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*How good and pleasant it is
when brothers live together in unity.
Psalm 133:1*

THE SUPPLY CHAIN ECONOMY: HOW FAR DOES IT SPREAD IN SPACE AND TIME?^{*}

ABSTRACT

The supply chain economy provides grounds for a non-linear economic leapfrog start in development. Rather than specializing in the whole production procedure, the new model enables specialization in production segments. All process links are related and must be of an identical high standard. The differential treatment of developing countries is therefore not acceptable in this economic model. Statistics provision and trade policy need to change. Duties must be either eliminated or applied on a value-added basis. A new wave of protectionism is testing the spread of the supply chain economy. Three-dimensional printing may pose a challenge to the length and future spread of value chains.

KEYWORDS: Global Value Chain, Fragmentation, Unbundling, Offshoring, Trade, Standards, Integration, 3D Printing

JEL CLASSIFICATION: F01, F10, F13, F15, F23, L23, O14, O25, O31

RIASSUNTO

L'economia delle 'supply chain': quanto possono 'espandersi' nello spazio e nel tempo?

L'economia *delle supply chain* è un terreno fertile per uno sviluppo economico non lineare, bensì a singhiozzo. Anziché specializzarsi sull'intero processo produttivo, questo nuovo modello si basa sulla specializzazione in segmenti di produzione. Tutti i segmenti della produzione sono

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correlati e devono avere gli stessi standard elevati. Perciò, trattamenti differenziati per i paesi in via di sviluppo non sono accettati in questo modello produttivo. Le statistiche e le politiche commerciali devono essere modificate. I dazi devono essere eliminati o applicati sulla base del valore aggiunto. La nuova tendenza protezionistica è un test sulla diffusione dell'economia delle *supply chain*. Le stampanti 3D potrebbero essere una sfida alla lunghezza ed alla futura diffusione delle catene del valore.

1. INTRODUCTION

This article is about the origin, structure, operation, spread, location and outlook of the supply chain economy. The paper gives an overview of the changing character of industrial organization (production), trade and international investment, and proposes changes that can be made to economic policy. The fundamental changes that can be seen in the global economy developed in the 1980s, and have been spreading on a large scale ever since. However, in light of the tendencies towards disintegration seen in the United States (US) Trade War that started in 2018, and in Brexit (2019), the future of smooth international trade and investment is rather uncertain.

Some elements of standard theoretical trade concepts have now become redundant, as most international trade no longer predominantly occurs in final goods and raw materials, but in intermediate products, a situation that can sometimes be regarded as trade in tasks. Outsourcing, offshoring, the spatial fragmentation of production and the creation of global value chains (GVCs), have created a situation where many countries add value to the final product. The spread of GVCs has been made possible by advances in technology – namely in communication, transport and management – and because of the liberalization of trade and foreign direct investment (FDI). These new challenges and opportunities require a new approach to industrial organization, trade and customs, and statistics and economic policy.

All mainstream trade theories analyze trade in final goods by using basic production factors. The comparative advantage theorem of David Ricardo is based on labour being the only input, while the neo-classical trade model by Heckscher-Ohlin analyzes only trade in final goods through the endowment of production factors (i.e. capital, labour and land). The new trade theory by Paul Krugman and others also focuses on final goods, but with a new dimension: economies of scale.

The new-new trade theory by Marc Melitz assumes the heterogeneity of firms, but still looks at the final goods. This article focuses on GVC and production trade in intermediate goods, and contributes to the further development of trade theory and policy.

Following this introduction, the article continues by considering the origins and conception of GVCs in sections 2 and 3, respectively. Section 4 describes the configuration of GVCs, while section 5 argues that strong adherence to standards is the connecting tissue that makes up a GVC. Governance in GVCs (section 6) precedes the search for the spatial location of “big money” (section 7). Most current trade rules were created for the situation that prevailed a generation ago, and require updates that deal with spatially dispersed production and trade (section 8). Various challenges that come from changing technology are presented in section 9. Section 10 sheds light on policy implications related to GVCs. They refer to the rules of origin, the labour market, devaluation, subsidies, the effect of spillovers on the local economy, and risks and uncertainty. The conclusion (section 11) is that GVCs are here to stay, at least for a while. They are in flux and are altering industrial organization and trade. In facing that challenge, the effective policy action is to achieve the life-long education of labour and management that aids adjustment to existing challenges and opportunities, and prepares for those of the future.

2. ORIGIN

The fragmentation of the production process is not new¹. Adam Smith explained the specialization (fragmentation, unbundling) of production in a pin factory. There were 18 distinct operations performed by 10 specialized workers (Smith, 2005 [1776], p. 11). Today, what is new, is the much wider spread and scope of unbundled production occurring across international space². It is powered by changing technology: reliable, fast and cheap communication; data processing that makes the spatial coordination of complicated activities possible; the global spread of knowledge; the trade and investment liberalization that opened up foreign markets; economic integration; and improved and affordable transportation. Various tasks or jobs existed for years or even generations (i.e. how to make a car). What has been changing is the process, or

¹ For example, almost from the start, motor car production was fragmented among parts producers. The difference is that they had to be not too far away from the assembly line in order to ensure coordination and the arrival of parts when necessary.

² This spatial spread of manufacturing is evident in the production of electronics and computing equipment. It is scattered throughout South-East Asia. The ‘centrality’ of chemicals production is still strong, with Germany and the United States the global production hubs.

how firms solve the linking of tasks³.

Modularity is related to the use of smaller subsystems in the creation of complex products or processes. Modules, such as components or subsystems, can be crafted independently of each other, but can operate successfully together as a whole (Baldwin and Clark, 1997, p. 84). Standards, official or otherwise, provide grounds for connection and communication between modules that fit and operate together. Computers and other electronic gadgets or vehicles are prime examples of modularity in production: different modules fit, communicate and operate together⁴. Technology changes fast, so extreme competition takes place in many segments (modules) involved in the final product. The success of the modular strategy depends on constant communication between the producers of modules, often on what may initially seem to be minor details.

The large wave of contemporary spatial fragmentation in production started during the 1980s. Japan had a considerable success in the development and export of goods to both the US and the European Union (EU). Japanese trade surpluses created frictions in trade. Tensions between the US and Japan started to calm following the 1985 Plaza Accord, when the dollar devalued by 51 per cent over two years. At that rate, it was too expensive to export from Japan to the US. In order to remain competitive on international markets, Japanese firms started investing in Asia, where wages were low. This investment and migration of production was initially focused on Thailand and Malaysia, while Indonesia and China were later targets for the location of manufacturing. Production was split in such a way that low-end and intermediate “Japanese” goods were produced abroad, while high-tech goods production was kept at home. The supply chain developed (Abe, 2016). At about the same time, the US and Mexico were developing *maquiladoras* on the Mexican side of the border. Initially, “screwdriver” production activities migrated from the US to Mexico.

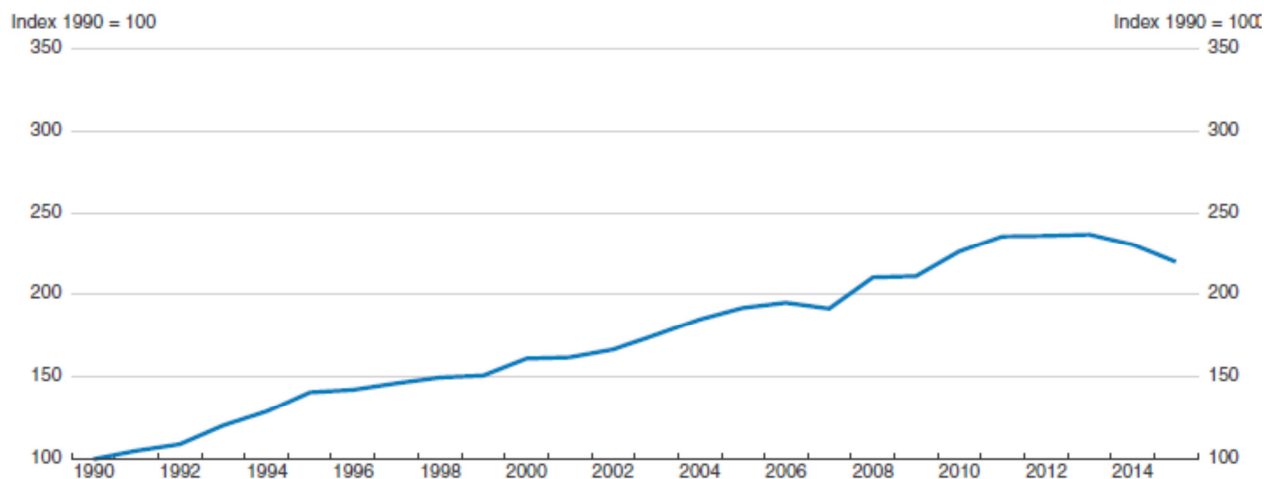
The business performance of Japanese firms that globalized – i.e. employed GVCs – was superior to that of Japanese firms that remained only at home. This created a snowball investment effect

³ Efficient transport services support GVCs, but they increase the carbon footprint of such industrial and trade networks. The snag is that transport services receive a certain level of protection both in the developed and in the developing world. There is still huge room for improvement in moving towards a more competitive transport industry. International transport is artificially and substantially subsidised because fuel can be tax free: globalization is therefore well beyond efficient levels, even without considering the carbon footprint.

⁴ Ikea furniture also fits into this picture.

from Japan towards South-East Asia. International production, its location, trade and FDI changed globally and gave a new shape to the global economy.

FIGURE 1 - *Global Value Chains have Expanded Markedly since 1990*



Note: The structural GVC indicator is computed as the ratio of intermediate goods imports to final domestic demand, corrected for commodity price and cyclical effects.

Source: OECD (2017). *Economic Outlook 101*. Paris: OECD, p. 82.

The current stage of globalization has, to an extent, been driven by an expansion of GVCs that started in the 1980s. Improved services such as communications, data processing, information technology, transport, distribution, improved codification schemes, as well as reduced barriers in trade and investment (changes in policy) have contributed to the strong expansion of GVCs, especially since 2000. Structural shifts and the Global Financial Crisis (2008) had an impact on the slowing of the GVC trend (figure 1). Foreign direct investment slowed globally and the globalization process plateaued.

One would expect in the standard trade model that developing countries would specialize in less-skilled economic activities. With this assumption, their exporting of lower-end products would be expected to rise. In the GVC industrial-organization world, this did not happen. “The share of low-skilled workers declined by 6 percentage points from 24 percent in 1995 to 18 percent in 2008. The share of medium-skilled workers increased” (Timmer *et al.*, 2014, p. 112). An increase in the share of higher-skilled labour in exports is taking place throughout the

emerging world. Poorer countries are narrowing in on the share of less-skilled jobs in the chain. Intangible capital is also increasing in importance and in its share of global exports. The following sections explain these developments.

3. CONCEPT

The creation, evolution and spread of GVCs changed trade, production and investment. National economic advantages can no longer be found in the production of final goods or services, but rather in specific tasks and intermediate goods along GVCs. Analysis and policy actions also changed. The GVC model altered earlier import substitution policies and reinforced the decisions of many developing countries to abandon inward-oriented policies in favour of continued openness for trade and FDI. Countries that are more open to trade and investment can benefit from economies of scale in specific kinds of production, which could provide the country with an additional growth bonus, no matter how small it may be.

Spatial fragmentation of the footloose production process (dispersion and clustering) is one of the most important features of the contemporary economy. Global value chains create complex links between such locations for the leading firm. This is different from the textbook model of perfect competition, where firms deal with each other at arm's length. The leading firm finds organizing business through a GVC to be superior to using competitive markets.

The internalization of operations (reduction in *internal* costs) explains the existence of firms, according to Ronald Coase. A new dimension is currently being added to this explanation for the existence of firms. The tipping point here is when the volume of the transaction cost internal to the firm is higher than the cost of managing a GVC "external" to the lead firm. The external costs of organization have fallen dramatically in line with changes in transport and coordination costs (computers and containers, in particular). Therefore, firms' costs became more compartmentalized than they had been. This is pure Coase, but operating in reverse as *external* costs fell.

Transnational corporations (TNCs) are the channel through which GVCs thrive (intra-firm activities). About 80 per cent of total international trade takes place either within TNCs or through GVCs organized by TNCs (Moran and Oldenski, 2016, p. 2). Another source states that around a half of intra-firm trade is related to GVCs. This trade is both intra-industry and intra-

regional (Taglioni and Winkler, 2016, p. 1 and 17). Even though the term “global” in GVC is widely accepted, it is often misleading. Firms try to minimize all operational and transactional costs. Transport costs and efficiency in production are important items on a firm’s list of considerations, as trade in intermediate goods is more sensitive to distance than trade in final goods. It is necessary to have close functional relations in the production of goods within a GVC, while in select cases face-to-face contact is indispensable. Longer GVCs are more difficult to monitor and manage. Global value chains are therefore often (but not always) “regional”, rather than “global”⁵. Nonetheless, as a term, GVCs are embedded in the literature and have a life of their own.

The minimization of transport costs for intermediate goods plays an important role in decisions on locations⁶. Global value chains cover, for instance, East Asia (electronics), North America (vehicles) and Western and Central Europe (cars). The regional hubs are China and Japan, and the US and Germany, respectively, while other countries are production spokes. The operation of GVCs is strongly supported by regional economic integration deals which facilitate trade and FDI. In fact, business operators demand from governments the infrastructure that facilitates commerce.

Cost reduction is at the heart of both outsourcing and offshoring. However, to achieve this basic goal, the two business models have different strategies:

- *Outsourcing* (arm’s length relations) involves contracting operations and/or inputs from a separate firm, rather than sourcing them in-house (make-buy choice). Firms outsource operations that have weak connectivity with other tasks in the firm. The deeper the internal vertical integration in the firm, the lower the outsourcing tendency. Outsourcing may take place either in the country where the lead firm resides or abroad.
- *Offshoring* (intra-firm trade) is the location of at least a part of a firm’s operations outside national borders (in a lower-cost foreign location). This does not entail external contractors (business remains within the same firm), but it involves FDI and the risks

⁵ ‘Within the industry value chains we studied, China exported 17 percent of what it produced in 2007. By 2017, the share of exports was down to 9 percent. This is on a par with the share in the United States but is far lower than the shares in Germany (34 percent), South Korea (28 percent), and Japan (14 percent). This shift has been largely obscured because the country’s output, imports, and exports have all been rising so dramatically in absolute terms. But overall, China is gradually rebalancing toward more domestic consumption’ (McKinsey, 2019, p. 12).

⁶ This has been a well-known observation since the time of Weber (1909).

involved in conducting operations at a distance.

