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Global Value Chain Analysis: Concepts and Approaches

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Abstract

The development of global value chains (GVCs) and their economic impact on countries, industries, and firms has been much discussed in the business and economics literature. This introductory paper reviews and highlights some of the key topics covered in GVC literature, aiming to give readers a comprehensive overview of the relevant material to enhance their understanding of GVC research. It has three sections: the first section explains key concepts, describes the characteristics of GVCs, and briefly discusses the factors behind recent GVC developments. The second section summarizes major GVC analytical approaches commonly used in the business and economics literature. The final section highlights the economic impact of GVCs in four important areas: competitiveness, economic development, labor markets, and trade costs.

Keywords: global value chains, GVCs, global supply chain management, trade in value added, offshoring, outsourcing, competitiveness, economic development, upgrading, trade barriers and measures, trade cost, labor effect, income distribution.

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Introduction

World economies are becoming more deeply integrated and interdependent, with global production networks and value chains (GVCs)[1] among the major drivers of structural economic changes at the global, regional, national, industry, and firm levels (Sturgeon and Memedovic 2011). Leveraging advancement in transport and communication technologies, large multinational enterprises (MNEs) incorporate offshoring and outsourcing[2] as key parts of their global strategies; together with the increase in foreign direct investment (FDI) and intrafirm international trade. Both the development of GVCs and their economic impact on countries, industries or firms have been widely discussed in business and economics literature, using various analytical approaches. This paper reviews and summarizes some of the major papers, aiming to give readers an overview of relevant material to facilitate their understanding of GVC research.

The paper consists of three sections. The first section explains key concepts in GVC literature and briefly discusses the factors behind GVC development over the past three decades. The second section summarizes three major analytical approaches commonly used in business and economic GVC literatures. The final section highlights the economic impact of GVCs in four important areas: competitiveness, economic development, labor markets, and trade costs.

Concepts and Background

Michael Porter first presented the concept of value chains in his influential 1985 book, *Competitive Advantage: Creating and Sustaining Superior Performance*. Porter identifies a value chain as a set of activities that a firm performs to deliver a valuable product or service to the market. A value chain can be broken down into five primary activities:

- *Inbound logistics:* such as receiving raw materials, warehousing, and managing inventory;
- *Operations:* all activities in the process of converting raw materials into a finished product or services;
- *Outbound logistics:* such as delivering the final product or service to the end user;
- *Marketing and sales:* all strategies and activities aimed at incentivizing potential customers to purchase the final product or services, including distribution channel selection, advertising, and pricing;
- *Post-sale services:* all activities that intend to improve consumer experiences, such as customer services, repairs, or maintenance services.

[1] See appendix A for a list of acronyms appearing throughout this article.
[2] Offshoring refers to a firm's arranging for work to be done in a different country, but by the same firm. Outsourcing refers to a firm contracting work out to an external organization. Offshoring can include outsourcing when the contractors are located in foreign countries.

A value chain could also include secondary or support activities that facilitate the efficiency of the primary activities, such as procurement, technology research, product development, human resource management, and firm infrastructure building.

Porter notes that these activities form a firm's value chain, each creating and adding value at every stage toward the end product or service. He suggests that a firm must understand its own value chain to develop and sustain a competitive advantage (Porter 1985).

Supply chain is another commonly used term. Early discussions on supply chains were more logistics-oriented. Since the mid-1990s, however global manufacturing networks have become increasingly integrated and interdependent. As a result, supply chains have been increasingly associated with business functions and processes beyond logistics within and across companies.[3] The Council of Supply Chain Management Professions (CSCMP)[4] defines a supply chain as the links between companies which interchange materials and information in the logistics process, stretching from acquiring unprocessed raw materials to delivering finished goods to end users (Vitasek 2013). These links generally encompass three functions: (1) supply of materials to a manufacturer; (2) the manufacturing process; and (3) the distribution of finished goods to final customers through a network of distributors and retailers.[5] Similarly, Stacy Fredrick (2010 and 2014) defines supply chains as production-related input-output links, which she illustrates within the value chain ecosystem using her value-chain reference model (VCRM) diagram (box 1).

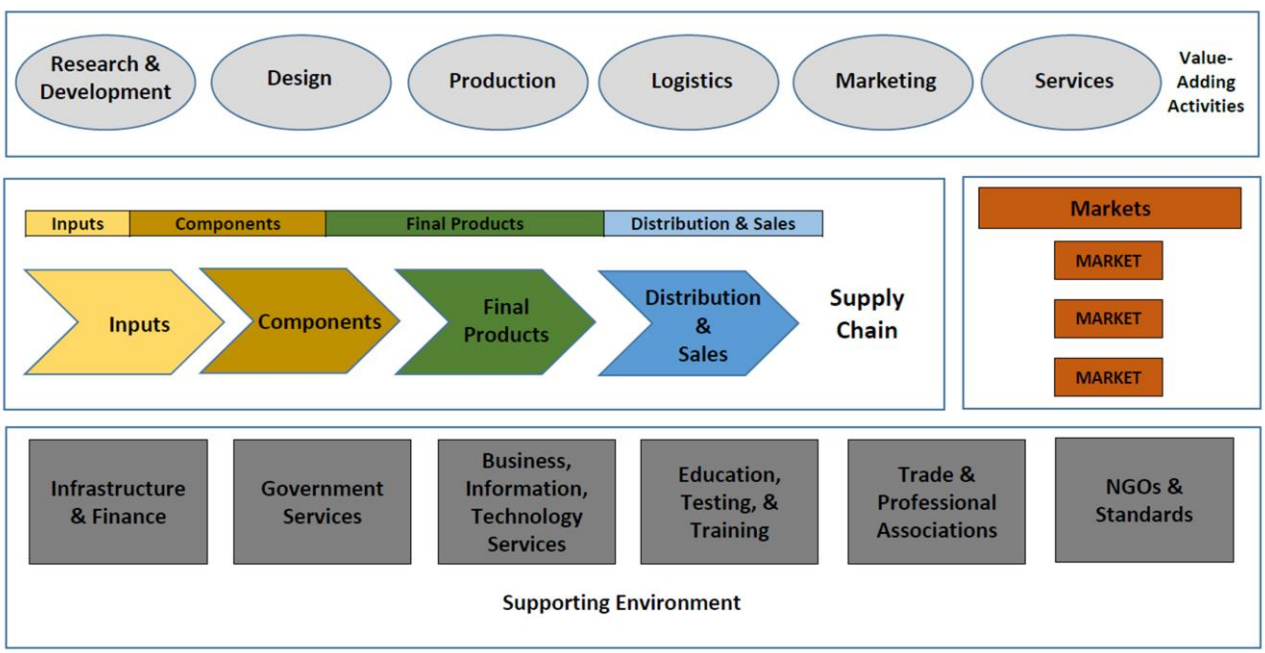
The concept of global value chains (GVCs) or global supply chains (GSCs) is the international extension of these definitions, responding to the growing phenomenon of global production fragmentation—the fact that business functionalities and production activities along a value chain are increasingly carried out by various entities located in different countries. As a result, GVC-related international transactions have become an important aspect of cross-border trade, and GVCs have been recognized as an important driver of structural change in the world economy (Sturgeon and Memedovic 2011).

