots$	$\cdots$	$\cdots$	$\cdots$
		Industry S	Z_{11}^{S1}	$\cdots$	Z_{11}^{SS}	$\cdots$	Z_{1J}^{S1}	$\cdots$	Z_{1J}^{SS}	F_{11}^{S}	$\cdots$	F_{1J}^{S}	Y_{1}^{S}
inputs	$\cdots$	$\cdots$	$\cdots$	$\cdots$	$\cdots$	Z_{ij}^{rs}	$\cdots$	$\cdots$	$\cdots$	$\cdots$	F_{ij}^{s}	$\cdots$	Y_{j}^{s}
	Country J	Industry 1	Z_{J1}^{11}	$\cdots$	Z_{J1}^{1S}	$\cdots$	Z_{JJ}^{11}	$\cdots$	Z_{JJ}^{1S}	F_{J1}^{1}	$\cdots$	F_{JJ}^{1}	Y_{J}^{1}
supplied		$\cdots$	$\cdots$	Z_{J1}^{rs}	$\cdots$	$\cdots$	$\cdots$	Z_{JJ}^{rs}	$\cdots$	$\cdots$	$\cdots$	$\cdots$	$\cdots$
		Industry S	Z_{J1}^{S1}	$\cdots$	Z_{J1}^{SS}	$\cdots$	Z_{JJ}^{S1}	$\cdots$	Z_{JJ}^{SS}	F_{J1}^{S}	$\cdots$	F_{JJ}^{S}	Y_{J}^{S}
Value added			VA_{1}^{1}	$\cdots$	VA_{1}^{S}	VA_{j}^{s}	VA_{J}^{1}	$\cdots$	VA_{J}^{S}				
Gross output			Y_{1}^{1}	$\cdots$	Y_{1}^{S}	Y_{j}^{s}	Y_{J}^{1}	$\cdots$	Y_{J}^{S}	$\cdots$			

Global I-O tables contain information on supply–use relations between *industries* (*S*) and *across countries* (J)

Value-added is the value that is added to each production stage of goods and services through the use of production factors (labour, capital).

Using this data, we can track the value-added generation process of *every product* in *every country* at *every stage of production*: the *country of origin* where value was created and the *destination country* where that value is ultimately consumed.

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Databases to trace value added trade

Many initiatives and efforts have recently been addressed to trace trade in value added calculated from the global I-O tables.

In this regard, some databases are worth mentioning:

Country and sectoral level					
Project	**Institution**	**Data Sources**	**Years**	**Countries**	**Industries**
Wordl Input-Output Database (WIOD)	EU-based consortium	National Supply-Use tables	2000-2014	43	56
Traded In value Added (TiVA) dataset	OECD	National I-O tables	2005-2016	64	36
UNCTAD-Eora GVC Database	UNCTAD/Eora	National Supply-Use and I-O tables from Eurostat, OECD, IDE-JETRO	1990-2015	189	26
ADB Multi-Region Input-Output Database (ADB MRIO)	Asian Development Bank	WIOD exstension	2000, 2007-2019	63	35
Global Trade Analysis Project (GTAP)	Purdue University	Individual researchers/institution	2004, 2007, 2011, 2014	141	65
EXIOBASE3	EU-based consortium	National Supply-Use tables	1995-2015	49	163
South American Input-Output table	ECLAP/IPEA	National I-O tables	2011, 2014	10	40

Main shortcomings: the sectoral disaggregation of GVC flows is coarse; strong assumptions in constructing the tables (i.e., import proportionality assumption).

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Measuring GVCs
Borin & Mancini (2015, 2019)'s refinement of the Koopman et al. (2010) breakdown of aggregate exports
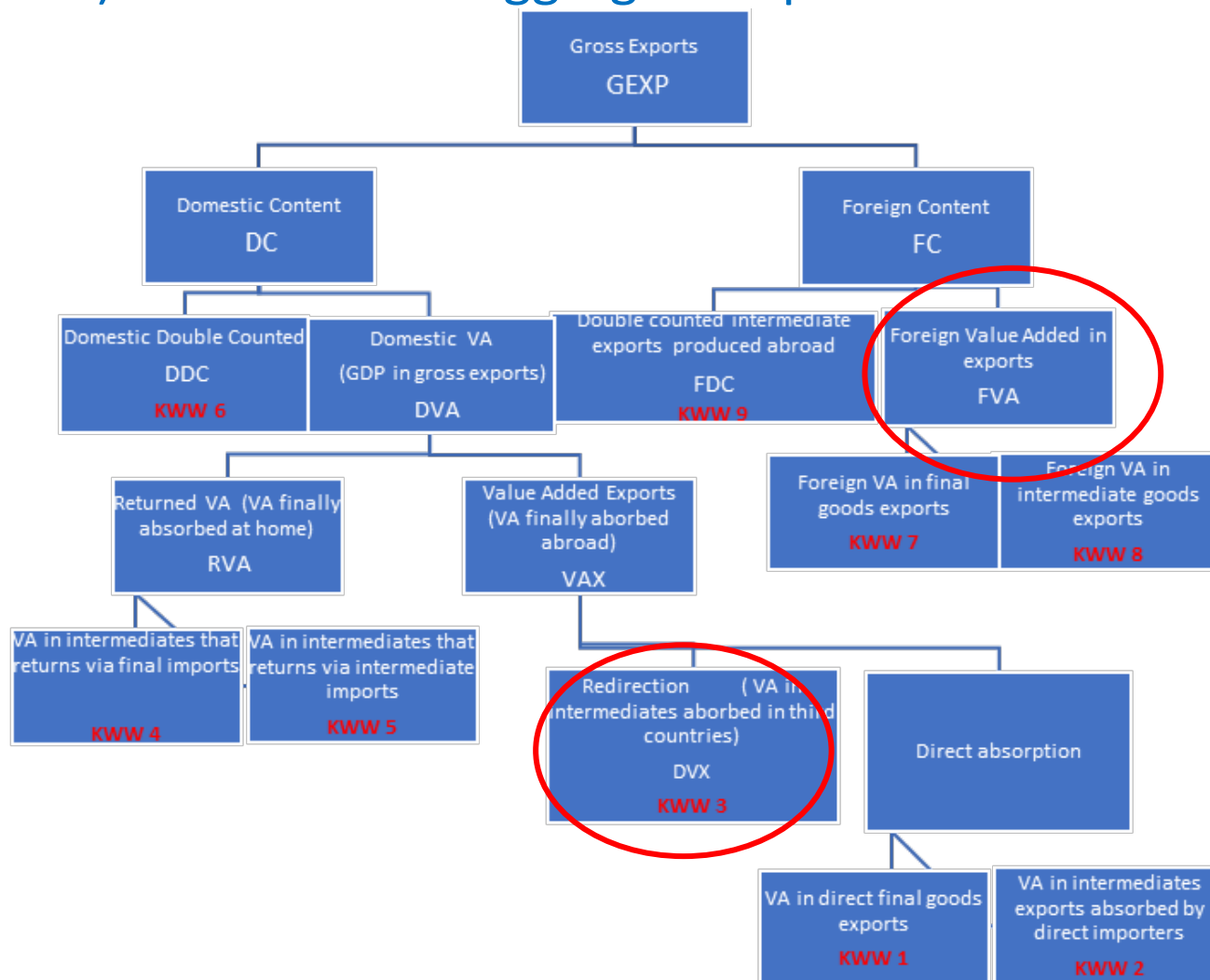
Source: Author's adaptation from KWW and BM

