UNIVERSIDADE ESTADUAL DE CAMPINAS

INSTITUTO DE ECONOMIA

MARÍLIA BASSETTI MARCATO

TRADE INTEGRATION IN A VERTICALLY FRAGMENTED PRODUCTION STRUCTURE: THEORY, METRICS, AND EFFECTS

INTEGRAÇÃO COMERCIAL EM UMA ESTRUTURA DE PRODUÇÃO VERTICALMENTE FRAGMENTADA: TEORIA, MÉTRICAS E EFEITOS

CAMPINAS
2018

UNIVERSIDADE ESTADUAL DE CAMPINAS

INSTITUTO DE ECONOMIA

MARÍLIA BASSETTI MARCATO

TRADE INTEGRATION IN A VERTICALLY FRAGMENTED PRODUCTION STRUCTURE: THEORY, METRICS, AND EFFECTS

INTEGRAÇÃO COMERCIAL EM UMA ESTRUTURA DE PRODUÇÃO VERTICALMENTE FRAGMENTADA: TEORIA, MÉTRICAS E EFEITOS

Prof. Dr. Fernando Sarti – orientador

Profa. Dra. Carolina Troncoso Baltar – co-orientadora

Tese de Doutorado apresentada ao Programa de Pós-Graduação em Ciências Econômicas do Instituto de Economia da Universidade Estadual de Campinas para obtenção do título de Doutora em Ciências Econômicas, na área de Teoria Econômica.

ESTE EXEMPLAR CORRESPONDE À VERSÃO FINAL DA TESE DEFENDIDA PELA ALUNA MARÍLIA BASSETTI MARCATO, ORIENTADA PELO PROF. DR. FERNANDO SARTI.

Campinas
2018

Agência(s) de fomento e nº(s) de processo(s): CAPES

Ficha catalográfica
Universidade Estadual de Campinas
Biblioteca do Instituto de Economia
Mirian Clavico Alves - CRB 8/8708

M331t

Marcato, Marília Bassetti, 1987-
Trade integration in a vertically fragmented production structure : theory, metrics, and effects / Marília Bassetti Marcato. – Campinas, SP : [s.n.], 2018.

Orientador: Fernando Sarti.
Coorientador: Carolina Troncoso Baltar.
Tese (doutorado) – Universidade Estadual de Campinas, Instituto de Economia.

1. Comércio internacional. 2. Relações intersetoriais. 3. Globalização. I. Sarti, Fernando, 1964-. II. Baltar, Carolina Troncoso, 1979-. III. Universidade Estadual de Campinas. Instituto de Economia. IV. Título.

Informações para Biblioteca Digital

Título em outro idioma: Integração comercial em uma estrutura de produção verticalmente fragmentada : teoria, métricas e efeitos
Palavras-chave em inglês:
International trade
Input-output analysis
Globalization
Área de concentração: Teoria Econômica
Titulação: Doutora em Ciências Econômicas
Banca examinadora:
Fernando Sarti [Orientador]
José Gabriel Porcile Meirelles
Marta dos Reis Castilho
Marco Antonio Vargas
Mariano Francisco Laplane
Data de defesa: 26-02-2018
Programa de Pós-Graduação: Ciências Econômicas

UNIVERSIDADE ESTADUAL DE CAMPINAS
INSTITUTO DE ECONOMIA

MARÍLIA BASSETTI MARCATO

TRADE INTEGRATION IN A VERTICALLY FRAGMENTED PRODUCTION STRUCTURE: THEORY, METRICS, AND EFFECTS

INTEGRAÇÃO COMERCIAL EM UMA ESTRUTURA DE PRODUÇÃO VERTICALMENTE FRAGMENTADA: TEORIA, MÉTRICAS E EFEITOS

Prof. Dr. Fernando Sarti – orientador

Profa. Dra. Carolina Troncoso Baltar – co-orientadora

Defendida em 26/02/2018

COMISSÃO JULGADORA

Prof. Dr. Fernando Sarti - Presidente
Universidade Estadual de Campinas (Unicamp)

Prof. Dr. José Gabriel Porcile Meirelles
Comisión Económica para América Latina y el Caribe (CEPAL)

Profa. Dr. Marta dos Reis Castilho
Universidade Federal do Rio de Janeiro (UFRJ)

Prof. Dr. Marco Antonio Vargas
Universidade Federal Fluminense (UFF)

Prof. Dr. Mariano Francisco Laplane
Universidade Estadual de Campinas (Unicamp)

A Ata de Defesa, assinada pelos membros da Comissão Examinadora, consta no processo de vida acadêmica da aluna.

À minha mãe,
pelo amor sem medida e – mais ainda – por me transmitir a
capacidade de superar as adversidades, resistir.

AGRADECIMENTOS

Abracei o mar na lua cheia
Abracei o mar
Abracei o mar na lua cheia
Abracei o mar
Escolhi melhor os pensamentos, pensei
Abracei o mar
É festa no céu é lua cheia, sonhei
Abracei o mar
E na hora marcada
Dona alvorada chegou para se banhar
E nada pediu, cantou pra o mar (e nada pediu)
Conversou com mar (e nada pediu)
E o dia sorriu...
Uma dúzia de rosas, cheiro de alfazema
Presente eu fui levar
E nada pedi, entreguei ao mar (e nada pedi)
Me molhei no mar (e nada pedi) só agradeci

(Agradecer e abraçar, na voz de Maria Bethânia*)*

Agradecer e abraçar: no momento, não me parece haver nada de maior importância. Ao longo desses anos de doutoramento desfrutei da companhia de diversas pessoas completamente singulares em essência e circunstância, mas aconchegadas por um traço comum: a generosidade. Algumas dessas pessoas foram fundamentais para que eu pudesse romper com o solipsismo tão particular desta trajetória escolhida. Na verdade, elas me ofereceram aquilo que nos é mais precioso: uma série ininterrupta e eterna de instantes, o tempo de suas vidas. Para com outras pessoas, meu débito é ainda maior, uma vez que não foram poucos os momentos que não pude estar presente.

Não me parece ser possível elencar gentilmente o impacto que a benevolência de cada um teve em minha vida. Resta uma certeza: esta força propulsora, a bondade, ainda há de mudar o mundo.

“Há algo de profundamente errado na maneira como vivemos hoje. Ao longo de trinta anos a busca por bens materiais visando o interesse pessoal foi considerada uma virtude: na verdade, esta própria busca constitui hoje o pouco que resta de nosso sentimento de grupo. Sabemos o preço das coisas, mas não temos ideia de seu valor. Não fazemos mais perguntas sobre uma decisão judicial ou um ato legislativo: é bom? É justo? É adequado? É correto? Ajudará a melhorar o mundo ou a sociedade? Essas costumam ser *as* questões políticas, mesmo que suas respostas não fossem fáceis. Devemos mais uma vez aprender a fazê-las”.

(Tony Judt)

ABSTRACT

The vertically fragmentation of production has changed our ability to analyze countries' patterns of specialization, as well as the relationship between trade and economic growth, revealing the need for using metrics that incorporate the emergence of global and regional value chains. This research aimed to investigate the conceptual and methodological aspects of trade integration in the context of vertically fragmented production and emergence of global and regional value chains, to evaluate different patterns of specialization, as well as to understand how trade's responsiveness to income has changed at the current phase of globalization. For our purposes, this research is divided into three main sections. In the first section, we presented some of the key concepts in global value chains (GVCs) theorization, emphasizing the concepts and measures of economic and social upgrading, to further examine the manifold outputs from participation in GVCs and to contribute to the organization of a formal theoretical apparatus within the GVC literature. We argued that GVC has become a practical and useful explanatory framework for understanding how firms and countries are engaged in the process of value creation, distribution and capture. The second section has quantified a country's engagement in GVCs from 1995 to 2011, as well as the regional trade dynamics of global production sharing, using value-added trade metrics built from international input-output tables. We presented a set of stylized facts to illustrate the importance of the value-added framework to our understanding of global trade and production. Further, our contributions to the literature on the geography of global value chains and its regionalization are centered on the analysis of the pattern of participation of South America in value chains compared to other regional blocs, as well as on the creation of a hubness measure in value-added terms. The third section seeks to analyze one of the multidimensional effects of countries' engagement in GVCs, investigating the relation between countries' participation in GVCs and economic growth. In particular, our empirical exercise was based on a dynamic error correction model to examine the short-run and long-run dynamics of the import-income relationship for a broad sample of advanced economies and developing and emerging countries. This issue has received renewed attention given the sluggish performance of world trade in recent years. In summary, the changing trade-income relationship has posed some challenges that may have consequences for the long-term economic growth dynamics across countries, being even more important for developing and emerging economies, and ultimately can transform the idea that trade integration can promote economic growth into a fallacy. Therefore, we have reinforced the need for measurement tools that encompasses the increasingly complex economic reality within global and regional value chains and can guide strategic policy responses for trade integration to ensure economy-wide benefits and sustained economic growth.

Keywords: vertically fragmented production; global value chains; regional value chains; pattern of specialization; international input-output table.

RESUMO

A fragmentação vertical da produção mudou a capacidade de analisar os padrões de especialização dos países, bem como a relação entre comércio e crescimento econômico, revelando a necessidade de usar métricas que incorporem o surgimento de cadeias globais e regionais de valor. Esta pesquisa teve como objetivo investigar os aspectos conceituais e metodológicos da integração comercial no contexto da produção verticalmente fragmentada e do surgimento de cadeias globais e regionais de valor, avaliar os diferentes padrões de especialização, bem como compreender as mudanças na capacidade de resposta do comércio às variações de renda na atual fase da globalização. Para cumprir nossos propósitos, esta pesquisa está dividida em três seções principais. Na primeira seção, apresentamos alguns dos conceitos-chave da teorização das cadeias globais de valor (CGVs), enfatizando os conceitos e métricas de *upgrading* econômico e social para analisar mais detalhadamente os diferentes resultados da participação nas CGVs e então contribuir para a organização de um aparato teórico formal no contexto da literatura CGV. Argumentamos que as CGVs se tornaram um quadro explicativo prático e útil para entender como as empresas e os países estão envolvidos no processo de criação, distribuição e captura de valor. A segunda seção quantificou o envolvimento de um país nas CGVs de 1995 a 2011, bem como a dinâmica comercial regional de compartilhamento da produção global, usando métricas de comércio de valor adicionado construídas a partir de tabelas insumo-produto internacionais. Apresentamos um conjunto de fatos estilizados para ilustrar a importância da abordagem de valor-adicionado para a compreensão do comércio e produção globais. Além disso, nossas contribuições para a literatura sobre a geografia das cadeias globais de valor e sua regionalização estão centradas na análise do padrão de participação da América do Sul nas cadeias de valor em comparação a outros blocos regionais, bem como na criação de uma medida de *hubness* em termos de valor-adicionado. A terceira seção procurou analisar um dos efeitos multidimensionais do envolvimento dos países nas CGVs, investigando a relação entre participação nas CGVs e crescimento econômico. Em particular, nosso exercício empírico baseou-se em um modelo dinâmico de correção de erros para investigar a dinâmica de curto e longo prazo da relação entre importações e crescimento econômico para uma ampla amostra de economias avançadas e países em desenvolvimento e emergentes. Essa questão recebeu uma atenção renovada dada a lenta performance do comércio mundial nos últimos anos. Em resumo, a mudança da relação comércio-renda colocou alguns desafios que podem ter consequências para a dinâmica de crescimento econômico de longo prazo em todos os países, sendo ainda mais importante para economias em desenvolvimento e emergentes e, em última instância, podem transformar a ideia de que a integração comercial pode promover crescimento econômico em uma falácia. Portanto, essa pesquisa reforçou a necessidade de utilizar ferramentas de medição que englobem a realidade econômica cada vez mais complexa das cadeias globais e regionais de valor e possam orientar respostas políticas estratégicas para que a integração comercial assegure benefícios econômicos e crescimento econômico sustentado.

Palavras-chave: produção verticalmente fragmentada; cadeias globais de valor; cadeias regionais de valor; padrão de especialização; matriz insumo-produto internacional.

LIST OF FIGURES

LIST OF TABLES

LIST OF BOXES

SUMMARY

Introduction

The role of international trade for growth and development is a heated and highly debated topic on the research field of economics. A vast literature argued that trade can spur economic growth in a number of ways through the diffusion of knowledge and technology, greater variety of imported input factors, more effective allocation of domestic resources, and increasing the size of the market. As such, trade integration is considered a powerful tool to promote economic growth and better living standards (INTERNATIONAL MONETARY FUND; THE WORLD BANK; WORLD TRADE ORGANIZATION, 2017; UNCTAD, 2013b; WORLD TRADE ORGANIZATION, 2014). These benefits rest on a supposedly fundamental rationale, trade openness. However, the political backlash to this assumption in recent years, with the widespread of protectionist speeches gaining popular support, reveals, once again, that the nexus between trade, economic growth, and sustainable development are not automatic or even homogeneous across and within countries.

Beyond the recent political wave of discontents with globalization, the signs that the interconnections between countries through trade, and hence the meaning of trade integration, have deeply changed are also posed both in theoretical and methodological domains. One of the most striking features of the recent wave of globalization is the surge of production fragmentation into various stages internationally dispersed. In addition to its pure expansion, trade has changed with the emergence of borderless production systems, and so has changed the linkages between trade, growth, and development.

This vertically fragmented production structure is commonly associated with global value chains (GVCs). This means that GVCs are an expression of an unprecedented fragmentation of production processes in an increasingly interconnected global economy, where the production of most goods relies on several stages located in different countries and intermediate inputs are crossing borders multiple times. As GVCs have become more pervasive over the past two decades, it becomes clear that the idea of becoming more integrated through minimizing imports and expanding exports will probably not enhance economic and social gains in the twenty-first century production. This new global production-trade paradigm has challenged our conventional wisdom. Indeed, some of the national development strategies that were used in the past are now almost unthinkable in the context of importing to export. This challenge is not restricted to policy responses, but it extends to theorization and the measurement tools that have been used to address the gains and losses from increasing trade

integration.

Nevertheless, the widespread of GVC trade does not reflect an equal involvement in GVCs across all countries. In fact, the concept of “global” value chain hides different regional patterns of trade integration. In other words, GVCs are not really global. Nor are the benefits from GVC integration spread equally among and within economies. Firms are the actual actors that have to face the outsourcing and offshoring decisions, which can decrease the cost of production and increase competitiveness; meanwhile they can also raise other costs by increasing the complexity and uncertainty associated with internationally dispersed activities (TAGLIONI; WINKLER, 2016). Nevertheless, the outsourcing and offshoring decisions of firms are influenced by national policies and geopolitical environment. Thereby, some developing countries have benefited from the movement of parts and components, technology, knowledge, and know-how, and others were able to improve the density of their production structure, while some economies did not achieve either. These issues are particularly relevant for developing and emerging country firms and countries that aim to capture a bigger share of the dynamic gains from trade and who has generally been taught that the greater the country's participation in world trade, the better.

The central assumption of this research is that the vertically fragmentation of production has changed our ability to analyze countries’ patterns of specialization, as well as the relationship between trade and economic growth, from traditional trade measures based on gross data, revealing the need for using metrics that incorporate the emergence of global and regional value chains. Yet, the effects of the new global production on the trade-income dynamics should not be taken as constant.

Recently, the responsiveness of trade to changes in income have raised several questions concerning its causes and consequences for the long-term economic growth dynamics across countries. Faced with the current trade slowdown, some studies have related this phenomenon with potential changes in the relationship between trade and income and then have investigated the behavior of trade responsiveness to changes in income, or more specifically the elasticity of imports to changes in income, and its cyclical and structural determinants. In a nutshell, cyclical factors are responsible for changes in trade elasticities that would dissipate after the recovery of the weak economic environment. However, the dismal performance of global trade growth in more recent years has called attention to the possibility of a deeper and longer-term change was established in the relationship between economic growth and trade. However, the empirical evidence on the drivers of this shift remains inconclusive.

Thus, one of the main purposes of this research is to explain how trade's

responsiveness to income has changed at the current phase of globalization, and the particular role played by vertically fragmented production across global and regional chains in this development. That is relevant because the symbiotic relationship between trade and economic growth is one of the basis of development strategies that advocates for greater trade integration. That is, the behavior of the relationship between trade and economic growth may show signs that the strategies of greater trade integration will not achieve the same results as in other periods. In addition, the effects of the new global production on the trade-income dynamics have not been deeply investigated. In order to do that, instead of simply analyzing the global trade-to-output ratio, this research captures the effects of vertical specialization on the independent effect of changes in income on trade, i.e. on the estimated income elasticity of trade. In addition, it reveals the need for measurement tools that encompasses the increasingly complex economic reality within GVCs and can guide strategic policy responses for trade integration to ensure economy-wide benefits and sustained economic growth.

This work is divided into three main sections. The first section, composed of one chapter, is dedicated to understanding the key concepts in GVC theorization to further examine the manifold outputs from participation in GVCs. Chapter 1 introduces the topic in greater depth, reviewing the main strands of chain- or network-based research and the facilitators of the emergence of GVCs. Henceforth, the analysis addresses the concepts and means of measurement of one particular dimension of the value chain analysis, the *upgrading*, which is twofold: the *economic* and *social* upgrading. Thereby, we emphasize that the economic gains from GVC participation may not automatically translate into improvements in living standards. The analysis focuses on how both dimensions are related to each other and provides the key elements for thinking about GVCs not simply as a buzzword but as a logical framework, even though a systematic theoretical foundation is still missing.

The second section quantifies a country's involvement in GVCs during the 1990s and 2000s, as well as the regional trade dynamics of global production sharing. The interdependencies between industries in fragmented and internationally dispersed production networks have imposed the need to use more accurate empirical measures. Before the emergence of GVCs, it was possible to compare gross-trade data to data on value-added without overstating the amount of domestic value-added in exports. However, the use of traditional global trade statistics may lead to a significant amount of double counting, since exports increasingly rely on significant (direct and indirect) intermediate imports. When based on gross concepts, the analyses may present a misleading portrait of which country ultimately benefits from bilateral trade flows by exaggerating the importance of producing countries at the end of

value chains, and even more importantly, it may lead to misunderstanding regarding the relation between trade and macroeconomic variables.

The second section is divided into chapter 2 and 3. Chapter 2 provides a set of stylized facts regarding the degree and nature of countries' interaction within GVCs. For that purpose, it integrates the most widely accepted metrics based on the concept of trade in value added, presenting its techniques and describing the specificities of the most used international input-output tables. Understanding the metrics used to assess how countries are integrated into GVCs and how they are interacting with its trade partners is crucial for building strategies consistent with the current global trade dynamics. It is not possible to assume which are the potential trajectories to follow without having a reliable map in hands, which clearly could not be build based on traditional gross trade metrics in the current phase of globalization.

Chapter 3 seeks to investigate the shifting patterns of global production, illustrating that different regional blocs play different roles in GVCs. This chapter provides evidences about the regional linkages of global production, considering both GVC trade within and across regional blocs, named Factory Asia, Factory North America, and Factory Europe. In addition, it investigates another regional bloc that is often disregarded in the GVC literature, *Factory South America*. More specifically, the chapter seeks to investigate how is the pattern of participation of South America in value chains compared to other regional blocs. In addition, it analyzes to what extent the intra-regional linkages of the South American regional-bloc have given rise to inter-regional linkages, and particularly what is the role of China in this changing scenario.

The third section seeks to analyze one of the multidimensional effects of countries' engagement in GVCs, investigating the relation between countries' participation in GVCs and economic growth. This issue has received renewed attention given the sluggish performance of world trade in recent years. The reasons for the weakness in global trade growth are still unclear and it is also uncertain what is exactly behind the recent changes in the relation between trade and economic growth. In fact, some signs of a deeper change in trade's responsiveness to changes in income were already posed before the Global Financial Crisis.

With that in mind, Chapter 4 investigates the changes in the trade-income relationship between cyclical and structural factors under an import demand function framework applied to a broad sample of advanced economies (AE) and developing and emerging countries (EME). Essentially, several explanations concerning the causes of the recent trade slowdown are tied to an investigation about the decline in the global income elasticity of imports, and this chapter evaluates its behavior for a broad sample of countries. It

also follows the literature that builds on the structural factors behind the recent change in the trade-income relationship, focusing on one particular factor: the country's participation in GVCs. The chapter seeks to answer the following questions: are there more structural factors operating in the recent behavior of trade elasticities? How has trade elasticity varied over time, and between both groups of AE and EME? How is the behavior of trade elasticities associated with countries' participation in global value chains? To address these questions, we estimate a dynamic panel error correction model, focusing on two sets of issues. Firstly, we investigate the responsiveness of imports to changes in income and whether structural factors have played a leading role in trade elasticities' behavior over the period 1989-2014. Secondly, we advance the import demand function by further accounting for the contribution of both backward and forward participation in GVC. In particular, the focus is on the effects of countries' GVC participation on the behavior of the long-term trade elasticity, for which we consider and expand the twofold country's GVC participation concerning both buying and selling perspectives. Overall, the changing trade-income relationship has posed some challenges that may have consequences for the long-term economic growth dynamics across countries, and ultimately can make the expectation based on the idea that the more integrated the country into GVCs the better not be fulfilled.

This research finishes with an additional chapter to provide the concluding remarks. Besides the main conclusions of the thesis, this chapter indicates some of the main strategic questions of this research agenda on GVCs and policy options to guarantee the mechanisms through which countries can maximize the benefits from participating into GVCs.

SECTION I. THEORETICAL FRAMEWORK

Chapter 1. The key concepts in Global Value Chains analysis

1.1. Introduction

The increasingly interconnected global economy has posed significant challenges to theorization in the field of economics. The traditional tools of economics, e.g. the theories of supply and demand and national comparative advantage, remind us of simpler times when several assumptions of mainstream economics were taken without considering the rising complexity brought by global integration (STURGEON; VAN BIESEBROECK; GEREFFI, 2008). Over the last decades, the global economy has become more integrated through trade simultaneously to a disintegration of the production processes led by firms that have found a way to become more competitive through outsourcing their non-core activities both domestically and abroad (FEENSTRA, 1998). There is a substantial change from what used to be analyzed in terms of international trade theories as a passive process of actors reacting to market signals to what is now debated in terms of value chain analysis as a dynamic and asymmetric system of organization and coordination by economic and non-economic actors (NEILSON; PRITCHARD; YEUNG, 2014). In that spirit, different conceptual models were formulated in recent years to understand the emergence of global production and distribution systems, which combine several economic and non-economic actors operating through complex structures of power relationships. While global value chains (GVCs) are an expression of this unprecedented fragmentation of production processes, it also became a practical and useful explanatory framework for understanding how firms and countries are engaged in the process of value creation, enhancement and capture. This issue is particularly relevant for developing and emerging country firms and countries that aim to capture a bigger share of the dynamic gains from trade.

GVCs are commonly used as an analytical tool for understanding not only how firms and countries participate in the global economy but also how would be the policy environment needed for an efficient allocation of resources (KAPLINSKY; MORRIS, 2003). The recent developments in value chain theorization have transformed a heuristic device into an analytical tool, providing a logical structure for studies at the country and firm levels. In order to analyze the emerging pattern of global trade, which has been named a shift from “trade in goods” to “trade in value-added” or “trade in tasks” (OECD, 2013), the GVC approach

provides a view of global industries from two contrasting vantage points: *top down* and *bottom up* (GEREFFI; LEE, 2012). The central concept for the *top-down* view is "governance", which focuses mainly on the power relationships between firms that set the parameter to other firms in the chain, and the key concept for the *bottom-up* view is "upgrading", which refers to the possibility of moving up in the value chain and focuses on the strategies used by countries, regions or firms to maintain or improving their positions in the global economy (FREDERICK, 2014; GEREFFI; FERNANDEZ-STARK, 2011; GEREFFI; LEE, 2012). More ambitious than previous approaches, the GVC framework aims to capture the determinants of the organization of global industries (BACKER; MIROUDOT, 2013), and both perspectives are what suggests the originality and singularity of this framework.