- *Re-shoring* (back-shoring) is the third tendency. It refers to business operations returning to the country of origin, as is the current policy of the US Government. Still, if certain textiles-related work, for instance, returns to the US, it will mostly be performed by robots. Most of the pre-existing American jobs that had been lost would not come back. A similar situation can be seen with the jobs lost in the steel industry. Contemporary production uses less and less steel. New steel plants are more productive than old ones, therefore requiring fewer workers, while mini-foundries have replaced old-fashioned steel mills and also use scrap metal. Jobs that have gone (even abroad) cannot be reinstated.

Offshoring may be attractive cost-wise, as expenses abroad for certain inputs (labour) may be much lower than at home. “Since all tasks trade is costly, only the firms in the technologically advanced country engage in offshoring” (Grossman and Rossi-Hansberg, 2008, pp. 1988-1989). Offshoring has received strong criticism, especially in the US, because of the allegedly negative effects of reallocating US jobs abroad. However,

The expansion of US firms abroad raises productivity, lowers costs, and increases their global market share, allowing these firms to hire more workers not just in other countries but also at home. The data show that US firms that engage in off shoring complement their movement abroad with greater investment and more job creation at home. When a US firm increases the employment at its foreign affiliates by 10 percent, employment by that same firm in the US goes up by an average of 4 percent (Moran and Oldenski, 2016, p. 4).

As already observed, the concept of GVCs is closely linked to globalization. The principal workhorses of globalization are:

- Spatial fragmentation and the spread of production;
- Standardization;
- Reduction in communication, coordination and management costs between a parent firm and its subsidiaries; and
- Reduction in trade, transport and investment costs between countries.

A GVC is a continuous and smooth range of coordinated domestic and foreign activities that a

lead firm takes on to create a product from an idea and a blueprint, and to facilitate fabrication, assembly (according to the agreed common standard), marketing, distribution and delivery to final consumers. Then comes after-sales service and end-of-life management once final use and consumption have taken place⁷. Global value chains provide a new opportunity to include many countries in the global investment, production and trade process, and are a potential avenue for diffusing technology and novelty. In addition, most global exports are channelled through GVCs:

About 60 per cent of global trade, which today amounts to more than \$20 trillion, consists of trade in *intermediate* goods and services that are incorporated at various stages in the production process of goods and services for final consumption. The fragmentation of production processes and the international dispersion of tasks and activities within them have led to the emergence of borderless production systems – which may be sequential chains or complex networks and which may be global, regional or span only two countries. These systems are commonly referred to as global value chains (GVCs) (UNCTAD, 2013, p. 122; original emphasis).

The key features of a GVC are:

- Spatially fragmented production becomes footloose;
- The spatial location of each segment is in a country where it is both technologically and commercially optimal⁸;
- Specialization in niches (development and expansion of core competences in tasks) to improve productivity and quality of output;

⁷ While a GVC refers to across-the-border operational links, a value chain is limited to one location or the operations of a firm in one country, such as the harvesting and processing of fruit or fresh milk. See: <https://globalvaluechains.org/concept-tools> accessed on 15 November 2018.

⁸ Low wages may not be and usually are not a significant attraction for the location of production, especially for production that is technologically complex. Low wages may often reveal that labour is neither educated nor productive. What matters for investors are not wages as such, but rather unit labour costs of production. If policymakers aim at supporting GVCs that are founded on low wages, they neglect the fact that such business operations are the easiest for investors to relocate elsewhere. Low-wage grounds for development are both perilous and flawed in the long term. Firms are not only searching for low-cost locations: they are increasingly interested in creative and productive talent. This does not come cheap.

For example, wages in Switzerland are high, yet the country dominates the production of high-quality watches. Technological excellence and design are principal competitive advantages, whereas low wages are not. Potential efficiency and quality losses that could stem from the production of Swiss watches abroad play a far greater role in the location decision than the high local Swiss wages. Similarly, the French company Valeo and the Japanese firm Denso lead in the global market for car air conditioners. Technical excellence is the major competitive foothold, not home-country wages that are much higher than in many other locations.

These examples should not make it sound as if low wages do not matter at all. They do, of course. Where productivity is the same from, for example, an educated worker in India and one in the US, there is a distinct advantage in using the lower-wage worker, as evidenced by the large number of firms that use Indian workers in everything from call centres to software programming, to the manufacturing of components.

- Strong links in the production process;
- The uninterrupted, smooth operation of all value-adding operations (no bottlenecks, nor piecemeal tactics);
- Trade is in intermediate goods and depends on smooth trade facilitation procedures, especially at borders;
- The strong protection of intellectual property rights;
- A decrease in the production cost per unit of output⁹, but with concurrent increased cost, uncertainty and risk of running a complex set of operations in different locations¹⁰;
- Possible risk of cyber-attacks and cyber commercial espionage, as there are many segments that have the potential to be intruded upon by competitors; and
- Total application and control of the highest public and private standards (both mandatory and voluntary) throughout the value-adding chain, as GVC task-based operations do not tolerate any gaps.

As can be seen from the above elements, GVCs are multi-faceted, dynamic structures.

Progress in production, information processing and organizational technology, together with declining barriers to trade and investment, created grounds for the efficient fragmentation of the footloose production process, and its regional and global spatial spread. This unbundling of the production process and its offshoring created new possibilities for countries – especially small and developing ones – to specialize within certain segments (tasks) of the GVC, rather than in the whole process of goods manufacturing, as was the case in the past.

Fragmented fabrication increases a firm's efficiency in production, makes the output cheaper for the final consumer and improves the firm's global competitiveness. During the 1980s, the main focus of the industrial organization system of GVCs was centred on both the quality and cost of the chain segments. This evolved over time, meaning new features were added to the organizational focus. They now include research and development (R&D), innovation, speed and flexibility.

⁹ The South industrializes, while the North deindustrializes.

¹⁰ Longer and more complex GVCs – as well as the search for low-cost operations – run important risks. Boeing underestimated the problems associated with an immensely complex subcontracting chain of suppliers for the 787 Dreamliner. The launch of the aircraft was postponed for three years. Another example of risk is exemplified by the discovery of horsemeat in several processed food items in Europe in 2013. The effective monitoring and application of quality standards may prevent similar safety and health hazards (Oxford Analytica, 'Complex global supply chains create new risks', 12 February 2013).

Managing a GVC that has “factoryless manufacturing”¹¹ presents a formidable and challenging business function; however, if successful like Apple, Nike or Li & Fung, it is a highly profitable business model. Farming out production to others is in the function of a business asset – it provides flexibility. Managing labour in a plant or across infrastructure can drain core competences and resources, and so it is passed on to others. Nonetheless, “old fashioned” ties with producers, and communication with them, are necessary because of trust, support and vision concerning investments.

Factoryless manufacturing was initiated by US firms that shifted the manufacturing of apparel to Japan in the 1950s. This was followed by toys in the 1970s. Later came the transfer of the production of electric and electronic goods, and finally, semiconductors (Bayard *et al.*, 2015, p. 84). The American firm Nike, for instance, “produces” (contracts out) its footwear in Asia.

The GVC model of industrial organization and trade offers a platform to small, medium-sized and developing countries to take part in international production and trade, but without the full production infrastructure necessary to make final goods (“linear” technological production in one location from raw materials to the final product). The GVC model as a non-linear platform provides a flexible springboard for development. Small developed countries such as Austria and Switzerland, or even Belgium, profit from specialization in the production of intermediate goods. One can enumerate only a few final globally known goods that each of these three countries produce and export.

Global value chains may be driven by producers or buyers/consumers¹²:

- *Producers* in high-technology industries (pharmaceuticals, semiconductors, electronics, aircraft, vehicles) control in one way or another spatially scattered production processes, in order to assure the highest standards and timely operations. It is also necessary to protect brands such as Apple, Toyota, Samsung, Airbus, Boeing, Novartis, Sony, etc ...
- Giant *retailers* also control GVCs. The influence of Walmart, CVS, Amazon, GAP, H&M, C&A, Zara, Toys “R” Us, Carrefour, etc ... is huge.

¹¹ ‘The “factoryless manufacturing” (FM) business model is employed by a rising share of U.S. firms. Factoryless manufacturers outsource the fabrication of products but maintain control of the production process, own the associated intellectual property, and bear the entrepreneurial risk. FM is an important component in the role of U.S. firms in global manufacturing value chains’ (Bayard *et al.*, 2015, p. 81).

¹² Evolutionary economics (and biology) may inspire GVC researchers to look at complex links between parts. The human body, for instance, is complex, adaptable, resilient, vulnerable and a self-healing system.

The relationship between suppliers and buyers in the GVC is strongly positive, and innovation and interchange between the two sides is mutually supportive. This additional or “external” knowledge between the links in the GVC is beneficial, and increases over time (Isaksson *et al.* 2016). Everyone in the GVC is in contact with the group as they all need to be in step if someone in the GVC improves something in the production process.

Involvement in a GVC is based on strong cooperation and trust among participants, as well as a common (often longer-term) vision of success in the joint project. Nonetheless, as a precaution, a firm’s participation in a GVC depends also on the enforcement of contracts¹³. If courts are inefficient and the enforcement of contracts is rather weak, as is the case in Italy, firms encounter difficulties and are less willing to enter into business with others as subcontractors (Accetturo *et al.*, 2017, p. 23).

Courts and the enforcement of law matter, but if business relations and GVCs rely on courts to enforce contracts, the game is already lost. However, if there is a climate of confidence and fairness (possibly through the distribution of ‘good points’ by the lead firm), then the GVC will be able to rely more on spontaneous coordination. This important “social capital” or business bond may, however, weaken as the GVC gets longer in terms of space. Still, when GVC partners share a vision of a common (longer-term) future goal, this provides grounds for openness to innovation and changes in technology, as well as innovative reactions to competitors and alternative suppliers.

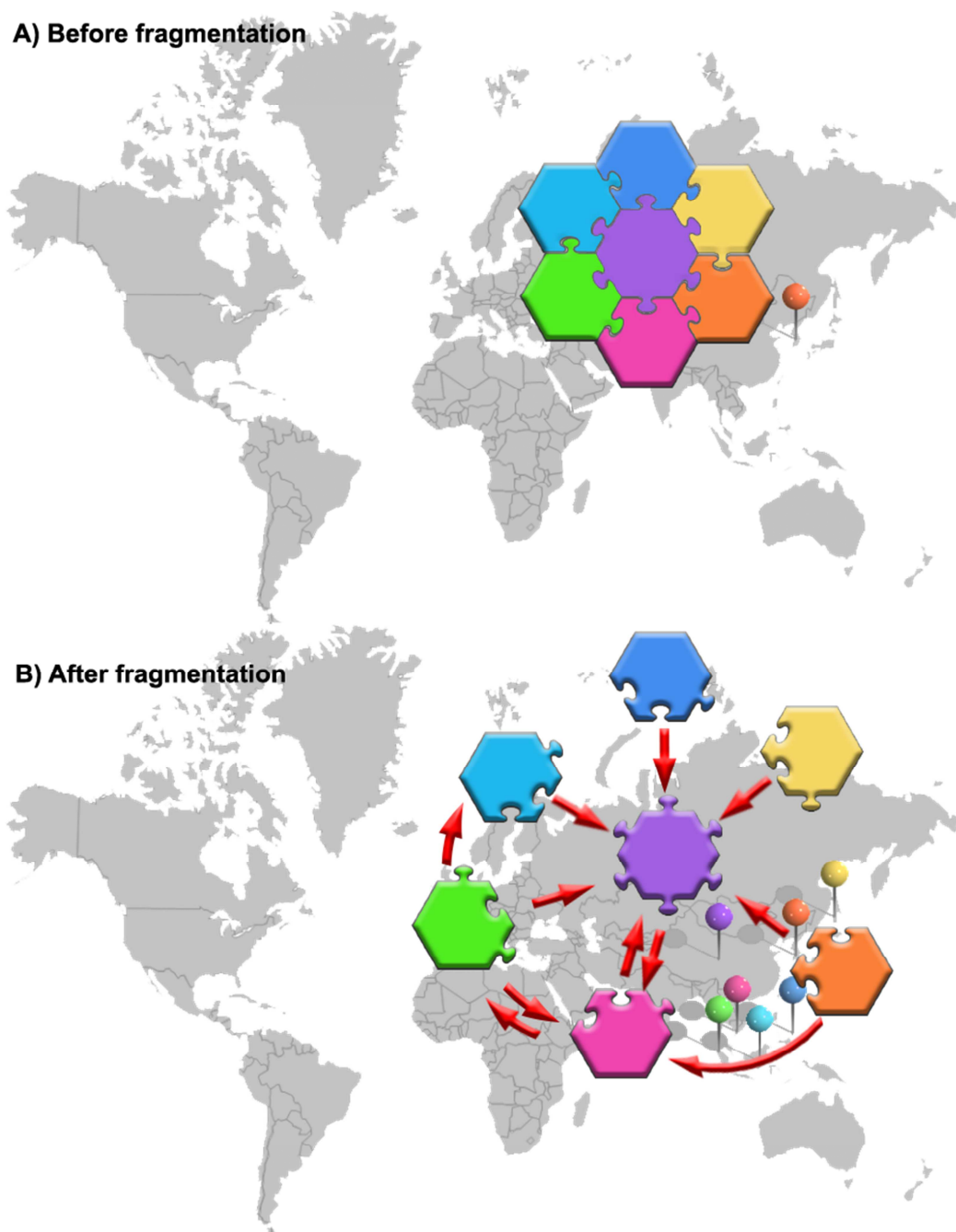
4. CONTOUR

There are two basic patterns of GVCs. “Snakes are processes whose sequencing is dictated by engineering; spiders involve the assembly of parts in no particular order” (Baldwin and Venables, 2013, p. 245). In practice, the basic patterns are often a complex mix of the two. New business possibilities are on offer, however, as there are many participants with potentially different objectives and priorities, and so there are potential coordination costs and failures.

¹³ The controversial antitrust ‘Illinois Brick doctrine’ is based on the 1977 US Supreme Court case (Illinois Brick Co. v. Illinois) that aimed to reduce legal costs. The gist of this case was that buyers of overpriced goods or services along a supply chain can file antitrust claims against colluding retailers, but not against price-fixing (colluding) manufacturers; only retailers can file claims against manufacturers. In a contemporary setting, the problem involves the application of this doctrine to the digital market.

Organizers of GVCs need to be on top of the administration of such a complex process. They also need to have developed contingency plans in place. If there is a high risk and cost of organizational failure, then GVCs have the potential to be rather narrow spatially, and there would be little offshoring.