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GVCs participation indicators

Several measures of GVC involvement have been developed in the empirical literature (Hummels, Ishii, and Yi, 2001; Daudin, Rifflart, and Schweisguth, 2011; Johnson and Noguera, 2012)

Koopman et al. (2010; 2014) calculated GVC participation by using the FVA component and the DVX component as follows:

$$GVC\ Participation = \frac{FVA + DVX}{Gross\ Exports}$$

Borin and Mancini (2019) extended the Koopman et al. (2014) methodology and overcame shortcomings that affected the previous decompositions:

$$GVC\ overall\ Participation = GVCbackward + GVCforward$$
$$= VS + VS1$$

Combining the VS (*imported inputs to produce goods that are exported*) and VS1 (*intermediate exports sent indirectly through third countries to final destinations*) shares, one can have *a comprehensive assessment of the participation of a country in GVCs*, both as a *user of foreign inputs* and *supplier of intermediates* used in other countries' exports.

GVCs positioning indicators

Several measures of the positioning of countries and industries in GVCs (see Fally, 2012; Antràs et al., 2012; Antràs and Chor, 2013; Fally and Hillberry, 2015; Alfaro et al., 2019; Miller and Temurshoev, 2017; Wang et al., 2017).

Two *indicators* are very popular:

The **upstreamness index** (Fally, 2012; Antras et al., 2012; Antras and Chor, 2013) – a **measure of distance of a production sector from final demand** - measures *how many stages of production are left before the goods or services produced by this industry reach final consumers*. Larger values are associated with relatively higher levels of upstreamness of the output originating from one sector.

The **downstreamness index** (Fally, 2012) captures the **distance or downstreamness of a given sector from the economy's primary factors of production** (or sources of value-added). Larger values are associated with relatively higher levels of downstreamness of an industry.

We use the *GVC overall participation indicator* and the *upstreamness indicator* computed at the country-industry level for the "Agriculture" and "Food & Beverages" sectors to present some stylized facts for the 180 countries in the Eora dataset for the period 1995-2015

$$U_i^r = 1 \times \frac{F_i^r}{Y_i^r} + 2 \times \frac{\sum_{s=1}^{S} \sum_{j=1}^{J} a_{ij}^{rs} F_j^s}{Y_i^r} + 3 \times \frac{\sum_{s=1}^{S} \sum_{j=1}^{J} \sum_{t=1}^{S} \sum_{k=1}^{J} a_{ij}^{rs} a_{jk}^{st} F_k^t}{Y_i^r} + \dots$$

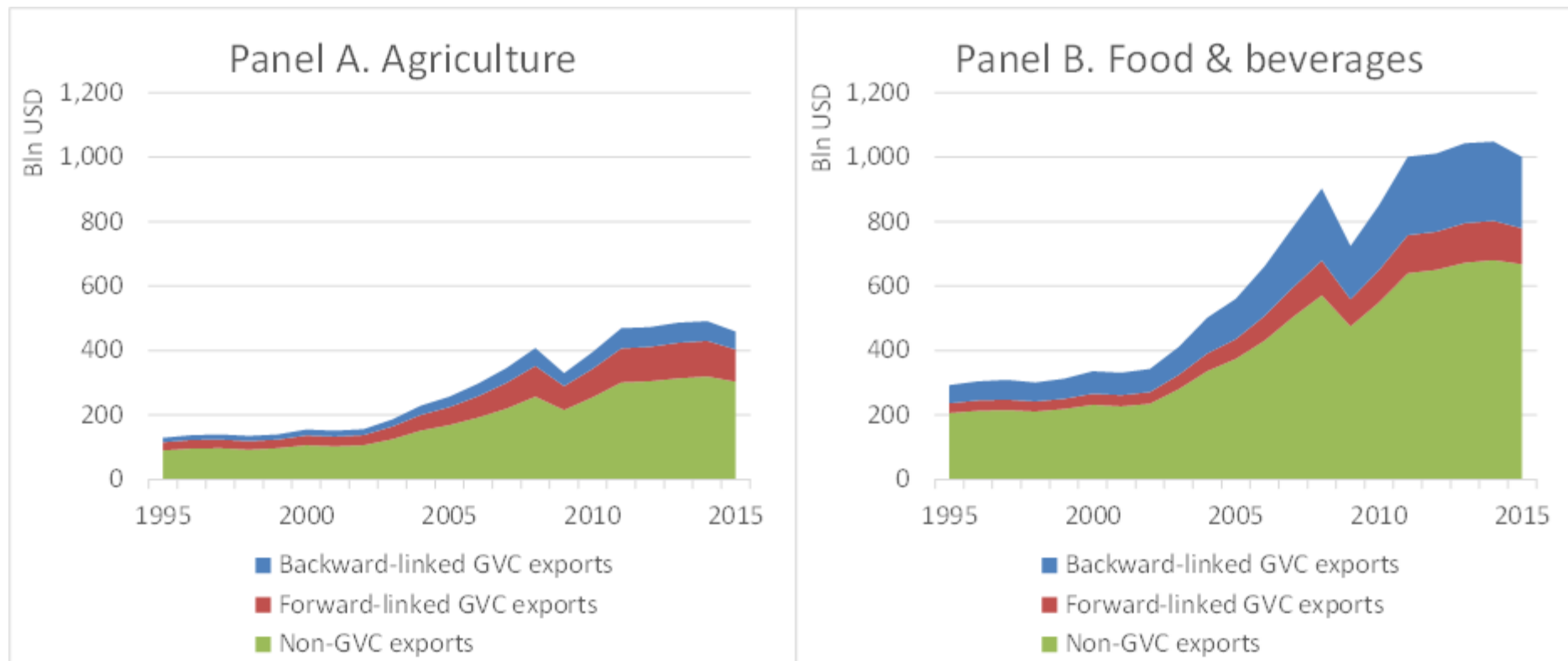Mapping GVC participation and positioning in agriculture & food: some stylized facts