Upgrading, which is usually associated with "moving into higher value-added stages", is commonly followed by positive spillovers regarding technology and productivity. Therefore, we emphasize the economic mechanisms in the process of GVC participation that have enhanced productivity growth. However, this narrow view of upgrading regarding firm-level competitiveness misses how the gains are distributed to workers regarding wages and improved working conditions. There are concerns that the economic gains from greater integration in GVCs may not be translated into improvements in living standards. For that reason, several scholars started to distinguish between two different dimensions of upgrading, and even more importantly, most of the recent analysis focuses on how both dimensions are related to each other. While economic upgrading is mostly seen in terms of the efficiency of production processes and the peculiarities of products and tasks developed by producers, some scholars may say that the different paths of upgrading are not linear, involving learning, the development of national and firm-level capabilities, and innovations (NATHAN; SARKAR, 2013; OECD; WTO; UNCTAD, 2013).

However, it is important to highlight that GVC analysis does not tell the whole story. Even in theoretical terms, a systematic framework on the specificities of GVCs is still missing. In general lines, there is a significant number of empirical studies of different value chains, without any substantial causal explanation for understanding economic development within this new geographical pattern of value creation and capture in the global economy. In this sense, it is important to understand that the GVC framework has several limitations and must not be taken as a panacea for economic development.

The aim of this chapter is to reflect upon some of the conceptual aspects of GVC theorization to further understand the complex balance between opportunities and risks commonly associated with greater integration into GVCs. In particular, this chapter reviews

and synthesizes the definitions and means of measurement of one particular dimension of the value chain analysis, which has two perspectives: the *economic* and *social upgrading.* It is usual to assess the concepts of economic and social upgrading by using different measures under distinguished levels. These different measures are applied to several case studies, challenging the possibility of extracting general conclusions about the outcomes of GVC participation. The choice to analyze this twofold dimension is consistent with the attempt to contribute to the organization of a formal theoretical apparatus within the GVC literature, given the notable diversity of definitions and measures. By reviewing the main definitions and measures addressed in the GVC literature, this chapter considers that no single measure should be used to determine the outcomes from GVC integration. This choice also reflects the view that not all firms and countries are equally engaged in GVCs and, more importantly, the gains from GVC participation are not symmetrically distributed among all firms and countries. Hence, it is argued that economic upgrading does not drive to social upgrading automatically and regardless of the context, indicating the important role to be played by policymakers.

The analysis proceeds in seven sections, including this introduction. Section 2 presents a brief set of concepts and analytical tools that differentiate three strands of network- or chain-based research that are relevant to describe the new patterns of global production. Section 3 discusses the main facilitators of the phenomenon of GVCs and, as the new wave of globalization has deeply changed the magnitude, structure, and role of international trade, various terms relating to GVCs start to be used interchangeably (in annex 1.1 we recover some of these basic concepts with regard to its meanings). Section 4 addresses the widespread outcomes related to GVC integration regarding economic upgrading, discussing the connections between GVC participation and increased productivity. We review the main definitions and measures addressed in the GVC literature and highlight that no single measure could be used to determine the outcomes from GVC participation. Section 5 discusses the effects of GVC participation on living standards and conditions of employment, which are referred to as social upgrading and have been incorporating other social aspects, such as gender equality. In section 6 we outline the relationship between both dimensions of upgrading, considering both neoclassical and institutionalist explanations for the connection between upgrading and the social impacts of GVC participation. Lastly, section 7 presents a systematization of this discussion, addressing its policy implications and the need for developing better quantitative measures of GVC participation to explain the effects of countries' involvement in GVCs.

1.2. Commodities, chains and networks: the three strands of research

The economic literature has adopted a variety of terminologies to describe the new patterns of global production and distribution systems. GVCs, sometimes called *global commodity chains* (GCCs), *global supply chains* or *global production networks* (GPNs), have become a commonly used acronym to describe both the firm and the industry-level value chains that covers several countries (IMF, 2013). Since the early 1990s, this new development of global economy has been theorized under sustained academic research and can be viewed as a type of industrial organization research. Industrial organization research focuses on how *economic agents*, *places* and *processes* are connected to each other and commonly uses a chain-based structure to represent how production is organized and geographically dispersed around the world (FREDERICK, 2014). Therefore, as a paradigm for thinking about economic globalization, this section highlights the existence of two other key interlinked strands of network- or chain-based research besides the GVC framework, as described by Coe *et al.* (2008b): the Global Commodity Chain (GCC) and the Global Production Network (GPN) approaches.

The core of all three conceptualizations is similar – "the nexus of interconnected functions, operations and transactions through which a specific product or service is produced, distributed and consumed" (COE; DICKEN; HESS, 2008a, p. 272). Even though these different approaches commonly show overlapped features, in practice, each one provides different perspectives of the structure and dynamics of global industries. Those different perspectives are related to different disciplines of three main sciences that conduct industrial organization research: Management Science, Sociology and Geography. Each one uses different names[1] to describe and analyze chain-based organizational structures, but all of them are connected in some extend to the field of Economics (FREDERICK, 2014). Apart from this, Strategic Management has economic competitiveness as a major subject, meanwhile other areas, such as Sociology and Geography, are more focused on economic development. Those different subjects directly reflect into the units of analysis used by each chain-based approach. According to Frederick (2014), a value chain approach produces a virtual division between the *macro* (global), *meso* (inter-firm), and *micro* (firm) level of analysis and it should be noted that each field adopts different levels of analysis – Management (micro-focus: processes); Sociology

[1] *Management Science* uses the concept of "supply chain", "firm value chain" and "value system"; *Sociology* uses "global value chain" and "value-added chain"; and *Geography* uses "production network", "global production network" and "filière". Meanwhile, "industrial cluster" is a concept used by all three main sciences (FREDERICK, 2014). The author also highlights that the overlaps of those areas result in the fields of *strategic management*, *economic sociology* and *economic geography*.

(meso-focus: people); Geography (meso-focus: places); and Economics (micro or macro-focus).

> *On the macro level*, it seeks to understand the roles and impacts of international institutions, organizations and standards on how and where new and existing products and technologies are developed and located. *On the meso level*, it seeks to understand the types and impacts of inter-firm relationships and national institutions (i.e. industrial policy) on economic development and a product's innovation to commercialization lifecycle. *On the micro level*, it seeks to understand how individual firms and/or the attributes of a particular product create opportunities or risks to the development of an industry or technology, or the development of such within a particular geographic location (FREDERICK, 2014, p. 6).

Despite their peculiarities, a general distinction can be made between the positive and the normative approaches to chain-based analysis. According to UNIDO (2009b, p. 4–5), the *positive* or *analytical approach* suggests that "the value chain is an heuristic device that helps in understanding the actors and linkages that are engaged in the production, processing and marketing of products and services"; i.e. a positive analysis would help to find out how value chain function. This means that value chains are a descriptive construct that provides a heuristic framework for the generation of data (KAPLINSKY; MORRIS, 2003). On the other hand, the *normative* or *operational approach* suggests that a spotlight on value chains leads to development, i.e. better coordination among actors and the development and upgrading of critical activities would lead to better ability to compete and achieve a better position in the value chain. The type of development at which each approach aims would be a key aspect to distinguish different approaches in the value chain literature[2]. To sum up, the principles that unify different strands in a normative sense, according to UNIDO (2009b) are: i) development of competences and skills, commonly called upgrading; ii) setting-up and improving the

[2] According to UNIDO (2009b), four main strands of value chain analysis approaches can be distinguished: i) *supply chain management*; ii) *industrial cluster development*; iii) *the global value chain*; and iv) *the innovation system*. The first approach is used by scholars mostly from the field of Strategic Management and Business Administration, which focus on the firm's value addition strategy and use terms such as "value chain management" and "supply chain management". The "management" concept is related to the idea of reducing costs and improving the firm's competitiveness, following Porter's original approach of the *firm development*. This would be the only approach to focus in a unique type of development. There would be another three types of "development" perspectives: i) *Commodity and product group development* – when value chain analysis are used to develop specific commodities and products, usually identified based on *ad hoc* analysis by governments and the private sector; ii) *Industry and sector development* – when the value chain analysis are used to stimulate the development of a whole sector, having concentrated the policies for industry/sector development strategies; iii) *Development in the less developed countries* – often used by international development agencies, the focus is building capacities among under-developed businesses and small producers in less developed countries, even if this means the creation of entire new value chains (UNIDO, 2009). The second approach, *industrial clusters*, would be the only strand of value chains analysis devoted to the whole range of different developments; meanwhile the *global value chain* and the *innovation system* approaches are focus on those last three types of development.

linkages among chain actors; and iii) foster competitiveness among and within chain actors, considering entire chains, clusters and industries.

Most importantly, recent developments in value chain theorization has transformed an heuristic device into an analytical tool, providing an analytical structure (KAPLINSKY; MORRIS, 2003). The analytical focus changed from trade in finished goods between national economies to cross-border trade of fragmented production under global coordination of firms, imposing significant challenges to theorization. Therefore, in this section, we discuss in details a set of concepts associated with this new paradigm of world production, distinguishing between the GCC, GPN and GVC frameworks.

1.2.1. The Global Commodity Chain (GCC) framework

During the end of the 1970s, an article by Hopkins and Wallerstein presented the general idea of tracing back all the sets of inputs and transformations that culminated in an "ultimate consumable", describing them as a linked set of processes called "commodity chain" (HOPKINS; WALLERSTEIN, 1977). This perspective intend to orient the world-systems program in a different understanding from the orthodox way of thinking about globalization (BAIR, 2005). Only a few years later the authors offered a short definition of 'commodity chain' as a "network of labor and production processes whose end result in a finished commodity" (HOPKINS; WALLERSTEIN, 1986, p. 159 *apud* BAIR, 2005). The concept of "global commodity chains" was later introduced by Gereffi (1994) and marked a different strand in the commodity chain research[3]. Put simply, the GCC framework focuses on the power relations embedded in the value chain, i.e. the inter-firm networks in global industries.

The GCC framework analyzes the structure and dynamics of transnational production systems from which emerged particular patterns of coordinated trade. Looking ahead from the state influence in shaping global production systems[4], Gereffi (1994) recovery the concept of commodity chains by focusing on the strategies of the private economic agents that control them, the firms, and their interrelationships. Part of the explanation for this change of perspective is the context of trade liberalization that restricted the ability of setting tariffs and local content rules (STURGEON, 2008). Another important feature is that the GCC

[3] According to Bair (2005), the world-systems theorists are concerned with the commodity chains' structure and the reproduction of a stratified and hierarchical world-capitalist economy, using long-range historical analysis. For a broader distinction between the world-system and the GCC research agenda, see Bair (2005).
[4] This state influence, e.g. local content rules and tariffs, is highlighted by the world-system theory. See Hopkins and Wallerstein (1977, 1986).

perspective goes beyond the geographical spread of economic activities across nations, named "internationalization", and includes their *organizational scope*, i.e. the degree of functional integration between those activities dispersed across countries, named "globalization" (GEREFFI; MEMEDOVIC, 2003). Hence, the production systems are segmented and dispersed across countries by large firms as part of their global production and distribution strategies. More simply, GCC analysis gives special attention to the most powerful or lead firms in an industry, because they would be the chain drivers, given their influence over the others participants and their potential role as agents of upgrading and development[5] (BAIR, 2005).

Gereffi (1994) argues that GCCs have three[6] main dimensions: i) an input-output structure; ii) territoriality; and iii) a governance structure. While the first and the second dimensions are related to inputs linked in a sequence of value-adding economic activities that can be in spatial dispersed or concentrated networks, the third dimension suggests that the power relationships determine how financial, material, and human resources are allocated, influencing not only the scope and dynamics of a chain, but the possibility of change. The governance dimension shed light to the question of which firms are most able to control various aspects of the production process and how they manage the value created in the chain (BAIR, 2005). Initially, the GCC framework builds on a key distinction made by Gereffi (1994) between alternative modes of organizing international industries: *producer-driven* and *buyer-driven* commodity chains.

Producer-driven commodity chains refer to industries dominated by transnational corporations, usually large manufacturing firms. In these industries, the most technology- and capital-intensive products are made (e.g. cars, computers and aircrafts) being more vertically integrated along all segments of the supply chain, though with the common strategy of subcontracting components for the most labor-intensive production processes (GEREFFI, 1994; GEREFFI; FERNANDEZ-STARK, 2011). Usually integrating an international oligopoly, the lead firms that coordinate the production networks are placed upstream and control the design of products and most of the assembly (BAIR, 2005; GEREFFI; MEMEDOVIC, 2003). Meanwhile, *buyer-driven commodity chains* refer to industries in which "large retailers, brand-named merchandisers, and trading companies play the pivotal role in setting up decentralized production networks" (GEREFFI, 1994, p. 97). Buyer-driven chains

[5] The process of linking up with the lead firms would be a condition for development under the GCC approach (GEREFFI; KAPLINSKY, 2001).
[6] In his original contribution, Gereffi (1994) identified only three dimensions, although later he added "institutional context" as a fourth dimension.

are more common in labor-intensive and consumer-goods industries, especially of relatively simple products. While producer-driven chains have more linkages between affiliates of multinational firms, buyer-driven chains usually establish linkages between legally independent firms typically located in the Third World.

The buyer-driven chains are known for frequently do not own any production facilities, i.e. they are "merchandisers" responsible for the design, marketing and brand development, but they are not "manufacturers" because they do not make the products they sell. In other words, retailers and branded marketers control a production that can be totally outsourced (ODDONE; PÉREZ; ANTUNES, 2014). One of the reasons for this is the fact that innovations in buyer-driven chains are more related to product design and marketing, turning the outsource of manufacturing to be relatively easy for lead firms[7], meanwhile the producer-driven chains face technology and production expertise as their core competencies, restricting the possibility of outsourcing most of the manufacturing (STURGEON, 2008). According to Gereffi (1994), the profits in buyer-driven chains are not relate to scale economies, volume and technological advances as is the case for producer-driven chains, but rather from the combinations of design, high-value research, sales, marketing, financial services, among others, that allow the lead firm to manage these production and trade networks. Moreover, buyer-driven chains are globally decentralized factory systems with low entry barriers controlled by firms that develop and sell brand products (UNIDO, 2009a).

Governance is one of the most studied features of chain-based analysis, not only because it helps to explain the current global scenario but also because is embedded with the possibility of change. Understanding governance and how a chain is controlled and coordinated can facilitate a firm entry and the development within global industries (GEREFFI; FERNANDEZ-STARK, 2011). Governance is understood as the framework in which firms will operate economically and interact, and is considered a dynamic element that evolves through time according to the changing strategies of the lead firms (GEREFFI; HUMPHREY; STURGEON, 2005). However, these changing strategies are exactly what turned this bimodal GCC typology[8] of buyer- and producer-driven chains increasingly difficult to assign nowadays characteristics of global production.

[7] According to Gereffi and Memedovic (2003), lead firms are those that have control access to major resources that generate the highest returns, such as new technologies, brand names or consumer demand. This not necessarily involves making finished products, nor being located in a specific link of the chain.

[8] The GCC typology is based on a static, empirically situated view of technology and barriers to entry (STURGEON, 2008).

A number of studies started to assess the shift in the organization of global production towards less vertically integrated and external networks (FEENSTRA, 1998; JONES; KIERZKOWSKI, 2001; STURGEON, 2008). Over the last decades, transnational corporations changed their strategies profoundly, establishing linkages between buyers and suppliers in both producer- and buyer-driven chains. Under the chain governance perspective, a typical "manufacturer" in a producer-driven chain has become a broader version of a buyer-like through outsourcing. Less integrated chains was being driven by the emergence of large retailers and by the widespread belief in the economic benefits of the maximization of shareholder value, including the shifting of fixed assets and risk to suppliers (LAZONICK; O'SULLIVAN, 2000; STURGEON, 2008).

Therefore, already in the 1990s, before being widely used in the 2000s, there was a change in terminology from "global commodity chain" to "global value chain", replacing the word "commodity" with "value" and incorporating the analysis of trade and industrial organization in the international business literature (BACKER; MIROUDOT, 2013). Meanwhile, recent studies started to use the concept of 'global production networks', and not 'chains', to highlight the complexity of a vast number of interlinked activities with multiple producers interacting in different countries. Both strands of research are closely related, being connected by several fields of social science, such as economic geography, economic sociology, development research, regional studies, international economics, and international business (YEUNG; COE, 2015).

A great number of works was produced on GCC framework over the time. According to Bair (2005), we can underline at least three significant contributions that GCC research has made: *first,* the GCC framework is a *methodological advance,* because it provides significant insights about international production networks in different sectors with a method that allows to analyze globalization *in situ*. It makes possible to map and analyze the path of different commodity chains, operationalizing the global-local nexus and giving more emphasis to the role of firms as potential development's agents. *Second,* GCC research contributed *theoretically* to our understanding of how global economy works, highlighting the nature of power relations within a chain (their governance structure). *Third,* GCC has inspired the chain research to move forward to *policy recommendations*. This last contribution has oriented most of the work on GVC approach, which has raised questions about what should be the effective policy interventions that would enable local firms to improve their positions in a value chain, in a process named "upgrading", and how local firms can gain competencies and skills required to participate in GVCs (BAIR, 2005). Finally, one could say that the GCC approach was a

pathbreaking paradigm in the literature, with significant distinctions from the previous world-systems perspective and with several implications for the following researches.

1.2.2. The Global Value Chain (GVC) framework

The *value chain* describes "the full range of activities which are required to bring a product or service from conception, through the different phases of production, delivery to final consumers, and final disposal after use" (KAPLINSKY; MORRIS, 2003, p. 4). These activities are not restricted by production *per se*, including others links, such as design, marketing, distribution and recycling, which gradually add value, as described and popularized by Porter (1985), and can be contained within a single geographic location or even a single firm. In a broader sense, a value chain can be understood as a set of business, activities and relationships engaged in creating a final product or service (UNIDO, 2009b). It builds on the idea that the value chain describes how different economic actors, separated by time and space, aggregate value to products or services, step-by-step and beyond manufacturing. When it comes to emphasize the manufacturing and the distribution-related steps, the concept commonly used is *supply chain*, which is also known as the industry-level value chain[9]. Therefore, is important to highlight that a value chain does not necessarily reflect a physical transformation.

Tracing back the history of the concept of value chain before being widely used in the 1990s, we find the first value chain studies in the 1960s and 1970s, with the aim of identifying development options for mineral-exporting countries (GIRVAN, 1987 apud KAPLINSKY, 2000). We also find similar concepts that fell into disuse, e.g. *filiere* (French scholars used this term to describe the flow of physical inputs in the production of a final product, and in general had been applied to domestic value chains analysis, especially to agriculture study cases) and *value stream* (which now is called value *chain*) (KAPLINSKY; MORRIS, 2003). There was a change of perspective by adding 'global'[10] to the concept, pointing out that a value chain can be more or less extended, besides being divided among multiple firms and geographic spaces. In this sense, the concept of GVC emphasize the potential large distance between the local producer of goods and services and its global consumer (BAIR, 2005). In a general sense, GVCs involve four features that differentiate them from traditional

[9] According to the IMF (2013), an "industry" value chain is often performed by *networks of firms* and evolves a vast number of processes; meanwhile, 'value chains' are commonly referred to as a chain of activities that a 'firm' operates in a specific industry.

[10] Value chains are considered "global" when they include steps, processes, and actors from at least two countries (GEREFFI; HUMPHREY; STURGEON, 2005).

production and trade: i) customization of production; ii) sequential production decisions from buyer to suppliers; iii) high contracting costs; iv) global matching of goods, services, production teams and ideas (ANTRÀS, 2015 *apud* TAGLIONI; WINKLER, 2016). Thus, one can say that the key features of the phenomenon of GVCs are the international dimension of production process and the "contractualization" of buyer and seller relationships (TAGLIONI; WINKLER, 2016).

Some authors consider that the GVC analysis was originated in the GCC framework, gaining popularity in the early 2000s as a way to analyze the geographical fragmentation and internationalization of supply chains (FREDERICK, 2014; GEREFFI; HUMPHREY; STURGEON, 2005; GEREFFI; LEE, 2012). The first formal organization on GVC research[11] was created at a workshop in Bellagio (Italy) in September, 2000 as result of an initiative to bring together scholars with research on different aspects of global networks (BAIR, 2005). Given the variety of terminologies, some authors argued that the analysis of similar developments across different sectors might be unclear. In this sense, they agreed that the study of economic globalization needed a common terminology to describe their collective analytical project and agreed to use a value chain label instead others such as commodity chains or supply chains. Besides been broadly used in recent academic publications that focuses on value creation and value capture across a wide range of economic activities, the GVC concept has been adopted by several important international organizations, such as the World Bank, the World Trade Organization (WTO) and the Organization for Economic Cooperation and Development (OECD) (GEREFFI; LEE, 2012). However, as questioned by Bair (2005), would this change in nomenclature from "commodity chain" to "value chain" reflect something else? Or is just a matter of using a broader terminology, without the misleading association with primary products that the term 'commodity' might denote? In other words, would the GVC research be considered another approach with singular aspects and distinctions from other approaches?

To answer those questions we need to clearly identify which are the common features between the GCC and GVC analysis from what distinguishes both frameworks. First of all, is important to note that a large part of the authors from GCC framework has further contributions under the GVC perspective. Furthermore, the scheme created by Gereffi (1994, 1995) to comprehend and describe the structure, dynamics and relationships among firms in a commodity chain, i.e. the four building blocks: input-output structure; territoriality; governance

[11]The Global Value Chain Initiative is housed at Duke University. See www.globalvaluechain.org.

and institutions, is also used under the GVC perspective. These four building blocks are used to reach the GVC approach focuses on how value is created, enhanced and captured within the GVCs. One can understand this four building blocks into a two-part research approach*: value chain mapping*, which uses input-output structure and geography to describe the structure of the chain; and *value chain analysis,* which uses governance and institutions to evaluate the current economic organization of the chain, in terms of actors, places and processes, and how it might evolve in the future (FREDERICK, 2014).

In a general sense, the GVC framework indicates how a sector, firm or country participates in the sequence of activities in a value chain, and furthermore which activities and technologies will be kept within a firm as a core competency and which will be outsourced to other firms domestically or abroad. Even though the focus was initially on economic and competitiveness issues, GVC analysis is currently incorporating other aspects, such as social, labor regulation, gender and environmental (GEREFFI; FERNANDEZ-STARK, 2011).