FIGURE 2 - *Contours of Production*



Global value chains provide a new platform for industrialization in developing countries (figure 2). This new industrialization podium has an advantage over the one that prevailed during the 1950s and 1960s. When South Korea industrialized in the 1950s, almost all of the production process had to be located in one geographical area, but not necessarily within one firm (figure 2 – panel A)¹⁴. In the 1950s and 1960s, organizational “snakes” followed the predetermined technical order. There was an “industrial champion”. Later on in the early 1990s, for instance, Intel made virtually all 486 microprocessors in a single factory near Jerusalem, but this production has now been spread over several countries¹⁵.

The new GVC era is based on communication, progress in technology, the management of scale, and transport and logistics. Spatial fragmentation (unbundling) of production offers the possibility for a country, especially a developing one, to specialize in only one or just a few segments (tasks, blocs) that are included in the final product, rather than in the entire manufacturing process (figure 2 – panel B). From the 1980s, the organizational “spider’s” web enabled firms – especially those of small and medium size – to specialize in production segments and market niches, rather than in the whole production process. In the production process of many goods (high-technology ones, in particular), everything is related to everything else in the GVC. To fit properly, each segment in the chain must be of an identical high standard.

The firm’s usual dilemma of “make or buy” does not appear in panel A of figure 2. Everything is made within a firm at one location. However, the dilemma appears after unbundling (panel B). There are a number of opportunities for where to locate (at home and abroad) the fragmented value-chain segments. Quality standards and cost considerations (lowering costs) play principal roles.

The average size of firms has been reducing since the mid-1970s. This is a great development-related opportunity, and a challenge for developing countries both big and (especially) small. National champions have little role to play in the GVC world. Malaysia and Thailand, and even

¹⁴ The original Ford Motor Company plant in River Rouge (Michigan), between the two World Wars, was 2.4km long and 1.6km wide. It had its own steel mill and a huge electrical power plant. It employed over 100,000 workers, even during the Great Depression. Ford operated a regional rail company and a fleet of ore freighters to bring in the necessary materials. This vertically integrated plant complex was producing cars in one facility, from the very first raw materials to the final product. The factory *‘took iron ore at one gate and disgorged it 28 hours later at the other as a motorcar, giving Ford the chance to profit on all the value added in between. ... Ford now buys in about a half of the components which make up its cars’* (“The rise and rise of America’s small firms”, The Economist, 21 January 1989).

¹⁵ S. Lohr, ‘Stress test for the global supply chain’, New York Times, 19 March 2011.

China, are countries that initially used the GVC model in their modern development. Rather than catching up in the development process in a linear way, the GVC model provided grounds for an economic leapfrog start in selected segments. This non-linear process puts a sudden pressure on a country's educational system, which needs to follow the highest standards. Special and differential treatment for developing countries does not have any justification in this regard. If any country does not follow the highest standards that are requested by GVCs, it is eliminated from the GVC by default. Countries may target the highest value-added segments of a GVC to attract business. If a country fails to do so, it may be destined for a simple low-profit "screwdriver" GVC segment. Education and technical training are therefore of crucial importance, both for technological leapfrogging and for inclusion in GVCs. The low labour-cost advantages of developing countries play little role in decisions related to the location of a GVC's business. The substitution of low-cost labour for technological disadvantage does not work in the GVC production and trade model.

Asian GVCs have been employed to assemble goods exported to the US and Europe. Once demand falls in those destinations, the whole GVC suffers. However, demand is increasing within China. The Chinese middle class comprises approximately 600 million consumers. This group is growing in size and its expanding income and level of demand require increasingly sophisticated products. This is an important world market, one that is significantly larger than the entire population of the EU.

5. STANDARDS

Standards are technical regulations that specify the characteristics of goods (and services) or the processes for their production, use and after-consumption disposal. Standards can be quite different between countries, as can be observed, for instance, in the disparate styles of plugs used for electrical appliances. Changes in technology and/or public demand (e.g. environmental or health protection) prompt continuous changes in standards. However, the administrative bodies that set standards often do not have the comprehensive capacity to follow up on such changes in full, and in a timely manner. Demanding compliance requirements create problems in trade. If there are no harmonized standards, then the mutual recognition of standards and technical regulations facilitate operations and the expansion of GVCs, which stimulate, in turn, the drive towards a global harmonization of standards, especially for new goods and services. This is

important, as standards enabled the modularization of production and created grounds for spatial fragmentation in the production chain¹⁶.

International commerce moved from trade in final goods to trade in value added/tasks. Compared with traditional trade, supply-chain trade is much more complex and asymmetric. The old type of exchange through trade – the “my market for yours” approach – has been replaced by “you get my factories and technologies if you protect my tangible and intangible assets” (Baldwin, 2012). Observance of and loyalty to the highest standards is of primordial importance. Without that, the location falls off GVC investors’ radar screens.

To enter a GVC and stay there, firms must respect and relentlessly apply the highest standards so that the quality of the final product is not affected. All firms in the chain must therefore produce to the same high standards.

Starbucks, the American coffee shops chain with global reach, manages a complex GVC linked with its core activity. Cooke (2010) stated that Starbucks employed 142,000 people on all continents; it sourced coffee beans from a number of countries in Latin America, Africa and Asia; it had 48 central distribution centres that were spread globally; it handled about 80,000 deliveries a week; it had 16,700 retail stores; and it served 50 million clients in 51 countries weekly¹⁷.

Global value chains create the situation in which, on the one hand, the industrialization threshold is lowered (the entire process of production of a final good in one place is not required), but on the other hand, the production process requires the highest technological standards. If one component produced for, say, an iPhone is not in line with all other inputs without any exception, that component is eliminated from the final product. All inputs to the

¹⁶ The 2013 Rana Plaza tragedy in Bangladesh is a reminder of how pressure to cut costs coupled with a lack of regulation and standards, may have disastrous effects. One needs to understand, in part, the locals that work in such dismal places, as the alternative for them may be unemployment, theft, drugs or prostitution. Low quality standards contributed to the collapse of the building where 1,134 people lost their lives, with around 2,500 injured. For many this was a wakeup call to watch and control suppliers.

¹⁷ Standardized goods and services do not always receive a universally good reception. Consumers often demand and pay for a great number of niche goods and services that they feel separate themselves from the crowd. This is the reason why globally oriented Starbucks, the American coffee shops chain, decided to close 61 of its 84 shops in Australia in 2008. Many Australians grew up on a quality diet, including superb coffee, introduced by the country’s Italian immigrants. The global and standardized (“linear”) tasting coffee and muffins of Starbucks did not go down well in Australia, as locals had first tasted Italian cuisine (P. Smith, “Starbucks tastes defeat in Australia”, *Financial Times*, 29 July 2008).

final product must adhere to the same standard as all others for the desired high-quality output to be achieved. This requirement provides a great opportunity for modern and relatively fast economic development, but it also demands a well-established and flexible educational system that may follow or even lead such an evolution, and also profit from the new opportunities and challenges. This, of course, needs to be supported by an efficient transport and logistics (including customs clearance) system. In 2013, for example, the Piraeus Port in Athens gained the long-delayed rail connection that provides it with a link to the hinterlands. This came as a result of the Chinese investor Cosco Shipping wanting a smooth transport link from the hinterlands to the port.

If standards are not strictly applied along GVCs, lengthy and complex technological and spatial GVCs may create unwanted problems. An example is the 2013 horsemeat contamination scandal concerning the sale of tinned beef in supermarket chains across Europe. In spite of having the highest level of British food standards accreditation¹⁸, the Scandia Food company in Romania planted a quantity of horsemeat in tins of sliced beef and in frozen meals. The processing GVC involved Romania, France and Luxembourg. Even though horsemeat is as safe for human consumption as beef, horsemeat is cheaper. To increase profit, commercial labels were misleading consumers, which is illegal. Some consumers may have allergies, while others may not wish to consume horsemeat for ethical reasons. The products were withdrawn from the market¹⁹.

The traceability of inputs in the final product is an important element in GVCs. While important for quality and the experiences of consumers, it is also useful for other matters. For instance, the police may trace the criminals involved in a car accident if part of the vehicle used is left behind (mirror, bumper, tail lights, etc.). Equally, the spread of epidemics such as e-coli in Germany (2011) may be discovered, tracked and contained if the supply chain is known.

¹⁸ This accreditation is needed because of the direct impact of food on human health.

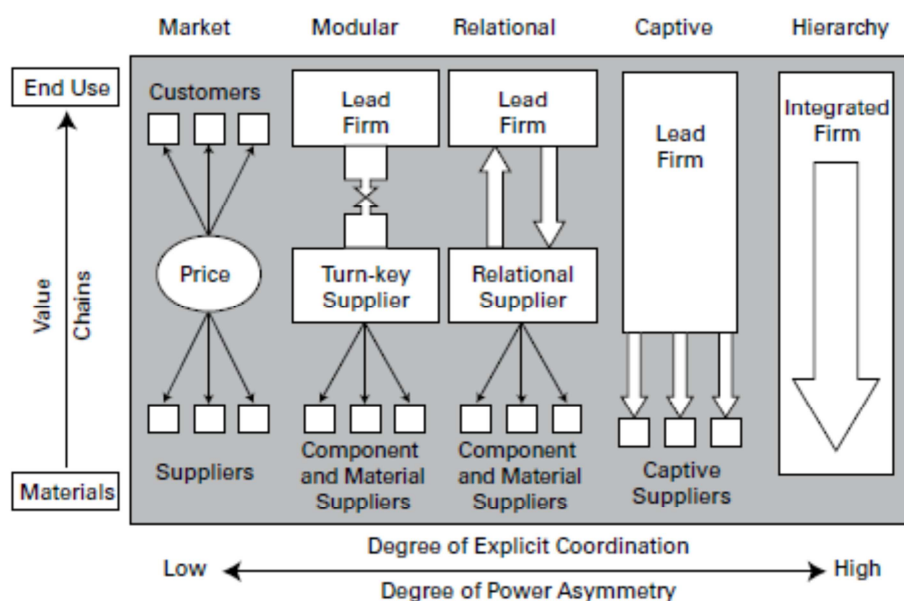
¹⁹ J. Meikle, 'Horsemeat found in tins of sliced beef from batch made in Romania', *The Guardian*, 31 October 2013; P. Allen, 'Horse meat scandal: How horses slaughtered in Romania end up on British plates', *The Telegraph*, 10 February 2013.

For a graphical presentation of this 'chain affair' consult: BBC, 'Horsemeat scandal', 10 April 2013, see <http://www.bbc.com/news/uk-21335872> accessed on 15 November 2018.

6. GOVERNANCE

Governance shapes the manner in which corporate clout influences the distribution of tasks, risks, profits and the other costs and benefits within a GVC. The lead firm is at the heart of this process. Figure 3 shows five stylized types of this governance. The market type is run by price and ownership (arms' length). The modular, relational and captive networks are stable or firm. The lead firm in these market types controls and sets who wins and loses in the GVC. In the hierarchy type, the entire GVC is integrated within a single firm. The challenge is to capture the highly profitable activities in the GVC, and to climb up the value chain – an important task for developing countries.

FIGURE 3 - Five Types of Global Value Chain Governance



Note: The turn-key supplier is responsible to the client for the entire result of the project, and presents it to the client completely finished and ready to use. The relational supplier provides only a specified product/service to other participants in the GVC.

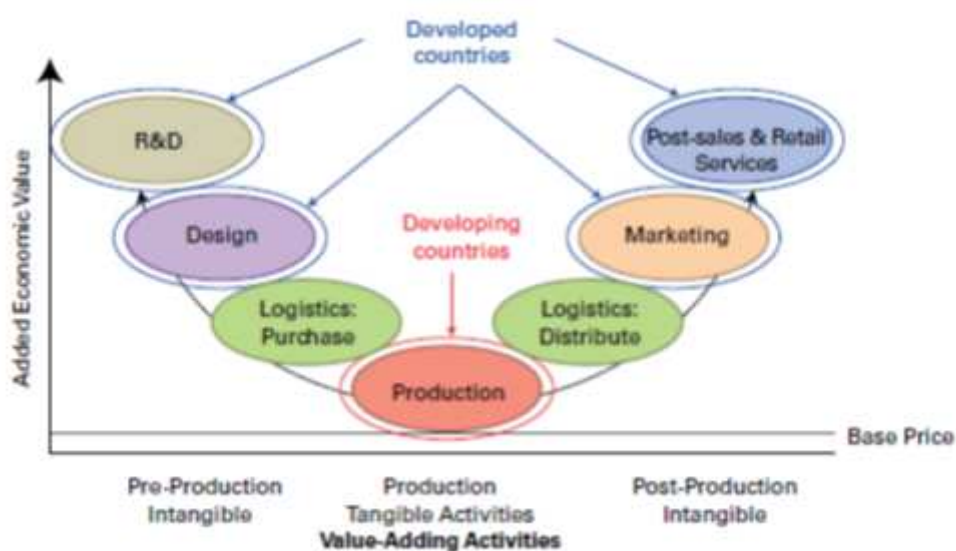
Source: Gereffi *et al.* (2005, p. 89).

7. WHERE IS THE NECTAR AND HOW DO TRADE STATISTICS COPE WITH IT?

Where is the biggest chunk of profit located? Is it in the making of goods, or in creating and selling ideas? These are questions that face many investors and managers. The methodological

and statistical differentiation is quite blurred, as are the boundaries between manufacturing and services²⁰. Is Apple a manufacturing or a services-based firm? It designs and sells its gadgets, but does not own the factories that manufacture them. The competitive advantages enjoyed by Apple and similar corporations are based on the architecture of relations between creators, suppliers, assemblers and retailers. Nonetheless, if a country does not have developed services, manufacturing is a great starting point, as the experience of South Korea shows.

FIGURE 4 - *Smile Curve of Value-Added Activities in Global Value Chains*



Source: Adapted from Gereffi (2016, p. 5).

Flat value-added relations between various segments of the production chain, where each part adds a similar share of value, are increasingly turning into U-shaped relations. Stan Shih, the founder of Acer, proposed the “smile curve” explanation of value-added appropriations along the production chain (figure 4). Manufacturing adds value, but it is at the bottom of the smile curve. Services at either side of the smile curve (before and after fabrication), with concept on the left

²⁰ The services component in trade and GVCs is increasing for several reasons. First, while many services are produced in-house within a manufacturing firm, many of them become sourced from independent outside sources. The production process becomes fragmented and many activities are reclassified. Second, unbundled production requires various services links (e.g. transport, communication, organization, control, etc.) among spatially fragmented, footloose production activities. Third, come changes in final goods (e.g. computers, electronics, telephones, cars, tractors, etc.); they all contain software which comes from the services sector (Heuser and Mattoo, 2017, p. 13).

and logistics on the right, add relatively more value than pure manufacturing. Even though manufacturing is highly important in the GVC process, it is the least value-adding activity in a GVC, especially in high-technology business. Big money is in the services provided by the innovative segments of the chain. The further a segment is from the manufacturing phase of the smile curve on either side of the curve, the higher the potential to make big profits and keep highly-paid jobs. If a firm in the production chain aims at a larger market, its smile curve will be flatter. However, if it targets niche markets, the same curve will be deeper.