Decreasing trade costs are among the major factors that have contributed to the recent GVC expansion. Trade costs include the whole range of costs that companies face to move goods or services from where they are produced to final consumers (OECD 2012). Global trade liberalization in the past few decades has significantly reduced costs associated with tariffs and some nontariff trade barriers. Regulatory reforms in transport and infrastructure sectors encouraged investment in roads and ports in many countries, improving logistical efficiencies.

[3] Recognizing the new dynamics and extended content in supply chains, Council of Logistics Management changed its name to the Council of Supply Chain Management Professionals (CSCMP) in 2005. Robinson (2015).
[4] Formerly the Supply Chain Council.
[5] Canadian Supply Chain Sector Council, "Supply chain definitions," http://www.supplychaincanada.org/en/supply-chain.

Box 1. The value-chain reference model (VCRM) diagram

Introduced by Stacy Frederick (2010 and 2014), the value-chain reference model (VCRM) provides a comprehensive picture of value chain ecosystem. It consists of four parts: *value-adding activities*, *the supply chain*, *end-use markets*, and the *business supporting environment*.



Source: Fredrick (2010 and 2014).

Value-adding activities include the six broad steps that may be required to bring a product or service from a concept to end users. These activities include research and development, design, production, logistics, marketing, and services.

The supply chain describes the input-output process with four basic stages—raw inputs, components and parts, final products, and distribution and sales—which make up production-related links in the value chain. These stages can be linked to the International Standard Industry Classification system (ISIC) or the North American Industrial Classification System (NAICS), and can be used to map the participants in the value chain. These input-output relations may differ substantially for different industries or products.

End-use markets include consumer retail markets, public-use markets, and industrial markets. Each market consists of many different products, but serves different purchasing purposes, whether for private household consumption, public and institutional expenditure, or business capital investment.

Supporting business environments can be separated into six broad categories: infrastructure and finance; government services; business, information, and technology services; education, testing, and training; trade and professional associations; and nongovernmental organizations (NGOs) and standards. Together they provide the basic structure for all economic activities, and can facilitate or hinder the movement of products along the value chain (Fredrick 2014).

The emergence of mega-scale ocean-going vessels and the adoption of standardized containers expanded shipping capacities and reduced average international shipping costs (UNESCAP report 2194). Advancement in information telecommunication technology, such as the Internet, enabled a new breed of logistics, distribution, finance, and business services providers, which facilitated the efficient configuration of GSCs and made the real-time management of GVC activities both feasible and inexpensive.

Corresponding to this more favorable trading environment were increases in offshoring and outsourcing activities, the use of imported intermediate inputs, and trade in intermediate goods. Three hypotheses attempt to explain these phenomena (Kleinert 2003):

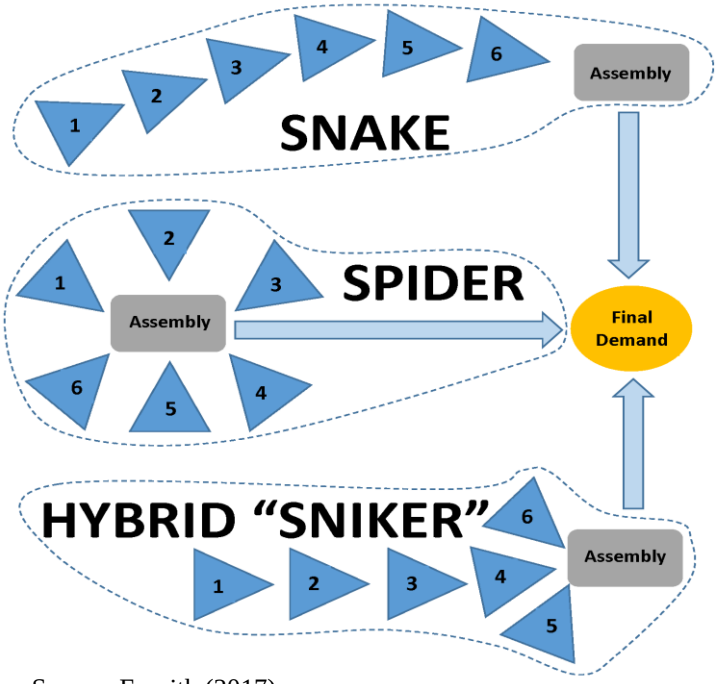
- "The *outsourcing hypothesis* argues that companies in industrialized countries respond strategically to increasing import competition from low-wage countries by relocating labor-intensive stages of their production process to foreign countries with abundant labor and lower wages." (Feenstra and Hanson 1996).
- The *multinational enterprise (MNE) network hypothesis* argues that increasing intermediate goods trade is due to the rising intrafirm trade within the trading networks of MNEs, occurring between MNEs' affiliates in foreign and home countries as well as with parent companies (Anderson and Fredriksson 2000).
- The *global sourcing hypothesis* argues that the increasing use of imported inputs is facilitated by international integration, whose factors, such as migration, proximity, former colonial ties, and common language, help achieve the best match between buyers and sellers (Rauch 1999).

While these hypotheses provide evidence for and arguments about motivations and enabling factors for the development of GVCs, it is rather the fundamental change in production processes that underlies the recent development of international outsourcing and trade. The traditional notion of production for foreign trade is horizontal, meaning that firms or countries are specialized in producing particular final goods or services from scratch within the firm or country and exporting them. Today, the notion of production is more akin to a highly complex network structure in which components and parts are produced at multiple stages across different countries that are linked horizontally, vertically, and diagonally (Henderson et al. 2002). Firms or countries are specialized in some but not all stages of the production process (Hummels, Rapport, and Yi 1998).

Such intra-product specialization is possible only when various tasks of a production process are physically separable and tradable, enabled by technological change (Grossman and Rossi-Hansberg 2006). Productivity gains, economies of scale, and potential savings in learning costs encourage the creation of firms focusing on component production. International fragmentation of production processes is a precondition for outsourcing and offshoring, and it creates a vertical intra-industry international trade of components and unfinished products, with a good share of this trade generated within MNEs (Andreff 2009).