In order to analyze the emerging pattern of global trade, which has been named a shift from "trade in goods" to "trade in value added" or "trade in tasks" (OECD, 2013), the GVC approach provides a view of global industries from two contrasting vantage points: *top down* and *bottom up* (GEREFFI; LEE, 2012). Being more ambitious than the GCC approach, the GVC theoretical framework aims to capture the determinants of the organization of global industries (BACKER; MIROUDOT, 2013), and both perspectives are exactly what suggests the originality and singularity of the GVC framework. While the main concept for the *top-down* view is "governance", which focuses mainly on the power relationships between firms that set the parameter to other firms in the chain, the key concept for the *bottom-up* view is "upgrading", which refers to the possibility of moving up in the value chain and focuses on the strategies used by countries, regions or firms to maintain or improving their positions in the global economy (FREDERICK, 2014; GEREFFI; FERNANDEZ-STARK, 2011; GEREFFI; LEE, 2012)[12]. Apart from being used under the GCC framework, these concepts were further developed in a more formal and dynamic structure of value chain governance and in a differentiated and multi-dimensional upgrading scheme of strategies.

[12] The bottom-up view, *upgrading*, will be discussed more properly in the next chapters. But simply put, there would be four types of upgrading: (1) *product upgrading*, the development and marketing of a product with improved performance characteristics; (2) *process upgrading*, the development and implementation of new or significantly more efficient production process; (3) *functional upgrading*, engaging in new and superior activities in the value chain; (4) *inter-sectoral upgrading*, moving to new productive activities or sectors, using the knowledge, skills and technological capabilities acquired previously (ECLAC, 2014, p. 23).

In the context of chain governance, the key questions are which activities and technologies a firm should keep in-house and which should be outsourced, and furthermore where this activities should be located (GEREFFI, GARY; HUMPHREY; STURGEON, 2005). In other words, when a firm decides where to locate their activities and with whom to partner, the decisions that have been made are on where to invest and from where to trade (UNCTAD, 2013b). These decisions impact the process of value creation and capture in host countries, and have to be considered under the (typically the lead firm) firm's coordination of their GVCs. Accordingly, GVCs involves a trade-investment nexus that includes: first, cross-border intra-company trade within the network of foreign affiliates (*Foreign Direct Investment – FDI*); second, contractual partners firms (*non-equity modes of investment – NEMs*); and third, cross-border intercompany *arm's length* transactions. Each one, or a combination of them, is chosen as an optimal mode of managing complex GVCs given an equation that involves elements such as transactions costs, power relations and the risks of outsourcing. Furthermore, "differences in industry drivers and dynamics, as well as TNC strategic responses to these, lead to a variety of GVC patterns – so their governance also necessarily varies considerably" (UNCTAD, 2013a, p.141).

More than simply random interactions or the obligation of a single agent of the GVC, chain governance is collective and ensures that the interactions between firms allows for reducing costs and risks along the GVCs (UNIDO, 2009b). As GVCs have developed, the insufficiency of the previous two-sided governance framework (in-house (*buyer-driven chains*) and arm's-length (*producer-driven chains*) global supply relations) became apparent, giving place to a multiplicity of lead firm-supplier relations. Under a new scale of operations and increased technological sophistication, the suppliers have establish a new set of relations with lead-firms, which involves several degrees of investment, technical support and long-term contracting and monitoring (TAGLIONI; WINKLER, 2016). In order to assess this more hybrid patterns of relationships between firms in GVCs, Gereffi *et al*. (2005) elaborated a more nuanced scheme of governance relationships, a five-categories typology: *market, modular, relational, captive* and *hierarchy.*

In a more general sense, this typology[13] is closely related to transactions cost economics[14] and is constructed under three criteria[15]: i) the *complexity* of transactions in terms of the information and knowledge related to product and process specifications; ii) the *ability to codify* transactions and thus be efficiently transmitted without the need for a specific investment; and iii) the *capabilities* in the supply base in relation to the requirements of the transaction (COE; DICKEN; HESS, 2008a; GEREFFI; HUMPHREY; STURGEON, 2005). The five governance structures are:

i) Market governance: governed with little explicit coordination, this structure involves simple transactions, which firms have little interaction and the information on product specifications can be easily transmitted. These interactions are not completely transitory, as is the case of spot markets, and their peculiarity is the minimum costs of switching to new partners on both sides. With exchanges that usually occur at arm's length, the central governance mechanism is price rather than a powerful lead firm (ECLAC - ECONOMIC COMMISSION FOR LATIN AMERICA AND THE CARIBBEAN, 2014; GEREFFI; FERNANDEZ-STARK, 2011; GEREFFI; HUMPHREY; STURGEON, 2005; TAGLIONI; WINKLER, 2016).

ii) Modular governance: modular value chains usually present suppliers that make products or provide services to a customer's specifications, having more substantial relationships than in simple market structures and with a high volume of information. Although the interactions between firms can be very complex, this structure is defined by low switching costs and few transaction-specific investments (suppliers use generic machinery and take full responsibility for process technology), revealing complex transactions that are still easy to codify. The central governance mechanism is information technology and standards for exchanging information (GEREFFI; HUMPHREY; STURGEON, 2005; TAGLIONI; WINKLER, 2016).

iii) Relational governance: relational value chains occur when firms rely on complex information, which is difficult to transmit or learn; resulting in a relatively small group of localized firms sharing knowledge among them. These interactions between buyers and sellers often create mutual dependence and high levels of assets specificity, which can be

[13] According to Gereffi *et al.* (2005), this typology is analytical, not empirical, although it is in part based on empirical observations, and it was conceived to be a simple framework.

[14] Transaction costs economics explains why firms should keep certain activities and technologies in-house in terms of the complexity of inter-firm relationships and the asset specificity. Although, this does not mean that complex and tightly coordinated inter-firm relationships will always result in vertical integration (GEREFFI; HUMPHREY; STURGEON, 2005).

[15] Each criteria is consider under only two values: *high* or *low*, resulting in eight possible combinations, but only five would be actually found (GEREFFI; HUMPHREY; STURGEON, 2005).

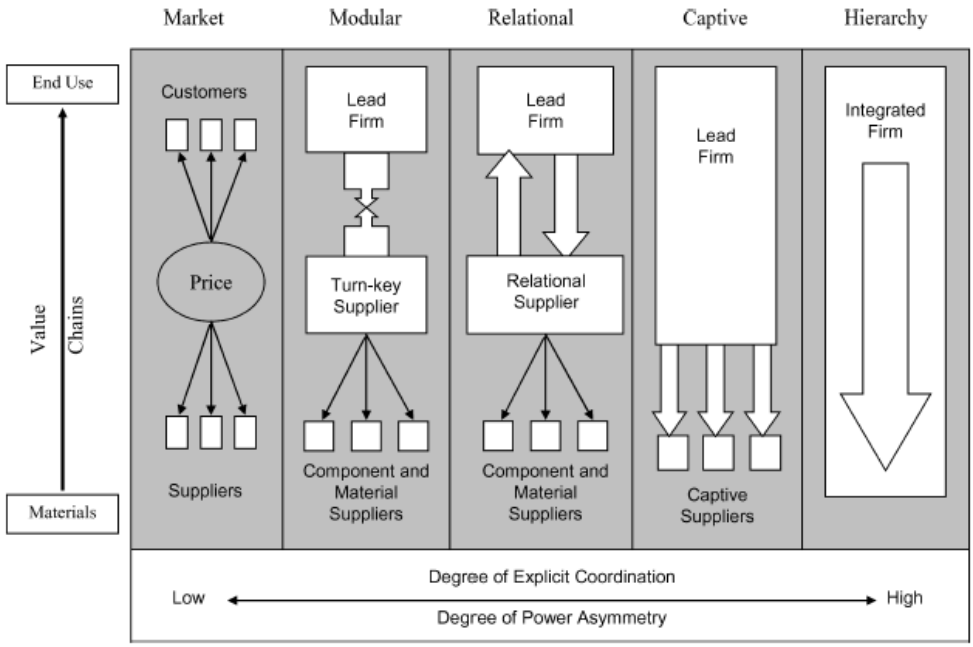
governed through reputation, social and spatial proximity, family and ethnic ties. Even with mutual dependence, one can see that lead firms still have the capacity to specify what is needed and the ability to strive some control over suppliers. Given the time need to build these interactions based on trust and mutual reliance, the cost of switching to a new partner is high (GEREFFI; FERNANDEZ-STARK, 2011; GEREFFI; HUMPHREY; STURGEON, 2005; TAGLIONI; WINKLER, 2016).

iv) Captive governance: in these value chains, small-scale suppliers tend to be dependent on one or few large buyers, which often exercise a great power. The name "captive" refers to the restrained condition of the suppliers in face of great switching costs. Commonly these structures are defined by a high degree of monitoring and control by lead firms, which the core competence tend to be in areas outside production (GEREFFI; FERNANDEZ-STARK, 2011; GEREFFI; HUMPHREY; STURGEON, 2005; TAGLIONI; WINKLER, 2016).

v) Hierarchy governance: this chain-governance is characterized by vertical integration, i.e. by transactions that occur within a single firm and its subsidiaries. The great form of governance is managerial control within lead firms, which develop and produce products in-house flowing from managers to subordinates, or headquarters to subsidiaries. This commonly occurs when product specifications cannot be codified, products are complex, or highly competent suppliers are difficult to find (GEREFFI; FERNANDEZ-STARK, 2011; GEREFFI; HUMPHREY; STURGEON, 2005; TAGLIONI; WINKLER, 2016).

The five GVC-governance types are related to the values of the three key variables that determine them, each one with a different trade-off between the benefits and risks of outsourcing (GEREFFI; HUMPHREY; STURGEON, 2005). Figure 1 illustrates this discussion in graphic form.

Figure 1.1 - Five GVC Governance Structures



Source: Gereffi *et al.* (2005, p. 89).[16]

From a developing perspective, the study of chain-governance is crucial for understanding how firms in those countries can gain access to global markets, the benefits and risks associated to becoming more integrated, and how is possible to increase the net of gains from participation in GVCs (GEREFFI; HUMPHREY; STURGEON, 2005). Although chain governance deals with power asymmetry and its abuse by certain agents, most of the analysis of chain governance structures do not consider a wide range of relationships between firms and non-firms and restrict the analysis only to relationships between firms and suppliers. Furthermore, the reasons for deciding whether to integrate production of intermediate inputs or outsource it, and for supplier locations (offshoring), reveal that the firm's governance decisions go beyond mere transactions costs and core competencies, encompassing the search for greater flexibility, diversification of location to reduce risk, and lower productions costs (MILBERG; WINKLER, 2013).

Therefore, it is important to highlight that the GVC approach does not have a unified theory. But instead it is build upon a set of analytical methods and it can focus on many aspects simultaneously, depending on the scholarly approach. In fact, the "firm perspective", commonly used in the field of International Business, defines GVCs as "fragmented supply

[16] "The small line arrows represent exchange based on price while the larger block arrows represent thicker flows of information and control, regulated through explicit coordination" (GEREFFI, GARY; HUMPHREY; STURGEON, 2005, p. 88).

chains, which have internationally dispersed tasks and activities coordinated by a lead firm (a TNC)", showing a different emphasis when compared with the "country perspective", from the field of Economics, which consider that "GVCs explain how exports may incorporate imported inputs; i.e. how exports include foreign and domestically produced value added" (UNCTAD, 2013b, p. 153). In addition to this distinct defining concepts, GVC analysis can be distinguished in two main approaches: *micro* and *macro* (AHMAD, 2013). The micro approach is generally conducted for specific products, as is best characterized by the Apple Ipod example (DEDRICK; KRAEMER; LINDEN, 2009). But from a different perspective, some studies have adopted a macro approach based on inter-country input-output tables to catch all the upstream effects and have a bigger picture of the effects of GVCs on several economic dimensions (JOHNSON; NOGUERA, 2009; KOOPMAN; WANG; WEI, 2008). Up to now, the GVC literature has mainly focused on empirical analyses and case studies (micro approach), describing how different types of governance determine different types of upgrading at the firm level (ECLAC, 2014; HUMPHREY; SCHMITZ, 2002). But recently this emphasis has changed.

In recent years, the GVC approach has been adopted by several international organizations concerned with economic development. Understanding that one of the central hypotheses of the GVC framework is that "national development requires linking up with the most significant lead firms in an industry" (GEREFFI; MEMEDOVIC, 2003, p. 4) reveals an important perspective of the GVC analysis: it is not about the profits of the companies in each segment of the value chain but on the whole value created and how it is distributed along the chain (UNIDO, 2009b). This is exactly why governance and upgrading are the two central analytical tools of GVC analysis, since both have influence under the distribution of value among actors along the chain. In other words, GVCs matter for economic development because "the ability of countries to prosper depends on their participation in the global economy", which is largely told as their role in GVCs (GEREFFI; LEE, 2012).

The GVC framework aims to understand what are the new features in power relationships of global-scale economic activities. In this sense, GVCs studies consider not only the efficiency of the production link in the chain but also those factors that determine the participation of particular groups of producers in final markets. Therefore, by being intrinsically systemic and integrated, GVC analysis turned possible to analyze agents, links and processes more closely. To sum up, the GVC approach helps to understand the structural shifts in the global economy and the interconnectedness of economies, their specialization in tasks and business functions rather than in specific products, and also gives insights into economic

governance (BACKER; MIROUDOT, 2013). Furthermore, GVC analysis are useful for new producers (including poor countries) who are willing to enter global markets looking for sustainable income growth and also as an analytical tool for understanding the policy environment (ECLAC, 2014b; KAPLINSKY; MORRIS, 2000).

1.2.3. The Global Production Network (GPN) framework

The relation between production, distribution and consumption, especially in terms of its geographical and organizational complexity, is also represented by a different terminology: the concept of *network*. 'Global production networks' (GPN) is a concept created by the "Manchester School" of economic geographers (COE *et al.*, 2004; DICKEN *et al.*, 2001; ERNST, 2002; HENDERSON *et al.*, 2002) to represent generically a form of economic organization through which several transactions, spatially dispersed across countries, are taken to produce a product or service in the current global economy. GPNs would be organizational platforms through which different actors dispersed geographically compete and cooperate for a greater share of value creation, transformation and capture (YEUNG; COE, 2015). The view is that is not only firms who operate GPNs, but a wide range of different actors, among them is: state, international agencies, non-governmental organizations (NGOs) and industry associations, each one with their own agendas. In a general sense, GPN is an organizational innovation seen as an outcome of globalization that combines concentrated dispersion with systemic integration, encompassing both intra-firm and inter-firm linkages (ERNST, 2002).

The concept of GPN builds upon the work of Gereffi previously discussed, but also incorporates several distinctions. An elementary distinction is the use of the term "production" in the place of "commodity". Henderson *et al* (2002) consider that the term "commodity" denotes the idea of standardized products, which would not include most of the post-fordist forms of activities, but more importantly the use of the term "production" is supported due to its analytical emphasis on the *social processes* that are embedded in producing goods and services. The authors also consider that adopting the term "global" shows an analytical concern in making a clear distinction from state-centric views, which commonly use the terms "international" and "transnational". In addition, the notion of *networks* emphasizes the nature and extent of horizontal, diagonal, as well as vertical links between economic actors (i.e. inter-, intra- and extra-firm relationships, including non-firm organizations), forming a wide set of non-linear and multi-dimensional structures of economic activities (HENDERSON *et al.*, 2002; STURGEON, 2001).

The GPNs are thus "complex political-economic systems in which markets, and their associated distribution of resources and authority, are constructed within, as well as actively shape, their socio-political context" (LEVY, 2008, p. 1). In other words, GPNs are "an organizational arrangement comprising interconnected economic and noneconomic actors coordinated by a global lead firms and producing goods or services across multiple geographic locations for worldwide markets" (YEUNG; COE, 2015, p. 32). As the global economy becomes geographically and organizationally more complex, production networks are presented as a generic form of economic organization (COE; DICKEN; HESS, 2008a). These authors understand that production networks are dynamic *per se*, once they would always be, by definition, in a process of flux, both organizationally and geographically[17]. In this sense, none of them would remain unchanged for a very long time, responding to internal and external factors, what reveals that the analysis of production networks requires a heuristic framework that is time and space[18] sensitive. For those authors, the GPN concept provides exactly this dynamic heuristic framework.

In methodological terms, the GPN approach is related to:

> i) The networks of firms involved in R&D, design, production and marketing of a given product, and how these are organized globally and regionally; ii) the distribution of corporate power[19] within those networks, and changes therein; iii) the significance of labour and the processes of value creation[20] and transfer; iv) the institutions (…) that influence firm strategy in particular locations absorbed into the production chain; and v) the implications of all these for technological upgrading, value-adding and capturing, economic prosperity etc. for the various firms and societies absorbed into the chains (HENDERSON *et al.*, 2002, p. 447).

Building on elements of the GCC/GVC frameworks, the GPN framework recognizes that: i) input-output structures are central to understand where intra and inter-firm networks takes place, e.g. value creation and working conditions; ii) the "territoriality" of

[17] GPNs do not connect economic agents only in terms of functional activities and territoriality but also in terms of social and spatial arrangements (HENDERSON *et al.*, 2002).
[18] Space is not seen in absolute terms, but as "spatial fields and relational scopes of influence, power and connectivity" (HENDERSON *et al.*, 2002, p. 442).
[19] The authors consider "power" within GPNs in three forms: i) *corporate power*: the extend to which the lead firm is capable of influencing other firms decisions and resources allocations; ii) *institutional power*: the power exercised by the national/local state, international inter-state agencies, "Bretton Woods" institutions (IMF, World Bank) and the WTO, and UN agencies; and iii) *collective power*: actions of collective agents such as trade unions, employers associations, NGOs, etc.
[20] The authors consider "value" as surplus value (Marxian notion) and economic rent.

production networks, i.e. the economic, social and political arrangements, is central for understanding the developmental consequences at the local level (HENDERSON *et al.*, 2002). In addition, some authors consider that a value chain would be a sub-set of a production network, what turned them to be governed by the same set of rules (STURGEON, 2001). This means that governance patterns are considered an important dimension for both value chains and production network analysis, being distinguish between how *loosely coordinated* (market-based trading structures) or *intensely coordinated* (vertically integrated) is a value chain/network (GEREFFI, 1994).

Network-style governance refers to situations in which "the lead firm exercises power through coordination of production vis-à-vis suppliers (to varying degrees), without any direct ownership of the firms" (FREDERICK, 2014, p. 8). In more specific terms, there are three network-style governance: *i) authority or captive networks; ii) relational networks;* and *iii) virtual network*s[21] - each one with a different outcome in terms of advantages and limitations for firms and countries. The first governance style, *captive networks*, refers to networks with a high degree of coordination or control by the lead firm, and usually occurs between small dependent suppliers and few buyers (FREDERICK, 2014). Sturgeon (2001) presents this governance-style in two sub-categories: i) *intra-firm networks*, which is based on the power of the administrative control; and ii) *captive networks*[22], or inter-firm, which the lead firm has power to coordinate tiers of captive suppliers, based on long-term relationships. The second governance style, *relational networks*, is related to a set of long term personal and inter-firm relationships, most of them between small and co-located firms, which is built based on mutual reliance, usually given their social and spatial proximity[23] (named "social networks" and "agglomeration networks", respectively), reputation, and others, in order to share knowledge. Last but not least, the third governance style, *virtual networks,* refers to a model of fluid relationships (low barriers to entry and exit) that was built mostly by American companies, which is based on "linking highly innovative but deverticalized lead firms with sets of highly functional suppliers" (STURGEON, 2001, p. 13). This would be the category with greater organizational flexibility and agility ("geographic agility" and "output agility"). Even though all three different types of governance has its advantages and disadvantages, Sturgeon (2001)

[21] Also referred as "modular networks", it occurs when the firms undertake complex transactions, which are easily to codify (FREDERICK, 2014).
[22] According to Sturgeon (2001), this last category of close buyer-supplier linkages has some advantages, such as high efficiency, flexibility and close coordination of "just-in-time" deliveries, while it also has several disadvantages, most related to their mutual dependence.
[23] Sturgeon (2001) highlights that, in most cases, social and spatial proximity are closely related, but this is not a rule. Moreover, relational networks would also commonly operate within the limits of a specific locality.

considers that in recent years virtual networks has become the most effective competitive instrument for American lead firms and their turn-key suppliers.

From a more critical perspective, the GCC/GVC frameworks would be essentially linear structures that have a narrow focus on the governance of inter-firm transactions, which are likely to under-theorize the origins and dynamics of various kinds of networks (COE; DICKEN; HESS, 2008a; YEUNG; COE, 2015). According to Yeung and Coe (2015), the static conception of industrial governance [24] turned the GVC framework myopic to aspects of territorial organization and most of all inept to theorize the competitive dynamics and evolutionary processes in production networks. The result is a vast literature that uses the GVC framework as a "methodology" and not a "theory", with plenty empirical work on particular value chains of specific firms or products. Meanwhile, the GPN framework would go beyond this linearity, incorporating all different set of actors, directions and relationships, and being concerned with the territorial development impacts of networks (COE; DICKEN; HESS, 2008a). This means that not only the actor's inter-related actions are considered, but also the broader structures and institutions that they are embedded. In a broader sense, others authors claim that there would be no "structure"; consequently there are no "micro", "macro" and "meso" levels (URRY, 2003 *apud* COE; DICKEN; HESS, 2008a).

The nested relationships within the GPNs are simultaneous and dynamically inter-connected processes, with asymmetries of power in their essence (COE; DICKEN; HESS, 2008a). Because of the economic and political character of GPNs, we can say that they evolve complex forms of governance at multiple levels that are capable of striving regulatory and coercive authority, along with facilitate both technical coordination and knowledge's diffusion among activities (ERNST, 2002; LEVY, 2008). About this complex asymmetry of power within GPN, some general lines can be draw out: i) the scarcity and the capacity of controlling the access to the asset in question are two decisive features of the relative power of actors; consequently the actors in the weakest position are exactly those producing commodities that are easily replaceable; ii) the actor's position within a GPN can contribute with the bargaining power, and this would not be a static scenario, i.e. the firms/countries can upgrade their assets and competencies (COE; DICKEN; HESS, 2008a).

The GPN framework encompasses the global, regional and local economic and social dimensions of certain aspects of economic globalization, specifically those related to production and consumption, and how the inter-organizational connections are related to

[24] Gereffi *et al.*'s (2005) governance typology.

economic development (HENDERSON *et al.*, 2002). These developmental consequences are usually seen in terms of the distribution of power and value creation and capture within the GPN, which are influenced by the socio-political contexts. However, one would have the early stage of GPN theorization (named "GPN 1.0.") as an insufficient developed theory of global production networks, because even though it builds on three interrelated conceptual categories – value, embeddedness and power, it has not developed the causal mechanisms to provide a dynamic and coherent theory (YEUNG; COE, 2015).

The recent theoretical advances in the academic literature, which has been named GPN 2.0, aims to contribute with the development of a more dynamic theory of global production networks by having an analytical focus on the *actors*, more specifically their strategies and organizational configuration within and across industries and localities, as well as on the structural *competitive dynamics*[25] and their risk environment (YEUNG; COE, 2015). In other words, the recent academic advances are actor-centered conceptualizations of the causal mechanisms[26] that shape different organizations of GPNs across industries and territories, leaving behind the narrow focus on the industry approach of GVC/GCC governance (on already existing interfirm governance structures) and the micro-level analysis of industrial upgrading and local development.