Empirical research by Miroudot (2016, p. 20) found that in a sample of 30 countries, “22 follow the pattern of a ‘full smile’”. The policy implications are clear (Gereffi, 2016, p. 5):

Increasingly many of the highest value activities are located in pre- and post-production manufacturing services, which challenge host countries to develop appropriate workforce development strategies to supply these services locally.

Developing countries need to improve both educational and hard infrastructure, as well as business-related services, if they want to climb up the value-added ladder, seize a better portion of profits and reduce vulnerabilities that stem from changing technology and demand.

Trade rules were developed after the Second World War when merchandise in trade consisted mainly of raw materials and final goods. Statistics provided the basis for trade and industrial policies. Tariffs were and are commonly levied on the gross value of imports. The domestic share in the value of exports is high in countries that are large exporters of natural resources, such as Russia, Brazil, Norway and Australia, as well as in crude oil exporting countries in the Middle East²¹. The same holds for large developed countries such as the US or Japan, which have wider inland value chains and rely less on imported inputs compared with other countries, especially if they are small. Conversely, smaller open countries such as Belgium, the Czech Republic, Hungary, Ireland, Luxembourg, Malaysia, Singapore, Slovakia, South Korea, and Thailand, have a rather high foreign value-added content in exports, so GVCs play a growing role in their trade²².

Technology used in production and trade has changed significantly since the 1980s. In the multi-stage GVC system, intermediate goods cross borders multiple times before they end up in a final

²¹ OECD (2018), ‘Domestic value added in gross exports’, data indicator. See <https://data.oecd.org/trade/domestic-value-added-in-gross-exports.htm> accessed on 15 November 2018.

²² See <http://stats.oecd.org/index.aspx?queryid=66237> accessed on 15 November 2018.

product. No matter how low standard tariffs are, they add to and increase the final price of the product at each international transaction in the value chain. Relatively low tariffs in a GVC world may create a high real level of protection, that may not be too apparent from low nominal tariff rates. This may reduce demand, production, trade and investment in different locations. This cumulative effect asks for changes in trade policy and for levying tariffs on a value-added basis, rather than on the basis of gross invoice value.

Traditional trade statistics practices and customs coverage need to change as they are marred with the double or multiple recording of goods in trade²³. The new statistics and customs templates need to record both domestic and foreign value added in order to assist in trade diplomacy, as well as in domestic trade and industrial policymaking²⁴.

The value-added approach may, however, create enforcement problems related to the transfer pricing and services (non-material) part of exported semi-finished products. The parent firm may, for instance, allocate an unjustified high share of headquarters cost to the foreign branch in order to reduce taxes on profits in the location where the branch operates. The Organisation for Economic Co-operation and Development (OECD) accepted the arm's-length standard and requests that internal pricing needs to be as if independent firms were involved in transactions in similar circumstances. In order to ease the operation of GVCs, it may be more attractive to smooth the progress of such trade and production through a multilateral deal under the auspices of the World Trade Organization (WTO), than to have a spaghetti bowl of different regional and sub-regional rules that are out of step with each other.

This may present a problem for authorities in certain importing developing countries, that depend on duties on imports for their budget. If the invoice value of the imported item indicates all costs properly, even for an intermediate product, then it reflects all value-added to the product *to date*. Why should the importing country only take into account the value added by the

²³ The modern best practice, certainly in developed countries such as Britain, involves 'virtual' customs, where physical inspections hardly ever occur and cargoes are checked by computer on the high seas or at origin. Rules of origin costs are therefore minimal because these are repeat cargoes from computer-registered traders. Furthermore, duties are only payable in principle on customs cargoes if not re-exported: modern payment systems simply carry a floating charge until the input has reached its final destination - if that is abroad, no charge is payable.

What is more, WTO rules exist on this. Discrimination against any particular country's trade is illegal under these rules. Now, obviously in some developing countries the same sophisticated, computerized systems may not exist. However, this is changing, especially in Asia. In principle, countries must not charge duty on re-exported goods.

²⁴ Many small- and medium-sized enterprises are taking part in GVCs, but the statistical methodology does not yet capture this. This is also important for taxation. Global value chains have become so complex that it is hard to know where to apply source-based tax on profits.

last actor in the chain?

The double or multiple-counting of intermediate inputs hides the actual substance of trade and creates bias and distortions in trade balances. Input-output matrices became the favoured tool for the measurement of trade in GVCs. This is important for countries where the final assembly takes place. For instance, in China “domestic value-added accounts for only 15 percent of the value of exported electronic and information technology products” (Branstetter and Lardy, 2006, p. 38). Recent estimates are that a third of Chinese exports have foreign content (the ‘Factory Asia’ effect).

Xing and Detert (2010, p. 4) found that out of the \$178.96 manufacturing cost of the iPhone3, only \$6.50 could be attributed to China (assembly costs). The rest is made up of imported components from Japan, South Korea, Germany and the US. Most of the export value of the iPhone3 has nothing to do with China. Even if the Chinese yuan revalued against the US dollar by 100 per cent, this would influence only the assembly costs (\$6.50) and would not significantly change the final price of the product. Americans are perfectly capable of putting together an iPhone, but their wages were 10 times higher (at that time) than their Chinese counterparts. Profit maximization by Apple determined the geographical location of assembly.

The OECD has a revealing example related to the iPhone4 (OECD, 2011, p. 40)²⁵. It was demonstrated

that China only operates as the assembling country in Apple’s GVC and imports the required intermediates from other countries like Korea, United States²⁶, Germany, etc. While China adds USD 6.54 to the manufacturing of the iPhone4, it exports USD 194.04 or the total factory gate price to the United States. For each iPhone4, the United States incurs a trade deficit of USD 169.41 (= 194.04 – 24.63) with China in ‘traditional’ trade statistics²⁷.

Standard trade statistics quantify the value of goods that cross frontiers. This does not include, in general, the value added linked to intellectual property. That is out of touch with the reality where the intellectual property component, especially in sophisticated goods, plays an

²⁵ A study of the iPod (Dedrick *et al.*, 2010) revealed an interesting snapshot of a final, end product in electronics. The US-based TNC Apple gains, as the ‘owner’, between a third and a half of the retail price of this product. Other suppliers of high-value inputs such as the display, memory and hard disk are based in Japan (Toshiba) and South Korea (Samsung), and take another major chunk of the retail price, while the assembly and testing in China covers approximately 2 per cent of the retail price.

²⁶ The material input of the US in the iPhone4 is \$24.63.

²⁷ A similar level of spatially fragmented production can be found in goods such as Barbie dolls, computers, vehicles and aircraft.

important role. Many globally important and influential firms specialize in innovation, R&D and the branding of goods, rather than in actual manufacturing (Apple, Nike, for instance). They outsource the production/assembly of goods and manage GVCs. Their intellectual property is implanted in the value of the finished good. For instance:

When Apple sells a \$500 iPhone to a foreign consumer, it sends the sale order to Foxconn in China. For assembling the iPhone, Foxconn imports \$172.46 worth of parts and components, of which \$10.75 comes from the US. When the ready-to-use iPhone leaves China, China's customs records a \$178.96 export for the country. As a result, the sale of a \$500 iPhone gives rise to a total \$351.42 export for all countries involved in the value chain of the iPhone. It is important to emphasise that only \$10.75 of the total export is recorded as a US export.

From the transaction, Apple receives \$321.04 for the value added of its brand and technology imbedded in the iPhone. It represents the export of Apple intellectual property. But, \$321.04 is recorded neither in US export in goods nor in services. This is a large missing export of Apple intellectual property associated with selling one iPhone abroad!

It is estimated that Apple captured \$23.5 billion from the sales in Greater China. While made-in-China T-shirts sold in the US market are recognised as part of China's exports to the US, Chinese consumers' payment for the value added of Apple is not recorded as part of the US export to China. Unambiguously, this asymmetric recording has distorted the true picture of the bilateral trade balance. If the value added of Apple were included in US exports to the region, US exports to Greater China would rise by 13.1% and its trade deficit with the region would decrease by 6.7%. It is noteworthy to mention that the changes are due to just one American company, namely, Apple. Many US multinationals operate in the same fashion. If we included all of the value added that US multinationals derive from their intellectual property in China as part of the US exports to China, the trade between the two countries would be much more balanced than is indicated by current trade statistics²⁸.

The US trade deficit with China would be reduced by up to 30 per cent if measured in value-added terms rather than in gross terms (Park *et al.*, 2013, p. 140).

If Nike or Apple export their products from China to Japan or to South Korea or elsewhere, statistics do not link such exports to the US, even though there is an important US value-related element in such exports. If one included the US intellectual-property value in such trade statistics, the global balance of international trade would be more objective and levelled. More

²⁸ Xing, Y., 'Global value chains and the US missing exports', VOX, 27 September 2017.

inclusive and focused trade statistics would be most welcome, as they would assist policymakers and trade diplomats in recalibrating their decisions.

The Trade War that started in 2018 between the US and China will have strong effects on GVCs and trade between the two countries. The stance of the US is primarily aimed at dissuading US companies from producing in China (because of low labour costs) and exporting goods to the US. China is also a giant consumer of computer chips made by US companies such as Qualcomm, Broadcom, Micron, Texas Instruments and others. The situation could well lead to an increase in the price of inputs used in Chinese products, and therefore the price of computer-related goods made in China and sold in the US. The bill will be footed by US consumers²⁹.

To better record trade in value-added terms, the WTO³⁰ and the OECD³¹ developed an ambitious Trade in Value Added (TiVA) data set. The World Input-Output Database³² contains tables with an annual time-series of world trade (input-output). More than four fifths of countries involved in international trade are covered. For instance, the domestic value-added content for German cars fell from 79 per cent to 66 per cent in the period 1995-2008. The share of foreign value-added shows the international fragmentation and spread of production (Timmer *et al.*, 2014, p. 103). No matter how incomplete it may currently be, such statistical input may assist (slightly) in the policy making³³.

The TiVA indicators provide a highly valuable tool for researchers and policymakers, with its wealth of new visions on production and trade. Nonetheless, there are concerns regarding their correctness and meaning. The TiVA indicators “are, essentially, estimations based on national I-O (input-output) tables that are themselves estimations” (Sturgeon, 2015). In addition, there are

²⁹ The principal clashing points between the US and China are: the need to reduce the US trade deficit; protection and enforcement of intellectual property rights; the lack of transparency in Chinese subsidies; cyber-related incidents; the ‘forced’ transfer of technology to China; and compliance (review and enforcement) to the trade deal.

³⁰ See https://www.wto.org/english/res_e/statistics_e/miwi_e/countryprofiles_e.htm accessed on 15 November 2018.

³¹ See <http://stats.oecd.org/index.aspx?quervid=66237> accessed on 15 November 2018, and http://www.oecd.org/std/its/trade-investment-gvc.htm?utm_source=Adestra&utm_medium=email&utm_content=International%20trade%2C%20foreign%20direct%20investment%20and%20global%20value%20chains&utm_campaign=STATS%20Flash%2C%20October%202017&utm_term=demo accessed on 15 November 2018.

Also see http://www.oecd.org/sti/ind/measuring-trade-in-value-added.htm?utm_source=Adestra&utm_medium=email&utm_content=Trade%20in%20Value%20Added%20%28TiVA%29%20database&utm_campaign=Resend%20of%20OECD%20Science%2C%20Technology%20%26%20Innovation%20N&utm_term=demo accessed on 6 January 2019.

³² See <http://www.wiod.org/home> accessed on 15 November 2018.

³³ There is scope for linking the two GVC statistical exercises: a macro approach at the national level, and a micro approach at the level of firms.

concerns related to the issue of what TiVA indicators actually are (Sturgeon, 2015):

If they are not statistics, much less official statistics, how can they be used for making economic policy? At the very least, the utility of the current figures can and should be treated with some scepticism. It is troubling to think that policymakers are reacting uncritically to TiVA estimates. A number of concerns:

- Given the underlying data weaknesses and inconsistencies across countries, especially in regard to services and prices, are I-O tables a proper source of information for the construction of highly reliable and detailed statistics?
- TiVA indicators currently treat firms as homogenous, when we know from other research that different kinds of firms have vastly different patterns of global engagement.

Firms are heterogeneous in various dimensions including size, ownership and involvement in trade (exporters, importers, two-way traders). A high level of statistical aggregation regarding both firms and industries, constrains the value of the TiVA indicators for analysts and policymakers. This is because they may skew analysis and understanding of the problem, possibly leading to inaccurate policy implications. The field research conducted by the World Bank in Viet Nam, for instance, found that the TiVA underestimated the foreign content of Vietnamese exports of transport equipment (Sturgeon, 2015). Still, at its present stage, the TiVA offers a new and additional platform from which one may observe with prudence and analyze with caution production, trade and economic policy.

8. TRADE RULES

The international economy has two rather new and important features. The first one is the spatial fragmentation of production and the rise of GVCs. To attain the stage of a final product, intermediate goods cross borders many more times than in the past. The spread of GVCs is based on expectations that the trading and investment environment will remain open for the smooth and swift movement of cheap supplies. Together with this denationalization of production and an increase of trade in components and parts, there is a second feature: a proliferation of economic integration agreements, some of them of mega-size, that have deep policy coverage and wide spatial reach (Jovanović, 2016).

Global value chains as components of industrial organization incite international regulatory concerns, especially in the field of trade facilitation. The organization of production is

influenced by three changes (Hoekman and Sabel, 2017, p. 4):

- *Vertical disintegration*: the whole production process is fragmented into separate tasks such as R&D, design, production of parts and components, assembly, distribution, etc ... with each part accomplished by independent firms linked through a GVC;
- *Globalisation of the supply chain*: production is located where its cost is the most advantageous and where it is close to a specific and targeted market; and
- *Continuous improvements* not only in immediate error detection and its rectification, but also in just-in-time production and deliveries.

Global trade rules were revised in 1995 (a creation of the WTO). More than a generation has passed since that time and many changes have taken place. Technological advances have allowed billions of people to have mobile phones with affordable internet access, while there have been exponential improvements in accessing information, and the long-distance coordination of business has become manageable. The new GVC situation asks for new global trade rules. Trade in tasks takes into consideration intermediate goods and offshoring, rather than only final products.