Baldwin and Venables (2013) identify two different configurations commonly existing in global production sharing: "spiders" and "snakes" (figure 1). The "spider" refers to multiple limbs (parts) coming together to form a body (assembly), being either the final product itself, or a component. The "snake" refers to the goods moving in a sequence from upstream to downstream, with value added at each stage. Most production networks are complex mixtures of the two, or a so-called "sniker." These configurations affect production locations as well as interactions between firms. The changes in trade frictions could have different outcomes for these two types of configurations (Escaith 2017).

Figure 1. An illustration of the "Snake, Spider, and Sniker" production configurations



Source: Escaith (2017).

Major Global Value Chain Analytical Approaches

Based on the business and economics literature reviewed, GVC analytical approaches can be grouped into the following four major categories (table 1). Each approach is discussed in further detail in the subsections below.

Table 1. Major global value chain (GVC) analytical approaches

Analytical approach	Description	Measurement method[a]
Supply chain management	A business analytical framework from the firm's perspective on how a firm can enhance competitiveness in the context of GVCs.	Specific business/industry expertise
Industry or product case studies	In-depth GVC analysis from the industry's perspective, such as value distribution along a supply chain, key players, the main characteristics of the value chain, etc.	Micro-level firm survey;[b] refined Broad Economic Categories by end use classification[c] to trade statistics.[d]
Input-output based analytical approaches	Quantitative analysis from a macro perspective, by applying the input-output framework to measure a country's specialization in global production networks and its GVC participation.	Trade in value-added (TiVA) measurement based on inter-country input-output tables.
Other analytical approaches	Applications of general and partial equilibrium models, as well as gravity models, for GVC-related analysis.	Industry or firm data; trade statistics; inter-country input-output tables, etc.

[a] Daudin, Rifflart, and Schweisguth (2011).

[b] Hanson, Mataloni, and Slaughter (2005).

[c] The Broad Economic Categories (BEC) is a 3-digit classification by U.N. Statistics Division that groups goods according to their main end use. The 4th revision includes seven top categories: food and beverage; industry supplied not elsewhere specified; fuel and lubricants; capital goods, parts and accessories; transport equipment, parts and accessories; consumer goods not elsewhere specified; goods not elsewhere specified. It is linked to the basic classes of goods in the System of National Accounts which include consumption goods, intermediate goods, and capital goods. Source: U.N. Statistics Division, "Classification by Broad Economic Categories," http://ec.europa.eu/eurostat/ramon/other_documents/bec/BEC_Rev_4.pdf.

[d] Sturgeon and Memedovic (2011) and Ferrantino and Schmidt (2018).

Supply chain management framework

One major branch of business literature on supply chains is supply chain management (SCM), a business analytical framework from the firm's perspective on how a firm can enhance competitiveness in the context of GVCs. First introduced by business consultants in the 1980s, the concept of SCM has developed significantly over the past two decades, drawing from other branches of literature such as logistics or marketing (Park, Nayyar, and Low 2013; Lambert and Cooper 2000).

There have been various definitions of SCM in the literature. According to New and Payne (1995), SCM encompasses the entire value chain, linking the manufacturing process from raw materials through to the end users. Harland (1996) described SCM as managing business activities and relationships internally within an organization, and externally with suppliers and customers along the supply chain. Farley (1997) reckons SCM is about how firms use their suppliers' processes, technology, and capability to enhance competitive advantage. Lee and Billington (1992) argue SCM is about the coordination of the manufacturing, logistics, and materials management

functions within an organization. Park, Nayyar, and Low (2013) and Stadtler (2005) define SCM as "the task of integrating organizational units along a supply chain and coordinating materials, information and financial flows in order to fulfil (ultimate) customer demands with the aim of improving competitiveness of the supply chain as a whole."

In short, SCM can be summarized as a cross-functional, integrated business approach to actively manage supply chain processes for maximizing value creation and achieving sustainable competitive advantages. It is the firm's conscious effort to coordinate supply chains activities in the most efficient way, and to cultivate collaborative supplier-customer relationships to ensure a seamless operation process. Such supply-chain activities include everything from product development, component and part outsourcing, and production to storage and logistics, as well as the information systems needed to coordinate these activities.

Within the past decades, SCM has emerged as a well-adopted business framework that promotes the enhancement of a firm's competitiveness through improvements in the organizational structure and process of a supply chain (Lambert and Cooper 2000; Mentzer et al. 2011). Important aspects of the SCM framework are the relationship between different organizations and their network effect within the supply chains that influences business functions (Park, Nayyar, and Low 2013; Mentzer et al. 2011). Forrester (1958) points out the importance of five flows (information, materials, money, manpower, and capital equipment) to the performance of business functions. Developing integrated business functions to effectively manage these flows between different entities in a supply chain is the essence of the SCM framework.

The Supply Chain Operations Reference (SCOR) model is the most recognized management tool under the SCM framework that can be used to evaluate, address, improve, and communicate SCM decisions within a company and with suppliers and customers (SCC 2004). This model is a cross-functional process-reference model developed and endorsed by the Supply Chain Council (SCC). SCOR integrates business concepts of process reengineering, benchmarking, and measurement into its framework (Huan, Sheoran, and Wang 2004), focusing on five distinct management processes of the supply chain: plan, source, make, deliver, and return (SCC 2007).

Industry or product case studies

Industry or product case studies are a common approach offering in-depth GVC analysis with sectoral perspective. Such literature usually maps value distribution along a supply chain, delineates the GVC characteristics, identifies the key actors, and discusses the evolution of GVCs in the corresponding sectors (Sturgeon et al. 2009). This subsection highlights some of the more well-known works.

Gary Gereffi is among an earlier group of researchers who have done considerable work analyzing GVCs at the industry level. Gereffi introduces the perspective of the global commodity chain (GCC), and argues that the governance structure of GCCs is essential to the coordination of the global production system. Two types of GCCs are identified, based on their governance structure: producer-driven and buyer-driven. In producer-driven GCCs, MNEs or integrated industrial enterprises play a central role in controlling the production system, including the forward and

backward linkages, through their domestic and foreign subsidiaries and subcontractors. This type of GCC is more common in capital- or technology-intensive industries, such as automotive, computers, aircraft, and electrical machinery. In buyer-driven GCCs, large retailers, brand-named companies, and trading companies play a pivotal role in setting up the production networks through different tiers of contractors, though production is generally carried out by independent factories. This type of GCC is more common in labor-intensive, consumer-goods industries, such as apparel, footwear, toys, consumer electronics, and housewares (Gereffi 1994 and 1999).