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Mapping GVCs participation

Evolution of global GVC participation rates in Agriculture and Food sectors
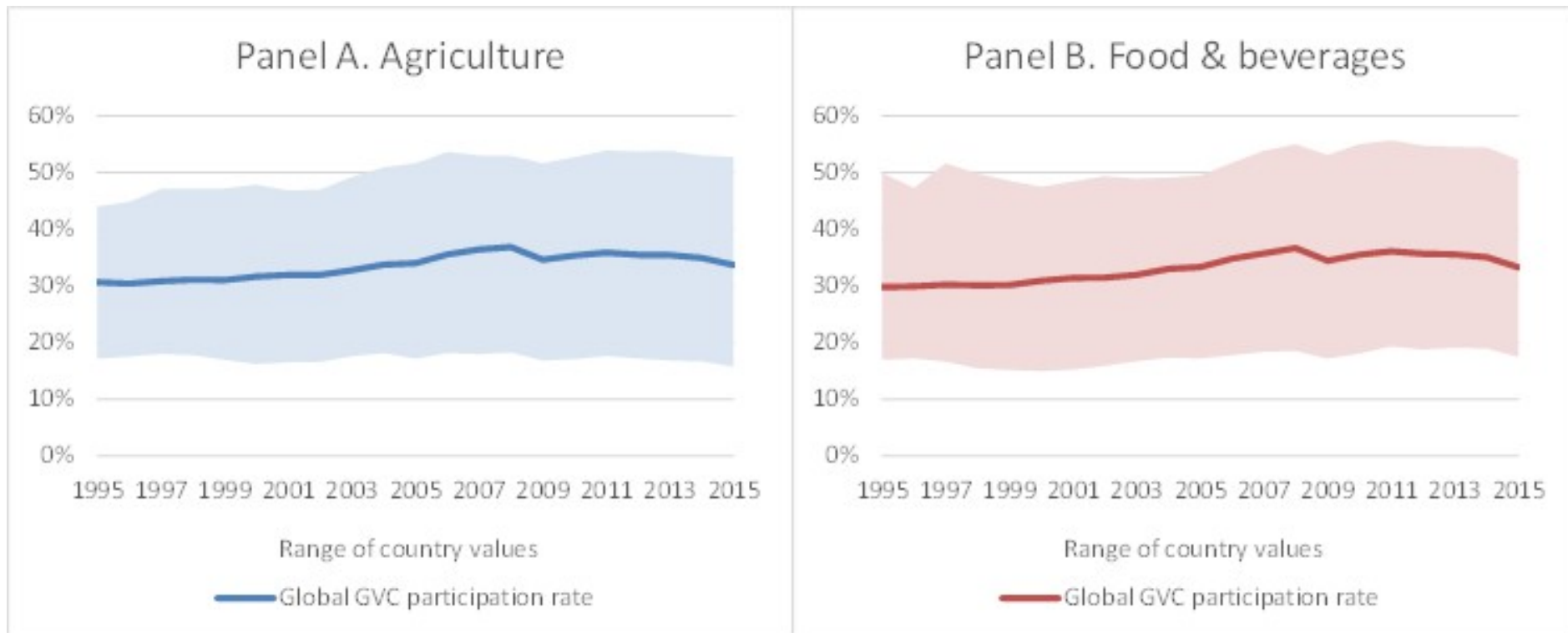
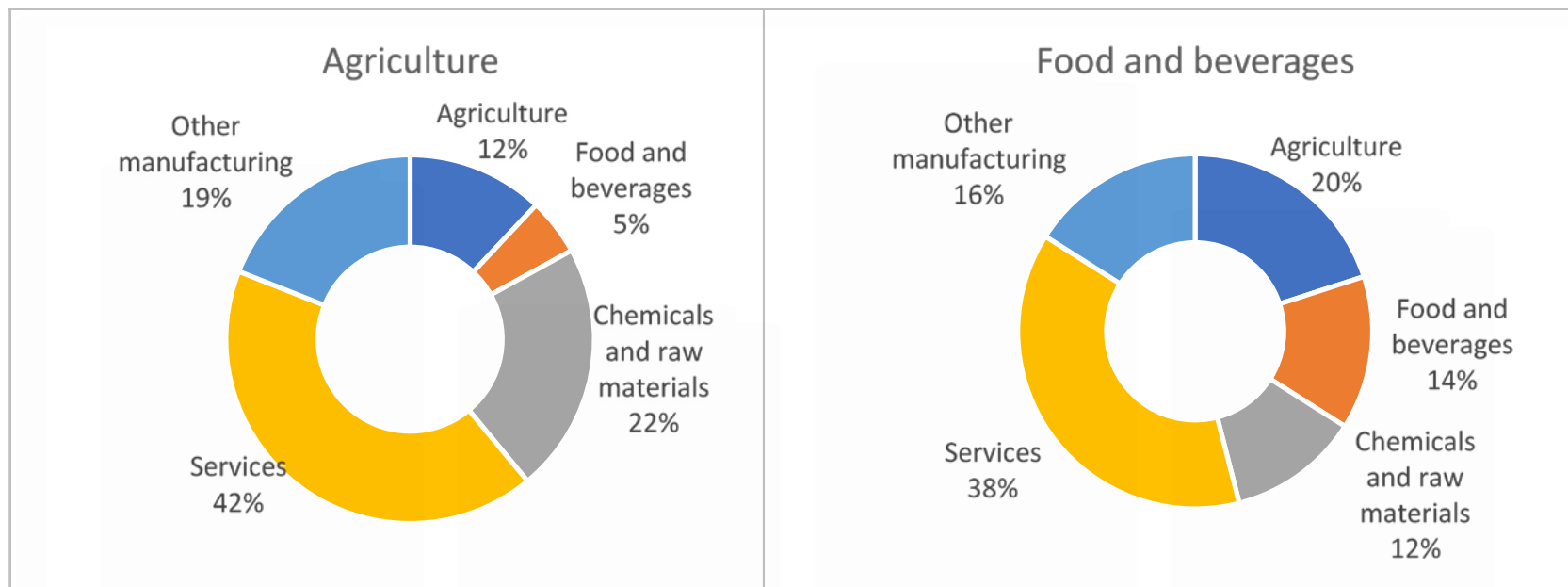*Source*: Dellink, Dervisholli and Nenci (2020) based on Eora data.