This WTO-type multilateralism has a serious problem. Consensus is the mode of operation in the WTO. Hence, “hostage-taking” exposes deal-making to tough, specific national and business interests that block progress. A practical way out of the impasse is found in plurilateral rather than in multilateral deals. If a cosy group of countries find a sensible solution to one of their problems (investment facilitation or e-commerce), and if they do not discriminate against other WTO countries, practical agreements may be reached. Outsiders cannot block the deal and may be left out.

The WTO has been moving with reforms for a couple of decades now, and at a very slow pace: false dawns, failures, procrastination and slim results. The latest Doha Development Round of negotiations started in 2001. It stalled in 2008 and nobody knows when it will end (and how). This organization has been trapped in the trade issues of the past century (tariffs, quotas, agriculture), leading players to search and sometimes find lateral and regional alternatives outside of the WTO in regional and mega-integration deals (Jovanović, 2016). Some of those deals, such as the ill-fated Trans-Pacific Partnership (TPP), exclude China and may have the tacit intention of being something like a WTO version 2.0, based on a Western-world platform

and geared towards its interests only.

New multilateral trade rules need to involve the principal players: the US, the EU, Japan and, especially, China. If China is left out of the new rule-making process (as was the case with the TPP), that would be like staging Hamlet without the prince. China may choose to (and does) create and spread a parallel, flexible and quite open trading and investment system of its own.

The new blueprint for integration deals needs to close off regulatory gaps and ease the operation of GVCs, because most products are mongrels with a pedigree that cannot be decoded. What matters for the new generation of trade deals is not only selling products (as was the case in the past), but also making goods (supply chain) and services. Contrary to the situation during the 1950s and 1960s, when goods were made entirely in the US, Germany or Japan, one may not now easily demarcate the origin of goods, services, firms or capital. This new competition-related development will be favourable if the newly created standards and regulations are not skewed by corporate lobbies.

The new GVC-friendly rules in integration agreements cover, among many other matters, intellectual property rights and the international mobility of factors, especially of people (managers, engineers, programmers, technicians, controllers, experts in logistics and audit, etc.) who are necessary for the smooth operation of GVCs. The peril is that various regional and bilateral trade and investment deals may not have rules that are in step. Multilateral harmonization may therefore be a welcome step towards making production and trade smoother and more efficient through network externalities.

In the developed world, tariffs on final manufactured goods are generally low or close to zero. However, the transaction costs of getting items through borders are rising relative to the fall in tariffs, because of controls related to standards, phytosanitary inspections, etc. Developing countries have higher tariffs, but the downward sloping trend in tariff rates is obvious. Efficient and unbundled international production rests to a large extent on an open trade and investment regime. Otherwise, if a country wants to protect its domestic industry with tariffs and non-tariff barriers (NTBs) in a GVC situation, the country will be harming such industry at home.

9. CHANGING TECHNOLOGICAL CHALLENGES

The long-lasting debate about the net impact of new technology (now automation, robots and sensors) on employment has been around since the time of the Luddites (1811-1816). It was started by textile workers in Nottingham, United Kingdom, and spread in that region. The Luddites destroyed new weaving machinery because they feared that the new technology would remove their embedded place in industry. If “New Luddites” want to destroy the robots, automats or sensors that are ruining their jobs, doing so would be preposterous. They may even choose to burn down the sites of corporations, but any damage would be minor as the principal assets of Google, Apple or Microsoft are in the intangible sphere of intellectual property. The principal assets usually walk (drive or take public transport) home after office hours. “Corporate culture” does not reside in computers, but rather in the heads of the employed.

It is clear that new technology has been changing the structure of employment, but the net effect is often disputed. Doubts about those net effects spring from methodology: how does one measure the new technology and its impact? Old jobs that are lost, or those that went abroad, normally do not come back.

The Bank of England cautioned in 2015 that around 15 million British jobs were at risk of being lost to automation. “Administrative, clerical and production tasks were most at threat”³⁴. New “workers” are robots that do not need long and extensive retraining. Robots often need only new software and they are ready to go. This development would further depress growth in wages. In this scenario, inflation would decelerate further as there would be no extra wages and no extra demand. The share of labour in the national “economic pie” would continue to shrink. This could take place much faster than it has in the past. The income gap between the rich (capital owners) and the rest of society would continue to widen.

Contrary to such an observation, the World Economic Forum (2018, p. 8) predicted that by 2020 “75 million jobs may be displaced by the above trends, while 133 million additional new roles may emerge concurrently”. In addition, Mann and Püttmann (2017, p. 6) found in the case of the US that “more automation delivers more employment. ... Manufacturing employment falls and service sector employment grows in response to new automation technology”. The loss in routine and manufacturing jobs “has been more than compensated by a rise in service jobs”.

³⁴ L. Elliott, ‘Robots threaten 15m UK jobs’, The Guardian, 12 November 2015.

Still, one needs to keep in mind that the number of new jobs needs to be observed through the lenses of their structure: the newly created jobs are different to those that have been lost.

The improved management of a GVC not only liberates storage space, but it also frees up financial resources. In addition, artificial intelligence is able to forecast demand for over a year for a number of products, which may assist in the management of GVCs. Management and logistics services are the connecting tissue of a GVC³⁵. However, the role and input of services as the GVCs bond is not limited to management and logistics. Global value chains always start with R&D, design and engineering, and end up with marketing and distribution (Miroudot, 2016, p. 8).

Offshoring has been taking place over the past few decades. Certain jobs and industries moved from the US or Europe towards the East (to China, in particular). These jobs have not been replaced, nor will they be. The current transfer of jobs is taking place from an actual (i.e. physical) economy to a virtual one (Arthur, 2017, p. 7). Just cast your mind back to checking in luggage and boarding an airplane. There are more and more airports in the world where passengers communicate not with airport personnel, but rather with sensors. A similar situation is becoming commonplace in banks, gas stations, libraries and supermarkets. One can spend a whole day out doing errands without talking to a real person³⁶. This trend will spread and “worsen”. Meanwhile, email services have reduced the need for postal workers, but increased demand for delivery services³⁷.

Considerations about the future location, quality and volume of jobs and their impact on output are plagued with uncertainties. Mauldin looks at the issue in the following way:

The glib answer to the question, “Where will the jobs come from?” has always been “I don’t know, but they will.” That is what has always happened in the past. We went from 80% of laborers working on the farm in

³⁵ ‘Directly and indirectly embodied services account for over a third of value added in chemicals, motor vehicles, textiles and food products’ (OECD, 2013, p. 27).

³⁶ A multipart bank transaction or the purchase of a complex airplane ticket may be done faster and with a higher quality if there is direct contact between a client and staff over the counter (or phone). The same holds for activities in which empathy, personal contact and intuition are essential. For instance, this includes working with someone on a chaotic divorce or a pre-nuptial contract.

³⁷ Credit and debit cards have drastically reduced the use of cash globally. This has changed global buying habits: the more the consumer is away from cash, the higher the chance that she/he will overspend. The losers are often the account owners, waiters and chambermaids (tips), charity boxes and the homeless. In addition, another change in consumers’ behaviour has occurred, in that they have decreased the amount they purchase in department stores and increased their online procurement of goods and services. This has increased the need for parcel deliveries and delivery personnel. People also care more about the fast delivery of goods ordered online than they do about the origin of their orders.

the 1800s at barely subsistence-level incomes to 2% producing far more food today. As these farm workers became redundant, they moved to where the jobs were. And with a lot of ups and downs, we managed over time to find jobs for nearly everyone. But that transition took place over 200+ years – 10 generations. There was time for people to adjust and for markets to adapt. Even when whole industries appeared and then disappeared again, it happened over generations. Everybody bemoans the loss of US manufacturing jobs, but few realize that we are producing almost as much as we ever have – just with fewer people. And this trend will continue. More production, with fewer workers. Just like we see in the oilfields³⁸.

Computers and machines are creating “technological unemployment”. Adjustments to the new economy will be necessary. It may take time, and perhaps a lot of it. The Industrial Revolution in the United Kingdom created the grounds for a strong increase in production. Nonetheless, the downsides of this could be found in hideous social circumstances (child labour, diseases, alcoholism, etc.). In turn, these conditions created the environment for social and safety laws. This change took a while – a couple of generations – but it did take place. In all, the turn of events can be taken as a positive development that proves adjustment to new conditions can and will take place again, just as it did in the past.

During the first wave of globalization (1840-1914), technology primarily affected industries and firms. This allowed the spatial separation (unbundling) of the location of production and the place of goods consumption. The second “high resolution” wave of globalization (1980-2008?) brought an additional possibility for the spatial fragmentation of production: certain operations within the same factory could be unbundled and performed elsewhere because they were footloose. Trade in specific tasks emerged. Some services also became tradable. Firms, such as Apple, specialize in R&D related to computers, imaging, amusement and communication products. Their focus is on innovation – predominantly in the US – while the actual manufacturing of its products is spread outside of the home country, throughout Asia.

Traditionally, innovation and R&D activities were the least decentralized business functions of firms. However, more and more firms are spreading this part of their operations along GVCs. Talent and new ideas are available globally. In pharmaceuticals, for instance, “Chinese R&D sites are opening or growing almost as quickly as European and US sites are closing or shrinking”³⁹. Research and development functions are increasingly being located closer to principal markets

³⁸ J. Mauldin, ‘The fragmentation of society’, *Thoughts from the Frontline*, 29 October 2017, p. 7.

³⁹ P. Waldmeir, ‘China offers a taste of R&D to come’, *Financial Times*, 14 November 2012.

to help adapt and customize products (or processes) to better satisfy local demand⁴⁰. The local availability of strategic assets such as the pool of skills and knowledge – especially relevant for the electronics industry – is an important lure. Existing skills and readiness to learn crucially determine the extent to which the local labour force may link up with the GVC, especially in higher value-added activities. Countries are therefore competing more and more through the various and changing skills of the local population. With the spatial fragmentation of production, this approach to competition offers flexibility in attracting certain, especially high-value-added segments in the production chain. Investments in the science, technology, engineering and mathematics (STEM) segments of education offer promising potential for a high payback on national investment. This needs to be set eye to eye with the needs of the business sector of the economy, to avoid the mismatch (brain waste) between public policy in education and the needs of firms. The continuous improvement of STEM skills and talents is surfacing as being among the principal attractions for investors, both domestic and foreign.

China is investing tens of billions of dollars annually in R&D to become a global superpower in innovation. “It files more patents each year than any other country (a record of 1.1m in 2015), and more than the US, Japan and Korea combined. ... China has overtaken the US when it comes to the total number of scientific publications: 426,000 to 409,000, in 2016. The US, though, still triumphs when it comes to highly cited papers (a measure of influence)”⁴¹. Nonetheless, China is continuing its meteoric ascent in R&D, as well as in innovation. The country’s objective is no longer to produce more products, but rather to create grounds for the production of more value added and climb up the value-added chain. The old saying “*Ex oriente lux*” (‘out of the East, light’) continues to have relevance and impact not only in manufacturing, but also in science and innovation.

As far as the emerging G5 telecommunications technology is concerned, “the central nervous system of the 21st century economy”, the head of Huawei argues:

Today, Ren says that being a privately held company gives Huawei the freedom to plow more money back into R&D – some \$15 billion to \$20 billion per year. Some 80,000 people, or nearly half Huawei’s

⁴⁰ The French company Renault located its second largest engineering centre in Romania in 2007, to profit from the local engineering talent and to adjust models according to regional needs and payment capacity.

⁴¹ A. Ahuja, ‘Cloning breakthrough heralds China’s scientific rise’, Financial Times, 30 January 2018.

workforce, are dedicated to research and development; tens of thousands alone work at Huawei's huge corporate campus in Shenzhen... Huawei has more 5G-related patents than any other firm⁴².

The global technological leadership and supremacy may be moving towards China, the place that China lost a couple centuries ago.

As the spatial relocation of R&D takes place, the fear is that innovation activities in home countries will shrink and become scaled down. However, Belderbos *et al.* (2016, p. 5) argue that

the offshoring of R&D and innovative activities does not hurt such activities at home. Rather, the evidence suggests that, if anything, outward investments in R&D and innovation, particularly if they concern development, design and testing, increase multinational enterprises' innovation activities in their home city. This confirms the notion that innovation activities at home and abroad are likely to be complementary.

Fears that GVCs may replace jobs in home countries are not easily substantiated. There is evidence that

Japanese manufacturing firms that increase the number of their affiliates in East Asia enlarge domestic employment and operations relative to other Japanese manufacturing firms, no matter whether in normal periods or during a crisis (Kimura, 2013, p. 376).

Total manufacturing is increasing in volume, but the number of manufacturing jobs is not rising in kind. Why? This is because of technological progress that includes the use of robots and automation. New machines reduce the need for human labour. They also do not ask for workers' rights and labour unions. For instance, the number of rigs in US oilfields is rising fast, while the number of oilfield workers is continuously falling. The explanation is as follows:

There is a new robotic machine called an Iron Roughneck that reduces the human labor required to connect pipe from a crew of 20 down to a crew of five. And those jobs were quite high-paying. Here's a picture of this new robotic roughneck. Fifteen workers per site at well over \$100,000 a year each? Does that machine look like it cost more than a few million? I bet it amortizes pretty quickly, and that's why it is

⁴² K. Johnson and E. Groll, "The Improbable Rise of Huawei - How did a private Chinese firm come to dominate the world's most important emerging technology?", *Foreign Policy*, 3 April 2019. <https://foreignpolicy.com/2019/04/03/the-improbable-rise-of-huawei-5g-global-network-china/> accessed on 12 June 2019.

being rapidly adopted⁴³.

Monotonous, standardized tasks are increasingly being passed on to robots. Skills-biased technical change and offshoring increases productivity, while the volume of low-skilled jobs reduces. The comparative advantages of developing countries are being deteriorated: low labour costs are losing their ability to compensate for a lack in skills and technology.

Labour standards in GVCs are increasing. Skilled, creative and experienced labour is gaining ground in terms of higher wages, but net employment is falling. Productivity in select locations may often increase, but local employment effects may be negative or at best ambiguous, a factor that is especially important in developing countries. Local policies on education and technical training may be of a great assistance to the expansion of local business communities, helping them to leapfrog toward a more advanced economic position through the use of GVCs (Farole, 2016; Rodrik, 2018).

Higher wages *per se* are not a deterrent to attracting and keeping high-wage jobs. What matters for profit-oriented firms are only unit labour costs (average labour costs per unit of output), not high/low wages. By comparing unit labour costs between locations (and with time), a firm may determine the relative differences in productivity among different production units, and decide on production and investment actions.

New technology is having an impact on current jobs. Some jobs are lost, never to be recovered, while others are to a large extent being replaced by different jobs, and often by algorithms that may perform certain sophisticated tasks, at least in part, faster and with less error than sophisticated professionals such as radiologists, for example⁴⁴.