Sturgeon et al. (2009) often uses GVC analysis in studies that break out industries into two broad types of firms: *lead firms* and *suppliers*. *Lead firms* focus on product and brand development, marketing, distribution, and sometimes late-stage manufacturing, such as final assembly. *Suppliers* focus on selling products and related services, many of them the result of value-chain activities that lead firms have decided to outsource (Sturgeon 2003; Sturgeon et al. 2009). Sturgeon (2003) introduces the concept of value-chain modularity, which states that distinct breaks in the value chain tend to form at points where information about product or process specifications can be formalized and standardized, largely determined by technical factors. Modular production networks emerge, encompassing nodes of value-chain activities linked through codified interfirm exchange, to create a global-scale production system. Such networks allow suppliers to take advantage of economy of scale and scope while offering lead firms cost-saving benefits as well as operational flexibility (Sturgeon 2003).

Apparel and textiles

Applying the GCC approach, Gereffi (1994) conducts a case study on the apparel industry, which he identifies as a buyer-driven GCC with two dimensions: textile versus garment manufacturing, and the standardized versus fashion-oriented segments. He discusses the development of the upstream textile and downstream retail industries in the United States, and analyzes the impact of these forward and backward linkages on garment producers as well as outsourcing practices in these industries. He notes the combination of concentrated buying power in the U.S. retailing and wholesale sector and excess capacity in overseas factories has permitted large buyers to dictate outsourcing prices and terms with their vendors. Although large buyers are sensitive to factors that could affect the global supply network, they are in a strong position to respond to changing economic and political factors by altering overseas production patterns.

Electronics

The electronics industry is arguably the goods-producing industry with the most dynamic value chain activities. Sturgeon and Kawakami (2011) find that in the past 20 years, East Asia in general and China in particular have become increasingly important in the electronics industry, both as production locations and final markets. Compared to other technology-intensive industries, there is less need for co-location of engineering or design with manufacturing in the electronics industry, and thus it is relatively easy for electronics firms to pursue the strategies of outsourcing and offshoring. As a result, GVCs in the electronics industry are the most geographically extensive and dynamic.

Sturgeon and Kawakami (2011) identify three principal actors in the electronics GVCs: *lead firms*, *platform leaders*, and *contract manufacturers*.

- *Lead firms*, such as Dell, Apple, and Cisco, place orders with suppliers and sell branded products and systems in final markets. These lead firms usually earn market powers through their technological research and development, and big investment in brand development, which allows them to select alternative vendors and capture the lion's share of value created within the chains.
- *Platform leaders*, such as Intel, are the companies which have been successful in implanting their technology into the products of other companies. They have the technological capability and market power to influence the value chains and capture a bulk of the profits. However, platform leaders are not common in electronics sectors other than personal computer (PC) and mobile phone industries.
- *Contract manufacturers* make products for lead firms by providing either production services, or so-called electronics manufacturing services (EMS), or manufacturing plus production design services, or so-called original design manufacturing (ODM) services. Contract manufacturers carry out component purchasing, circuit-board assembly, final assembly, and testing. Since the technology used in electronics manufacturing processes is quite generic, substitutability is relatively high, so contract manufacturers usually face fierce competitions as well as low market power and profit margins. Nonetheless, the rapid rise of contract manufacturers is the most notable feature in the electronics value chains (Sturgeon and Kawakami 2011).

Sturgeon (2003) notes that the production structure of the electronics industry is extremely modular, with semiconductor foundries carrying out chip fabrication, full-services contract manufacturers assembling circuit boards and final products, and the vendors of production equipment, such as Applied Materials and Siemens, driving process technology. This type of industry structure allows "virtual" lead firms and "fabless" design houses without in-house production to carry out global production strategies, while creating a new class of globally operating suppliers with vast capabilities in production as well as cross-border value chain activity integration (Sturgeon 2003; Sturgeon and Kawakami 2011).

Automotive industry

Sturgeon and his co-authors have also written a number of papers on the automotive industry. They find that the opening of new markets in emerging economies such as India and China has resulted in a surge of foreign direct investment (FDI), and the automotive industry has been transformed from discrete national industries into a more integrated global industry (Sturgeon et al. 2009).

As a producer-driven GVC, several unique features distinguish the automotive industry from buyer-driven industries such as textiles. These features include the extreme concentration of lead firms; the lack of open, industry-wide technical standards, which undermines the wide application of modular production; the implementation of lean production techniques and just-in-time (JIT) parts deliveries; the increasing adoption of "build-to-order" and product customization; the wide

range of local market differences, such as different emission standards, safety regulations, and road conditions; and the closer proximity of parts production to final assembly and end markets.

The concentrated firm structure gives substantial coordination and buying power to a few giant lead firms, and allows each of them to create its own specifications and standards. The lack of industry standardization forces close interaction between lead firms and suppliers, which in turn shapes the structure and relations of value chains. As a result, although the lead firms and largest suppliers have become global with multinational operations, the need for close collaboration on producing customized vehicles for a specific geographic market has led to the development of multiple regional production systems (e.g., North America, East Asia, Latin America). These are characterized by strong regional integration of the production structure and the tight linkage of local and national value-chain activities within the region. Because of heavy investment in capital equipment and skills, as well as tight value-chain linkages, these automotive producing clusters tend to be more stable and long-lived than other industries (Sturgeon et al. 2009).

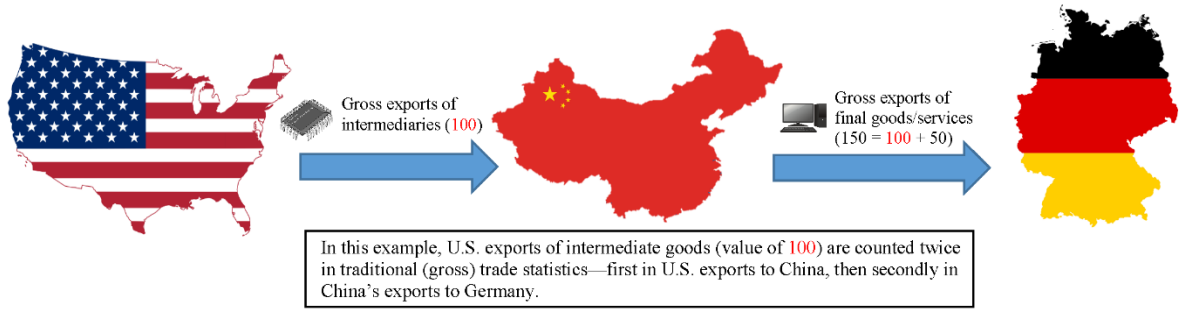
Apple Inc. products

Apple's products are a popular subject for GVC case studies. Dedrick, Kraemer, and Linden (2010) apply a micro-level analytic methodology to measure, map, and analyze the distribution of the value embedded in Apple products along the supply chain. They identify and isolate components used in the products, and obtain the corresponding factory prices and/or costs for these components and parts. They use operating margin rates of suppliers as a proxy to estimate the value captured by these input suppliers. Similarly, they estimate gross profit margins for manufacturing, distribution, and retail services as a proxy to estimate the value captured by these services providers. They find that after these estimates are deducted from the price of Apple products, the residual value—roughly about 30 percent for iPods or iPads, and 56 percent for iPhones—went to Apple, the lead firm in the value chain.