Composition of gross exports

Note: values calculated at the country level and then aggregated.
Source: Dellink, Dervisholli and Nenci (2020) based on Eora data.

Origin of foreign value added in Agriculture and Food sectors (2015)

Source: Nenci' s elaboration based on Eora data

GVC Participation for the Agricultural & Food and Beverages sectors by country (2015)

Agriculture
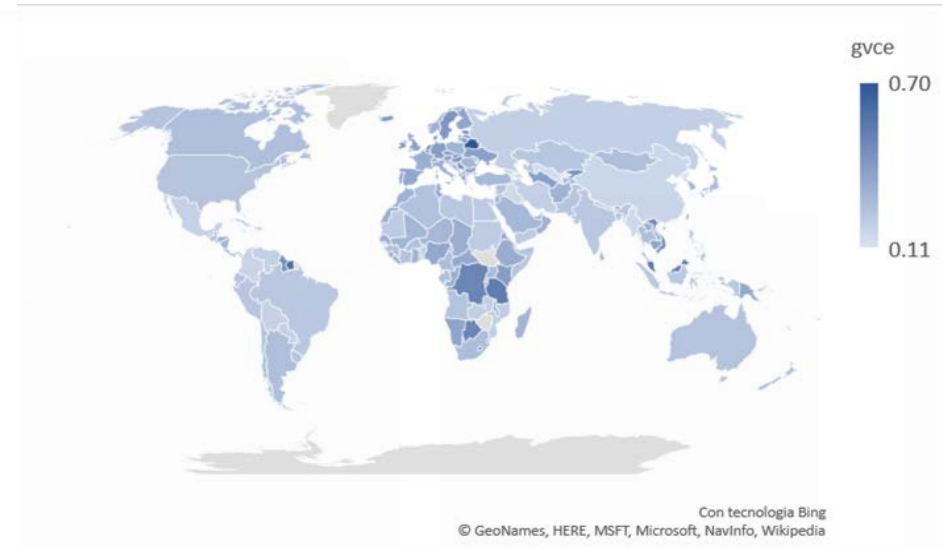
Food & Beverages

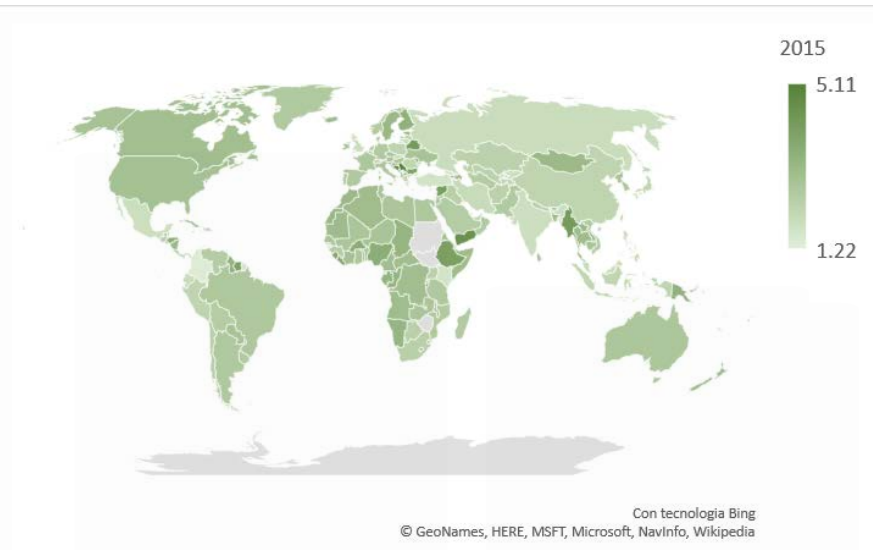*Source*: Montalbano and Nenci (2021) using EORA data

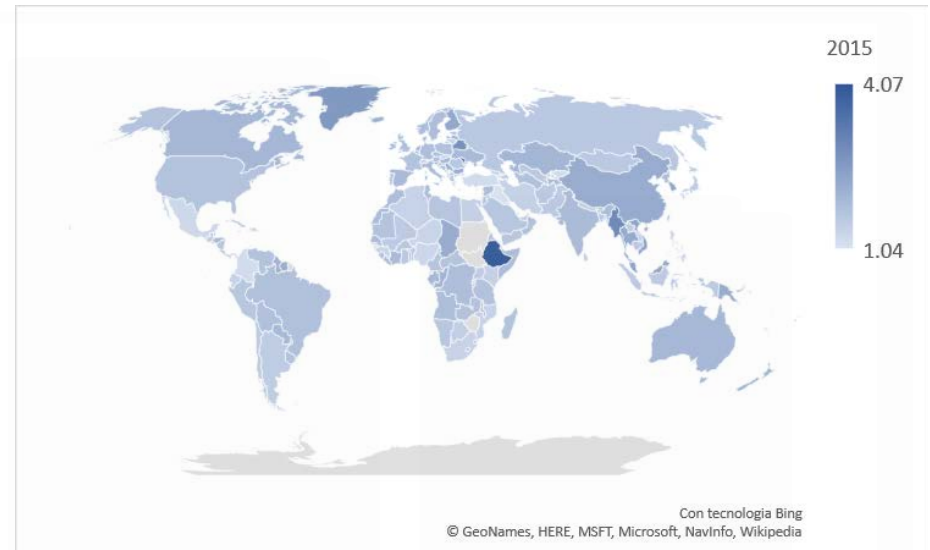# Mapping GVCs positioning

GVC upstreamness at global level

Source: Nenci's elaboration based on Eora data.