As can be seen, the loss of certain jobs, perhaps the majority of them, has little to do with the offshoring of production to China or elsewhere. It often has more to do with changes in technology that increase productivity and require less labour. Certain monotonous, standardized, repetitive and routine jobs/tasks have been lost for good. Robots and computers have not only replaced them, but also increased productivity. Any policy action designed to

⁴³ J. Mauldin, 'The fragmentation of society', Thoughts from the Frontline, 29 October 2017, p. 3.

⁴⁴ I recently had a magnetic resonance medical examination. Technicians took over 3,000 images within an hour. There is no way that a radiologist can reasonably and carefully examine all of those images within the relatively short given period of time (there are other patients). This is something that powerful computers can do within a few seconds to spot anomalies, and if there are any, they can indicate to the radiologist areas that require special attention.

protect or restore such lost jobs is like driving while only looking in the rear-view mirror. China-bashing will not help. The solution can be found in policies that continuously educate the labour force and management in the necessity of being flexible, so that they can profit from ever-changing technology and new opportunities⁴⁵. As such, a country, especially a small one, will be ever-present on the radar screens of investors, as such locations have the potential to fit easily into GVC segments.

More and more routine tasks completed by lower- and middle-skilled workers are being taken by technology (capital). Capital has the ability to substitute for labour with ease. The elasticity of substitution between capital and labour is greater than one. In such an environment, lower- to middle-skilled labour suffers. As labour costs are lower in developing countries than in developed ones, offshoring offers the possibility of moving lower-end tasks and jobs towards the developing world. However, McKinsey (2019, p. 8) referred to the deteriorating situation in low-labour cost developing countries:

As global value chains expanded in the 1990s and early 2000s, many decisions about where to locate production were based on labor costs, particularly in industries producing labor-intensive goods and services. Yet counter to popular perceptions, today only 18 percent of goods trade is based on labor-cost arbitrage (defined as exports from countries whose GDP per capita is one-fifth or less than that of the importing country). In other words, over 80 percent of today's global goods trade is not from a low-wage country to a high-wage country. Considerations other than low wages factor into company decisions about where to base production. These include access to skilled labor or natural resources, proximity to consumers, and the quality of infrastructure.

Moreover, the share of trade based on labor-cost arbitrage has been declining in some value chains, especially labor-intensive goods manufacturing (where it dropped from 55 percent in 2005 to 43 percent in 2017). This mainly reflects rising wages in developing countries. In the future, however, automation and artificial intelligence may amplify this trend, transforming labor-intensive manufacturing into capital-intensive manufacturing. This shift will have important implications for how low-income countries participate in global value chains.

Even the menace presented by offshoring has the potential to weaken the bargaining position of labour when up against the owners of capital. If a labour force bolsters certain existing demands

⁴⁵ The policy challenge is what to do and how to assist those that are left behind, but who have the will and interest to change.

or introduces new ones, owners of capital may threaten to offshore or outsource certain activities to mitigate their demands. Fiat used such pressure to reduce the demands of labour unions in Italy. If the unions refused to moderate their demands, Fiat threatened to relocate additional operations to low-wage Serbia.

Keeping in mind the above, it is no wonder that in the period 1991-2014 “global labor share of income declined by some 2 percentage points” (Dao *et al.*, 2017, p. 12). This distribution of income has wider implications not only for the volume of final demand (which is potentially smaller), but also for inequality in societies that favour owners of capital. Divided societies do not function well. Markets do not guarantee equality; in fact, they will always produce inequality in line with the differences between individuals’ innate capacities, luck and (to a degree) merit. Politics is all about reducing these inequalities without harming the markets that create them – and seeking prosperity for all to enjoy.

International trade has been growing steadily since the end of the Second World War. In fact, “World trade, which used to grow faster than GDP, seems turned sluggish”⁴⁶. Hoekman observes that

The world’s trade-to-GDP ratio climbed steadily for six decades. The rise slowed even before the Global Crisis and world trade growth has been anaemic since 2010. Recent data shows it declining, leading some to wonder whether global trade has peaked⁴⁷.

This slowdown has several sources. One is a relative end to the large-scale integration of China and Eastern Europe in the global economy, as well as a plateau in the global spread of the spatial fragmentation of production. Managers may reconsider the spread and reach of GVCs that have reached maturity, and shorten them if necessary. They may make them more concentrated in particular regions and/or employ new technologies such as 3D printing, thereby possibly reducing the global volume of transport and trade. If this is compounded by the turn of China toward production for home consumption, this may to a large extent explain the possible statistical plateau in the trend of growing international trade⁴⁸. This plateau may be reinforced and the “disintegration” or deglobalization tendencies present in the world economy may be

⁴⁶ ‘Globalisation’s retreat?’, The Economist, 25 June 2015.

⁴⁷ B. Hoekman, ‘Trade growth – end of an era?’, VOX, 24 June 2015.

⁴⁸ B. Hoekman, ‘Trade growth – end of an era?’, VOX, 24 June 2015.

underpinned by the Brexit (2019),⁴⁹ as well as by US protectionist measures and the reactions of its trading partners. The Trade War – the US against everyone – (from 2018) will only contribute to the slowdown and the plateau in globalization measured in the volume of trade and FDI. It will also bring forward the next recession and a daunting outlook for GVCs.

Global value chains and the spatial fragmentation of production permitted a reduction in the domestic content of a nation's output. However, China is an exception. Over time, as domestic Chinese suppliers increased their sophistication and competitiveness, Chinese output achieved an increased share of domestic inputs. This has had a partial impact on the slowdown in global trade (Chinese imports).

The stated plateau in globalization was reinforced by “buy national” politics, especially in EU countries during the Global Financial Crisis and in the US (both during the office of President Barack Obama⁵⁰ and the Donald Trump presidential era from 2017). However, this may not necessarily remain unchallenged. The spread and reach of robots, sensors and artificial intelligence are creating new technological grounds for international exchanges, and are a driving force behind the reinvigoration seen in some segments of globalization. Still,

Any optimism about the scale of contribution by GVCs has to be tempered by three sobering facts. First, the expansion of GVCs seems to have ground to a halt in recent years. Second, developing-country participation in GVCs, and indeed in world trade in general, has remained quite limited, with the notable exception of certain Asian countries. Third, and perhaps most worryingly, the domestic employment consequences of recent trade trends have been quite disappointing (Rodrik, 2018, p. 3).

The current shift in the shape and location of production has been brought by new intelligent technology. Arthur (2017, p. 5) argued that

The interesting thing here isn't the form intelligence takes. It's that intelligence is no longer housed internally in the brains of human workers but has moved outward into the virtual economy, into the conversation among intelligent algorithms. It has become external.

⁴⁹ BMW has four production sites in Britain. They rely heavily on imports of components from EU suppliers. The company would be forced to stop production in Britain if components cease to flow smoothly from the European continent (P. Campbell, 'BMW issues threat to shut British plants if parts supply is disrupted', Financial Times, 26 June 2018).

⁵⁰ Especially in the aftermath of the Global Financial Crises.

Therefore, to continue to be a part of a GVC, each segment (location of production) has to be in step with the previous, following and surrounding links in the production chain, even virtual ones. If this actual and virtual communication and support is not in step and of the same standard, the GVC segment drops out.

Continuous communication and permanent upgrading is the key not only to progress, but also to the survival of a firm. Sony, for instance, faced a number of competitors for its Walkman. However, Sony was able to charge 25 per cent more than its competitors even though its product was not technologically superior. Sony had much better design, marketing, and communication with consumers than its competitors (Czarnitzki and Thorwarth, 2009, p. 9).

Relatively low labour costs in China could have been the reason why many started to locate certain operations there at the start of the 1990s; but the situation has changed. It was reported that the Pearl River delta in China attracted \$1 billion of FDI a month. Microwave ovens are produced in Shunde. Just one of its giant factories produces 40 per cent of the global output. Shenzhen produces 70 per cent of the world's photocopiers and 80 per cent of its artificial Christmas trees. Dongguan has 80,000 people working in a single factory making running shoes for the world's teenagers. Flextronics is a Singapore electronics maker that produces for Microsoft, Motorola, Dell and Sony. The manager of its Chinese plant in Doumen said: "It is a myth that companies are coming here just for the cheap labour. It is the efficiency of the supply chain that drives them here as more and more of worldwide demand is consolidated in this area"⁵¹. In addition,

Apple CEO Tim Cook declared that, "China stopped being a low-labor-cost country many years ago, and that is not the reason to come to China." The country's manufacturing strengths now lie in its advanced production know-how and strong supply-chain networks. Understandably, China's leadership wants to increase productivity and continue to move further up the value chain⁵².

Average hourly wages in China, especially in the coastal region, were increasing 15-20 per cent a year (OECD, 2017, p. 17). If not linked to an increase in productivity, this may erode cost advantage in China and negatively affect a section of GVCs. It may make sense, therefore, to

⁵¹ J. Kynge and D. Roberts, 'The Pearl river delta is attracting \$1bn of investment a month amid one of the fastest bursts of economic development in history', Financial Times, 4 February 2003.

⁵² S. Johnson and J. Ruane, 'China, the innovation dragon', Peterson Institute for International Economics, 3 January 2018.

consider at least some re-shoring (to the US, for instance). In addition, the logic of security in the supply chain contributes to such business considerations.

Rural to urban migration was one of the principal sources of growth in China. This trend now seems to be spent, so firms face labour shortages and therefore need to pay higher wages. In spite of continuous wage increases in China (approximately 15 per cent annually from 2000-2015)⁵³, the country continues to have a strong export performance. Flexibility, productivity and the use of new technology in production and organization are the most essential elements behind this performance.

Increased income in China also translates into an increase in domestic demand, which may positively affect the evolution of GVCs. This all creates a golden opportunity for other developing Asian and African countries to attract labour-extensive production segments from China. The problem working against this possible development is that robots and automats may replace a number of repetitive and standardized operations, thereby reducing the number of lower-level employed. The way out is continuous education and improving the skills and potential of human capital.

Cars and other vehicles become computers, sensors and cameras on wheels. They have autonomous life-long communication with their manufacturers and receive updates by default; they communicate with satellites, as well as with road infrastructure. In the pipeline is a car that may be able to read a driver's brainwaves and conduct the bulk of the driving activity. The times when a driver could change even a simple light bulb on their own, have gone. A standard contemporary liquid-fuel powered car contains around 30,000 different parts (an electric car contains about 7,000)⁵⁴. Each final car is a result of complex GVCs, as many parts are sourced from a wide array of international suppliers. What will be the impact of the spread of electric cars on car manufacturing jobs? Will the GVCs be spatially shorter, and less complicated? How

⁵³ This increase slowed to single digits from 2016, and may stay like that for the foreseeable future. While this may be unpleasant news for Chinese workers and domestic demand, the development is relatively favourable for the Chinese economy, as the domestic labour market may remain competitive compared to those of Viet Nam or Cambodia ('China's workers are saying goodbye to double-digit pay raises', Bloomberg, 16 June 2017).

⁵⁴ 'Cars and gadgets have become more complicated, with engineers forced to specialise. Yoshinori Iizuka, a Tokyo University professor, said: "There are fewer and fewer people who understand how all the parts work together". Cars now use more electronics and digital electronics uses more software. Yoshiki Matsui, a professor at Yokohama National University, said: "For electronics, quality is largely determined at the design stage. If there's a flaw, it doesn't matter how good quality control is at the assembly plant"' (R. Harding and J. Soble, 'Japanese fret over quality of manufacturing', Financial Times, 3 March 2010).

will it impact service jobs in garages? Gas stations and the production and distribution of liquid fuel will also be affected.

New and often superior technology replaces its older equivalents. For instance, Germany excels in car making. However, diesel cars are on their way out of the market. This may take some time, but the trend is revealing. An electric car made by the American company Tesla permits easier manufacturing, as electric cars have much fewer parts than their liquid-fuel counterparts. New technology may make electric cars even more acceptable once cars are available that link a solar roof, hood and/or bonnet with a built-in battery. Such developments are making life hard and complex for standard car manufacturers that have a load of technological and legal liabilities on their hands (e.g. the 2015 VW dieselgate scandal). Attending to these challenges and opportunities would have an impact on the substance, volume, spread and reach of GVCs.

An interesting evolutionary transformation of a car-making business took place in Fremont, California. Japanese technology was exemplary and often copied. General Motors (GM) and Toyota established the New United Motor Manufacturing Inc. (NUMMI) to produce liquid-fuel cars. General Motors went bankrupt in 2010 and closed the plant. However, Tesla, the electric-car manufacturer took over the plant and revived it by employing another base technology.

Manufacturers in the EU worry about “regulatory overload”. The EU promulgates around 100 new pieces of production-related regulation each year. They affect production and increase costs, and hence reduce incentives for investment, risk-taking and competitiveness. This may jeopardise participation in GVCs. For instance,

The European chemicals industry’s global market share has already halved from 32% to 15% over the last 20 years and industry investment is now eight times greater in the United States than in Europe⁵⁵.

However, GVCs may create their own internal standards (within the general legal framework) and good practices. These may be transformed later into accepted global standards.

Economic integration and the lifting of barriers to trade act to simplify and ease commerce in car components. Disintegration tendencies, such as the 2018 Trade War and Brexit in 2019, influence the operation of GVCs in an inverse way. They bring disruption to established GVCs,

⁵⁵ H. Haller, ‘Why Europe needs an industrial strategy’, EurActiv, 21 June 2017.

broken information flows, and a loss of “social capital” within the chain, etc. Such “software” losses do not show up in trade and investment statistics.

British carmakers intend to increase their local sourcing. The United Kingdom will have to conclude new trade deals with third parties. The amount of local British content will have to increase to comply with the new rules of origin in these commercial agreements. To be ready for the coming situation, the “British” car manufacturer Nissan “wants to double the share [by value] of parts made in Britain from around 40% to 80%”⁵⁶. Similarly, Russia imposed in 2005 a local-content obligation on foreign car makers to source at least 30 per cent of components locally by 2009. This was raised in 2010 to 60 per cent by 2015⁵⁷.

If policy actions such as the 2018 Trade War, economic sanctions⁵⁸ or disintegration (Brexit) continue, then investors may find themselves in a situation with multiple equilibria. Business expectations face increased uncertainty, which create the grounds for coordination failures.

Improvements in sophisticated robotics, automats, sensors, artificial intelligence and additive manufacturing (also known as 3D printing) – and the expansion of their use – have created a situation in which there will be less need for humans to do the actual work. The problem is that this state of affairs may not be distributed evenly across space and generations. A similar phenomenon has been evolving since the mid-19th century. The average working week time of some 60 hours was halved some 150 years later. The future structure of work will be very different from in the past, but its distribution may still be contentious: some may have too much work, while others too little.