Input-output based analytical approaches

Although qualitative or microdata-based product or industry case studies provide in-depth information on the configuration and characteristics of a specific supply chain, they do not offer a comprehensive picture at the macro level of the gap between value added and gross trade, as well as an economy's participation in global production chains (Koopman, Wang, and Wei 2014, hereafter KWW). Because of the "double-counting" problem in conventional gross trade statistics, mainly caused by intermediate goods crossing borders multiple times (figure 2), approaches based on conventional trade data risk overstating domestic value-added content of exports (Johnson and Noguera 2012).

Figure 2. An example of the double-counting problem in intermediate goods trade



Source: Authors modified based on a diagram from World Trade Organization (WTO) Secretariat.

Using inter-country input-output (ICIO) tables that link production processes within and across countries has been recognized as the most feasible, consistent, and comprehensive approach to measure trade in value-added (TiVA) terms globally (Degain et al. 2014).

Hummels, Ishii, and Yi (2001, hereafter HIY) are among the early researchers who propose using the input-output framework to estimate foreign value-added content embodied in intermediate imports used for producing exports as a way of measuring vertical specialization (VS). In their computation, they take into account imported inputs that are used directly for the production of exports, as well as indirectly for the production of domestic inputs that are subsequently used in the production of exports. From an export point of view, HIY (2001) proposed an alternative VS measure (VS1) referring to a country's intermediate exports that are used as inputs into another country's production of exports.

Johnson and Noguera (2012) pointed out that HIY's (2001) VS measure was applied under the strict assumption that a country's exports are entirely absorbed in final demand abroad. KWW (2014) had a similar comment regarding the HIY (2001) approach. First, they pointed out a problem with the first assumption in HIY's (2001) VS estimation, which states that the intensity in the use of imported inputs is the same between production for exports and production for domestic sale; KWW (2014) noted that this assumption does not hold in the presence of processing trade. They also pointed out a problem with HIY's (2001) second assumption, which holds that imported inputs are 100 percent foreign sourced. Again, KWW (2014) showed that this assumption does not hold when a country's initial intermediate goods exports eventually return to the home country for the next stage of production.

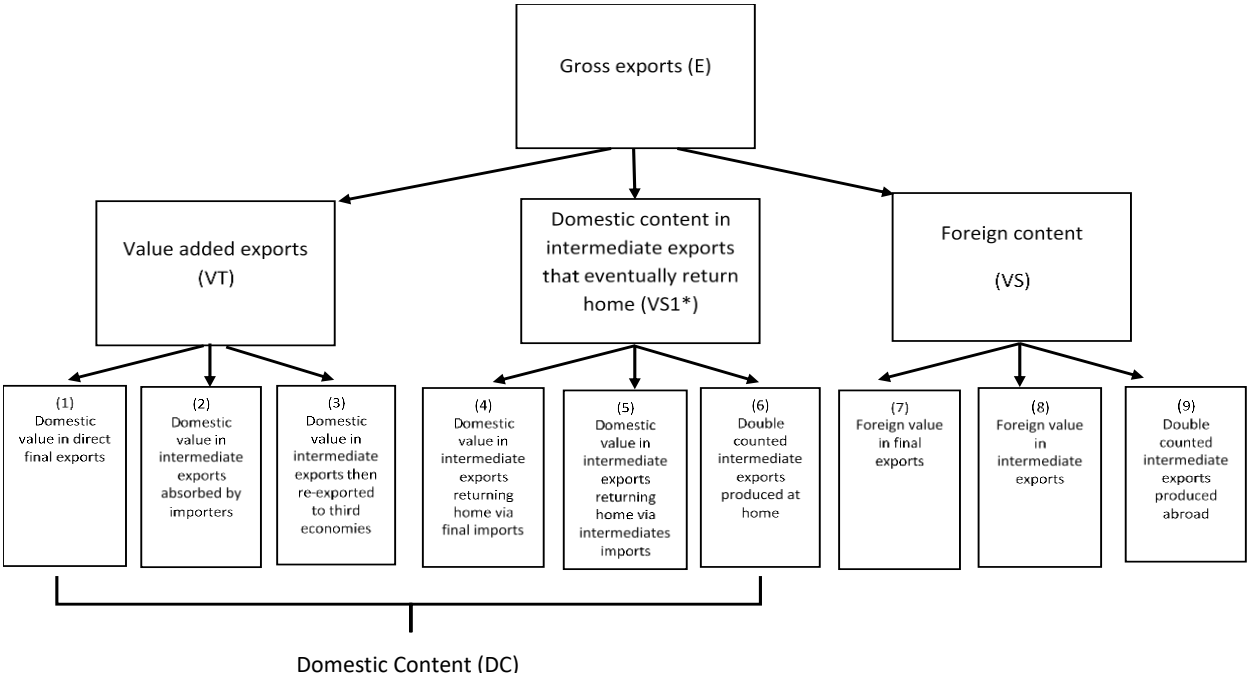
Following HIY (2001), a growing literature uses a similar input-output framework, but adopts different approaches to estimate TiVA measures. Daudin, Rifflart, and Schweisguth (2011) take the HIY (2001) approach further and propose VS1*, defined as the initial exports that come back to the country of origin as embedded in imported goods that are either consumed, invested, or used as inputs for domestic final use. Using input-output and bilateral trade data from the Global Trade Analysis Project (GTAP), Johnson and Noguera (2012) estimate the ratio of value added to gross exports (VAX) as a way of measuring the intensity of production sharing. Also based on GTAP input-output data but with additional refinement, Koopman, Powers, Wang, and Wei (2010, hereafter KPWW) make the initial effort to decompose gross exports at the country-sector level,

and propose a new way to measure revealed comparative advantage (RCA), bilateral trade balance, and trade-cost effects in value-added terms. Based on the World Input-Output Database (WIOD), Stehrer, Foster, and de Vries (2012) decompose value-added content by splitting production factors into capital and labor with different education attainment.

KWW (2014) extend the gross export decomposition methodology in KPWW (2010), integrating different TiVA measures in the literature. They then provide a unified accounting framework (figure 3) that breaks gross exports into various value-added components by source, including value-added exports (VT), domestic value added that returns home (VS1*), foreign value-added (VS), and additional double-counting terms. One of the major contributions of KWW's (2014) gross export accounting framework is that it makes it possible to quantify and allocate different types of double-counted terms in gross exports. KWW (2014) differentiates the definitions of "domestic value-added in exports" and "domestic content in exports." The former excludes domestic value added in intermediate exports that eventually returns home (VS1*), but the latter includes VS1*. Another contribution of this framework is bridging the gap between official trade statistics, which are in gross terms, and national accounts, which are in value-added terms.