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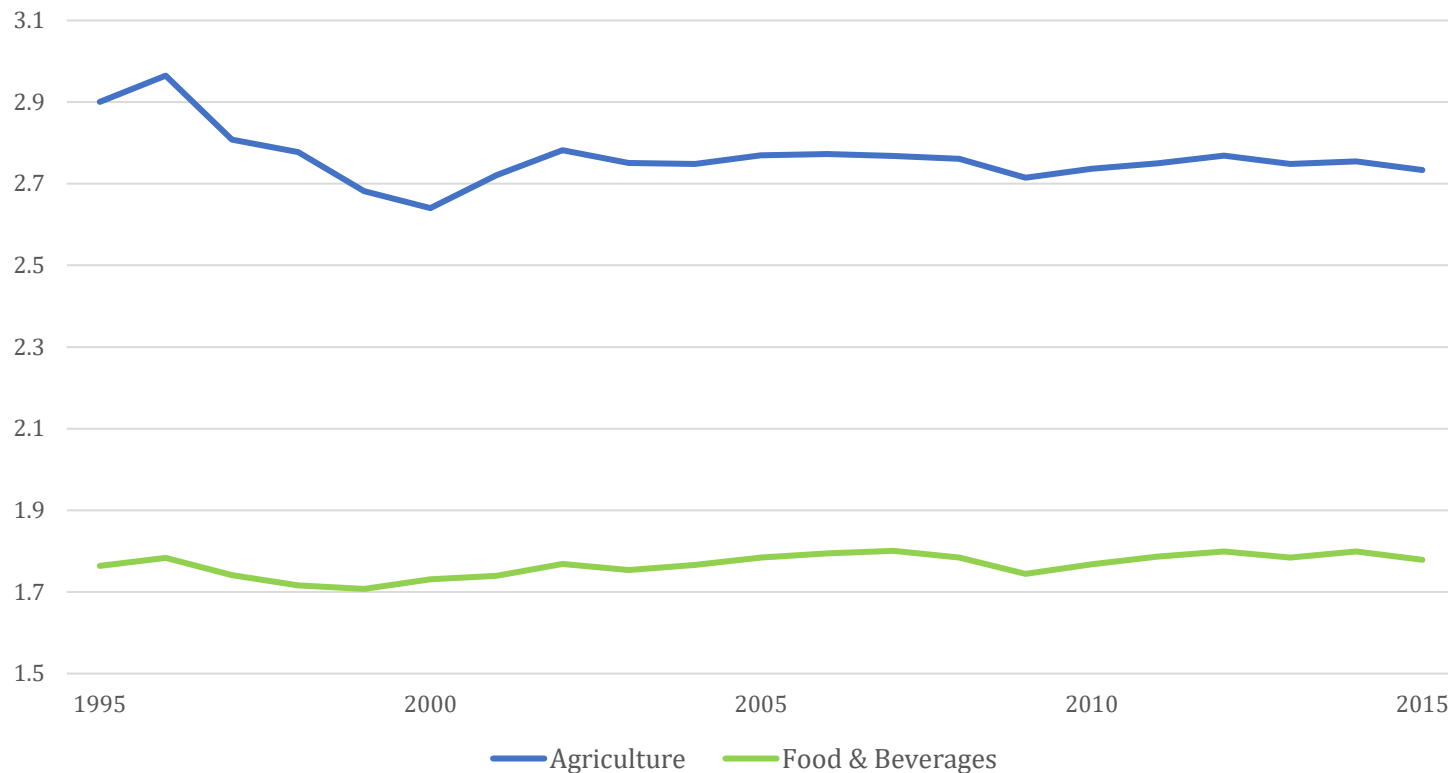
Upstreamness of the Agricultural and Food & Beverages sectors by country (2015)

Agriculture

Food & Beverages

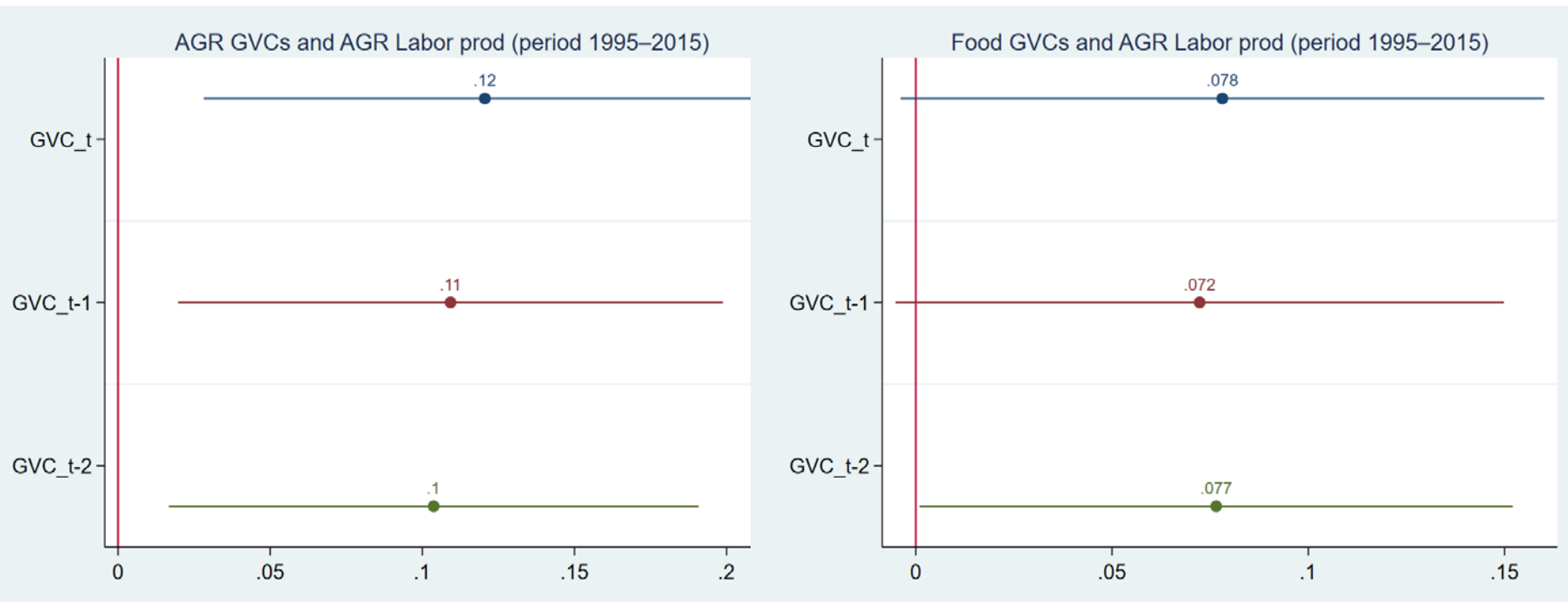*Source*: Montalbano and Nenci (2021) based on Eora data.