The evolving Third or Fourth Industrial Revolution could redress the currently embedded manufacturing techniques and locations of production of the era of fully blown globalization (1980-2008). Even though low-cost manufacturing used to be and still remains a relatively safe path on the development route, this could well change. New production methods do not rely on cheap (i.e. unsophisticated and inexperienced) labour. Advanced robotics is based on the economical use of energy and resources (next to zero waste), as well as on the guidance and

⁵⁶ ‘Brexit triggers a round of reshoring’, *The Economist*, 19 October 2017.

⁵⁷ ‘Russia’s tentative revival’, *The Economist Intelligence Unit*, 29 November 2017.

⁵⁸ Economic sanctions on countries such as Russia, Iran or North Korea replace their preference for imported intermediate goods with a forced choice of obtaining them from domestic sources. Russia was highly successful in its sanctions-prompted increase in domestic production of food. Russia became one of the principal global exporters of grain.

supervision of high-level engineers and innovative designers. The advantages of cheap labour are no longer seen as being attractive for the location of business in this new technological environment. Education, based on the current and especially future needs of businesses, is the suggested policy for all geographical locations. Human capital needs to meet and accommodate the challenge that comes from ever-changing technologies: upgrading existing skills and acquiring new ones is the leitmotif of flexibility and adaptability in a rapidly changing environment. Otherwise, locations that do not get on the new technological bandwagon may be neglected by international business, and could enter or stay in a vicious economic circle.

While only a few years ago 3D printing was a desktop “toy” for innovators (and hobbyists and those making busts of themselves at the office), it is now turning out to be a viable manufacturing platform for a certain (still limited) number of products⁵⁹. The emerging paradigm is on its way to radically reducing the cost of production. For instance, robots’ dexterity and the complexity of their programming are increasing, allowing them to assemble more intricate products, such as those with complicated wiring and circuitry. By automating the assembly process – which for many industries is largely manual – robots could someday lead assembly lines to move away from cheap labour pools, undoing one of the biggest shifts underpinning globalization and eliminating many of the benefits that came with longer supply chains.

Progress in additive manufacturing may further degrade the effects of globalization. Still, as it is a rather new and scattered method of production, data available for the deeper analysis of 3D production are rather scant. Traditional manufacturing methods require separate molds to be made (incurring additional capital costs) for each product. But 3D printers, which produce multiple designs on the same machine, do not. Because of this, economies of scale do not carry the same advantages with 3D printing as they do in a world of traditional manufacturing. As 3D printing improves and is used more widely, it could reverse some of the specialization and standardization of GVCs that has taken place over the past few decades, allowing more parts to

⁵⁹ Three-dimensional printing does not affect solid wood, cork, leather, paper, natural textiles or tobacco products. It does, however, affect simple low-volume products such as those that are small in size, made of one input and that do not have many interactive parts. These include prototypes, jewellery, medical instruments, dental crowns, cakes or toys (puzzles, chess pieces, construction toys, games). Products that are likely to be affected in the future by 3D printing include food (candy and chocolate that have complex geometries, wedding cakes and confectionary); drugs; apparel (plastic clothing, shoes and boots with complex geometries); metal products (parts for vehicles); and ceramics. Large merchant vessels or armies in combat zones may also make use of 3D printing in the future (Laplume *et al.*, 2016).

be made in fewer locations⁶⁰. For instance,

Some modern factories, such as the Philips shaver factory in Drachten in the Netherlands, are almost fully robotic. This particular factory employs only one-tenth of the workforce employed in Philips' factory in China that makes the same shavers. More recently in 2016, Adidas opened a fully automated shoe factory using 3-D technology and robotics in Germany, in order to individualise their products and react more promptly to consumer needs by bringing manufacturing closer to its clients and speeding up delivery. The number of jobs in this new production facility is a fraction of the number of people that were working in emerging economies in the production of the same sportswear (OECD, 2017, p. 21).

The biggest game changer in the evolution of the GVCs comes from new technology: the digitalization of production and 3D printing. Offshoring may become a less attractive option in industrial organization in the longer term. The location of production in the developed world may become more attractive, meaning the future, spread and length of GVCs would be quite different from its past.

Advanced software-based manufacturing technologies such as 3D printing present a challenge to both GVCs and the transport of goods in the decades to come, especially for low-volume and high-value parts, components and final goods. Layer-by-layer production uses less input material. Production is located close to the consumption point, leading to a decline in demand for low-end production in places with low labour costs, as well as for the transport of intermediate and finished goods. Inventories are also reduced in this emerging business system. The transportation of cargo may be replaced in part with the transfer of data. Nonetheless, there are still important technical difficulties in this new production technology, especially regarding the production of goods that involve metals. While the 3D printing of certain plastic products is rather affordable, the method based on binding metal layers together is technologically demanding: assembling an object using pressure and heat may for some time be slow and costly. For the 3D printing of metal parts to be commercially acceptable, the cost of production needs to fall substantially. Advances in material science (metal, plastic, ceramics and others to come) is necessary as powder used in 3D printers needs to be of the highest quality and fully standardized, to provide a usable final product that does not need additional post-printing adjustment.

⁶⁰ 'The rise of manufacturing marks the fall of globalization', Stratfor, 7 June 2016.

Three-dimensional printing is still in its infancy and is the offspring of digital technology and robotics. It represents an important step in manufacturing technology as it reduces transport, material waste and labour inputs. In order to transform 3D printing from a “cottage production” of prototypes into a fully-blown and massively accepted manufacturing method, one needs developed and widely used software, adequate manufacturing inputs at affordable prices, sales networks and service support.

The ING report (2017) foresees that by 2060, 3D printing may reduce global trade in goods and services by almost a quarter (p. 3). In particular (p. 3):

Automotive, industrial machinery and consumer products are the industries that, as a result of 3D printing, will take the lead in suppressing cross border trade. These industries are top investors in 3D printers and are large players in world trade.

In automotive, the dominant bilateral trade flows are exports from Mexico, Japan, Germany and Canada to the US. So these flows will be most affected by 3D printing.

The direction of flows in the most important 3D printing industries will lower US trade deficits with Mexico and Germany (automotive) and China (machines, consumer products), all large contributors to the US trade deficit.

Less trade means that countries with trade deficits in manufacturing will see deficits decline. This will be more pronounced for countries that import relatively many products from leading industries in 3D printing. Countries with a surplus in manufacturing trade will see their surpluses shrink, especially if they currently export many products that will be 3D printed in the near future.

It is tricky to define the exact potential of 3D printing, but some experts expect a share of 50% in manufacturing over the next two decades. Tentative calculations show that, if the current growth of investment in 3D printers continues, 50% of manufactured goods will be printed in 2060 in scenario I, with this figure possibly being achieved as early as 2040 in scenario II in which investment doubles every five years.

The new direction in the additive manufacturing process is 4D printing. Four-dimensional objects may reassemble themselves and change shape and size in response to altered features in their environments such as pressure, humidity, temperature, light, sound or jolting. Still, this is an issue for the future.

The transition to the new manufacturing model will not be abrupt. It will take many years. It will be possible to produce more and more goods close to the location where they will be consumed. Far-off locations offering low wages would lose their attraction as new technologies would be employed to produce low-end goods closer to consumers. This would change the contour and length of GVCs. Countries with educated labour and relatively low wage rates may benefit in this emerging environment. China – a country that has strong promotion of new technologies, active acquisition of foreign new-technology firms, improving standards in education and a huge domestic market – may be one of the principal beneficiaries of the emerging model of manufacturing.

10. POLICY IMPLICATIONS

The production and trade platform of GVCs creates new challenges and reinforces old ones for policymakers. This is especially important in light of the high time-sensitivity present in the trade in components. Obstacles to the development of GVCs that authorities need to address include rules of origin; value-added tariffs; trade facilitation with customs clearance procedures, automation at border posts (in-bond treatment for goods in ‘transit’), corruption, the lack of one-stop shops for investment and other administrative procedures, ambiguous laws; an educational system which is adverse to flexibility, i.e. does not produce the labour that is demanded by investors; increasing labour costs which are not justified by increased productivity; indifference from potential local suppliers that could provide inputs; and other NTBs. Special attention must be accorded to technical and other standards that facilitate chain linkages.

10.1 Rules of Origin

Rules of origin, especially stricter ones, have an impact on the creation, spread and reach of GVCs. The North American Free Trade Agreement (NAFTA) rules of origin, for instance, stipulate that a car must have at least 62.5 per cent intra-NAFTA content to be eligible for benefits in trade between the US, Canada and Mexico. This relatively demanding request protects domestic firms in the NAFTA, and has been supporting the spread of the intra-NAFTA value chains. However, on the cost side of this issue is the request for the broad recording of the value and source of each input at the firm level. That increases overhead costs and means time is

spent on administrative rather than productive tasks. This is especially relevant if output goes to various countries with overlapping trade agreements and different rules of origin⁶¹. In addition, if a car's origin is below the NAFTA 62.5 per cent origin norm, firms may go for regional NAFTA inputs that could be costlier than those obtainable from suppliers in third countries, just to fulfil the NAFTA rules.

The US-Mexico-Canada Agreement (USMCA)⁶² of 2018 replaced the NAFTA in 2019 after its ratification. The new origin rule norm for autos and parts in the USMCA was increased to 75 per cent. A passenger vehicle originates in the USMCA only if the vehicle producer certifies, on an annual basis, that its production meets a 40 per cent labour value content in a way that this is contributed to by plants located in North America, with an average production wage of at least \$16 per hour. This is, of course, affecting production in Mexico. High wage vehicle-related jobs and manufacturing in the US and Canada are protected. This will have a negative impact on GVCs in the USMCA. In addition, there is an "anti-China clause" (Article 32.10). It also affects Cuba and North Korea. If a party intends to negotiate a trade deal with China, it must notify other partners in the USMCA. It must also give its USMCA partners the right to "clear" such a deal. This is an evident deterrent to Canada and Mexico from entering into new trade deals with China. It is not hard to see that this may damage GVCs, at least in part.

The "sunset clause" (Article 34.7) states that the USMCA will expire 16 years after entry into force. It may be extended for the same period if each party confirms its wish to continue in the Agreement. The sunset clause could create uncertainty regarding investment and the GVCs in Canada and Mexico, especially in the second half of this period. Still, this clause is not as bad as it seemed to be at the start of negotiations, when the US proposed a five-year lifespan for the deal.

Rules of origin need to be designed in a GVC-friendly way. They need to be simple, harmonized and cumulative, as is the case with the 2013 Pan-Euro-Mediterranean cumulation of origin. This friendly system of rules of origin involves the EU, the European Free Trade Association (EFTA), Mediterranean counties, as well as the EU candidate countries. It allows all partners in a preferential trade agreement to use inputs from any participating country, and the final status of

⁶¹ There is a need for some international cooperation, even harmonization, in the area of rules of origin if trade is to be smooth. If protection sentiments prevail, well, tight rules of origin may be a handy policy tool.

⁶² See <https://ustr.gov/trade-agreements/free-trade-agreements/united-states-mexico-canada-agreement/united-states-mexico> accessed on 16 November 2018.

the good for this trade group is as if the good were produced in the country where the transformation was undertaken.

Even though a possible tightening of the rules of origin may increase production within an integration group (in the short term), it would influence the technological mix of components in the final output and it may not necessarily reduce longer-term deficits in trade. However, tighter rules would interfere in the operation of GVCs. For instance, Siemens is a huge corporation which buys much more from its numerous small suppliers than it sells to each of them. Hence, tight rules of origin may have a strong impact on GVCs.

Rules of origin, the cornerstones of all free trade areas, were designed in both the EU and the NAFTA/USCMA well before the organization of production and trade for the new GVCs took place. The time has come to reform such rules to make them friendly to new industrial organization and commerce. The 304-page NAFTA annex (which describes rules at the product level) or the 234-page set of USMCA rules (Chapter 4 on Rules of Origin) need to be replaced by a simple rule. This would cut across all trade within North America. Regional content may be reduced to 40 per cent; the *de minimis* threshold may be such that under it goods do not need to be certified; and the creation of a global norm would ease exporters' conformity obligations (Freund, 2017, p. 9). Reality went another way. The US Government headed by Donald Trump pushed through sizeable and restrictive changes to the USMCA rules of origin.

10.2 Education and Labour Market

As engineers, managers and workers are at the heart of the successful operation of GVCs, policy intervention needs to concentrate on life-long learning so as to make those inputs in the production process not only constantly available in sufficient qualities and quantities, but also flexible in order to follow and lead changes in technology. Education needs to provide workers with more than one basic skill to make them adaptable to ever-changing technology and market demand, so that their transition from one set of tasks to another is as smooth as possible, both for them and for the production process⁶³. This is not always simple and cheap, because operations taking place at a distance incur the costs of coordination, monitoring and control.

⁶³ The targeting of select tasks and specialization in them, need to be supported by focusing on education and the training of labour to fit into such a policy. Morocco, for instance, carved out a GVC niche in the aerospace industry with various clients.

Global value chains are geographically the longest in the manufacture of vehicles, electronic goods and certain metals⁶⁴, while they are shorter for services (apart from transport). As technological sophistication increases, more and more countries are engaging in GVCs that are becoming longer and wider in space. Technology (communication, data processing, sensors) makes the management of these networks possible and affordable.

While developing countries have a comparative advantage in low-cost labour manufacturing, these advantages may not translate directly to exports of goods or services. A certain level of investment in capital, education and time is necessary to upgrade the local labour force (and its management) to the standards necessary and acceptable for inclusion in GVCs. Samsung, the South Korean electronics giant, worries about the shortages of engineers and technicians in Africa. In order to attend to that problem, Samsung created Electronics Engineering Academies in Kenya, Nigeria and South Africa in 2011 (Tagioni and Winkler, 2016, p. 11). Other TNCs such as Microsoft, Lucent, Cisco and Cemex support education, especially in countries where they expect an increase in demand for their goods and services.

10.3 Devaluation

The use of GVCs in production may have a notable impact on the macroeconomic management of economies. For instance, if the production of final, upper-end exported goods such as electronics or vehicles requires a lot of imported inputs (or people in the case of services), currency depreciation to increase competitiveness may have only a limited impact. Japan depreciated (2012-2014) the rate of exchange of the yen, but the expected great improvement in the trade balance did not happen. Britain (2007-2009) had the same experience.

A standard textbook example says that a currency devaluation or exchange-rate depreciation should increase a country's export volume. However, in the contemporary economy such macroeconomic policy measures have a rather weak effect compared to the textbook situation. Why? A valuable part of the answer to this situation can be found in the existence and spread of GVCs. The GVC model of production is based on the simultaneous import, export, re-import and re-export of inputs and components. This is most obvious in the case of electronics and vehicles.