The GPN approach is considered a quite potential research field (LEVY, 2008). In the one hand, some critical gaps in the GPN studies have been identified: i) a typology that covers the entire range of spatial scale (local, domestic, international, regional and global-scale); ii) a better-specified terminology on productive actors, since, more than a semantic problem, the false homogeneity (and false heterogeneity) of a set of terms (e.g. "original equipment manufacturer" (OEM)) could ignore important analytical differences (or mask similar patterns); iii) most of the studies do not consider how central is the problem of *logistics* to coordinate and integrate operations; iv) the treatment of the firms as a black box, e.g. the simplistic dichotomy of a lead firm, which plays a dominant part in GPNs, and supplier firms; v) the disposition for ignoring the natural environment under GPN analysis (COE; DICKEN; HESS, 2008c; STURGEON, 2001). On the other hand, is important to highlight some learning points: i) the GPN framework incorporates a wide range of (economic and non-economic, firms

[25] More specifically, their work aim to explain why and how three forms of competitive dynamics (optimizing cost-capability ratios, sustaining market development, and working with financial discipline) interact with actors (firms and nonfirms), producing four different strategies for GPN organization: i) intrafirm coordination; ii) interfirm control; iii) interfirm partnership; and iv) extrafirm bargaining (YEUNG; COE, 2015). In reality, those strategies are not isolate and can be combined in several ways.

[26] This means "structural dynamics as causality and firm-specific strategies as mechanisms" (YEUNG; COE, 2015, p. 33).

and non-firms) actors; ii) it is concerned with the territorial development impacts of networks in multi-scalar dimensions (from local to global networks), which; iii) are influenced by the social-political context; iv) it is not based on a narrow emphasis on the power relationships of firms, but includes collective and institutional power; v) it is oriented to understanding value creation, enhancement (e.g. in terms of upgrading) and capture (COE; DICKEN; HESS, 2008c). The following section addresses the main driving forces behind the emergence of GVCs.

1.3. The main facilitators of GVCs emergence

GVCs are one of the most prominent features of globalization[27]. The phenomenon of breaking the production process into parts, which will be performed domestically or abroad with increasing interaction among economic and non-economic agents, has variously been called by several terms, each one with a partial perspective of this multifaceted research object. *Fragmentation*, *offshoring, outsourcing, disintegration of production, intra-product specialization*, *vertical specialization, second unbundling*[28] and *slicing up the value chain*[29] are some of the concepts[30] or "language" used to explain the new global economy in the context of GVCs (BALDWIN, 2006; MENG; FANG; YAMANO, 2012). Whilst the fragmentation of production and the outsourcing of activities across countries are not new phenomena[31], the importance of internationally fragmented production has undoubtedly been growing over time. Thereby, to understand why GVCs emerged, allowing some countries to specialize in specific

[27] By 'globalization' we do not simply mean a more integrated global market. Globalization concerns a functional integration between economic activities that are now internationally dispersed (GEREFFI, GARY; MEMEDOVIC, 2003). Whilst globalization is a complex, multifaceted and more recent phenomenon, 'internationalization', defined as the "simple geographical spread of economic activities across national boundaries with low levels of functional integration" (DICKEN, 2011, P.7), does not represent a new characteristic of global capitalism. In this sense, globalization can be defined in more general terms as "the pervasive decline in barriers to the global flow of information, ideas, factors (especially capital and skilled labor), technology and goods" (KAPLINSKY; MORRIS, 2003, p. 15), and according to the authors, international integration through trade is one important indicator of globalization.

[28] From a historical perspective, Baldwin (2006, 2013) studies some of the main transformations of international trade over the last centuries, understanding globalization as two great unbundlings. The first unbundling was mostly about the geographical separation of consumption and production that was made possible by the steam revolution, especially railroads and steamships, leading to lower transportation costs and turning profitable to produce at vast scales. This first paradigm is still characterized by locally clustered production, although dispersed internationally, once the proximity reduces the costs of coordinating the complexity of production. More recently, lower transmission and coordination costs turned possible to geographically separate the production stages without loosing efficiency or timeliness, giving place to a new paradigm, the second unbundling.

[29] Originally used by Krugman (1995).

[30] As all of them indicate the same fact, an upsurge of trade in parts and components, the use of these multiple terms may require a more precise analysis of its meanings. See Annex 1.1.

[31] For decades, factories in developing nations have imported parts and components from countries with more advanced technology, though generally these imports were only for the assembly of local sales (TAGLIONI; WINKLER, 2016).

tasks or components rather than entire final products, one has to investigate the driving forces underlying the expansion in international trade and the growing interconnectedness of production processes across countries.

The pace, scale and scope of GVCs have raised a number of questions about what are the factors influencing the decision by firms to internationally fragment their production. And as discussed in Hillberry (2011 *apud* AMADOR; CABRAL, 2014), it is quite difficult to separate the driving forces that impact on the internationally fragmentation of production from those of the increase in international trade.

One of the main factors discussed in the literature is the lowering of trade costs. Trade costs include the whole range of costs between supplier and final consumer, e.g. in the case of goods, would be the sum of land transport, port costs, freight and insurance costs, tariffs and duties, non-tariff costs, mark-ups from importers, wholesalers and retailers; and in the case of services, include communication costs, and trade barriers as non-tariff measures (BACKER; MIROUDOT, 2013). Other important costs related to GVCs are coordination costs. Some studies observed that the level of fragmentation will be determined by technical characteristics of products and the costs incurred when the stages of production are placed in different locations, specifically a *trade-off* between lower production costs and higher coordination costs (BACKER; MIROUDOT, 2013; JONES; KIERZKOWSKI, 2001).

Lower trade costs are primarily a result of technological advances, especially in transportation and communication. Putting the decline in transportation costs in perspective, Hummels (2007) argues that both ocean and air shipping had experienced significant technological improvements (e.g. advances in materials, the adoption of jet aircraft engines, greater inter-modality of freight, automation and containerized shipping), being critical to the first and second era of globalization, respectively. The information and communication technology (ICT) advances made it possible to coordinate this new complex paradigm of production at distance. Whilst several costs have to be considered with the international spatial dispersion of production stages, cheaper and more reliable ICT tools have increased the tradability of goods and services (OECD, 2013). More recently, a more advanced level of automation and connectivity in the production process has been broadly discussed, with a digital transformation that has been exponentially growing by the use of several technologies (e.g. sensors, 3D printing, powerful computing processes, intelligent logarithms, intelligent robots, autonomous drones, and the so-called “internet of things”). Many of these technologies are not new, however, the recent boost in computing power and the reduction in cost, turned

them suitable for industrial use[32].

As it is discussed in Baldwin (2013), before the ICT revolution, a great part of international sourcing was done among mature economies. The new feature is that developing nations become part of international production networks, importing inputs for processing them and export in the form of goods, parts, components, and services (TAGLIONI; WINKLER, 2016b). Technological innovations turned possible to coordinate all stages of production at distance without increasing the coordination costs, but most importantly was the vast wage differences between developed and developing countries what turned this globally dispersed production profitable (BALDWIN, 2013). Thereby, according to the author, was possible to combine developed-economy technology with developing-nation labor.

Furthermore, Athukorala (2005) observes that there is a two-way link between the expansion of international product fragmentation and the improvement in production/communication technology, with the former resulting in lower production costs and rapid market penetration, encouraging new technological efforts and further product fragmentation. However, this trend is not restricted to technological change. The author observes that when it comes to the expansion of international product fragmentation, three mutually reinforcing developments over the past decades have to be considered: i) *the liberalization policy reforms*, which has been responsible for removing trade and investment barriers; ii) *technological innovations in communication and transportation*, which decreased the distance between nations; and iii) *production technology*, which turned possible to slice up the value chain into finer and portable components. Therefore, international competition, which used to occur mainly at the level of sectors, started to be defined at the level of production stages. And besides the technological perspective, trade and investment liberalization has also played a role in lowering trade costs.

The fragmentation of production beyond national borders was also facilitated by trade liberalization policy reforms in both home and host countries. This process has resulted in falling trade barriers, first in advanced economies and more recently in many developing

[32] The term "industry 4.0" has been used as an acronym for a broad process of changing the bases of industrial production, which has also been called "Fourth Industrial Revolution" and "Advanced Manufacturing". The industry 4.0 introduces a new way of producing compatible with the concept of "intelligent factory", in which production processes are monitored by a cyber-physical system (CPPS) with a very high technological and automation level, making use of systems developed and equipped to control autonomous robots with low dependence on operations controlled by people. According to DELOITTE (2015, p.5), "CPPSs are online networks of social machines that are organized in a similar way to social networks. Simply put they link IT with mechanical and electronic components that then communicate with each other via a network. Radio frequency identification (RFID) technology, which has been in use since 1999, was a very early form of this technology". For a further discussion about industry 4.0, see Mckinsey & Company (2011, 2015) and GTAI (2016).

countries (RIAD; ERRICO; HENN; SABOROWSKI; SAITO; TURUNEN, 2011). A worldwide process of trade liberalization was in progress since World War II, with notable reduction of global tariffs as the result of multilateral and bilateral free trade negotiations under the GATT (KRUGMAN, 1995), and leaping into the 1980s and early 1990s, trade was facilitated beyond arm's-length operations through FDI and trade in services, as most of the countries liberalized their capital accounts (AL-HASCHIMI *et al.*, 2015)[33]. Miroudot, Lanz and Ragoussis (2009) argue that trade tariffs on intermediate goods has been lower than those on final goods during the last 20 years, what partially explains this new dynamic of trade in intermediate goods as the main driver of global trade. From a political perspective, GVCs has raised in a period of trade and investment liberalization and deregulation (FEENSTRA, 1998). Thereby, regulatory reforms, especially in transport and infrastructure sectors, have also contributed to lower trade costs.

These technological and political developments have enabled firms to look at relative costs and factor endowments, building more efficient value chains (OECD, 2013). Hence, a part from lowering international trade costs, other important motivations are *cost efficiency* and *market access* (UNESCAP, 2015). According to the report, spreading production stages internationally may allow firms to achieve cheaper inputs and large economies of scale (which is desirable for certain tasks of GVCs involving high fixed costs), and can be related to institutional factors or the availability of infrastructure and related costs. One may say that the fundamental rationale of GVCs is economic efficiency and competitive advantage, which are based on transaction cost minimizing behavior of firms (BHATIA, 2013). Following, another important motivation is access to foreign markets, both to strategic inputs (intermediate-import and -export markets) and the entry into new markets (with the proximity to final demand as a key-factor) (UNESCAP, 2015). This last motivation is in accordance with the greater participation of emerging market economies, which has experienced a rapid integration into the world economy (AL-HASCHIMI *et al.*, 2015). Furthermore, the emergence of Asia, especially China, has not only boosted international trade but radically increased the size of world demand (BACKER; MIROUDOT, 2013). In a GVC context, it is important to highlight that the benefits

[33] According to Al-Haschimi *et al* (2015), most of the standard trade models are unable to explain the impressive increase in trade as a share of global output because they usually are restricted to one factor, trade liberalization. From a wider perspective, the authors consider that the growth of international trade was fostered by at least four fundamental structural developments. Besides a worldwide process of *trade liberalization*, the authors highlight a *greater participation of emerging market economies*, capital accounts liberalization, and technological advances as key factors. In other words, according to the authors, would be a contradiction to explain the second wave of globalization using the falling in tariff barriers as single parameter, because the trade growth substantially outpaced output growth after the mid-1980s, and tariff liberalization was better well founded until the mid-1980s.

from local agglomerations are commonly related to social-, environmental factors and trade agreements. To sum up, the report considers that "for GVCs to emerge, trade costs must be low enough to enable firms utilizing country-specific advantages related to cost efficiency and/or market access" (UNESCAP, 2015, p. 107).

One of the main driving forces of the emergence of GVCs are the changes in corporate thinking and business strategies. As trade costs have decreased drastically in the past years, turning international sourcing of intermediates cheaper and easier, firms changed their global strategies (e.g. offshoring of non-core activities; with greater use of cross-border non-equity modes; including other forms of production organization besides vertical organization, such as mergers and acquisitions, and joint ventures) (OECD, 2013; OECD; WTO; UNCTAD, 2013; UNCTAD, 2013a). As it is discussed in Milberg and Winkler (2013), offshoring is not a new business practice, but it is part of a larger business strategic shift over the last twenty-five years, involving a search for lower costs and more flexible process of "mass customization". According to the authors, firms have demonstrated an increasing concern for core-segments of their value chains and for shareholder value in the short-run (the "shareholder value revolution"). In a general sense, the lead firms are continuously re-evaluating the risks of offshoring or outsourcing their production in the light of several changing aspects, such as technological and political changes, geographical shifts in demand, changing consumer preferences, and locational risks (BHATIA, 2013).

More recently, one may observe the consolidation of some GVCs, given an increasingly difficult access to trade finance and higher levels of uncertainties in the supply of some inputs, which reflects higher transaction costs (BACKER; MIROUDOT, 2014). Therefore, the idea that there would be an unlimited expansion of GVCs is not sustained in the most recent period. Beyond a physical limitation that reflects the optimal level of fragmentation, which is explained by technical features of products and the costs associated with splitting the production stages in different locations, companies have reassessed their strategies of offshoring. They have been driven by complex tradeoffs that can affect their global performance and not only by a particular facilitator, such as lower labor costs (e.g. rising wages in China). The drivers vary from more control of the product, especially the technology, to underestimation of the full cost of offshoring, an increase in the cost of shipping and a decrease in domestic energy prices in the United States (BACKER et al., 2016; COHEN, LEE, 2015).

The nowadays global economy is clearly not about a mere quantitative geographical spread, but about "the qualitative transformation of economic relationships across geographical space", involving a set of distinct driving forces (DICKEN, 2011, p. 7). In this sense, the review

of the vast literature on the facilitators of GVCs is beyond the scope of this section. GVCs are multifaceted, and so are its driving forces. But GVCs are not all equally complex and widespread (OECD, 2013). Nor are the gains from GVCs. The next section addresses the widespread benefits usually associated to greater participation in GVCs across countries.

1.4. Economic upgrading: definitions and measures

One of the main reasons why value chain analysis is valuable is its capacity to assess who is benefitting from GVC participation, whether households, firms, sectors, regions or countries, and a particular challenge is to unravel analytically and empirically what are the outcomes associated with increasing participation in GVCs. Even though the analysis does not allow establishing causality[34] (TAGLIONI; WINKLER, 2016), the strategy of deepening integration into GVCs has been seen as an opportunity for countries to improve their competitiveness by greater access to global markets. Thereby, the economic gains of participating in GVCs are conceived in the GVC literature regarding *economic upgrading*.

Upgrading, which is commonly referred to as "industrial upgrading" or "economic upgrading"[35], is defined by Gereffi (2005, p. 171) as "the process by which economic actors – nations, firms, and workers – move from low-value to relatively high-value activities in global production networks". Cattaneo *et al.* (2013) consider upgrading as a dynamic movement, highly associated with increased benefits from one stage of production to another within the value chain. It is often implicitly assumed that the benefits from GVC participation are not equally distributed among all production stages and a position in higher-value-added activities generates larger economic benefits, including higher incomes, high-wage employment, and positive spillovers regarding technology (OECD, 2013). Once countries and firms are integrated into GVCs, upgrading their position in value chains may raise as the best long-term strategy for preserving and capturing more gains of participation in GVCs (CATTANEO *et al.*, 2013). Therefore, the positioning of a producer within a GVC and the nature of the value chain are taken as important aspects to understand the distribution of risks and opportunities of GVCs' participation (GEREFFI; LUO, 2015).

[34] According to Taglioni and Winkler (2016), it is not simple to establish the exogeneity of GVC participation. In this sense, the causality between GVC participation and country performance could run in both directions, whether one consider GVC integration as endogenous to the developments in the economic environment.

[35] The GVC literature initially referred to "industrial upgrading", as most of the analysis used to focus on labor-intensive manufacturing, such as garments and footwear (GEREFFI, 1999; 2005). But in recent years, the concept of "economic upgrading" has been used as a broaden definition, which is not restricted to a specific manufacturing and is more suitable to analysis across sectors, including agriculture and services (BARRIENTOS; GEREFFI; ROSSI, 2010; ROSSI, 2013).

But upgrading is not always about “moving up the value chain”. According to Kaplinsky and Morris (2003, p. 38), it is important to understand the challenge of upgrading from a wider perspective, which involves “changes in the nature and mix of activities, both within each link in the chain, and in the distribution of intra-chain activities”. In other words, it is about “making better products, making them more efficiently, or moving into more skilled activities” (GIULIANI; PIETROBELLI; RABELLOTTI, 2005, p. 552). Economic upgrading has often been associated with increasing competitiveness in higher value-added products, tasks, and sectors (TAGLIONI; WINKLER, 2016), and may be identified as “directly related to increases in competitiveness in value added process and with national gains in productivity and labor qualifications” (SALIDO; BELLHOUSE, 2016, p. 9). Put it simply, upgrading refers to “the improvement of a firm’s productivity and competitiveness through the creation of technological and managerial capacity to ensure its inclusion in GVCs” (UNIDO, 2015, p. 21).

The GVC literature has mainly focused on the ability of producers to engage in more knowledge-intensive activities and on their ability to learn, i.e. the enhancement of technological capabilities for developing new products or processes. In this sense, upgrading is also understood as the ability to innovate to increase the value added of products and processes (GIULIANI; PIETROBELLI; RABELLOTTI, 2005; HUMPHREY; SCHMITZ, 2002; KAPLINSKY; READMAN, 2001). As such, there is a logical contradiction when the concept of upgrading is used as a synonym for innovation, yet it is also understood as the outcome of an innovation process, resulting in several empirical studies of upgrading mixing up causes and effects (MORRISON; PIETROBELLI; RABELLOTTI, 2007). Although the capacity to innovate is associated with the producers’ ability to increase value added, it is necessary to compare it with the innovation efforts of their rivals, whether to truly increase both value added and market share. This means that if the rate of innovation is lower than of its rivals, the outcome may be declining value added and market share (KAPLINSKY; READMAN, 2001).

Furthermore, according to Taglioni and Winkler (2016), upgrading is not exclusively about transitioning from an agricultural to a services economy, as traditional international trade and development views (“old paradigm”, as named by GVC literature) suggest. But it is about achieving higher value-added production via skills and know-how, capital and technology, and process upgrading. This means a rupture with the old sector-based paradigm focused on final goods and moving a step forward to a new paradigm focused on intermediates. From a developing country perspective, economic upgrading overcomes the old paradigm based on exploring their comparative advantage on cheap labor costs to become a path to pursue development build on skills and value-added (ROSSI, 2013).

In the context of GVCs, there are four equally relevant trajectories that firms can adopt to upgrade (HUMPHREY; SCHMITZ, 2002; KAPLINSKY; MORRIS, 2003), namely: i*) process upgrading:* occurs when firms are increasing value-added shares in existing GVC tasks by having a better organization of internal processes than those of rivals or by introducing new technologies, which turn possible to process more complex tasks, resulting in efficiency gains and reduced per-unit costs, in other words, it is productivity growth in current activities; ii) *product upgrading:* firms are producing new products in the existing value chain (higher value-added products) or even improving old ones faster than their rivals, in a process that usually involves moving into more sophisticated product lines, more skilled jobs or the acquisition of technology capability; it can be measured as the value added per unit of output; iii) *functional upgrading*[36]*:* occurs when firms increase the overall skill content of activities, i.e. firms are increasing value added by changing the activities that are performed by the firm or by moving the locus of activities to new segments of a GVC associated with higher value-added; it can be measured as a higher share of value added in the output of the final product; and iv) *chain (or inter-sectoral) upgrading:* participating or moving horizontally to new GVCs that produce higher value-added per unit of output and requires similar knowledge and skills.

Jiang and Milberg (2012) created a new category of upgrading, named *vertical upgrading*, that captures structural changes in the import content of export at the sectoral level, isolating the changes in import content from the growth in exports. In other words, the authors focused on the type of industrial upgrading that is directly related to vertical specialization, i.e. upgrading associated with capturing a higher proportion of domestic value-added. However, their measure of vertical upgrading shows a few limitations. They highlight that even if a sector upgrades vertically, this does not necessarily mean that the sector is moving to higher value-added production, and more importantly, vertical upgrading is not a concept related to technological change. This means that a sector that shows vertical upgrading may actually be experiencing functional or chain upgrading given a change to higher-tech or higher value-added foreign inputs as it is producing domestically a higher value-added product, for instance.

The literature on GVCs emphasizes the case studies of functional upgrading, i.e. moving to higher value-added tasks. From a dynamic perspective, the trajectory of functional upgrading process is made of steps from assembly typical of export-processing zones to original equipment manufacturing (OEM) to original brand name manufacturing (OBM) and original

[36] According to Barrientos *et al* (2010), a functional upgrading can occur in at least two different ways: vertical integration (adding new capabilities to a firm or cluster) or specialization (substituting an activity for another).

design manufacturing (ODM) (GEREFFI; FERNANDEZ-STARK, 2011)[37]. There are, however, other forms of learning processes equally relevant. Additionally to the primary four paths of upgrading, UNIDO (2015) presents three other forms: i) *organizational upgrading* (the organization of producers in business units, e.g. cooperatives or joint business), ii) *territorial upgrading* (the focus is on a certain locality), and iii) *structural upgrading* (which is related to firm size and business structures). Moreover, Fernandez-Stark *et al.* (2011; 2014) present two other types of upgrading: i) *entry into a GVC by a new actor*; and ii) *end-marketing upgrading*, which means moving into more sophisticated markets with rigorous standards or into larger markets with mandatory production on a larger scale and price accessibility.

This last type of upgrading reveals how deeply mistaken is the narrow view of upgrading simply as the need to capture a growing share of a product's value[38]. Whilst upgrading is interpreted as the need to capture a growing share of domestic value added in exports, most of the authors that propagate this simplistic, and perhaps erroneous, idea make use of the "smile curve" thesis to put forward the idea that it may be better to move away from the assembly stage of the GVC, given its small share of value of the final products (KOWALSKI *et al.*, 2015).

The "smile curve" is one of the most reproduced diagrams in discussions about the different opportunities usually associated with different stages of a value chain and it was first articulated around 1992 by the founder of Acer, Stan Shih, to represent Acer' strategy of upgrading from assembly to higher value-added activities in the value chain for computers (LOW, 2013). This diagram asserts that manufacturing, especially the final assembly, adds smaller shares of the final product value than post- or pre-manufacturing services (e.g. marketing, distribution, sales/after service, or concept, R&D, design, branding, respectively). This hypothesis is presented in a graph with Y-axis for value-added and X-axis for value chain, resulting in a curve with the shape of a smile (YE; MENG; WEI, 2015). After the second unbundling, it seems like the smile curve has deepened, increasing the difference among stages (BALDWIN, 2013). However, this view of upgrading simply as "moving up the value chain" do not consider the *volume* of the activity, which is as much, or more, crucial as the share of the product (OECD; WORLD BANK GROUP, 2015). Using the manufacture of garments as example, the joint report from OECD and The World Bank Group shows that in spite of just

[37] One may say that there is a hierarchy in upgrading, as firms are moving from assembly to ODM in a process that reflects their developed capabilities. In other words, the degree of disembodied activities increases in a trajectory from process upgrading to product, through functional and finally chain upgrading (KAPLINSKY; FAROOKI, 2010; KAPLINSKY; MORRIS, 2003).

[38] This idea is commonly driven by the oft-cited iPad case study.

being considered a relatively labor-intensive process with a small share of the total value of the final product, it is also possible to say that important benefits can be obtained from the specialization of SMEs in this manufacturing activity and their aim to perform on a larger scale.