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Impacts of GVCs on agriculture and food performance: empirical evidence

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Impacts of GVCs on agriculture and food performance

Positive perspectives:

- supporting the ongoing transformations in the agriculture and food markets, especially in developing countries (Greenville, Kawasaki, and Beaujeu, 2017; Del Prete, Giovannetti, and Marvasi, 2017; Balié, Del Prete, Magrini, Montalbano, and Nenci, 2019)

- boosting agricultural GVC participation and agricultural value added generation via sectors that demand agricultural inputs (Dellink, Dervisholli, Nenci, 2020)

- enhancing overall sector growth – improving the returns to farmers and food makers along the value chain - and employment growth as a result of access to more efficient and higher quality inputs and services & reaping productivity gains from new technologies and wider innovations (OECD, 2020; Montalbano and Nenci, 2020)

- opening access to unprecedented flows of knowledge, capital, and, in particular, sophisticated inputs (IMF 2015; Montalbano, Nenci and Pietrobelli, 2018), which can lead to an accelerated and widespread path of structural transformation and income growth

- promoting a more efficient allocation of resources, raising the availability of food, lowering prices and improving consumer choice (OECD, 2020)

- improving income stability and food security (Cattaneo and Miroudot, 2015)

GVC participation is positively and robustly associated, on average and *ceteris paribus*, with changes in agriculture value added per worker.
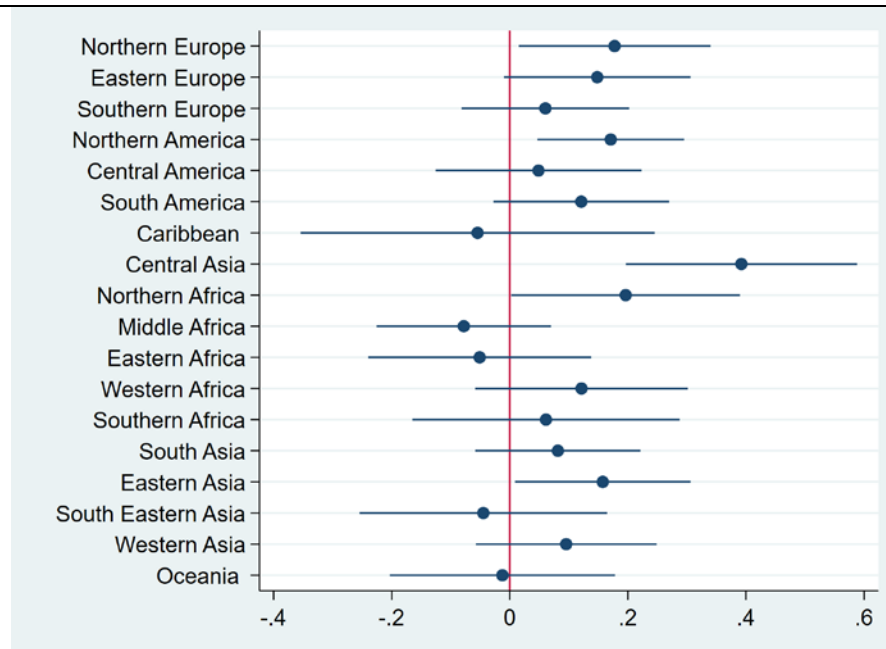

Source: Montalbano and Nenci, 2021, «Does Global Value Chain participation and positioning in the agriculture and food sectors affect economic performance? A global assessment"

… However, there is regional heterogeneity
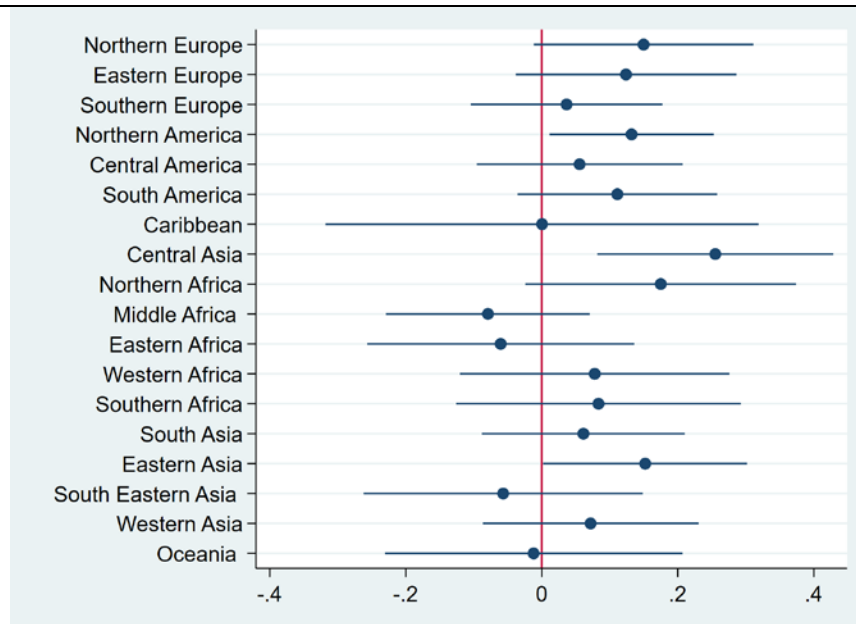
(panel a) agriculture

(panel b) food

Source: Montalbano and Nenci, 2021, «Does Global Value Chain participation and positioning in the agriculture and food sectors affect economic performance? A global assessment"

Impacts of GVCs on agriculture and food performance

Main difficulties:

Most of the (micro) empirical analyses underline that getting access to, involvement, and participation in a GVC is not an easy task mainly because of:

- high standards, see Dolan and Humphrey, 2000; Reardon *et al.*, 2009; Gibbon, 2003; Berdegué *et al.*, 2005; Jaffee and Masakure, 2005; Belton *et al.*, 2011; Bamber and Fernandez-Stark, 2014;
- high transaction costs, see Swinnen, 2016; Lee *et al.*, 2012; Montalbano *et al.*, 2018a;
- weak regulatory institutions, see Hazell *et al.*, 2010.

Positive impacts on the domestic economy should not be taken for granted: significant effects only for middle- and high-income countries (Fagerberg, Lundvall and Srholec, 2018)

In summary, the empirical evidence yields a mixed picture on the capability of countries – and small farmers – to join agri-food value chains and exploit their economic benefits.

Critical issues on GVCs

Main issues

There are some critical aspects that are currently affecting the GVCs – global but also agri-food ones - which may affect and shape the future of GVCs.

Among the issues identified by scholars (Antras, 2020; OECD, 2017; Fortunato, 2020), we focus on the following:

1. the relationship between GVCs and trade policy

2. the advent of new technologies

3. the impact of COVID-19

1-Trade policies and GVCs: the bidirectional nexus

Recent developments in international trade literature have attempted to shed light on the interrelation between trade policies and trade patterns within GVCs.

The issue is complicated since GVC-trade policy nexus is bidirectional:

➤ the *reduction in trade barriers* has been identified as one of the *determinants of the spread and diffusion of GVCs* (Antràs, 2020a)

➤ and, conversely, the *global fragmentation of production influences trade policy* (Goldberg and Pavcnik, 2016; Blanchard et al., 2016; Antras and Staiger, 2012; Ruta, 2017; Ludema et al., 2019; Bown et al., 2020; Raimondi et al. , 2021).