Using the gross export decomposition in KPWW (2010) and KWW (2014), a number of additional TiVA measures have been developed. One is a GVC participation index, which consists of two components reflecting the upstream and downstream links in the GVCs. First, *forward participation* in a GVC refers to domestic value added embodied in foreign exports as a share of total exports of the source country (OECD, 2017). This corresponds to "(3) Domestic Value in intermediates re-exported to third countries" in figure 3. Second, *backward participation* in GVC refers to foreign value added embodied in exports as a share of total gross exports of the exporting country (OECD, 2017). This corresponds to "(7) Foreign Value in final goods exports" and "(8) Foreign Value in intermediate goods exports" in figure 3. *Forward participation* provides the supplier or seller perspective, where an upstream economy exports intermediate inputs for downstream production, and *backward participation* provides buyer or sourcing perspective, where a downstream economy imports intermediate inputs for its production of exports (WTO, accessed December 3, 2018).

Figure 3. The gross-export accounting framework



Source: Koopman, Wang, and Wei (2014).

Building upon the KWW framework, Wang, Wei, Yu, and Zhu (2017, hereafter WWYZ) propose two additional analytical frameworks, the *GDP decomposition frameworks* and *final goods production decomposition framework*. The *GDP decomposition framework* provides a producer-perspective, forward linkage-based analytical framework, which breaks GDP down into three segments: (1) a pure domestic segment, where production activities directly satisfy domestic final demand; (2) a traditional trade segment related to final goods exports, where production activities are for direct final consumption abroad; and (3) a GVC segment related to intermediate exports, where production activities are for intermediate trade that would be further processed along GVCs. In addition, WWYZ (2017) break down the GVC segment further into simple and complex GVCs: the former refers to production of intermediate inputs that cross borders once; and the latter refers to production of intermediate inputs that cross borders multiple times. The *final goods production decomposition framework* provides a user-perspective, backward linkage-based analytical framework. This framework breaks final-goods production down into domestic and foreign final uses, with embedded value derived from domestic and foreign sources. Under these two frameworks, WWYZ (2017) proposed a new TiVA measure, the production length index, that measures a production chain length from primary inputs in sector i of country s to final products of sector j in country r. WWYZ (2017) also revised the measurement of forward and backward GVC participation index: the forward participation index measures the share of production factors employed in a country-sector pair that are involved in cross country production sharing activities; the backward participation index measures the share of final products produced by a country-sector that comes from GVC activities.

Other analytical approaches

A considerable number of papers use other approaches to analyze certain aspects of international trade that are relevant to GVCs. For instance, the Eaton and Kortum model, a Ricardian general equilibrium (GE) trade model (Eaton and Kortum 2002), is often adapted to analyze the impact of production fragmentation and offshoring (Rodríguez-Clare 2010) or the optimal location of production and the specialization of countries within GVCs facing trade barriers (Antràs and de Gortari 2017). Standard computable general equilibrium (CGE) models such as the GTAP model (Tsigas, Wang, and Gehlhar 2012), partial equilibrium (PE) models (Barbe and Riker 2017), gravity models (Baldwin and Taglioni 2011), and econometric approaches (Antràs and Chor 2013) have also been adapted for GVC-related analysis. These methodologies are not provided in further detail, though the results from some of these papers are presented and discussed in the next section.

The Economic Impact of Global Value Chains

While these major analytical approaches provide a variety of tools for better understanding how GVCs have developed and functioned, there remains a great deal of nuance to be explored regarding their local and global externalities. Because GVCs function at such a refined level—linking stages of production for various goods and services across time and space—their economic, social, and political effects vary based on the unique combination of value-chain position and linkage, production stage, location, and product type found in each one. Existing literature has thus far attempted to study the economic impact of GVCs through the lens of familiar indicators, which are generally outlined below as competitiveness, economic development, labor effects, and trade costs.

Competitiveness

Competitiveness is both a driver and a consequence of GVCs. Fully understanding how GVCs affect competitiveness first requires clarification of the concept itself. At the macro level, competitiveness is "the set of institutions, policies and factors that determine the level of productivity of a country," as defined by the World Economic Forum (WEF), an international organization which has been measuring competiveness among countries since 1979 (Cann 2016). At the micro level, competitiveness is the ability of a given firm to successfully compete in a given business environment (Porter 1990) and outperform its competitors in terms of profitability, sales growth, or market share (Lall 2001). Four main factors contribute to a firm's competitiveness: (1) production and delivery capabilities, (2) production and delivery costs, (3) operational capacity, and (4) innovation and product differentiation (David, Semanik, and Torsekar 2018). Whether at the country or firm level, the common parameters for measuring competitiveness have long been relative productivity or efficiency (Reinert 1995).

In the context of international trade, competitiveness has been defined as the measure of a country's advantage or disadvantage in selling products or services in international markets (OECD 2014). Based on traditional trade statistics, Balassa (1965) develops the *revealed comparative advantage* (RCA) *index* as a measure of a country's relative trade performance and

competitiveness by comparing the share of a sector in a country's total exports relative to the world average of the same sector in world total exports. The resulting index reveals the country's comparative advantage (disadvantage) in exporting a product if the index's value is greater (less) than one (Pelzmen 2016).

Just as the rise of GVCs has fundamentally changed the structure of international trade, their emergence also demands new approaches to measuring competitiveness in international trade. Standard RCA applications, which are in gross terms and thus double-count intermediate input trade flows, often over- or underestimate a country's comparative advantage. Recognizing this double-counting problem in using traditional trade statistics, KPWW (2010) and KWW (2014) apply the RCA approach to TiVA statistics and use domestic value added instead of gross exports. They find notable differences between the results obtained using these two measures.

For instance, with standard RCA indices, both China and India have strong revealed comparative advantage in the finished-metal products sector and are ranked first and fourth, respectively, among the set of countries KPWW (2010) and KWW (2014) study. However, using value-added RCA indices, both countries' revealed comparative advantage as well as their rankings decline, while the rankings for some other countries move up. In fact, India even shifts from having a comparative advantage to having a comparative disadvantage in this sector. Applying similar methodology, Escaith and Miroudot (2016) calculate the differences between the standard and value-added RCAs at sector level for 61 countries, and their results show that the differences can be significant for some countries. Such revelations have spurred the discussion on expanding competitiveness measures to incorporate market accessibility, productivity performance, training and research levels, infrastructure, and regulatory environments in the context of GVCs (Timmer et al. 2013).