Some authors understand that the possible paths that firms have undergone through participating in GVCs can be resumed into two broad categories: the *low road* and the *high road* (KAPLINSKY; MORRIS, 2003; KAPLINSKY; READMAN, 2001). Simply put, it is about two routes to raising international competitiveness that depends on production costs (MILBERG; WINKLER, 2011). The low road is a trajectory of firms that fight to keep competitive based on lowering wages and profit margins. Usually from developing countries, those firms are trapped in low value-addition activities and become engaged in a "race to the bottom", facing a situation of immiserizing growth[39] (KAPLINSKY; READMAN, 2001). The low road based on lowering wages is often named "social downgrading". On the other hand, the high road is about raising productivity and increasing value added as a result of innovation, which is commonly facilitated through knowledge gained from other firms in the GVC (BERNHARDT; POLLAK, 2015). Instead of that built on developing countries' comparative advantage on cheap labor costs, this path is based on skills and added value, and it is identified as "economic upgrading" (ROSSI, 2013). Furthermore, those who pursue a high road exhibit the ability to enter a virtuous circle of participation in GVCs and reach sustained income growth (KAPLINSKY; READMAN, 2001). But what explains the differences between both roads to competitiveness? One of the possible explanations considers the role of different capabilities of firms to "upgrade", or in other words, their *ability to learn* (GIULIANI; PIETROBELLI; RABELLOTTI, 2005; KAPLINSKY; READMAN, 2001). Therefore, the next sub-section emphasizes the role of innovation and learning capacities for boosting productivity spillovers from GVC integration.

1.4.1. Upgrading, productivity and technology spillovers

One of the most discussed dimensions of GVC participation is technology. Several studies show the positive effects of transferring technology and knowledge through GVC participation, which would lead to increased productivity and greater opportunities for

[39] "Immiserising growth" was first defined by Jagdish Bhagwti in 1958 as a theoretical situation where economic growth may drive a country to a worse outcome than before the increasing of the overall economic activity, e.g. if producers are competitive only through continual devaluation of the currency, this may led to a reduction of the international purchasing power of domestic incomes; increased exports can only be paid for by lower wages; if growth is export-led, this may lead to a fall in terms of trade (KAPLINSKY; READMAN, 2001).

economic growth (NATIONAL BOARD OF TRADE, 2013a; OECD, 2013; WTO, 2014a). Moving into higher value-added stages is commonly followed by positive spillovers concerning technology, productivity and skill upgrading, leading to endogenous technology creation (SHEPHERD, 2015). The different paths of upgrading may not be linear, involving learning, the development of national and firm-level capabilities and innovations (NATHAN; SARKAR, 2013). Hence, successful upgrading paths do not depend only on the value added trade participation and domestic value added, but may also depend on participating in GVCs of increasing technological sophistication (OECD; WTO; UNCTAD, 2013). But what are the economic mechanisms in the process of GVC participation that have enhanced productivity growth?

According to OECD (2013), besides the general impacts of globalization on productivity as a result of greater access to foreign knowledge and technology, the scope for specialization and economies of scale, and the impacts of international competition on improving efficiency, GVCs participation has an additional effect: it may increase productivity by facilitating access to cheaper or better-quality intermediate inputs. By analyzing the OECD countries, the report claims that those countries with higher share of imported intermediate goods present on average higher productivity, which would be the result of three effects: i) *a price effect:* lower prices of intermediates as the result of stronger competition among producers of intermediated; ii) *a supply effect:* greater variety of intermediates available; iii) *a productivity effect:* increased intermediate imports may spur innovation by improving access to foreign knowledge. As firms within countries deepen their access to GVCs, this affects their potential for learning and productivity growth. Thereby, GVC integration has also affected technology and knowledge transfers. Piermartini and Rubinova (2014) shows that technology and knowledge transfers tend to be higher across countries that are more connected within GVCs. Shepherd (2015) examines some vectors through which technology transfer may take place within GVCs, explicitly and implicitly, ranging from inward FDI, technology licensing, imported intermediates and capital goods, to demand effects. Furthermore, Amiti and Konings (2007) shows that imported intermediates are related to higher technology transfers if compared with imports of final goods.

GVC integration has strong potential for productivity gains via several transmission channels (“dynamic productivity effects”), even though static labor productivity is negative for employment creation (i.e. when the same amount of value added is created with fewer workers) (TAGLIONI, WINKLER, 2016). This said, Taglioni and Winkler (2016) have identified the

main transmission channels for economic and social upgrading[40], namely: i) *forward links:* sales of GVC-linked intermediates to the local economy, resulting in an upsurge of production and/or productivity in downstream sector; ii) *backward links:* GVC-linked purchases of local inputs, rising production and/or productivity in several upstream sectors; iii) *technology spillovers:* improved productivity of local firms in the same or related downstream/upstream sectors as a result of GVC production; iv) *skill demand and upgrading:* similar to iii), but connected through training of and demand for skilled labor; v) *minimum scale achievements:* for example, when GVC participation stimulates investments in infrastructure that would otherwise not be profitable and that may spur local production in other sectors.

To begin with, the backward and forward links creates a *demand effect* and an *assistance effect* in the host country, i.e. lead firms to tend to require more or better inputs from local suppliers and can assist local suppliers through knowledge and technology sharing, advance payments, and others forms of assistance. Both backward and forward links also generate technology spillovers, improving the production of local firms through two mechanisms: *diffusion effect* (diffusion of knowledge and technology) and *availability and quality effects* (GVC participation increases the availability and quality of inputs in the buyer's industry). In addition, GVC participation can result in pro-competitive market-restructuring effects that extend to nonparticipants of the GVC. Put it simply, the *pro-competition effect* occurs when GVC participation increases competition for the limited resources in the country, resulting in an overall increased average of productivity. There is also a *demonstration effect*, which reveals that knowledge and technology spillovers can upsurge from direct imitation or reverse engineering by the local participant or non-participant firms. The minimum scale achievements also amplify pro-competition effects, by stimulating investment in infrastructure and backbone services that would not be realized if it was not for the scale generated by GVCs. This created infrastructure also spurs local production in other sectors. Furthermore, the minimum scale achievements have also a *sustainability effect*, i.e. it reinforces the ability of the country to sustain GVC participation over time (TAGLIONI, WINKLER, 2016). Following Taglioni and Winkler's (2016) argument, the last mechanisms analyzed are related to how GVCs benefit labor markets. The authors highlighted three effects: i) *demand effect*, i.e. GVC participation involved higher demand for skilled labor; ii) *training effect*, i.e. the local firms engaged in GVCs are more likely to receive training; and finally, iii) *labor turnover effect*,

[40] See Figure 1.2 (Annex 1.2).

which shows that the knowledge embedded in the workforce of participating firms may move to other local firms.

Taglioni and Winkler (2016) use the case of Bulgaria to illustrate the impacts of countries' GVCs participation on the productivity of firms, more specifically on how a firm's absorptive capacity and a country's institutional variables affect the firm productivity from structural integration[41] in GVCs in manufacturing industries. Their estimations for the full country sample confirm that GVC participation increases the productivity of firms in a country, both domestic and foreign firms. In the one hand, several characteristics at the firm level can increase the productivity spillovers from a sector's structural integration in GVCs. Among the factors that affect positively the productivity gains from GVC participation on both buying and selling sides, the authors highlight a lower technology gap of a firm (related to the median productivity level of foreign firms in the same sector), the firm's technology level, size, export share, and FDI status. On the other hand, many national and institutional characteristics are associated with the productivity spillovers from structural integration in GVCs. In a general sense, productivity spillovers from structural integration in GVCs are lower in countries with higher education, less trade protectionism, higher GDP. On the contrary, they are higher in countries with high innovation capacity.

However, learning in GVCs is not automatic, nor all countries can benefit from technology and skills dissemination within GVCs (UNCTAD, 2013a; UNESCAP, 2015). According to the report, GVCs can also act as barriers to learning for local firms, limiting learning opportunities to few firms and locking firms into low technology and low value added activities. Shepherd (2015) suggests that GVC participation may support technology upgrading in developing countries under proper circumstances, depending on several factors, such as social structure, policy environment, and most importantly, the domestic governance institutions (especially the rule of law and contract enforcement). UNIDO (2015) reveals that the positive effects of GVC participation regarding technological learning and innovation depend on governance patterns and power relationships that characterize the GVC, as well as on the domestic capabilities of the firm. Nathan and Sarkar (2013) argue that the role of developing country firms as suppliers is not restricted to receiving technology and learning how to use it. Beyond knowledge using, there is also the possibility of knowledge-changing capabilities, which would enable both catch-up through reverse engineering and innovation. This possibility is determined not only by the firm- or industry-level capabilities, but also by

[41] The authors use network analysis and metrics to measure Bulgaria's structural integration in GVCs in terms of buyer-related and seller-related measures. See Santoni and Taglioni (2015).

national scientific and innovation capabilities and incentives. Thereby, without sufficient investment in skills, technological progress and GVC participation will not be translated into productivity growth (OECD; WTO; UNCTAD, 2013).

1.4.2. Measuring economic upgrading

No single measure can be used to determine the benefits and risks usually associated with GVC integration. Hence, it is usual to assess the concept of economic upgrading by using different measures under distinguished levels. These various measures are applied to several case studies, challenging the possibility of extracting general conclusions about economic upgrading. This sub-section assesses a set of different metrics on how GVC participation may impact the economic performance of producers.

According to Milberg and Winkler (2011), economic upgrading has been measured mostly through notions of *productivity growth*, *international competitiveness*, and *unit prices*[42]. This reveals that economic upgrading is mostly seen in terms of efficiency of the production process and the peculiarities of the product and tasks developed by producers. According to the authors, by taking productivity growth (i.e. increasing output per worker[43]) as a *proxy* for economic upgrading, it is common to use *output* and *value added* mutually when measuring at the national level. As the authors present accounting as the basis of a recent set of measures of economic upgrading, and following their argument, *international competitiveness* is usually measured by relative *unit labor costs*[44], with greater competitiveness when unit labor costs are lower. Although, from the total differential of the equation of unit labor costs[45], it becomes clear that a decline in the growth rate of relative unit labor costs (i.e. improvements in international competitiveness) can be the result of several events, such as a decline in wage growth, an increase in productivity growth, or from currency devaluation. Hence, in the presence of these different factors of competitiveness, it would be a difficult task to associate a better trade performance with economic upgrading. Therefore, looking for a measure of upgrading in accordance with the previously discussed concept of upgrading, Milberg and

[42] According to the authors, a closer look at the precise definitions of these concepts may reveal some dichotomy in relating them to social upgrading.
[43] By measuring labor productivity (π) as output (Q) per worker (L), we have the growth in labor productivity ($\pi\hat{}$) as the growth in output ($Q\hat{}$) surplus the growth in employment ($L\hat{}$) (MILBERG; WINKLER, 2011).
[44] By the equation: $R = W (1/\pi)E$, where R is unit labor costs in foreign currency terms, W is wages, π is labor productivity and E is the nominal exchange rate (MILBERG; WINKLER, 2011).
[45] $R\hat{} = W\hat{} - \pi\hat{} + E\hat{}$, where $R\hat{}$ is the growth rate of relative unit labor costs, $W\hat{}$ is the growth rate of wages, $\pi\hat{}$ the growth rate of labor productivity, and $E\hat{}$ the growth rate of the exchange rate (MILBERG; WINKLER, 2011).

Winkler (2011) consider one of the first studies that measured economic upgrading by using unit prices *and* market share, Kaplinsky and Readman (2005).

Some studies emphasize the producer's ability to learn. Kaplinsky and Readman (2005) consider the relative innovative performance as a reflection of upgrading, which is measured in terms of unit-prices in accordance with data on market shares. As a first step, the authors distinguished the capacity to innovate (to produce something new or with increased efficiency) from the capacity to upgrade, i.e. to innovate faster or better than rivals. Therefore, their measure of upgrading focuses on outcomes rather than processes and inputs, using unit prices and market share as an indicator of competitiveness. Put it simply, a producer has experienced economic upgrading when it shows that it: i) *increased its export unit values*[46] *relative to the industry average*, and ii) *increased its world export market share*. On the other hand, a combination of falling unit prices and falling market share within the respective GVC is taken as downgrading process. Other combinations would end up in ambiguous results[47]. This metric of upgrading was applied by Kaplinsky and Readman (2005) to a particular economic activity – wooden furniture, during the 1990s, given their methodological purpose of capturing upgrading in a specific sector in different countries using trade statistics in general.

Following Kaplinsky and Readman's (2005) definition, Bernhardt and Pollak (2015) consider the growth differential between a country's export unit values and the global industry average as one indicator[48], and also complement their analysis by adding the change in world export market shares. These two indicators can show evidence of different paths of upgrading, e.g. product, functional and process upgrading (BERNHARDT, 2013). However, using these indicators may not allow distinguishing which type of upgrading is associated with the competitiveness performance, nor capturing directly the inter-sectoral upgrading[49]. Their analysis of upgrading dynamics was applied to four manufacturing GVCs (Apparel, Wood furniture, Automotive, and Mobile phones), ranging different degrees of technological

[46] Export unit values are seen as proxies for product quality and "are calculated by dividing the total value of a country's exports (of a certain commodity or product group) in a given period by the quantity or volume of these exports" (BERNHARDT; POLLAK, 2015, p. 9).

[47] According to Kaplinsky and Readman (2005), when market share decreases (increases) and unit value rises (falls) relative to industry average, the result depends on the degree of price increase (falling), on the degree of falling (rising) market share and the opportunity cost of the resources invested in exports.

[48] The growth differential is used in order to avoid a measurement bias and to adjust for sector-wide inflation. The authors consider that because export unit values are a nominal concept, it can be driven by increases in input factor and other productions costs (reflecting, for example, an increase in the technology gap relative to the frontier), what would lead to misunderstanding increases as economic upgrading.

[49] According to Bernhardt and Pollak (2015, p. 10), economic downgrading within a sector may not be an undesirable outcome, "but may be a manifestation of the country's economy undergoing a process of structural change, i.e. a shift in the composition of economic activities towards sectors with higher value-addition".

sophistications, as well as different governance structures, and a sample size of around 35 countries. Their results indicate a notable variation across the four GVCs, with economic upgrading revealing to be more common in complex sectors with a higher degree of technological sophistication, and conversely, economic downgrading in low-tech sectors. In addition, developing countries, which have been gaining importance as producers and exporters, have been more likely to experience economic upgrading[50]. To sum up, the authors conclude that "the promise of economic upgrading through participation in GVCs does not materialize for everyone", as they find that only a quarter of the cases in their sample had experienced economic upgrading (BERNHARDT; POLLAK, 2015, p. 31).

Similarly, Bernhardt and Milberg (2011) present economic upgrading as a combination of growth in world export market-shares and export unit values. When taken them separately, an increase in the world export market-shares shows that a country's exports are internationally competitive and an increase in the export unit value indicates the production of higher-value products. However, an increasing export unit value may also reflect rising production costs, which would lead to a loss of international competitiveness (BERNHARDT, 2013). Thus, upgrading in a given sector takes place when *both* conditions are experienced simultaneously. The authors focused on four sectors (Apparel, Horticulture, Mobile phones, and Tourism), varying in terms of technological intensity, and for each sector they analyzed a set of eight to ten developing countries for the period 1990-2009. In respect to the economic upgrading, their findings show that multiple patterns can be traced across sectors, although two parallel can be extracted: first, an association between economic upgrading and growth in world export market share in all sectors, except apparel; second, export market share was generally associated with declines in export unit values. The authors also found that economic downgrading does occur, but social downgrading would be more common. Following the approach used by Bernhardt and Milberg (2011), Salido and Bellhouse (2016) recently focused in the case of Mexico, analyzing four aggregated sectors (Agriculture, Manufacturing, Mining, and Tourism). The authors slightly modify the Bernhardt and Milberg analysis, by adding the measurement of the national productivity to capture data on labor and production, regardless the external sector performance. According to the authors, this approach that includes productivity data would provide a more dynamic view of the changes in the Mexican economy.

Another set of measures of economic upgrading is used by Taglioni and Winkler (2016): i) *growth of domestic value added embodied in gross exports*; ii) *level of domestic value*

[50] Bernhardt and Pollak (2015) suggest that advanced economies are less likely to undergo economic upgrading than developing countries because of their loss of world market share to dynamic emerging market economies.

added; iii) *productivity* (labor or total factor productivity). Even though the first variable is only available at the sector level, the others can be measured at the firm level. All three measures of economic upgrading were used as dependent variables, and then related to various measures of GVC integration at the sector level (the "GVC links"). By using statistical methods or econometric analysis, the authors aim to explain the impacts of GVC participation, more specifically: i) if the intensity and nature of GVC links[51] are important aspects of growth in domestic value added that is exported; ii) the effects of GVC integration, as buyer or seller, on domestic value added, considering the mediating role of national policy[52]; iii) the effects of GVC participation of an industry on a firm's productivity[53].

On the other hand, Kowalski *et al* (2015) are critical to analysis that simply defines upgrading as increasing the domestic value added share of a product[54]. Thereby, claiming for more rigorous empirical works on how GVC participation may impact the economic performance of countries, the authors use three different forms of measuring the outcomes of GVC participation: i) *the overall per capita domestic value added embodied in a country's exports*; ii) *the sophistication of export bundles*; and iii) *the diversification of exported products*. Their empirical analysis is mostly based on OECD Trade in Value Added (TiVA) data, but EORA database is also used to maximize the covered countries, as well as the BACI dataset (based on UN Comtrade and the World Bank Development Indicator databases) for non-value added-based measures and controls. The entire sample is composed of 152 countries and 15 years.

The first measure captures the benefits related to exporting that spread to domestic labor and capital. In other words, it would be a value added measure of productivity changes

[51] Different metrics were used to measure GVC links, such as "GVC measures of structural integration as buyers and sellers in networks, foreign value added embodied in gross exports, domestic value added embodied in exports of third countries, GVC participation index, position in GVCs (upstreamness), domestic length of sourcing chains, and share of foreign output in a sector" (TAGLIONI; WINKLER, 2016, p. 121)

[52] The policy variables used in their analysis were able to assess a country's ability to join GVCs and its ability to upgrade, e.g. a country's infrastructure, foreign presence, legal institutions, and innovation capabilities.

[53] The authors merged the Farole and Winkler (2014) data set with two sector measures of structural integration in GVCs, i.e. BONwin (i.e. buyer's perspective) and BONwout (i.e. seller's perspective). Farole and Winkler (2014) investigate "how foreign investor characteristics, domestic firm's absorptive capacity, and a country's institutional variables influence intra-industry productivity spillovers to domestic firms from FDI" (TAGLIONI; WINKLER, 2016, p. 124). The description of these variables (chapter 6), the baseline of the estimation equation (annex 7B), and an application of this model to Bulgaria (annex 7C), see Taglioni and Winkler (2016).

[54] They illustrate their questioning with the case of China's electrical and optical equipment: with a domestic content of exports falling from 87% to 57% between 1995 and 2009, and the volume of domestic value added embodied in exports increasing more than tenfold, China had grown its domestic share of global value added in exports of electrical and optical equipment (from 3% to 22%). These developments show that profit-maximizing firms operating in China had increased the foreign content of their products meanwhile increasing their production. Therefore, the authors suggest that product or functional paths of upgrading are scarcely possible if not followed by higher productivity.

associated with GVC participation (similar to *process upgrading*). With the aim of testing econometrically for complementarity/substitution between domestic and foreign value added in imported inputs, and to better understand the relationship between GVC performance and access to more sophisticated intermediate inputs, Kowalski *et al* (2015) estimate the correlation of this first variable with: i) changes in the use of foreign value added in exports; and ii) changes in measures of sophistication of imported manufacturing intermediate inputs and primary intermediates. They find evidence that foreign value added is *complementary* to increasing per capita domestic value added in exports; changes in the sophistication of imported non-primary sector intermediates have a positive impact (though it decreases at higher levels of sophistication), as well as positive changes in per capita GDP; and, on the other hand, a growing distance from economic activity have a negative impact. The second variable is based on the methodology of Hausmann *et al* (2007) and is considered a *proxy* for product upgrading. By measuring its changes, becomes possible to identify the path of increasing (or decreasing) sophistication of exported products. Empirical evidence suggests that growing backward participation (i.e. a bigger share of foreign value added in exports), using more sophisticated inputs and higher per capita GDP are positively associated with producing more sophisticated export products; however, positive changes in FDI inflows are not. The third measure, which is based on the presumption that lower degree of export concentration has a positive correlation with a diversified exporting structure, is considered a *proxy* for functional upgrading. By measuring the diversification of exported products, it is possible to assess a country's competitiveness and quality of integration with international markets. The empirical evidence on the third measure shows that diversification can be associated with positive changes in backward participation and the use of more sophisticated non-primary imported intermediaries, meanwhile, concentration is associated with growing per capita GDP (KOWALSKI *et al.*, 2015).

Furthermore, Kowalski *et al.* (2015) have found different paths of process, product and functional upgrading across income groups, respectively: i) most of the gains in per capita domestic value added embodied in exports from high-income countries are driven by a growing use of more sophisticated primary and non-primary intermediates, while it is the sophistication of non-primary intermediates that matters the most for low-income countries and the growing flows of inward FDI in the case of middle income countries; ii) engaging in wider fragmentation as the basis of most of the product upgrading in high/middle-income countries; and iii) high-income countries importing more sophisticated non-primary intermediates results in more diversified exports, whilst middle/low countries shows a wider engagement in backward

participation. Put it simply, their results show no regularity when it comes to the spread of gains associated with value chain trade. However, a wider GVC participation, e.g. by using the more foreign content of intermediates imports or importing more sophisticated intermediates, is assumed to correlate with positive outcomes. Thereby, the possibility of gaining from GVC participation appears to be highly associated with the structure of specialization and level of development (KOWALSKI *et al.*, 2015).

The literature presents several challenges for measuring and analyzing economic upgrading, such as the quality of the data available, the level of analysis and its comparability, and the fact that most of the case studies suffers from a bias towards examples of successful upgrading (BERNHARDT; MILBERG, 2011; SALIDO; BELLHOUSE, 2016). Beyond those limitations, the analysis of upgrading focused on value added does not address the question of distribution of value added among profits, wages, and taxes, or even different types of labor (MILBERG; WINKLER, 2013). In addition to the problems related to which variable to choose, the authors highlighted the issue of magnitude. In this sense, to address how much change in a given variable is enough to constitute upgrading or downgrading, they used a cross-national evidence to measure "absolute" and "relative" upgrading[55] (MILBERG; WINKLER, 2011). According to them, this distribution is essential to the analysis of the relationship between economic and social upgrading. To sum up the measures of economic upgrading and complement Milberg and Winkler's (2011) analysis, Table 1 (annex 1.2) shows a list of measures of economic upgrading that have been discussed in this section at different levels of analysis (country, sector or GVC, and the firm level).

While missing how the gains from upgrading are distributed to workers and improved working conditions, the view of upgrading restricted on firm-level competitiveness was soon criticized for its narrow view of development (WERNER; BAIR; FERNÁNDEZ, 2014). Thus, GVC scholars started to distinguish between two different dimensions of upgrading: economic and social upgrading. According to the authors, the relationship between both dimensions of upgrading is the main study subject of the current research frontier of GVC studies, overcoming the first generation of studies focused on the relationship between governance and upgrading. The next section discusses the social dimension of upgrading.