1. Impact of trade policy on GVCs

The literature highlighted two potential effects :

a) a "magnification effect" whereby goods that cross national borders multiple times incur multiple tariff costs (Yi 2003, 2010; Muradov 2017).

b) a "chain effect", which influences all the stages of a GVC and, consequently, a country's backward and forward participation (*protective measures against any country have knock-on effects on all its trading partners in the value chain*) (Blanchard, Bown and Johnson, 2016; Balié, Del Prete, Magrini, Montalbano and Nenci, 2019).

Also non-tariff measures (NTMs) affect GVCs. They tend to be higher for agricultural and food products than for many other sectors (Unctad). They can support or hinder trade, depending on their design:

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Simulations of trade policy impact on GVCs

Computable general equilibrium (CGE) models allow for supply chain cross-border linkages corresponding to the global ICIO table (Walmsley et al., 2014; Minor and Walmsley, 2017; Antimiani, Fusacchia, and Salvatici, 2018; OECD, 2018).

Change in GVC backward and forward participation by sector (percent): Scenario d) (All policies)

Source: Fusacchia and Salvatici, 2020
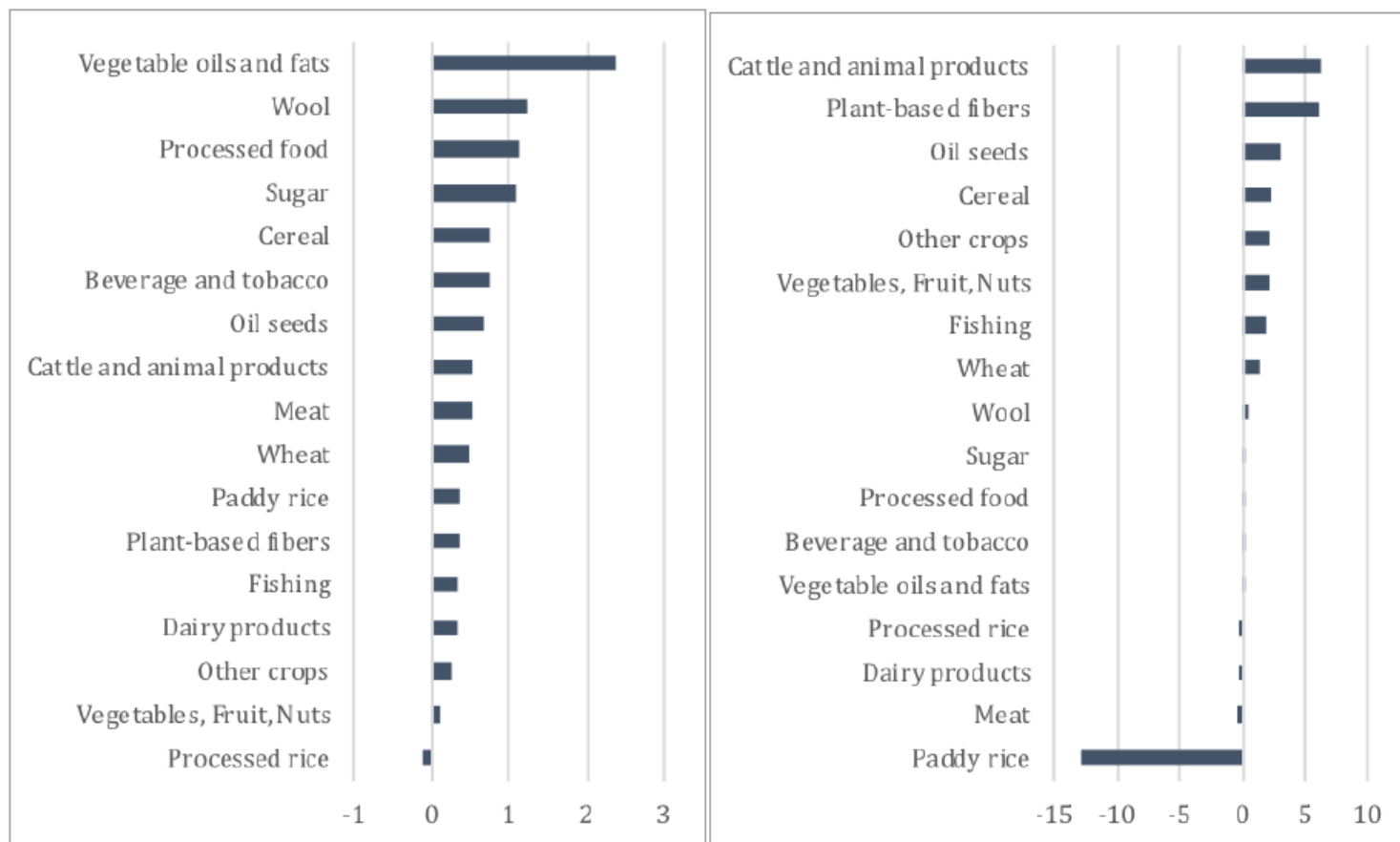
2. The advent of new technologies

The "new technologies" - automation, digitalization, advanced robotics and smart factories -affect structural and agricultural transformations across the globe (Christiaensen et al., 2021): they reduce transaction costs, change economies of scale and modify the optimal inputs mix in agricultural production, processing and marketing:

➢ Digital platforms allow the matching of buyers and sellers, fostering verification and monitoring in firm-to-firm relationships and thus lowering the initial fixed costs associated with GVC participation and information frictions (Antràs, 2020a).

➢ The ability to access and share agricultural data can support more efficient transactions, improve trade facilitation and cross-border customs processes, reduce traditional constraints to trade, enhance transparency and traceability of agricultural products and design demand-side policies (OECD, 2020).

➢ Robots are beginning to be used in fields and packaging plants, together with tech-savvy agricultural workers, to integrate new technological solutions into specific goods and tasks. Solar-driven water pumps, cold storage and agro-processing equipment are also beginning to spread in developing countries, *accelerating the transition away from subsistence production* (Banerjee et al., 2017; World Bank, 2020).

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2. The advent of new technologies -2

However, these emerging innovations can prove to be quite disruptive.

For instance, typically demand for automation can lead to a reduction in the demand for workers (Rodrick, 2018; Acemoglu and Restrepo, 2020, Acemoglu et al., 2020). Since some agricultural tasks are highly automatable, automation could accelerate the exit of workers out of agriculture in developing countries and transform farms and food processing firms in the industrialized world.