The impacts on competitiveness from GVC participation are dynamic and not universally felt. For example, small and medium-sized enterprises (SMEs), which account for 90 percent of all firms in most economies, face dual issues with regard to competitiveness (Park, Nayyar, and Low 2013). As SMEs are relatively less burdened by massive production chains and bureaucratic processes, GVCs offer increased opportunities for flexible SMEs to enter the global market at various production niches. However, SMEs in niche markets also face encroachment from larger enterprises with superior resources and market power (Park, Nayyar, and Low 2013). Ultimately, the outcome on competitiveness depends on SMEs' ability to increase productivity, a topic covered in the following subsection on economic development.

Economic development

The rise of GVCs has led to changes in international trade and economic development paradigms (Taglioni and Winkler 2016). Policy makers increasingly recognize that the economic opportunities from GVC participation go beyond the traditional notion of increasing exports; opportunities also include technology and knowledge transfer, rising FDI, and human capital upgrading. These benefits can lead to long-lasting productivity gains and sustainable economic growth. Low- and middle-income countries (LMICs) are particularly situated to benefit from

GVCs, as their participation fosters an adeptness that enhances ongoing processes of industrialization and "servicification" (Taglioni and Winkler 2016).

At the country or firm level, GVCs can stimulate productivity growth through four channels: (1) specialization, (2) foreign inputs, (3) technology spillovers, and (4) knowledge transfer. The expansion of GVCs allows greater specialization in specific activities within value chains (Criscuolo, Timmis, and Johnstone 2016). Participating firms are able to capture productivity gains by specializing in core tasks that represent their most efficient allocation of resources, while offshoring tasks at which they are comparatively less efficient (Grossman and Rossi-Hanberg 2008).

Such specialization is enabled and facilitated by the increasing accessibility of foreign intermediate inputs (Criscuolo, Timmis, and Johnstone 2016). Based on having comparative advantage in a value chain, firms can participate as upstream suppliers of inputs to foreign firms through forward linkage, and/or as downstream producers using foreign inputs in their own production and exports through backward linkage. GVC linkages allow greater economies of scale in specialization and better leveraging of cross-border complementarities. GVC participation provides not only competitive alternatives to domestic sourcing, but also greater variety and quality of foreign inputs available to a local economy (Amiti and Konings 2007; Topalova and Khandelwal 2011; Bas and Strauss-Kahn 2015). These participation benefits can lead to productivity gains in GVC-participating firms.

GVC participation also brings local firms into closer contact with "open innovation" systems, as well as advanced knowledge, technologies, and standards set by major GVC participants, thus inducing technology/knowledge spillovers (Teece et al. 1997; Sturgeon and Memedovic 2011; Ketels and Memedovic 2008). Such benefits can be realized through three mechanisms in GVCs. The first mechanism—*the diffusion effect*—states that MNEs can assist local firms through knowledge and technology sharing. The second mechanism—*the availability and quality effect*—states that GVC participation increases the availability and quality of inputs in the buyer's industry. The third mechanism—*the demonstration effect*—states that technology and knowledge spillovers happen by firms "imitating or reverse engineering GVC products, business models, marketing strategies, production processes, and export processes" (Taglioni and Winkler 2016).

Though participating in GVCs allows developing countries to capture productivity gains in the global market, some economies may eventually experience a slowdown—also known as the middle-income trap (Engel and Taglioni 2017). According to the OECD, such a slowdown can be offset by moving towards higher-value added activities within or across industries (OECD 2013). Depending on a country's relative level of economic development, it can use such upgrading to maintain or improve its position in the global economy (Gereffi and Fernandez-Stark 2016). Within the GVC framework, Humphrey and Schmitz (2002) identify four types of upgrading: (1) process upgrading; (2) functional upgrading; (3) product upgrading; and (4) chain or inter-sectoral upgrading. Process and functional upgrading focus on productivity improvements, such as improving organizational or technological efficiencies. Product and chain upgrading emphasize

moving vertically or horizontally along value chains (Humphrey and Schmitz 2002). Both product and chain upgrading require developing specialization in new tasks with a higher value added (Humphrey and Schmitz 2002). Bamber et al. (2014) present three upgrading opportunities in GVCs: entry into the value chain, upgrading backward linkages, and upgrading the end market. Most literature uses improvement in export volume or export unit value as a common measure of upgrading (Milberg and Winkler 2011).

Labor effects

It is challenging to assess the net effects of GVCs on labor demand, wages, skills, and levels of inclusion (Farole 2016). Because most of the structural changes in labor markets are triggered by technological innovations or changes in consumer demand, isolating GVC effects from other contributing factors can be quite difficult (Escaith, Inomata, and Miroudot 2018).

Developed economies

The labor impact associated with outsourcing and offshoring in advanced economies is well established. Early work by Feenstra and Hanson (1996 and 1999) finds that outsourcing of non-skill-intensive activities in goods-producing sectors accounts for 31−51 percent of the increase in relative demand for skilled labor, contributing to the rising wage inequality between skilled and non-skilled workers in the United States. Their follow-up work argues that the labor effect of trade—especially trade in intermediate inputs—is larger than most studies give credit for, thereby reaffirming that production sharing and foreign outsourcing has contributed to increases in the share of wages paid to skilled workers in the cases of the United States, Japan, Hong Kong, and Mexico (Feenstra and Hanson 2001). Acemoglu and Autor (2010) shares a similar finding that offshoring and outsourcing reinforces the skill-biased labor effects of technical change in advanced economies. Hummels et al. (2014) finds that offshoring contributes to the widening wage gap between skilled and less skilled employees in Denmark. The recent study by Farole, Hollweg, and Winkler (2018) confirms that this polarized labor skill effect is most evident in high-income economies, but also appear to a lesser degree, in emerging economies.

While the GVC effect of skill polarization in relative labor demand and wages seems indisputable, the effect on total labor demand in advanced economies is less straightforward because of the conflicting results generated through different channels. First, *the substitution effect*: offshoring moves a portion of production activities overseas and replaces domestic labor with foreign labor, thus reducing domestic labor demand. Secondly, *the productivity effect:* outsourcing allows a greater degree of specialization and improves labor productivity, thus reducing labor demand for each unit of output. Lastly, *the scale effect*: offshoring reduces production cost, leading to lower prices and higher demand, which in turn increases demand for labor to produce higher output (Amiti and Wei 2009; Farole, Hollweg, and Winkler 2018). The net effect on labor demand should be determined by how these three effects play out in an economy.

With the GE approach, Antràs, Fort, and Tintelnot (2017) illustrate a net-negative direct impact on U.S. domestic employment given increased outsourcing opportunity from China. Their analysis

concludes that the gains from increased production and domestic outsourcing by U.S. manufacturing firms outweigh the loss from non-outsourcing firms that either contracted or exited the market. With the input-output approach, Wang et al. (2018) find a net positive impact on U.S. total employment and real wages from imports of intermediate inputs from China. The negative labor effect in directly competing manufacturing and related upstream industries is was more than offset by the positive gains in the downstream industries, which benefited from lower-priced Chinese intermediate inputs, especially in services sectors.