[55] "We calculate an "upgrading ratio", z, as the ratio of the growth in value added per person engaged to the growth in exports and define three measures of upgrading, as follows: if $z > 1$, it indicates "strong absolute upgrading"; if $z > 1/3$, it indicates "weak absolute upgrading"; if $z > 1/\beta$ (where β is the slope coefficient in the regression), it indicates "relative upgrading"" (MILBERG; WINKLER, 2011, p. 350)

1.5.Social upgrading: definitions and measures

The effects of GVC participation on living standards and conditions of employment are commonly referred to as "social upgrading". By emphasizing the role of workers as social actors, several authors define social upgrading in terms of the quality of employment, and also in multiple aspects of economic and social life, such as working conditions, remuneration, gender quality, labor regulation, workforce development, the greening of value chains, social protection and entitlements (BARRIENTOS; GEREFFI; ROSSI, 2010; FERNANDEZ-STARK; BAMBER; GEREFFI, 2014; GEREFFI; LUO, 2015; MILBERG; WINKLER, 2011; ROSSI, 2013; SEN, 1999). In a general sense, social upgrading can be understood as the portion of gains from economic upgrading captured by workers, which may be translated in terms of wages or improved social wellbeing (SALIDO; BELLHOUSE, 2016). Put it simply, social upgrading is considered the social impact perceived by the workers involved in a GVC.

The concept of social upgrading can be analyzed in terms of the notion of "decent work" framed by the ILO over the past ten years, which is based on four pillars[56]: employment, standards and rights at works, social protection and social dialogue (BARRIENTOS; GEREFFI; ROSSI, 2010; MILBERG; WINKLER, 2011). Apart from the labor dimension of economic upgrading related to skills development and the productivity of workers, social upgrading does not consider labor simply as a productive factor complementary to capital. Social upgrading, as the quantitative and qualitative improvements within a specific enterprise, may help to reduce the risks for worker households and remove some of the volatility that they otherwise would have to confront (GEREFFI; LUO, 2015). Thereby, the main focus of social upgrading analysis is workers as social actors.

The impacts of GVC integration on employment are highly complex. Farole (2016) assesses the impact of GVC integration on jobs in developing countries in four dimensions: i) *the number of jobs*; ii) *the return to jobs* (job-specific wages and upgrading potential); iii) *the distributional impacts of jobs and wage effects*; and iv) *the working conditions present in GVC-linked jobs*. Hence, the GVC integration impacts on labor market go beyond jobs, including changes in relative payoffs to skills, levels of inclusion, and skill developing (upgrading) potential. Their main findings are complex and multi-faceted. In respect to jobs, in general terms, the scale and nature of job impacts depend on comparative advantages for hosting labor-intensive stages of production. Apparently, countries with large labor surpluses and low wages presented strong jobs growth. Moreover, those countries that successfully attract GVC

[56] See Ghai (2003) and ILO (2008) for an explanation of this four elements.

investment usually also experienced a significant increase in formal manufacturing jobs, which may not result in an increase in "labor intensity"[57] (i.e. a larger spending of labor relative to capital). When it comes to wages, large-scale job creation in GVCs usually requires sustained low wages (countries may be trapped in a "race to the bottom" on costs), and consequently, in terms of development requires, what matters are unit labor costs and not wages per se. But overall, wages rise and net employment falls, with more skilled workers gaining most. In terms of inclusion, as the demand is higher for lower-skilled labor-intensive activities, the GVC-investment contributes to more "inclusive" job creation, i.e. access to jobs for youth, women, and lower-skilled workers. Finally, as GVC participation imposes higher labor standards, the outcome appears to be a win-win situation, where workers benefit from better working conditions and firms benefit from productivity gains (FAROLE, 2016).

On the other hand, several studies by OECD find evidence that economic globalization has little, or none, impact on aggregate employment in OECD countries, showing that the shift from manufacturing has been compensated by considerable job growth in services and that there is no systematic association between cross-country differences in trade openness and unemployment rates (OECD, 2013). Furthermore, the composition of employment may have been affected in terms of activities and skill categories. The general idea is that those labor-intensive production stages are more likely to be offshored, and then their corresponding employment will decline, meanwhile, these job losses may be compensated by the upsurge of productivity and competitiveness of the remaining activities, which may lead to employment growth (OECD, 2013). De Backer (2011) describes the losses in labor market as visible and concentrated, while the gains appear to be more hidden and diffused. Moreover, despite the small impact on the aggregate level of employment, the effects on composition ("winners and losers") are wide larger. Low (2013) considers that the job consequences of moving into higher value-added activities on a GVC will depend on the structure of the entire economy. This means that while upgrading apparently can imply fewer employment opportunities on that GVC, other factors, such as skills levels and the functioning of the labor market, may have an important role in the employment consequences of upgrading.

The characteristics of the actors involved in the process of social upgrading may play an important role. Barrientos *et al* (2010) illustrate[58] three possible trajectories: i) *small-*

[57]In fact, GVC participation will usually result in fewer jobs relative to a given volume of output (in part, because firms are gaining productivity from scale economies).

[58] By using a diagram with the horizontal axis representing different types of work (from small scale household-based work; through low- and moderate-skilled labor-intensive work; to high skilled technology-intensive work and knowledge-intensive work) and the vertical axis indicating social upgrading (by measurable standards).

scale worker upgrading: workers keep within home based production (agriculture or manufacture), but are still able to enjoy improvements in their work conditions (e.g. more secure contracts, better wages and safety in the workplace); ii) *labor intensive upgrading*: workers more to better labor intensive types of work that provide better working conditions; and iii) *higher skill upgrading*: workers move towards better paid jobs combined with progressive social upgrading (e.g. workers from India that gain sufficient education and training and were able to more from lower-paid and low skilled work into the IT sector). The authors indicate that moving from lower to the higher skilled type of work may lead to social upgrading, but this is not an automatic or homogenous process[59].

Several authors analyze the impact of GVCs on jobs and inequality. If upgrading may lower total employment (by increasing demand for more skilled labor and reducing even more demand for low-skill labor), it may also act in the opposite way (by raising demand for high-skill labor and for home-based or informal workers even more) (MILBERG; WINKLER, 2013). Apparently, the emergence of GVCs increased aggregate employment through the reallocation of tasks across and within countries. Following Görg (2012)'s argument, GVCs impact on employment through a number of channels. The productivity of the offshoring firm becomes higher with trade in tasks, leading to an upsurge of sales that creates employment. Meanwhile, offshoring also results in firms offering intermediate and final goods at lower prices. This means that other businesses that now will obtain cheaper inputs will expand, resulting in growing employment. Employment may grow also through an increase in demand of final consumers, which are experiencing their real incomes surge (IMF, 2013). But GVCs have also contributed to a global reallocation of jobs, with developing countries, in particular East Asia, attracting labor-intensive manufacturing jobs given their lower labor costs, among others (WORLD BANK, 2013).

It is important to highlight that GVCs can be associated with short-term unemployment for specific types of workers. Low-skilled workers, workers specialized in less complex tasks and workers with industry or occupation specific skills are more likely to suffer the adjustment costs in the short-term, even if aggregate unemployment is not reduced (IMF, 2013). Hence, "results show that an increase in offshoring to low-income countries can increase short-term unemployment for certain occupations in advanced economies, but this effect (when positive) is economically very small" (2013, p.13). Nadvi (2004) analyzes the link between GVC participation and local employment and poverty impacts by focusing on the export-

[59] Evidences suggest that regular workers are the main beneficiaries from GVC participation in terms of measurable standards and enabling rights (BARRIENTOS; GEREFFI; ROSSI, 2010).

oriented horticulture, garments and textiles industries in four countries (Bangladesh, Vietnam, Kenya and South Africa). Their broad findings are consistent with significant employment and income gains to workers, especially women workers, depending on where workers are engaged in higher value-added GVCs that shows greater income gains and better working conditions. However, workers are increasingly vulnerable to changing employment contracts and increasing casualization of work.

The impact of GVCs on the recent raising inequality shows that "offshoring can affect inequality by increasing relative demand for high-skilled workers both in developed and in developing countries (HANSON; FEENSTRA, 1996, 1997, 1999), by reducing job opportunities for workers in advanced economies whose occupations are more easily offshored to low-wage countries (EBESTAIN et al, 2009), and by increasing wages of workers in firms that offshore relatively to workers in firms that source domestically (AMITI; DAVIS, 2012; HUMMELS et al, 2011)" (IMF, 2013, p.13). Gonzalez *et al* (2015) also find evidence of the relationship between GVC participation and wage inequality, showing that countries with a higher degree of backward participation in GVCs have lower levels of wage inequality. The authors also suggest that the type of offshoring matters. In the one hand, countries with a higher degree of low-skilled task offshoring are associated with lower wage inequality, as the result of a productivity boost of the remaining low-skilled workers (what would increase their wage and reduce the gap between high and low skilled wages). On the other hand, offshoring high-skilled tasks would also result in a productivity boost (and higher high-skilled wages, deepening the gap between high and low-skilled wages). Considering that low-skill offshoring is more expressive than high-skill offshoring, the result on aggregate is lower wage inequality (GONZALEZ; KOWALSKI; ACHARD, 2015).

Similar to the case of economic upgrading, the extent of social upgrading will be influenced by several factors, such as governance structure, labor regulations and labor unions, and opportunities for acquiring new skills relevant to employment (BERNHARDT; POLLAK, 2015). Gereffi and Fernandez-Stark (2011) provide a resume of the main commercial and social drivers of social upgrading: i) commercial drivers: cost (wages, transportation, inputs), time to market, volume and quality, end-market demand/preference, technology and skills, the nature and location of GVC lead firms, social (ethical) standards and certifications, and corporate social responsibility; and ii) social drivers: effectiveness of labor law, policies and regulations (education/skills, health/safety, gender, and environment), degree of activation of NGOs, existence and power of trade unions, and nature of industrial relations (e.g., tripartite cooperation). Shingal's (2015) review suggests that even though GVC integration has been

associated with greater employment opportunities, income gains for workers and better working conditions, the position of the firm in the GVC is a key determinant factor and may have also contributed to the skilled-unskilled labor division. Taglioni and Winkler (2016) consider that social upgrading can derive from labor regulation and monitoring (e.g. occupational safety, health, and environmental standards in GVCs), besides the role of well-functioning labor markets, given the reallocating resources within becoming integrated into GVCs. Although, the authors emphasize that for social upgrading being translated into social cohesion through better living standards, it is necessary to ensure "equal opportunities to strengthen social cohesion by: i) creating a sense of belonging and active participation, ii) promoting trust, iii) offering upward social mobility, and iv) fighting inequality and exclusion" (TAGLIONI, WINKLER, 2016, p. 30). The authors thus conclude: "equal access to jobs (including for women and minorities) is the most important opportunity in GVCs" (2016, p.30).

Gender equality is also an important dimension of the impacts of GVC participation. As GVCs are gendered structures, with men and women playing different roles in households, working in different sectors and stages of GVCs, with different occupations, and with different access to resources and basic services[60], GVC participation and upgrading strategies may affect men and women differently (STARITZ, 2013). Tejani and Milberg (2010) find that different paths of upgrading are closely related to different patterns of female labor force participation relative to male participation, as is the case of East Asian firms that were moving into higher-technology industries and showed decreases in the incidence of female employment. At the same time, gender inequality may also have implications for upgrading processes in GVCs and its outcomes. Women are usually exposed to occupational segregation, what tends to maintain women's wages artificially low and may act as a twisted source of export competitiveness, especially in labor-intensive exports sectors (BUSSE; SPIELMANN, 2006; STARITZ, 2013). On the other hand, gender inequality can affect negatively the gains from GVC participation, such as skill development and innovation, constraining the possibility of moving into higher and more complex value added stages within GVCs (FONTANA, 2009; HAGEN, 2014). Salido and Bellhouse (2016) find evidence that women experienced greater increases in wages and employment in the case of Mexico for all analyzed sectors, with the exception of agriculture. Undoubtedly, this is a fruitful field of research in GVC literature. Finally, it is possible to say that the concept of social upgrading is broader than the previously

[60] Usually the reasons for gender inequality are not related to their capacities and economic potential but to social norms (STARITZ, 2013).

discussed concept of economic upgrading, resulting in several local case studies and a great challenge to link the mixed findings.

1.5.1. Measuring social upgrading

The measurement of social upgrading varies according to how the concept is understood. In general lines, social upgrading encompasses both quantitative and qualitative variables, distinguished by their difficulty to measure and quantify. The first element is composed of measurable standards, which are easy to quantify through factory visits and to modify through policy interventions, such as total and type of employment (formal and informal), wage level, physical wellbeing (e.g. health and safety, working environment, and working hours), and employment security (e.g. social protection, type of contract). The second component, less easily quantifiable variables, is related to labor conditions and enabling rights, which would be the full expression of the rights and entitlements of workers as social actors, including freedom of association and collective bargaining, the right to freely chose employment, non-discrimination, voice and empowerment (BARRIENTOS; GEREFFI; ROSSI, 2010; BARRIENTOS; SMITH, 2007; MILBERG; WINKLER, 2011; SALIDO; BELLHOUSE, 2016). It is thus quite difficult to measure social upgrading by using one single indicator.

Social upgrading is usually measured by changes in employment and wages (MILBERG; WINKLER, 2011). Social upgrading occurs when both conditions are satisfied: i) *increased (or at least no decrease) in sectoral employment*, and ii) *increased in sectoral real wages*[61] (BERNHARDT, 2013; BERNHARDT; MILBERG, 2011; BERNHARDT; POLLAK, 2015). Their option for these indicators suggests a simple logic: by creating jobs, labor encompasses the chance of earning income, and then moving away from poverty and an overall increased social well-being. Whether formal jobs, it may provide social insurance and certain workers benefits (BERNHARDT; POLLAK, 2015). At the same time, real wages are a measure of how much workers benefit from the value created by production in their country. In other words, it would be an indicator of labor' bargaining power and of the distribution of value among production factors (labor and capital). Taglioni and Winkler (2016) consider wage growth as a reasonable representation of social upgrading. Wide apart from fully capturing the qualitative features of social upgrading, real wages are seen as a proxy for the quality of

[61] Bernhardt (2013) applied this metrics to analyze the developments of the apparel sector during the 2000s in 18 selected developing countries. Bernhardt and Milberg (2011) focused on four sectors (apparel, horticulture, mobile phones and tourism) of ten developing countries.

employment, however, it may not always be translated as better working conditions (BERNHARDT, 2013). Bernhardt and Pollak (2015) findings suggest that the patterns of social upgrading are quite varied across all four[62] GVCs analyzed, but the overall number of social downgraders countries is lower than the number of social upgraders in every GVCs. According to the authors, with the exception of the automotive GVC, job cuts and increases in real wages have been very common across GVCs and this combination has been even more common in developed countries, reflecting a structural transformation in these economies. Bernhardt and Milberg (2011) findings show a general pattern of employment growth and considerably less growth of real wages, but a considerable variation in outcomes across different GVCs.

According to Milberg and Winkler (2011), there are several qualitative aspects of social upgrading that may not be extracted from a value added analysis, e.g. the incidence of informality in labor markets, features of worker rights and labor standards. To overcome the problems of using qualitative aspects of social upgrading, the authors used the concept of social upgrading in accordance with the notion of "decent work" developed over the past ten years by the ILO (i.e. employment, social protection, workers' rights, and social dialogue) and each category can be measured by a set of variables.

Taglioni and Winkler (2016) analyze the impact on labor and wages by distinguishing two groups of measures: indirect and direct measures of social upgrading. The first group is composed mainly by descriptive statistics that can be used to assess which sectors are associated with better labor market outcomes, namely: the averages of the number of employees, wages and salaries, wage rate (wages and salaries divided by the number of employees), or labor share (wages and salaries as a percentage of value added). According to the authors, these labor market indicators may be regressed on indicators of GVC participation by running cross-country "controlled correlations" at the sector level. Furthermore, the authors provide a more direct way to measure the link between GVC participation and labor market outcomes, by constructing several indicators already developed in literature that are based on international input-output data.

The first indicator of the group of direct measures of social upgrading is *labor content of gross exports*. By computing a dataset based on matrix data available in the Global Trade Analysis Project for more than 100 countries, 24 or 57 sectors, and covering the period of 1995-2011, their findings shows that there are two cases of successful GVC insertion: the Chinese machinery and equipment, and the Indian private services. The second indicator

[62] Apparel, wood furniture, automotive, mobile phone manufacturing sectors.

pointed by Taglioni and Winkler (2016) is *labor component of domestic value added in exports*, which was developed by the UNCTAD and is a proxy for the employment-generating potential of exports. By using UNCTAD EORA GVC database it is possible to see the positive correlation between GVC participation and labor component of domestic value added in exports, and even more, those countries with faster growth in GVC participation have also faster growth in the labor component of domestic value added in exports, even if the country depend on higher foreign value added share.

The third indicator is *jobs sustained by foreign final demand* and was developed by the OECD-WTO as part of the TiVA database. This indicator goes one step further by considering the domestic value added in foreign final demand and not the domestic value added in total exports, which could be used as intermediates in third countries and be exported as final goods. In other words, it calculates how the domestic employment is affected by changes in the final demand in foreign markets ("upstream impact"). Their analysis considering the period of 1995-2008 shows a general higher share of jobs sustained by foreign final demand, even though it appears to vary in accordance with countries' size and specialization. The fourth indicator is the number of *jobs generated (domestically and abroad) by a country's involvement in GVCs* (TAGLIONI; WINKLER, 2016). Jiang and Milberg (2013) decomposed the employment effects of a country's trade in five detailed components: i) labor content in exports; ii) labor content in imports; iii) labor content in the import content of exports; iv) labor content in the export content of imports; and v) labor content in intermediates contained in imports. The last three components reflect trade in intermediates, and the general idea is to assess the different channels through country's trade, especially in GVCs, can result in creating jobs. Hence, a country's exports create jobs and incomes in foreign countries because of the import content of exports, meanwhile, a country's imports may contain its own exports in the form of intermediate inputs that were exported to foreign countries. In other words, a country's imports generate jobs domestically because of the export content of imports (TAGLIONI; WINKLER, 2016).

The fifth, and last, the indicator is *jobs in GVC manufacturing*, which was applied for selected countries between 1995 and 2008, using WIOD. It shows a broader picture of the employment structure in GVCs within a country by measuring (directly and indirectly) the number of GVC jobs involved in the production of final manufacturing goods (TAGLIONI; WINKLER, 2016). Their findings shows: i) with the exception of China and Turkey, the share of manufacturing GVC jobs in overall employment has declined; ii) only about one-half of the workers in manufacturing GVCs are employed in manufacturing (the other half is employed in

non-manufacturing industries that deliver intermediates); iii) employment in manufacturing GVCs increased in the services sector (for Germany, Italy, and Spain, the job creation in services were higher than the losses in manufacturing and agriculture). To sum up the measures of social upgrading and complement Milberg and Winkler's (2011) analysis, Table 1 (annex 1.2) shows a list of measures of social upgrading that have been discussed in this section at different levels of analysis (country, sector or GVC, and firm-level). The next section outlines the relationship between economic and social upgrading.

1.6. The relationship between economic and social upgrading

Several studies have analyzed the relationship between economic and social upgrading, investigating whether social upgrading is endogenous to economic upgrading or not. While the traditional presumption in the literature is that economic upgrading brings social upgrading, there has been an increasing concern that this may not be an automatic process. Beyond different findings, there are distinguished theoretical explanations for the connection between economic upgrading and the social impacts of GVC participation, as it is revealed by the debate between neoclassical and institutionalist theories.

The neoclassical theory, mainly based on the tradition of marginalist analysis, understands that wage growth is closely attached to productivity growth. This traditional microeconomic view understands that the marginal product of labor determines wages, with firms continuing to employ until market wage equals labor's value of marginal product (VMP_L) and marginal revenue product (MRP_L)[63]. This relation implies a series of assumptions, such as economic agents (workers and firms) are "wage-takers", given the prevalence of perfect competition in labor market; firms are profit-maximizing; labor is mobile and substitutable to other production factors (e.g. capital), among others. This said, the wage rate will be determined by the interaction of demand and supply curves of a competitive labor market, with higher productivity leading to higher remuneration (given constant prices of the good produced). For our purpose, this economic theory (*marginal productivity theory of wages*) gives a potential explanation for the relationship between economic and social upgrading, whether the first is measured by productivity growth and the second is measured by wage growth, respectively. Put it simply, in accordance with the marginal productivity theory of wages, social upgrading would be the automatic outcome of economic upgrading (BERNHARDT, 2013; MILBERG; WINKLER, 2011).

[63] This relation can be seen in most of the microeconomic textbooks, such as Mankiw (2006).

Alternatively, the institutionalist view considers the influence on wages of other factors that are time and local-specific. In this sense, wages are the result of a bargaining power, in which social norms, and the strength and credibility of social institutions play an important role (MILBERG; WINKLER, 2011; SALIDO; BELLHOUSE, 2016). Thereby, differently from the neoclassical perspective where labor market regulation would cause a distortion in ideal competitive markets, the institutionalist view highlights the existence of labor market imperfections and the role of labor regulatory interventions to improve the outcomes[64]. According to Milberg and Winkler (2011, p.358), "union density, bargaining rights, minimum wages and active labor market policies have been found to be significant determinants of labor market outcomes in developed and developing economies". Thereby, Gereffi and Luo (2015) understand that economic upgrading is related to, but it may not determine, the extent and type of social upgrading, since other institutional factors and actors also influence this possibility, such as the extent and nature of worker organization, civil society actions, and government legislation and its enforcement.

Several case studies have shed light on the relationship between economic and social upgrading, supporting that the link between both is not automatic. In order to do so, some studies created a single (composite) index of economic upgrading and a single (composite) index of social upgrading, and thus plot them together (BERNHARDT, 2013; BERNHARDT; MILBERG, 2011; BERNHARDT; POLLAK, 2015). A 2x2 matrix of possible combinations of economic and social up/downgrading is used to analyze the four different scenarios: overall upgrading (i.e. economic and social upgrading) *versus* overall downgrading (i.e. economic and social downgrading), and a mixed combination of both (economic upgrading and social downgrading, and economic downgrading and social upgrading). Following it, it is necessary to reduce these four outcomes to just two dimensions. Beyond several possibilities to create these indexes, the authors' first option is a simple method of giving equal weight to each component of both indicators (Method 1), composing a symmetrical composite index[65]. But what if a country has experienced an increase in export market shares and a decrease in export unit values, or when employment grows but real wages are falling?

[64] For this conflicting views, Quibria (2002) argues that excessive regulations have worked against workers interest by creating an inflexible market, reducing the profitability of investments (as a reflection of the redistribution of economic rent from capital to labor), and creating economic rigidities. In other words, excessive labor regulations may hurt wage and employment growth. For a recent analysis of the influence of globalization on labor market institutions, see Potrafke (2013).

[65] Economic upgrading (or downgrading) = 0,5*(%-change in market share) + 0,5* (%-change in export unit value); and social upgrading (or downgrading)= 0,5*(%-change in employment) + 0,5*(%-change in real wages).

Undoubtedly, there are several ways to create these composite indexes. In the face of a certain pro-upgrading bias of the first method, the authors follow checking for robustness[66]. In this sense, to address the problem of the existence of a lower bound in the absence of an upper bound, they introduce Method 2[67]. This method is considered stricter than Method 1 because when one of the two indicators has declined, a country would have to show a bigger increase in the second indicator to still record an economic or social upgrading in the composite index. But following Kaplinsky and Readman (2005), an even stricter method is suggested: Method 3 considers that "a country can be said to have experienced economic or social upgrading if and only if both underlying indicators have positive signs" (BERNHARDT, 2013, p. 25).