Technological changes may have a deep impact even on income differentials. A vast strand of literature points out that participation in GVCs increases the skill premium, thus exacerbating wage inequality, especially in developing countries (Chaudhuri et al., 2010; Li et al., 2016; Shen and Zheng, 2020).

Consequently, the overall impact of these technologies on GVCs is ambiguos.

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3. The impact of COVID-19: trade

Significant trade reduction (Baldwin, 2020; WTO, 2020): - 5.3% in 2020 in the volume of world merchandise trade; - 8% in nominal US dollar terms and -20% for commercial services exports.

Increasing **research on its economic impacts** (Baldwin and Tomiura, 2020; Baldwin and Freeman, 2020; Miroudot, 2020; Antràs et al., 2020).

World merchandise trade volume

Index, 2015=100

Source: WTO
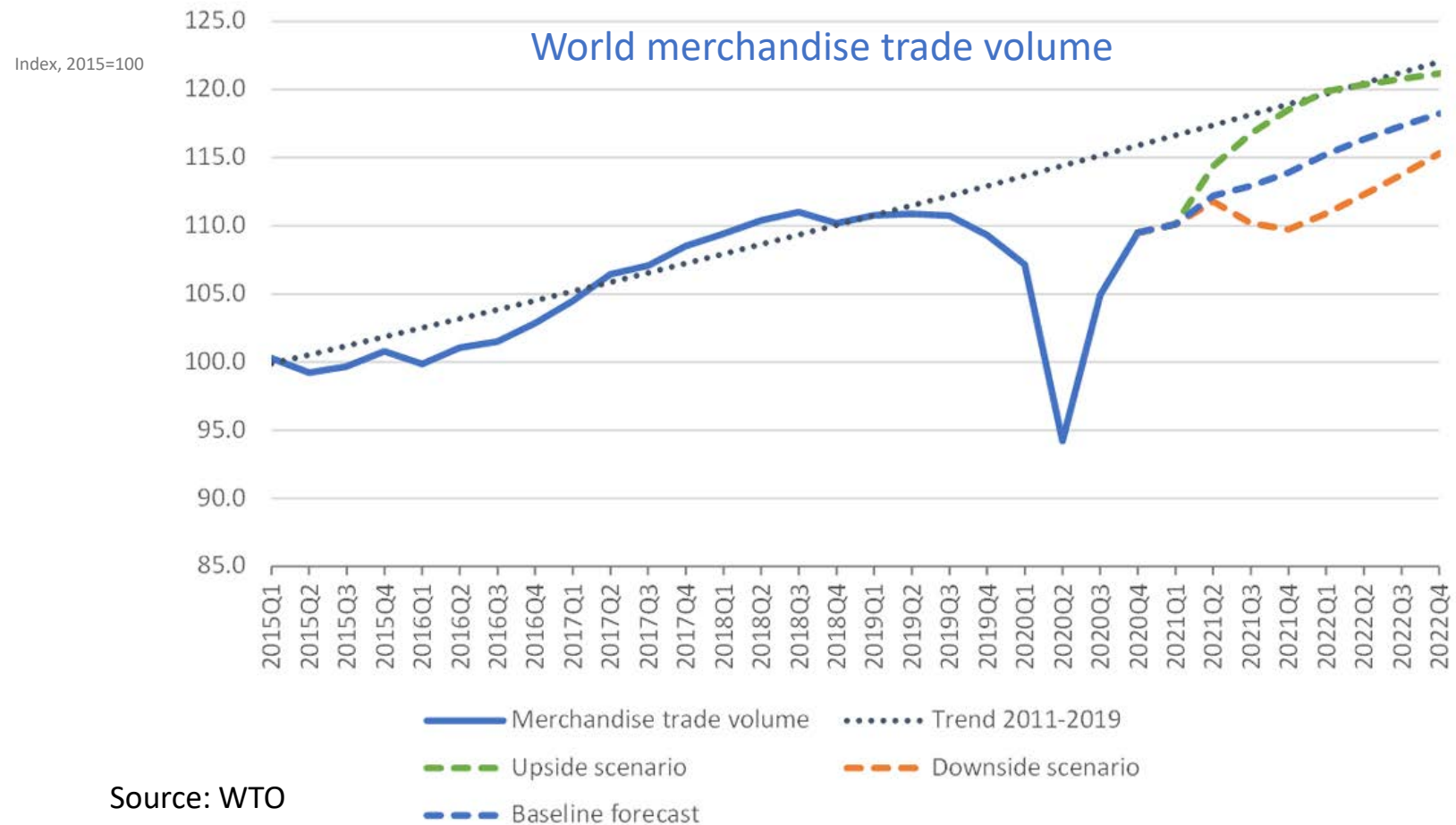
The impact of COVID-19: empirical evidence

A negative impact (Sforza and Steininger, 2020; Di Nino and Veltri, 2020; Pahl et al., 2021), strictly related to the degree of participation of countries in GVCs (Eppinger, 2020).

In the agriculture and food GVC: agri-food supply chain disruptions (Christiaensen et al., 2021)

The pandemic has imposed shocks on all segments of this supply chain

Heterogenous effects: not all sectors and products have been equally affected (OECD, 2020):

- agri-food supply chains in the developed world have demonstrated *remarkable robustness and resilience* in the face of COVID-19

- in the developing world, the impacts on agri-food-supply chains are *expected to be felt widely but unevenly* (Reardon et al., 2020).

In term of actions, local governments have actively strengthened food safety nets and social protection mechanisms to maintain access to food. Also subsidies, tax breaks and transfers. These measures have been indispensable but acted basically as coping strategies (Morton, 2020; Montalbano and Nenci, 2021).

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Conclusions

The future of GVCs

The complexity and high restructuring costs related to GVCs will probably prevent the large-scale dissolution of the existing GVCs (Bonadio et al., 2020; Antras, 2020; Miroudot 2020; Qiang et al., 2020; Simola, 2021).

Most GVCs will probably be concentrated in a few large and centrally located hub economies, while smaller, poorer and peripheral countries risk being set adrift.

The key question then becomes how to consolidate GVCs in the future and ensure that the benefits are maximised and shared across countries.

In this context, *can policies play a critical role?*

➢ Reshaping trade policies to foster access to imported technology and world class inputs;

➢ Adopting policies to deal with the uneven distribution of GVCs gains across countries, firms and individuals located in different development contexts;

➢ Designing stabilization policies to keep food safety and nutrition security in a GVCs environment exposed to risks;

➢ Adopting non-distorting domestic agricultural policies (such as R&D, education and high quality physical infrastructure).

Thanks for your attention!

Silvia Nenci