Developing economies

Theoretically, GVC participation creates more exporting opportunities for firms in developing countries; and exporting firms generally employ more workers and pay higher wages, which should lead to a positive labor effect (Shepherd 2013). Taglioni and Winkler (2016) argue the labor markets in developing countries can benefit from GVC integration through three effects: (1) the *demand effect:* GVC-participating MNEs increase demand for skilled labor in the local labor market; (2) the *skill-upgrading effect*: local labor receives trainings and the types of skill upgrading from MNEs; and (3) the *spillover effect*: local labor moves from MNEs to local firms, bringing acquired skills and knowledge with them.

However, Farole (2016) finds these effects do not always translate into broad positive outcomes in the labor markets of developing countries. Instead, Farole (2016) finds some winners and losers in the process. Countries with a large labor surplus and low wages see strong job growth following GVC integration. But as sectors and countries upgrade, wages rise while net employment falls, with skilled workers gaining and women losing. The paper identifies several key factors shaping labor outcomes in developing countries, including the type of sectors involved, lead firms' strategies, the domestic skills base, and the institutional environment.

Farole, Hollweg, and Winkler (2018) proceed a step further by differentiating a country's GVC participation into two types: one as buyers through backward linkage, and the other as sellers through forward linkage. The authors show that the overall labor demand is positively correlated with GVC participation either as a buyer or a seller, but the latter with a much lower magnitude. The intensity of backward GVC integration, measured by the share of foreign value added in exports, is negatively correlated with labor demand in the direct sector, though the positive effect in the indirect sectors is large enough to offset the negative direct effect, resulting in greater aggregate labor demand.[6] The intensity of forward GVC integration, measured by the share of domestic value added in third countries' exports, is negatively associated with labor demand in both direct and indirect sectors.

It is worth noting that the studies on GVC labor effects in developing economies remain somewhat limited, largely due to the availability and quality issues in labor statistics.

[6] The direct sector, defined as the exporting sector, is generally located towards the end of the domestic production chain. Likewise, the indirect sector supplies the direct sector with the inputs and can be located upstream in the domestic production chain.

Trade costs

In the past decades, many trade barriers have been reduced or addressed through unilateral trade liberalization, bilateral or regional trade agreements, and multilateral negotiations. However, trade barriers continue to matter, especially in the context of GVCs in which intermediate inputs often cross borders multiple times, potentially causing trade costs that accumulate with a cascading effect along the value chain (Rouzet and Miroudot 2013; Escaith 2017; USITC 2017). Such trade costs include applied tariffs, border taxes, transportation and insurance costs, and un-harmonized regulatory measures. These costs increase production costs by 18 percent, on average, at each stage of the value chain (Escaith 2017). Ferrantino (2012) finds the average ad valorem trade cost of 10 percent leads to a compound ad valorem tariff equivalent to 34 percent by the end of a five-stage supply chain. As the number of production stages increases, the compounded effect escalates. Hence, as these costs accumulate, the expected gains associated with GVC participation are eroded.

Studies find that the costs associated with these barriers are disproportionately burdensome to countries specializing in downstream activities, which exhibit more foreign content in their exports (Escaith 2017). As gross value increases along a GVC, downstream industries typically face relatively larger trade costs from barriers regardless of their own value added (Ferrantino 2012; Rouzet and Miroudot 2013). Antràs and de Gortari (2017) term this relationship between downstreamness and trade costs—which increases along the GVC—as "stage-specific trade cost elasticity."

The compounding effect of trade cost along GVCs has both macro- and micro-economic implications, ranging from the effectiveness and externalities of countries' trade-protection policies to lead firms' decisions on optimal production locations. Diakantoni et al. (2017) find that asymmetrical nontariff measures (NTMs), such as regulations, licensing requirement, contract and institutional weaknesses, and consumer preferences, account for two-thirds of compounded trade costs. These NTMs are found to disproportionately burden developing countries (Ghodsi and Stehrer 2016). Using simulations, Diakantoni et al. (2017) find that trade costs erode 27 percent of the gross profit margin of the highly integrated German automotive industry. Additionally, reductions in direct tariffs on inputs from upstream industries reduces the indirect tariffs faced by downstream industries by 5−10 percentage points (Diakantoni et al. 2017; Rouzet and Miroudot 2013).

Summary

The development of GVCs and their economic impact on participating countries, industries, or firms have been widely discussed in business and economics literature. This introductory paper reviews and highlight some of the key topics covered in the GVC literature, aiming to provide readers with broad coverage of the relevant material to develop their understanding of GVC research.

This paper covers key concepts and major analytical approaches commonly used in the GVC literature. It discusses important economic and technical factors driving recent GVC development, and highlights characteristics found in many GVCs, such as producer- and buyer-driven commodity chains, the "snake and spider" value-chain configurations, the rise of contract manufacturing, and modular production. This paper also discusses the economic implications of GVCs on competitiveness, economic development, the labor market, and trade costs.

Although this paper surveys a wide scope of GVC-related literature, and highlights topics central to developing a comprehensive understanding of existing GVC research, it is by no means exhaustive. Nonetheless, we offer this paper as an accessible work that will help industry analysts, trade researchers, and students alike to embark on their own GVC journeys.

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Appendix A. List of Acronyms

Acronym	Full wording
BEC	Broad economic classification
CGE model	Computable general equilibrium model
CSCMP	Council of Supply Chain Management Professions
DC	Domestic content
EMS	Electronics manufacturing services
FDI	Foreign direct investment
GCC	Global commodity chain
GSC	Global supply chains
GTAP	Global Trade Analysis Project
GVC	Global value chain
ICIO table	Inter-country input-output table
ISIC system	International Standard Industry Classification system
JIT delivery	Just-in-time delivery
LMICs	Low- and middle-income countries
MNEs	Multinational enterprises
NAICS	North American Industrial Classification System
NGO	Non-government organization
NTMs	Non-tariff measures
ODM	Original design manufacturing
OECD	Organization for Economic Co-operation and Development
PC	Personal computer
PE model	Partial equilibrium model
RCA	Revealed comparative advantage
SCC	Supply Chain Council
SCM	Supply chain management
SCOR model	Supply Chain Operations Reference model
SME	Small- and medium-sized enterprise
TiVA	Trade in value added
UNESCAP	United Nations Economic and Social Commission for Asia and the Pacific
USITC	U.S. International Trade Commission
VAX ratio	Value added to gross exports ratio
VCRM	Value-chain reference model
VS	vertical specialization
VT	Value added exports
WEF	World Economic Forum
WIOD	World Input-Output Database
WTO	World Trade Organization