⁶⁴ China exports rare-earth metals. They end up in various electronic gadgets throughout the world. Similarly, Australia exports iron to China and Mexico. Final iron-related goods end up in the US and elsewhere.

The extensiveness of GVC-related imports is the key part of the explanation for the transmission impact of currency devaluation. However,

When assessing the consequences of currency movements on exports, one must be cautious about accounting for the extent of currency unions and currency pegs. Indeed, when measuring the share of foreign value-added in exports, one should not account for imports stemming from countries sharing the same currency as the price of those are not affected by a devaluation. The same argument applies when constructing the domestic value added that is re-imported home or the share that is re-exported and absorbed in a third country. The definition of what is home and foreign must be based on currency, not countries. ...

... imagine a sector that sources a significant share of its input from a country with a different currency, sells its good abroad, which is re-imported back for domestic consumption. In such a case, due to the foreign value-added part, a devaluation would increase the production price in domestic currency. Moreover, since final demand is located at home, consumers simply see an increase in the final price and hence decrease consumption (de Soyres *et al.*, 2018, p. 2).

In order to assess the expected impact of devaluation or currency depreciation on the volume of trade, policymakers should have a well-developed and detailed input-output database. In any case, a superior way to increase competitiveness to devaluation is an increase in productivity, innovation and technological competence.

There is a special case that relates to devaluation. Consider, for instance, a small economy that specializes in a couple of parts integrated into a GVC. As a result of a populist government, wages have been raised to a level so high that the parts are made uncompetitive. Either wages can be forced down or the currency devalued. Regardless, life-long vocational training and fidelity to top standards are the key components of success in GVC industrial organization and trade.

10.4 Subsidies

Location tournaments can create subsidy-related “wars” to attract high-quality investment. International coordination and rules can alleviate such wasteful and damaging policies. Location-related subsidies reveal the uncompetitive features of such places; otherwise, they would have already featured on investors’ radar screens.

Location subsidies create market distortions between firms that are subsidised and those that are not. They are also damaging on ideological grounds as poor domestic taxpayers transfer wealth to rich foreign capital owners. A superior public policy would be to discuss with investors the issue related to the selection of the GVC niche and the profiles of labour that investors need, and then educate the labour force to be in line with the present and future needs of the business sector of the economy. The same holds for the supporting infrastructure, hard (supply of utilities, roads, railways, ports, airports) and soft (institutions, their operation, economic policy). Such a public policy has the ability to translate national production potential into quality and safe jobs, as well as into sound economic growth.

10.5 Spillovers

The potential spillover (positive externality) onto the local economy depends on the local availability of factors, and the local absorptive capacity for novelty. The local environment needs to recognize and seize the new opportunity, and to assimilate, apply and extend it locally. This can be done through either contractual relations and/or by imitation. The government needs to support such links, especially through education and training in the type of labour and management demanded. This may not always be easy as such faculties differ across industries and countries. However, this is not a reason to give up. The local economy may improve the quality of jobs and output, while also profiting from economies of scale, improving productivity and efficiency, as well as creating a local economic base that could be taxed. “In East Asia, for instance, foreign manufacturing firms source 70 percent of inputs locally” (Reyes, 2017, p. 12). This is especially relevant for businesses that have links with GVCs. Sound opportunities exist for linkages with the local economy and for sourcing from it.

While GVCs may create linkages with the local economy, in some cases, such as footwear, global buyers restrain, hinder or even prevent design, branding or marketing by local producers, as such activities invade upon global buyers’ core competence (Humphrey and Schmitz, 2002, p. 1020).

The local technological capacity to engage with the TNC’s subsidiary is often a problem. For instance, the Dominican Republic created an export processing zone in the expectation that foreign companies located there would link (source from) the local economy. However, firms in

that zone “purchased no more than 0.0001% of material inputs from the domestic customs area, signalling that efforts to create backward linkages were unsuccessful” (Engman *et al.*, 2007, p. 35). This failure stemmed from the non-existence of a sufficient pool of local suppliers (development gap). Those that existed suffered from the “quality gap”, as they could not meet the necessary quality standards, prices and terms of delivery, while local entrepreneurs did not perceive sufficient returns to start the necessary investment.

The policy and business challenge is to carve out a competitive niche in a GVC, and to become highly specialized and competitive in it. Such a rapid change in industrial organization and trade does not fit in with the traditional setting of production and trade. While this may be a positive economic push for the local economy, it may also create vulnerabilities to disruptions in demand from principal clients. In addition, there may be links with the local economy and the spread of positive spillovers – or at least the expectation of it. However, the literature offers a rather mixed, ambiguous and inconclusive result on this matter (Jovanović, 2015, p. 330).

10.6 Risk and Uncertainty

Since the creation of a GVC is based on specialization and the spatial fragmentation of footloose production, such industrial organization brings complexity and requires coordination risk. Output is not necessarily a product, but rather a process. The Hong Kong-based Li & Fung, a global supply chain manager primarily for US and EU brands, department stores, hypermarkets and specialty stores, explain the matter in the following way:

Say a European clothes retailer wants to order a few thousand garments. The optimal division of labour might be for South Korea to make the yarn, Taiwan to weave and dye it, and a Japanese-owned factory in Guandong Province to make the zippers. Since China’s textile quota has already been used up under some country’s import rules, Thailand may be the best place to do the sewing. However, no single factory can handle such bulk, so five different suppliers must share the order. The shipping and letters of credit must be seamless, and the quality assured⁶⁵.

⁶⁵ ‘Li & Fung: Link the global chain’, *The Economist*, 31 May 2001.

The longer and more complex the GVC⁶⁶, the higher the risk of failure of a link or two in it, and of a negative domino effect on the whole GVC.

Both outsourcing and offshoring are driven by cost and efficiency considerations. Limiting such considerations presents risks (against which one may get insurance) and uncertainty (no insurance available). These include unknown costs such as ones that come from wars in the Middle East (supply of oil, passage through the Suez Canal or the strait of Hormuz), cyber-space wars, natural disasters (tsunamis, earthquakes, floods, fires, volcano eruptions, epidemics), changes in the cost of transport because of hikes in the price of oil, strikes and terrorist attacks. Natural disasters struck GVCs in Asia in 2011. Floods in Thailand, for instance, inundated almost half of the global production capacity for hard-disk drives. The manufacturing of cars and electronics also suffered. Japanese TNCs shifted parts of their production to other Asian countries, not because of cost-minimization considerations, but rather to mitigate potential risks (Abe, 2016, p. 9).

The fragility of certain established GVCs may be reflected in operational risk and uncertainty. While considering the development and operation of GVCs, managers need to identify risk, audit to avoid risk, and create and apply strategies to mitigate exposure to risk. These include stockpiling (oil, for example), diversification, substitution and sharing information along the GVC. Governments need to work together with the private sector to prepare their collective reactions to Black Swan (i.e. catastrophic, but infrequent) events. These strategies include surveillance, analysis and early-warning systems; preparation to counter contamination and the spread (domino effect) of harmful events; and employing instruments to moderate the impact of the damage. In addition,

The first step in supply chain risk management is to identify the risk. Companies need to scrutinize their supply chains in a systematic way to find the potential risk they are exposed to. Then those risks should be analysed to ascertain their severity, probability of occurrence, triggering conditions, propagation patterns, and so on. Third, the pre-risk preparation can be realized through building early warning systems, establishing resilience and responsiveness, as well as business continuity plans. Fourth, proper mitigation actions are executed when risk occurs. Finally, monitoring systems should be active to sense the emergence of risks (Rong *et al.* 2009, p. 3).

⁶⁶ The complexity stems from the textile quotas.

An additional uncertainty may come from the arrival of new suppliers (Huawei, for instance, appeared from thin air, and Samsung replaced Nokia in the mobile phone industry). The lead firm may play one supplier against another in order to bid down prices. This means that backup plans both with the lead GVC firms and their “independent” suppliers need to be in place.

Independent producers (links in a GVC) may need to have a certain flexibility, to be able to cater to other clients and reduce the risk linked to a drop in orders from the “principal” or usual buyer. For example, Samsung might find Apple to be a client, a partner or a competitor in different GVCs⁶⁷.

To mitigate risk in the just-in-time business model, firms may choose to apply a just-in-case attitude and cement backup plans to mitigate potential hazards. Inventories may soften the risk of diminished supplies, but they may freeze a part of the firm’s capital. In addition, there may be a two-supplier rule for critical components. Nonetheless, standards need to be monitored and enforced.

11. CONCLUSIONS

The supply chain economy is a multi-faceted dynamic and structural (not cyclical) phenomenon. It has changed the way we observe trade, analyze production and think about economic development. The spatially unbundled, network production process is driven by advances in technology and the liberalization of trade and investment. This complex international network of specialized production segments is here to stay for the foreseeable future. It creates great new development opportunities. Rather than firms and nations having to catch up in the development process in a linear way, across the board – as was the case during the 1950s and 1960s – the GVC model provides grounds for a non-linear economic jump start and the diffusion of novelty and technology.

Those that want to be included in the GVC network must apply the highest standards in each production segment (otherwise they would not meet the standards of the final product), and

⁶⁷ One of the properties of GVCs is that they have complex and widespread tentacles, meaning the analysis of GVCs requires a multidisciplinary and complex slant.

they need to supply the life-long educational system for labour that suits both the present and future needs of the GVC process.

Changes to education systems are neither easy nor fast. The field is rather conservative, and slow moving in general. To design any new education system is difficult given the uncertainties linked with the future of GVCs. Nonetheless, forward-looking governments need to recognize trends and discuss with the private sector their needs. Some luck is also needed in the design and implementation phases of effective human-capital-development policy.

Special and differential treatment – i.e. the application of lower standards in developing countries – cannot be justified in the GVC system of production and trade. Such treatment would only harm, not assist these countries. They would not fit into the supply-chain economy model and would fall off it by default. Devaluation makes no sense in an economy that is crisscrossed by GVCs. One may devalue as much as possible, but if the local input segment is not up to the standards demanded by the GVC, the local link drops out of it. Another complication could arise if a populist government raises wages to levels so high that parts of the production chain become expensive, less attractive, and uncompetitive. Either wages must be forced down, or the currency devalued.

Fragmented fabrication increases a firm's efficiency in production, makes the output cheaper to the final consumer and improves the firm's global competitiveness. The spatial length of GVCs is getting longer (Wang *et al.*, 2016, p. 56). This reflects increasing fragmentation in production. Nonetheless, GVCs may transform over time and come to an end (in the distant future) – a fate shared by other past forms of industrial organization.

The US has for a century been the global champion of the liberal trading and investment system. A new wave of protectionism, especially in the US, may disrupt the operations of GVCs and have a negative impact on employment and growth, especially in the USMCA. This has opened the door to China rising as the “natural heir” and champion of the global liberal trading system. In line with this, China has been implementing an ambitious plan since 2013 called “One Belt, One Road” initiative, to develop a two continent-wide overland transport infrastructure system for trade. The plan is supported by two investment banks. Hundreds of billions of dollars will be invested over the coming decades to link Asia and Europe via the new overland and maritime Silk Roads.

Global value chains alter the structure of the economy and the pattern of development in the developing world. Timmer *et al.* (2014, p. 100) point out that “emerging economies surprisingly specialize in capital-intensive activities; the capital share in their value added is rising, while the share of low-skilled labor in their value added is declining.” The implication for income distribution is that low-skilled labour is on the losing side. The best advice for policymakers is that they pay attention to the education and life-long learning of the local population.

While many countries in Asia and North America have used GVCs as an opportunity for their development, GVCs are still weak or non-existent in Africa and other developing regions. In Africa there is especially weak confidence, trust, and rule of and respect for law – essential environmental prerequisites for the proper functioning of GVCs (without them the risks are too high). In addition, as the prices of capital goods tend to fall, regions with sizeable pools of low-end labour such as Africa and India, may find it tough to enter into GVCs. If these regions do not improve levels of education and training, as well as the openness of their economies, the exceptional East-Asian experience of a superb entrance into the GVC economic model may not be easily repeated elsewhere.

The decline in the rate of trade growth and globalization since the Global Financial Crisis is related to the partial redirection of GVC output towards the domestic market in China. This also explains the noted increase in the domestic wealth and sophistication in consumption of the Chinese. Still, all is not lost for globalization. The spread and reach of services, robots, sensors and artificial intelligence have laid new technological grounds for its continued relevance.

Global value chains make goods cross borders many times over before they reach their final stage. Imports are an indispensable part of exports. No matter how low customs duties may be, they create a barrier for the smooth operation of GVCs as they mount on each trade transaction and cumulatively increase the price of the final product. Tariffs need to be levied on value added, rather than on the invoice value of imported goods. This also needs to be reflected in trade statistics that must provide superior statistical material to policymakers. Such developments demand policy changes, and policy regimes need to be trade-friendly. This requires the existence of trade facilitation, customs and other clearance procedures at borders, pre-arrival electronic processing of documents, and single-window administrative procedures, to reduce as much as possible the time sensitivity of trade in components and food. As trade and investment

connections are complex and long, legal regimes need to shift away from the bilateral, towards a multilateral system.

It is hard to predict future developments in GVCs as there are many uncertainties. The future will be dictated by technological changes in organization and production (such as robots, intelligent production and 3D and 4D printing) and new standards; the wage gap (i.e. increases in wages in developing and newly industrialised countries); the attractiveness of countries as locations for production; increases in domestic demand in those countries; energy prices and costs of transport; trade and investment policy regimes (protection and trade wars); and Black Swans and unforeseen political events.

With the above in mind, an important question is: For how long will GVCs spread across space and time? It is easy to imagine they will continue to evolve for quite some time and create new opportunities and challenges, both for the industrial organization of firms and for public authorities. Amongst the threats to the survival of GVCs is the advent and expansion of 3D and 4D printing, which has the potential to replace (in the distant future) cargo transportation links with the transfer of data, potentially shortening GVCs spatially and reducing their importance. The exchange of opinions and needs by GVC actors (firms and governments) requires continuous communication and cooperation to ensure the coordination of activities. Policies therefore need to be sensitive to the intentions of firms, provided they have been designed to be in step with local social demands. Since the situation and its developments are both challenging and changeable, policy decisions need to be based on a new set of specific and disaggregated data, both on the micro and macro levels.

Depending on the industry and the technologies involved, GVCs may be long and short, both in space and in time. Distance means more management issues and a decline in spontaneous coordination. The optimal length of a GVC depends on the balance between its internal and external costs of operation. The public policy challenge is to create conditions in GVC segments that attract lead firms to those locations and keep them there, while attempting to provide high value-adding activities and high-quality jobs. Continuous education is therefore essential, and the catering of firms to these types of needs plays a crucial role in that regard.

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