Bernhardt and Milberg (2011) find evidence that social upgrading occurs generally in the presence of economic upgrading[68], but economic upgrading does not guarantee social upgrading. Besides a considerable variation across sectors[69], social downgrading appears to be more common than economic downgrading. Bernhardt (2013) investigates whether an overall upgrading has occurred among the apparel-exporting of developing countries. Bernhardt's (2013) findings are consistent with a positive correlation between economic and social upgrading in the apparel sector, although no clear pattern has emerged. It is important to highlight that they found no single case in their sample of social upgrading occurring without economic upgrading[70], even though not every country that experienced economic upgrading also experienced social upgrading. These findings lead them to conclude that whether economic upgrading does not automatically translate into social upgrading, it is at least a conducive condition. Bernhardt and Pollak (2015) applied the same indicators of social and economic upgrading of Bernhardt (2013) in four selected GVCs - apparel, wood furniture, automotive, and mobile phones manufacturing – and found a considerable variation across the four GVCs. In general lines, there are more cases of overall upgrading than overall downgrading or

[66] "A drawback of this first method (…) is that the underlying indicators have a lower bound of -100 percent but an upper bound of infinity. To be sure, none of the indicators can fall below zero – which would correspond to a decrease of -100% from any initial level. On the other hand, countries can in principle register increases on any of the indicators that go (far) beyond +100 percent" (BERNHARDT, 2013, p. 24).

[67] Economic upgrading (or downgrading)= [(1+Δmarket share) *(1+ Δ unit value)]-1; and social upgrading (or downgrading) = [(1+Δemployment) *(1+ Δ real wage)]-1.

[68] To recall, social and economic upgrading are proxied by increasing employment and real wages, and rising export market shares and unit export prices, respectively.

[69] Their analysis is applied for four sectors (apparel, horticulture, mobile phones and tourism). In apparel and horticulture there is a positive correlation between economic and social upgrading, however, in mobile phones there is considerable economic upgrading without social upgrading, and finally the opposite is seen in the tourism value chain, i.e. social upgrading without signs of economic upgrading (BERNHARDT; MILBERG, 2011).

[70] With the exception of Jordan (by using Method 1 and 2) and Nicaragua (Method 3).

intermediate cases[71]. Expanding the 2x2 matrix into 3x3 in order to include intermediate cases, the situations where economic upgrading is associated with social upgrading correspond to the cells in the diagonal from the bottom-left to the top-right. Among their sample of countries, Bernhardt and Pollak (2015) found that the direction of economic and social upgrading run at the same time in more than half of the countries, and more specifically, the automotive GVC presents the strongest relationship while the wood furniture shows the weakest. There are only a few cases of economic upgrading without social upgrading and of countries that have achieved social upgrading without economic upgrading (with the wood furniture sector as an exception).

Rossi (2013) analyzes under which conditions economic upgrading is translated as social upgrading by using the Moroccan garment sector as an empirical case study. The evidence shows that different paths of upgrading result in mixed outcomes for workers, with process upgrading leading to reductions in excessive overtime worked, improved the working environment, and regulated contracts; and product upgrading related to skill upgrading for regular workers, if the product involves a more sophisticated production. When it is about functional upgrading, becomes clear that different types of workers may have different experiences: for regular workers, moving into new activities can imply training, skill upgrading, better measurable standards and enabling rights, but functional upgrading may pressure for reducing costs with more flexibility and speed of delivery, resulting in social downgrading for less skilled irregular workers (employed in packaging, storage, and loading, for example), both in terms of measurable standards (irregular contracts, poor wages, and long working hours) and of enabling rights (discrimination at the workplace) (ROSSI, 2013).

Barrientos *et al.* (2010) suggest that economic and social upgrading are often interweaved, but one does not necessarily lead to the other. The authors suggest that economic upgrading can lead to social upgrading or downgrading, depending on how local-suppliers manage lead-firms' pressure for higher quality with lower costs' pressure to remain competitive. These suppliers may take a "low road" involving economic and social downgrading or a "high road" involving economic and social upgrading, or even, as most of them, a mixed approach, reflected in the use of regular and irregular workers together. While producers undertaking a low road strategy based on worsening labor conditions are risking losing out on quality, those on the high road are risking losing out on price competitiveness for improving wages and labor conditions (BARRIENTOS; GEREFFI; ROSSI, 2010). But may

[71] In other words, "social upgrading without economic upgrading" or "economic upgrading without social upgrading".

not be possible to ensure that the high road will be followed by wage growth, meanwhile, it is possible to say that the low road strategy of lowering wages has limits, which are posed by human subsistence and political stability (MILBERG; WINKLER, 2011; TAGLIONI; WINKLER, 2016). Salido and Bellhouse (2016) argument that a view based strictly on the performance of external sectors would give the wrong impression. In the specific study case of Mexico, following Bernhardt and Milberg's (2012) approach, the authors find social upgrading being achieved in a context of economic downgrading. However, the authors provide more specific information about the Mexican case by adding measures of national productivity, besides wage and employment, and thus finding different outcomes: an overall upgrading.

The relationship between social and economic upgrading is not clearly and unambiguously identified yet, varying in accordance with the context. The research available confirms that economic upgrading can result in social upgrading, but this may not always be the case. The connection between improvements in firm efficiency, productive capacity and functional capabilities is not inherent to poverty reduction and better living standards (WERNER; BAIR; FERNÁNDEZ, 2014). Whilst it is important to highlight that the impacts of economic and social upgrading are not homogeneous, affecting firms and producers according to several features, such as their size, position in the GVC, formality, skills, income, or gender (GEREFFI; FERNANDEZ-STARK, 2011). After all, developing strategies that combine social and economic upgrading requires further analysis of the new features of the global economy, so policymakers can improve their ability to define goals and capture greater benefits from GVC participation.

1.7.Partial concluding remarks: some policy implications

This chapter has critically documented a vast literature addressing the multi-layered outcomes associated with participating in GVCs, contributing to the organization of a formal theoretical apparatus within the GVC literature. From the firm to the macro-level, for instance, some of the outcomes considered within the GVC literature are: increased productivity, greater access to new markets and technologies, diffusion of technology and knowledge, higher skilled and better paid jobs (direct and indirect) creation, enhanced economic growth and higher per capita income, political and economic stability, better living standards and working conditions, and better and more sustainable use of resources (CATTANEO *et al.*, 2013; TAGLIONI; WINKLER, 2016; UNESCAP, 2015). While participating in GVCs can accelerate the catch-up of developing countries' economic growth rates and income levels at the global level, leading

to a greater convergence between economies, the effects of GVC participation may be much more heterogeneous at the level of individual developing economies (UNCTAD, 2013b). In fact, this different potential impact of GVC participation becomes clear when we consider the distinguished activities that lead firms and other firms are engaged, with the former controlling higher value added activities (e.g. innovation activities, branding and new product development) and the later engaged in assembly activities that earn less, have fewer opportunities to growth and are more vulnerable to business cycles shocks (UNCTAD, 2013b).

GVC participation is not all about benefits. It is the possibility of downgrading what makes some authors wonder that rather than questioning if producers – firms, regions or countries – should participate in GVCs, the key issue in GVC literature is *how* they should do so (KAPLINSKY; MORRIS, 2003; KAPLINSKY; READMAN, 2001). While the literature has recognized its mixed impacts, GVC participation alone may not ensure development benefits and, as a matter of fact, it may entail a number of potential downsides. Beyond the several obstacles to access GVCs, producers are exposed to several risks once they are actively participating in GVCs. From greater interdependencies across economies that reveal greater exposure to external shocks and supply disruptions, through exacerbated inequalities and environmental degradation, to labor markets deterioration and narrow learning capacities, GVC participation can lead to multiple negative impacts (STURGEON; MEMEDOVIC, 2011; UNESCAP, 2015; WTO, 2014b). More importantly, governments are unable to control these risks directly, because GVC participation is the outcome of firm's choices. However, this does not imply that policymakers cannot influence firm's judgment and strategies. Thereby, these risks need to be appropriately taken into account.

Firms, and not countries, are the main actors in GVCs, and when it comes to GVCs participation, one may say that firms have three general objectives regarding GVCs: i) entry to GVCs, ii) expand their presence and deepen it, and iii) upgrade to higher value-added positions within the GVC (ILIUTEANU, 2016). As is discussed by Kowalski *et al.* (2015), firms' engagement is associated with the possibility of making profit, and there are at least two considerable differences in terms of a country or policymaker's perspective on GVC participation and the firm perspective. First, a country perspective on GVCs participation considers gains not only to capital but also to labor or, in general terms, other social outcomes. Second, it considers that the policy environment can influence firm's choices and then the several dimensions of the outcomes of GVC participation at the country level. While the rationale of firms' decisions to participate in GVCs is related to economic efficiency and competitive advantage, policymakers are expected to analyze GVCs from a different

perspective that considers economic, political and strategic factors (BHATIA, 2013). As is added by the author, policymakers also have a different perspective from that of firms on the issue of upgrading, which usually involves higher technology that is labor saving. It is seen from an economic logic by the firms, and a part of having positive implications, yet there can be some situations where firms may use economic downgrading as a business strategy. Meanwhile, the viewpoint of policymakers is broader and involves generating the most jobs and capturing the maximum value within the country.

Finally, there are some strategic questions that policymakers should formulate when it comes to upgrading. By facing the challenge of maximizing the benefits from GVCs participation and choosing which type of economic upgrading they want to pursue, policymakers should focus on strengthening existing GVC-domestic economy links, which usually are associated with greater diffusion of knowledge, technology, and know-how from foreign investors or trade partners abroad, along with strengthening domestic firms' absorptive capacity (TAGLIONI; WINKLER, 2016). In that sense, both economic upgrading and GVC densification are key-factors to transform GVC participation into sustainable development. This means that the effort is not only about becoming more competitive in higher value-added activities, but also about engaging more local actors, both firms and workers, in the GVCs. Thereby, this may suggest that moving into higher value-added activities may not always result in large value addition for a country, and more importantly, in some cases this may come from performing in lower value-added activities on a large scale.

This chapter has discussed several studies on economic upgrading have recently emphasized its connection to social upgrading. Understanding how economic and social upgrading are related is a necessary step forward in the direction of more suitable industrial and commercial policies in agreement with the sustainable development goals (SALIDO; BELLHOUSE, 2016). To economic upgrading translates as sustainable development, policymakers should be concerned with the distribution of the opportunities and outcomes for GVC participation among all segments of society, and this means formulating social policies to create a balanced distribution of the gains that leads to social cohesion (TAGLIONI; WINKLER, 2016). For that reason, considering the absence of a single measure, this chapter has systematically analyzed the different measures applied to several case studies concerning both economic and social upgrading. Thus, the existence of several measures at different levels reflects, to a certain extent, the absence of a formal theoretical apparatus in the GVC literature. Considering that economic upgrading may drive to social upgrading, but not automatically, the

role of policymakers in promoting social upgrading is an important topic in the GVC research agenda.

Annex 1.1

Box 1.1 - Distinguishing related concepts

The use of multiple terms may require a more precise analysis of its meanings, especially if we are looking for evidences of a new paradigm of globalization. A first step is to distinguish between final and intermediate products. Final products are goods and services consumed (including private and public consumption) or invested as capital goods, in contrast to intermediate products that continue on in the production process of downstream products (HOROWITZ; RIKER, 2014; TIMMER *et al.*, 2014). Capital goods are *used* but not *used up* in the production process, in other words, this means that capital goods enter as a fixed asset in the production process, while intermediate goods are used and incorporated in the final output (MIROUDOT; LANZ; RAGOUSSIS, 2009). This distinction is especially important for explaining and assessing trade on its contemporary dimension, considering the increased trade in parts and components as a share of total trade in recent years.

Fragmentation, whether domestic or international, is a term originally proposed by Jones and Kierzkowski (1990) to describe the organization of production processes. On their research, the authors define fragmentation as the decomposition of production into separable component blocks connected by service links. Needless to say, not all production processes have various phases that are physically separable, and in this sense, *intra-product specialization* can only take place where the manufacture of a product is amenable to fragmentation (ARNDT; KIERZKOWSKI, 2001). The fragmentation of a production process can take the form of sequential chains (or "snakes", where intermediate goods are sent and incorporate sequentially from one country to another, until delivery the final stage of production) or complex networks (or "spiders", where the intermediate parts come from a multiple number of destinations to a single location in no particular order) (BALDWIN; VENABLES, 2013; UNCTAD, 2013a). Despite these extreme cases, production processes normally are a complex combination of both forms (TIMMER *et al.*, 2014).

Fragmentation and *offshoring*, which involves only a change in the *geographic location* but not in the firm's ownership (MIROUDOT; LANZ; RAGOUSSIS, 2009), may occur within a given firm, *insourcing* (vertical integration), or in separated ownership, *outsourcing*, i.e. "buying inputs from outside sources rather than producing them internally" (INTERNATIONAL MONETARY FUND, 2013). This means that production stages may be spatially apart, but close or apart in ownership, or spatially close but organizationally separated or integrated by ownership (ARNDT; KIERZKOWSKI, 2001; CATTANEO *et al.*, 2013; MIROUDOT; LANZ; RAGOUSSIS, 2009)[72].

Several studies have argued that international fragmentation of production creates a strong trade-investment nexus (IMF, 2013; UNCTAD, 2013a). It is also possible to say that this nexus has another important determinant, *ownership*. According to Arndt and Kierzkowski (2001), in cross-border production structures where separate ownership is not feasible, multinational corporations and foreign direct investment (FDI) are more likely to play a dominant role, meanwhile where is feasible, arm's-length relationships are possible and FDI is less relevant.

There is another conceptual difference between terms commonly taken as synonymous: *global sourcing* and *international outsourcing*. What distinct both terms is the initial organization structure of the enterprise. In the first case, the product or service is supplied by an external supplier in the domestic market, while, in the second case, was the firm within its own boundaries that was producing in the domestic market; and both moved from domestic supplier to abroad (MIROUDOT; LANZ; RAGOUSSIS, 2009). Meanwhile, offshore sourcing and production, i.e. foreign outsourcing and FDI, has become a common practice for several industries, including automotive and electronics, where final products can be broken down into discrete components separately produced, easily transported and assembled in low-cost locations (UNCTAD, 2013a). As a result, when production processes are split into subsequent phases and spatially separated, they may now be undertaken where are the lowest trade costs of each component.

Source: Own elaboration.

[72] For a general framework about firms new sourcing strategies according to geographical and organization parameters see Antràs and Helpman (2004) and Miroudot, Lanz and Ragoussis (2009).

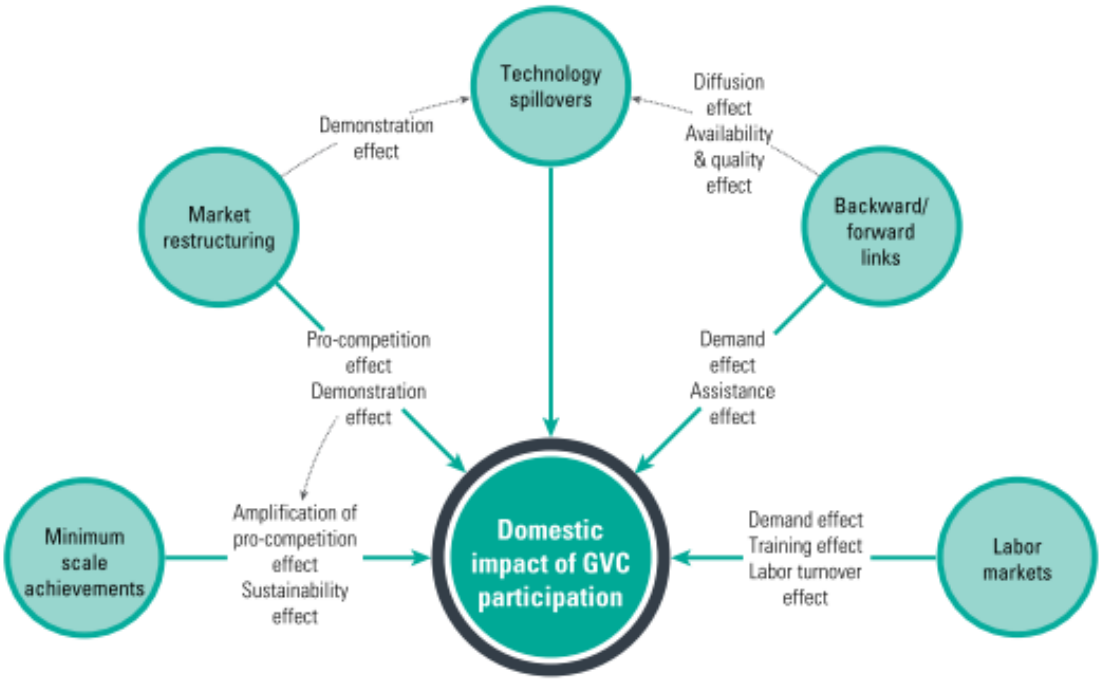
Annex 1.2

Table 1.1 - Synthesis of the measures of economic and social upgrading

Measures of economic upgrading	Measures of social upgrading
Country-level	
Productivity growth (labor or total factor)	Wage growth
Value added growth	Employment/popultion growth
Profits growth	Formal employment
Increasead capital intensity	Decline in youth unemployment
Export growth	Gender equality in employment and wages
Growth in export market share	Poverty reduction
Unit value growth of output	Share of wage employment in non-agricultural employment
Unit value growth of exports	Improved labor standards (including the right to freely choose employment, freedom of association, and collective bargaining, job safety, child labor, forced labor, employment discrimination, voice and empowerement)
Unit cost growth of labour	Regulation of monitoring
Per capita domestic value added embodied in a country's exports	Improved political rights (freedom house index)
Sophistication of export bundles	Human Development Index (HDI)
Diversification of exported products	Employment security (e.g. social protection, type of contract)
	Labor share (wages and salaries as a percentage of value added)
	Labor content of gross exports
	Labor component of domestic value added in exports
	Jobs sustained by foreign final demand
	Jobs generated domestically and abroad by a country's involvement in GVCs
	Jobs in GVC manufacturing
Sector or GVC-level	
Productivity growth (labor or total factor)	Wage growth
Value added growth	Employment growth
Profits growth	Labor share (wages and salaries as a percentage of value added)
Export growth	Jobs sustained by foreign final demand
Growth in export market share	Jobs generated domestically and abroad by a country's involvement in GVCs
Growth of domestic value added embodied in gross exports	Jobs in GVC manufacturing
Unit value growth of output	Improved labor standards (including the right to freely choose employment, freedom of association, and collective bargaining, job safety, child labor, forced labor, employment discrimination, voice and empowerement)
Unit value growth of exports	
Increasead capital intensity	
Increased skill intensity of functions (assembly/OEM/ODM/OBM/full package)	
Increasead skill intensity of employment	
Increasead skill intensity of exports	
Level of domestic value added	
Firm-level	
Increased skill intensity of functions (assembly/OEM/ODM/OBM/full package)	Number of workers per job
Developing skills to manage the supply chain	Type of contract
Composition of jobs	Improved standards in plant monitoring (e.g. management and working conditions audit (M-audit) criteria)
Increasead capital intensity/mechanization	
Product, process, functional, chain upgrading	
Level of domestic value added	
Productivity growth (labor or total factor)	

Source: Author's elaboration based on Milberg and Winkler (2011).

Figure 1.2 - The main transmission channels for economic and social upgrading



Source: Taglioni and Winkler (2016).

SECTION II. METRICS

Chapter 2. Mapping Global Value Chains: patterns of value added trade in the global economy

2.1 Introduction

The labels of "Made in" have become obsolete symbols of a different era of international trade flows. Over the last decades, countries have specialized in specific stages of production networks rather than in final products. As a result, final products are now considered "packages" of several nations' productive factors (BALDWIN, 2011b), turning the fact of a product being "completed" in a particular country into a narrow story about its specialization patterns. World production is now vertically fragmented across different countries, with intermediate products and services crossing borders multiple times and exports being produced using foreign inputs from several countries. This new scenario has posed significant challenges to the use of traditional measures based on gross trade and has called for new metrics. Thus, several measures derived from the input-output approach have been developed to investigate to what extent a country is involved in vertically integrated production connected by international trade.

The interdependencies between industries in fragmented and internationally dispersed production networks have become a crucial aspect of nowadays trade analysis. Before the emergence of GVCs, it was possible to compare gross-trade data to data on value-added without overstating the amount of domestic value-added in exports. However, the use of traditional global trade statistics may lead to a significant amount of "double counting" in gross exports, since exports increasingly rely on (direct and indirect) intermediate imports. When based on gross concepts, the analyses may present a misleading portrait of which country ultimately benefits from bilateral trade flows by exaggerating the importance of producing countries at the end of value chains, and even more importantly, it may lead to misunderstanding in regard to the relationship between trade and macroeconomic variables. In this sense, most recent analyses are based on "factor content" or "value-added" trade that rely on international (or inter-country) input-output (IIO) data (HUMMELS; ISHII; YI, 2001a; JOHNSON, 2014b; LOS; TIMMER; DE VRIES, 2015a;

TIMMER *et al.*, 2014).

Differently from other approaches, such as firm-level analysis that use individual firms' micro-level data and are limited to the structure of a particular product network, input-output analysis covers all set of industries that compose an economy system. IIO tables turned possible to identify the vertical structure of international production sharing (BULLÓN *et al.*, 2014). How each country specializes in specific stages of a production sequence is a particular dimension of inter-country production linkages, which is commonly presented as vertical specialization in trade. This notion emphasizes the sequential, multiple-border crossing and the back-and-forth aspects of production processes that are increasingly fragmented geographically. But how vertical specialization can be measured? If the production process is split into phases that can occur globally, regionally or be restricted to only two countries, then how to assess "*who produces for whom"*? What are the new metrics for measuring how globally or regionally integrated is a country or economic bloc? Some of those questions have been the object of several recent studies and the recent availability of international input-output tables has turned possible to expand the concept of vertical specialization and capture different characteristics of value added embedded in trade (AMADOR; MAURO, 2015; DAUDIN; RIFFLART; SCHWEISGUTH, 2011; DI GIOVANNI; LEVCHENKO, 2010; HUMMELS; ISHII; YI, 2001b; JOHNSON; NOGUERA, 2012; LOS; TIMMER; DE VRIES, 2015b; STEHRER, 2013).

There are many different ways to capture the degree and nature of trade interactions along GVCs. For instance, the import content of exports (HUMMELS; ISHII; YI, 2001), the method of disaggregation of gross exports (KOOPMAN; WANG, 2012; KOOPMAN; WANG; WEI, 2014), the value added exports (JOHNSON; NOGUERA, 2012), the "import to export" (I2E) and "import to produce" (I2P) (BALDWIN; LOPEZ-GONZALEZ, 2013), and the vertical specialization of (value-added) trade (DAUDIN; RIFFLART; SCHWEISGUTH, 2011). The recursive concepts used in this chapter are strongly based on the macro level of this literature, which is set apart from case studies for single products or specific firms, and is concerned with a broad view of countries engagement in GVCs.

The main objective of this chapter is to provide for more and better evidence regarding the degree and nature of countries' interaction within GVCs. For that purpose, it integrates the most widely accepted metrics based on the concept of trade in value added that give a more precise picture of the changing nature of international trade. Firstly, the chapter provides a more detailed vision of a set of indicators based on value-added terms, presenting

its techniques and how they relate to each other. Further on, it describes the specificities of the most used international input-output tables. The empirical exercise that follows is based on two of the main IIO databases, OECD-WTO Trade in Value-Added (TiVA) and World Input-Output Database (WIOD). TiVA database provide a set of ready-to-use GVC indicators and trade in value added decompositions, which are calculated by their own methodology based on OECD's Inter-Country Input-Output (ICIO) system. This means that the indicators present differences in terms of decomposition level and nomenclature. For our purpose, whenever it is possible, we will indicate the compatibility of the indicators provided by the TiVA database with the measures based on WIOD data, which are calculated using the method of decomposition of gross exports by Koopman *et al.* (2010, 2014).

Even though the value-added measures are less up-to-date and require simplifying assumptions in their construction if compared to gross trade, value-added analysis provide a more revealing perspective on how countries are integrated into GVCs and how they are interacting with its trade partners. Understanding these metrics is crucial for building development strategies consistent with the current global trade dynamics, allowing the identification of sources of competitiveness and the challenges regarding developing new competitive areas. Besides that, it also adds new perspectives on complex issues with political consequences, such as the discussions about environmental protection and "job content" of trade. Thus, it is not possible to assume which are the potential trajectories to follow without having a reliable map in hands, which clearly could not be build based on traditional gross trade in the current phase of globalization.

This chapter is organized as follows. Section 1 discusses the main indicators based on trade in value-added, emphasizing the most recent contributions to measure value-added trade. Section 2 describes the main international input-output databases. Section 3 documents a series of stylized facts based on TiVA and WIOD databases applied to selected countries and industries. Section 4 offers concluding remarks.

2.2 Measuring GVCs: main indicators based on trade in value-added

This section introduces the main indicators used to provide some evidence on the importance, intensity and length of GVCs, as well as the position of countries in specific production lines.

There are two main strands of literature to analyzing global value chains. Several studies measure the foreign content of domestic production by considering only the share of

directly imported inputs in production. Feenstra and Hanson (1996) were the first to formulate and calculate this measure, which since then has been built in different forms. This first strand, named *"global value chain" approach*, describes a more general picture of how the value added is distributed across all countries, regardless if the final product is sold domestically or exported. The second strand is the *vertical specialization (VS)* rooted in the seminal work by Hummels *et al.* (2001), which emphasizes both the *direct and indirect* import content of exports. In this second approach, the major concern is to estimate the domestic and foreign value-added in a country's exports. At the same time the VS approach is narrower, because it considers only the resulting output that was exported, it is considered more complete since it also includes the imported inputs that have been used indirectly in the production of exports, which is crucial when goods and services are crossing borders multiple times[73].

Feenstra and Hanson (1996)'s indicator for outsourcing is presented as the share of imported intermediate inputs in the total purchase of non-energy materials of individual industries. Much of its relevance in the literature is explained by its simplicity in reflecting the international production fragmentation at the industry level. A few years later, the same concept was used with a general proposal to develop a new methodology to estimate the impact of trade and technology on wages, specifically for the United States (FEENSTRA, R.C.; HANSON, 1999). The extent of international outsourcing of intermediate input production is portrayed as "structural changes", which was measured as "the share of imported intermediate inputs in total costs and the share of high-technology capital in the total capital stock" (FEENSTRA, R.C.; HANSON, 1999, p. 924). Their measure of international outsourcing combined data on U.S. imports and exports of final goods by four-digit SIC manufacturing industry with data on total input purchases from the *Census of Manufactures*[74].

Feenstra and Hanson (1999) then proposed two indicators: a *broad* and a *narrow* measure of international outsourcing. The *broad* measure is presented by the imported intermediate inputs relative to total expenditure on intermediate inputs in a specific industry. The *narrow* measure is obtained by restricting to the import share of intermediate inputs from the same *two-digit SIC* industry and, as they argued it, it would best capture the idea of outsourcing. Put it simply, the difference between both perspectives is represented by the intermediate inputs from outside the two-digit purchasing industry that are sourced from

[73] Further explanations about the differences between both approaches are illustrated in Los and Timmer (2015) and discussed by Amador and Mauro (2015).
[74] Used as raw data to construct input-output tables, the *Census* data present the value of intermediate inputs of each four-digit manufacturing industry purchased from other manufacturing industries.

abroad. This means that imports of steel by German car manufacturers would be considered a form of international outsourcing in a broad measure, but it would not be seen as such rather a narrow measure is considered (LOS; TIMMER; VRIES, 2013).

However, one would say that Feenstra and Hanson (1996, 1999)'s indicators are actually proxies of *offshoring* (DE BACKER; YAMANO, 2007), which generally involves firms' purchases of intermediate goods and services from foreign firms at arm's length or to foreign affiliates (i.e. changes in the *geographic location*). Another critical aspect is that, even though being simple to calculate, Feenstra and Hanson (1996, 1999)'s measures are considered too wide[75]. Hence, other narrower measures have been proposed, for instance, restricting outsourcing to outward processing (EGGER; EGGER, 2001) and computing the level of offshoring as the share of non-energy imported intermediate inputs in total non-energy intermediate inputs (BACKER; YAMANO, 2007).

The second strand of measures of value-added trade is based on the concept of *vertical specialization*. Vertical specialization occurs when the production of goods is fragmented in multiple stages and takes place across countries, with each country specializing in certain stages of the sequence of production (DIETZENBACHER, 2010). The primary measure of vertical specialization was developed by Hummels *et al.* (2001), and it is essentially the (*direct and indirect*) import content of a country's exports, i.e. the domestic and foreign value added embodied in exports. Put it simply, it would be measured by "the export weighted average direct import coefficient or by the export weighted average import multiplier (including also the indirect import requirements)" (DIETZENBACHER, 2010, p. 2).

The empirical results of implementing the VS measure rely primarily on IIO tables, which turned possible to calculate the value of imported inputs used indirectly in the production of an exported good. In general terms, a country may participate in GVCs in two distinct ways: i) using imported intermediate inputs to produce exports; and ii) exporting intermediate goods that are used as inputs by another country to produce goods for exports. In this sense, there are two broad measures of GVC participation: i) ***VS***:

[75] Others would say that they still suffer from a series of shortcomings. Los, Timmer and Vries (2013) indicate that some of the main faults are: *a country-size bias*, once larger countries would have lower import shares reflecting a wider variety of domestic input producers; and *double-counting of imports*, disregarding the back and forth trade across borders and the country of origin, since it only considers the total value of imports. Those faults are exactly what Los, Timmer and Vries (2013) tried to overcome years later.

measures the value of imported contents embodied in a country's exports, and ii) ***VS1*****:** measures the value of intermediate exports sent indirectly through other countries to final destinations, i.e. the percentage of exported intermediate goods and services that are used as inputs to produce other countries' exports (HUMMELS; ISHII; YI, 2001). On the one hand, the VS share estimate the importance of *upstream links*, providing a metric of the involvement of a country or industry as a user of foreign inputs (i.e. *backward participation)*. On the other hand, the VS1 share estimate the importance of *downstream links*, measuring the involvement in GVCs from a supplier perspective (i.e. *forward participation*) (BACKER; MIROUDOT, 2013; CADESTIN; GOURDON; KOWALSKI, 2016).

Despite the existence of both types of GVC participation, the VS is commonly used as an acronym for vertical trade. This is justified by the perception that it is more difficult to compute VS1 than it is to estimate VS[76]. However, when analyzing the vertical specialization of trade (in short, vertical trade), one may also have to consider the domestic-produced exports that are used by another country as inputs in its own exports (i.e. the VS1 side).

Both primary measures proposed by Hummels *et al.* (2001) are based on two key assumptions: i) all imported intermediate inputs are 100% foreign value added, what would tend to over-estimate foreign value-added share and underestimate domestic value-added share in exports – this is particularly important for developed countries since their imports often embodied a large share of its own value-added; and ii) both goods that are produced for export and for domestic final demand have the same intensity in the use of imported inputs – this is a restricted hypothesis especially for developing countries, which turn to have a significant portion of processing goods as a portion of exports (KOOPMAN; WANG; WEI, 2014). That is relevant, because these simplifications turned Hummels *et al.* (2001)'s

[76] Hummels *et al.* (2001) did not construct the mathematical formulation for the VS1 indicator, basing their empirical study in the gross exports of intermediate goods. According to Daudin *et al.* (2011), computing the VS1 is more difficult because it requires matching bilateral trade flow data with intermediate delivery matrices for all trading partners, while the VS can be measured using only the delivery matrix of the reporting country.

measures useful only in a special case, which is when only one country's intermediate goods are used abroad.

In recent years, new measures in value-added trade have been formulated attempting to overcome these restricted assumptions and to explore other characteristics of value added embedded in trade.

Daudin *et al.* (2010, 2011) composed a set of studies that builds newer measures in value-added trade from a global input-output framework. Considering the challenge of computing the VS1 perspective of vertical trade, Daudin *et al.* (2010, 2011) created a different measure (named VS1*) to further distinguish the part of VS1 that is re-incorporated to the country of origin, i.e. the domestic value-added in intermediates first exported then returned home in *final* goods imports. In general terms, the VS1* would be the domestic content of invested or consumed imports. Hence, the total value of value-added trade would be equal to standard trade minus "VS + VS1*", which is equal to total world vertical exports.

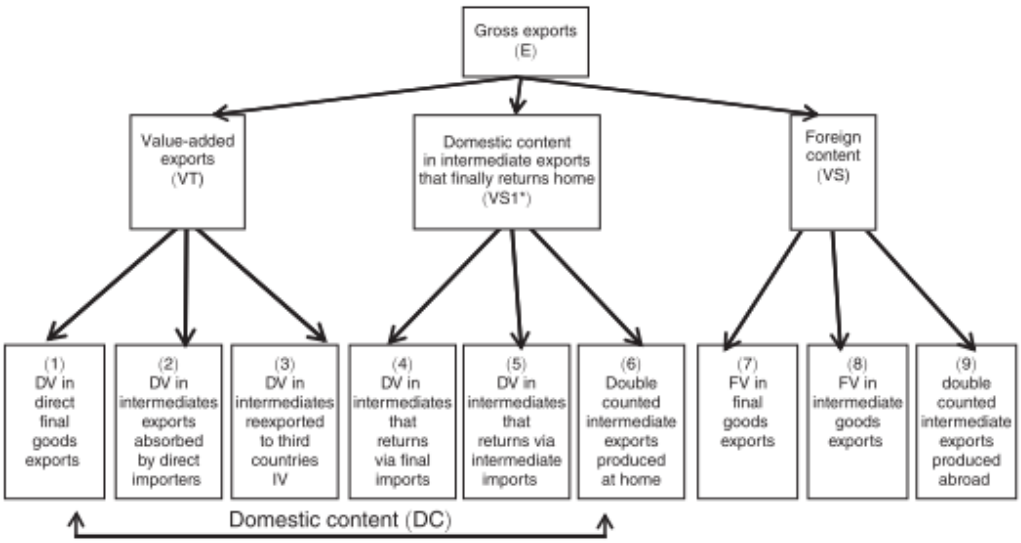
Johnson and Noguera (2012) introduced the concept of value-added exports (VAX) that indicates the value-added produced in a source country *s* and incorporated in destination country *r.* The authors proposed a measure, named "VAX ratio", that allows estimating the two-way trade in intermediates, i.e. both import and export intermediate goods of each country. Their measure is defined as the ratio of value added to gross exports and can be thought as a metric of the domestic content of exports. Based on GTAP 6 database, their analysis showed a profound variation between metrics based on gross value and in value-added trade across countries and sectors. Antràs (2013, p. 6) calls the VAX ratio "an appealing inverse measure of the importance of vertical specialization in (…) world production". In a more recent study, the VAX ratio is presented as a useful measure for tracing the effects of final demand shocks (JOHNSON, 2014a). However, both measures by Daudin *et al.* (2010, 2011) and Johnson and Noguera (2012) were not able to identify all value-added components in gross exports.

It was only recently that a comprehensive conceptual framework was developed, with a unified accounting and a better understanding of the relationship

between the measures proposed so far. Expanding the original metrics by Hummels *et al.* (2001), and adding two new measures of value-added trade, Koopman *et al.* (2010, 2014) provided a mathematical framework to decompose a country's exports into broad value added components. In that regard, not only Koopman *et al.* (2010, 2014) presented a mathematical formulation for the VS1 share that was not formulated before, but also turned it possible to derive all existing measures in the VS approach from a unified mathematical framework. The authors consider that to better understand the relation between the two types of measures (VS and VS1), it is necessary to define both measures in mathematical terms and derive them from a common framework. In that spirit, their work turned possible to decompose gross exports into a set of components that can be estimated independently.

Figure 2.1[77] depicts these components, for instance, export of value added, domestic value added that returns home, foreign value added, and properly including various double-counted terms. It is important to note that Koopman *et al.* (2010, 2014) formulated an accounting exercise, without investigating the causes or consequences of GVCs. In addition, this decomposition exercise is only done at the aggregate level. In that sense, Wang *et al.* (2014) provided a methodological framework to decompose bilateral sector level gross exports into 16 items (see Annex 2.1 and 2.3).

Figure 2.1 - Method of decomposition of gross exports



Source: Koopman *et al.* (2014).

[77] See Annex 2.1 for Koopman *et al.* (2010, 2014)'s mathematical formulation.

It is necessary to determine how to allocate the pure double-counted terms to overcome the "no two-way trade in intermediate goods" restriction of the primary measures of VS (KOOPMAN; WANG; WEI, 2014). In that sense, the authors allocated the double-counted intermediate exports according to where they are originally produced. In terms of the components presented in Figure 2.23 (Annex 2.3), the VS1 measure by Hummels *et al*. (2001) is equal to (3) + (4) + (5) + (6), and their VS is equal to (7) + (8) + (9). The VS1* by Daudin *et al*. (2011) is equal to (4). Moreover, lastly, the VAX ratio by Johnson and Noguera (2012) is equal to (1) + (2) + (3) divided by gross exports. It is important to phrase that Koopman *et al.* (2014)'s measure of forward participation (i.e., VS1) is similar to Daudin *et al.* (2011), but includes not only domestic value added returned home in *final goods imports* but also the domestic content returned home by being embodied in *imports of intermediate goods*. As argued by Koopman *et al.* (2014), the exclusion of this second part would consistently under-estimate actual vertical specialization.

Further on, Koopman *et al.* (2010, 2014) proposed two original measures to address the involvement of a country or industry in a particular GVC. The first, *GVC participation*, summarizes the importance of a GVC for a specific country-sector and it is defined as the sum of the indirect value-added (IVA) exports (i.e. the value of inputs produced domestically that are used in other countries' exports) and the foreign value added (FVA) embodied in a country's exports[78]. Combining both the VS and VS1 shares, it is possible to have a general picture of to what extent a country is engaged in vertically fragmented production processes, both as a user of imported inputs ("import content of exports") and as a supplier of intermediate parts and components used in other countries' exports, respectively. In other words, the GVC participation index captures both backward (*VS share*) and forward participation (*VS1 share*), and it excludes exports of final goods that have no foreign input content.

[78] See Annex 2.1.

In general, all the measures mentioned so far showed the importance of a country's participation in GVCs, rather than its position in a GVC or the complexity of the production system.

The second measure proposed by Koopman *et al.* (2010), *GVC position*, captures whether a country is positioned upstream or downstream in the GVC, depending on its specialization. For that purpose, it compares the amount of indirect value added exports (IVA) with the amount of value added imported to produce exports (FVA), both as shares of total exports. A country lies *upstream in a GVC* whether it tends to participate more as a provider of value added than as a recipient of foreign value added, presenting a positive value of *GVC position index*[79]. While countries upstream are engaged in activities at the beginning of the GVC ranging from raw materials to intangibles, countries downstream specialize in activities such as assembly or costumer services. Thereby, if a country is specialized in the last stages of the production process, it is likely that it has a high value of backward participation relative to forward. It is important to note that countries with very different engagement in GVCs can exhibit similar GVC position indexes. In that sense, the authors highlight that it is necessary to analyze the GVC position index along with the GVC participation index.

In fact, investigating a country's relative production-line position (upstream *versus* downstream) is related to a primary feature that reflects the complexity of production systems: *the length of GVCs*. Dietzenbacher and Romero (2007) investigated the fragmentation of production systems from a spatial-functional perspective, using an input-output conceptual framework to propose a new concept, the *average propagation length* (APL). The APL provides an estimate of the number of production stages in GVCs. Multiple indicators have been proposed based on the number and size of the internal linkages, understanding the complexity of the production system as the degree of sectoral intermediate production interaction (ROMERO; DIETZENBACHER; HEWINGS, 2009). But differently from analyzing the size of the effects between sectors, the APL emphasizes the distance between any two sectors. Thus, it is assumed that the greater the distance of a

[79] See Annex 2.1.

production system, the greater the number of steps it takes for a stimulus in one sector to affect another sector.

To quantify the length of production networks, Fally (2012) proposed a first measure that reflects the number of stages required for production. Namely, the relative location of an industry along the production process, which has been named "downstreamness" and is further explored in Antràs and Chor (2012). In addition, Fally (2012) proposed an index on the number of stages between production and final consumption, i.e. "distance to final demand". This measure is also referred to as "upstreamness" and is further explored by Antràs *et al.* (2012).

More recently, Los, Timmer and Vries (2013) created an index of international production fragmentation, named *IPF index*, which considers the full distribution of value added in all stages of production. The IPF index measures "the distance between the actual cross-country distribution of value directly and indirectly added in the production of a particular good and the cross-country distribution of world GDP" (LOS; TIMMER; VRIES, 2013, p. 2). By using global input-output tables, it considers the value-added generated by not only the immediate but also the second-tier and further upstream suppliers of parts and components. Thus, their research works at a more aggregate level and focuses on sets of narrow classes of final products, which are identified by the industry and country where the last production stage takes place ("the country-industry-of-completion"). In contrast with the previous measures of "length" and "distance" that focused on physical aspects of production processes, their emphasis is to measure the distribution of value added along the value chain. Put it simply, the IPF index indicates the level of fragmentation of the GVC, which is considered low whether most value is added in a downstream position country. In their work, they provided empirical evidence to support the idea of an increasingly fragmentation of most production processes across several countries.

Another application of the decomposition of gross exports proposed by Koopman *et al.* (2014) is *the revealed comparative advantage (RCA) index based on value-added trade*. Primarily based on the Ricardian comparative advantage theory, and originally proposed in gross terms by Balassa (1965), this indicator provides additional evidence of a country's specialization patterns and its export performance. In that sense, as one of the key features behind GVC trade is that it allows the denationalizing of comparative advantage, since countries could join GVCs rather than building the whole value chain (BALDWIN; LOPEZ-GONZALEZ, 2015), the RCA in value-added terms gives a more accurate picture of the patterns of comparative advantage. The adapted version of this index is defined as the share of

domestic VA of industry *i* in a specific country's total domestic VA relative to the share of domestic VA of industry *i* of the world (the sum of all countries) in world's total domestic VA[80]. When the RCA is greater than 1, it indicates a revealed advantage for that sector.

A set of other indicators can be constructed from the IIO tables, such as bilateral trade balance in value-added terms and the sectoral contributions to value-added exports, which is particularly important in the case of services. Therefore, some of the key indicators based on value-added terms will be used to build a set of stylized facts in section 2.4.

2.3 Available IIO databases

The IIO tables depicts the international sources of value added incorporated in goods and services produced throughout the world. An IIO table is derived from: i) national IO tables, ii) bilateral trade data, and iii) additional information or assumptions about the use of imported inputs by using industries (JONES, LIN; POWERS; UBEE, 2013; POWERS, 2012). Put it simply, the main techniques that have been applied to national accounts, developed by Leontief in the 1940s, are now analogously been applied to an international setting, where inputs can be sourced from multiple countries and may cross national borders multiple times before being consumed[81].

The greatest challenge in constructing an IIO table is that only a few countries register how imported inputs from each country are allocated to each domestic industry (POWERS, 2012). Hence, most IIO tables have to suppose as fact that the proportion of imported inputs by country-source in every industry is equivalent to the proportion in aggregate imports, what is known as the *proportionality assumption*. For instance, if 30 percent of Brazil imported intermediate electronics comes from China, the IIO table assumes that 30% of imported electronics inputs in each industry come from China. In other words, considering an IIO table, it is a common import proportion for all cells in a use row.

The proportionality assumption adds critical limitations to value-added measures. As it does not capture the cross-sectoral variation in domestic input demand, Winkler and Milberg (2009) argue that this assumption minimize the foreign inputs used in some key sectors and can lead to significant errors in terms of the effects of offshoring on domestic employment. This aggregation bias may be especially problematic whether one is measuring trade flows for export-processing zones, which are very intensive in the use of imports and are commonly

[80] See Annex 2.1.
[81] See Powers (2012) for a general structure of an IIO table with *two* countries and *n* sectors.

found in developing countries (ESCAITH; TIMMER, 2012). As argued by the authors, trade in value-added are an "estimate" rather than a "measurement", given that most trade data are not based on direct observations and considering that the construction of an IIO table is a statistical estimate in itself[82]. However, some improvements can be seen over standard proportionality, as well as best techniques to decompose intermediate exports since new IIO datasets have been launched.

Overall, the number of GVCs analysis with IIO tables has grown notably as IIO tables have become more widely available. Currently, the main sources of IIO tables are: i) the WIOD; ii) the OECD-WTO TiVA database; iii) the Eora Multi-Region IO database; iv) the Global Trade Analysis Project (GTAP) data; v) the Institute of Developing Economies (IDE-JETRO) Asian International Input-Output Tables (AIIOTs); vi) the Asian Development Bank Multi-Regional Input-Output tables (ADB-MRIO); and vii) the EXIOBASE. These databases differ in their method of construction and data sources[83], as well as their coverage of countries, regions, sectors, and time spans. Table 2.1 presents some general distinctions.

[82] Another assumption is the *production assumption*, which assumes that all firms allocated in a given industry use the same goods and services to produce the same outputs. See Trade in Value-Added (TiVA) Indicators (Guide to Country Notes) available at: *http://oe.cd/tiva.*

[83] Timmer *et al.* (2015) compared the value added exports derived from different databases and the correlations were between 0.93 and 0.98.

Table 2.1 - International Input-Output Databases

Database	Producing organization	Reference years	Number of countries	Number of industries	Data source
WIOD (release 2013)	European Commission	1995-2011 (yearly)	40 +RoW	35 industries, 59 products	http://www.wiod.org/database/wiots13
WIOD (release 2016)	European Commission	2000-2014 (yearly)	43 + RoW	56 industries	http://www.wiod.org/database/wiots16
TiVA	OECD-WTO	1995-2011 (yearly)	63	34 industries	https://stats.oecd.org/index.aspx?queryid=75537
TiVA Nowcast Estimates	OECD-WTO	2012-2014	63	34 industries	https://stats.oecd.org/Index.aspx?DataSetCode=TIVA_NOWCAST
EORA	University of Sidney	1990-2012 (yearly)	187	20-500	http://www.worldmrio.com
GTAP-MRIO	Center for Global Trade Analysis in Purdue University	1990, 1992, 1995, 1997, 2001, 2004, 2007, and 2011	129	57 industries	https://www.gtap.agecon.purdue.edu
AIIOT	IDE-JETRO	1975, 1985, 1990, 1995, 2000, 2005	10	78 (1985-95), 76 (2000-05)	http://www.ide.go.jp
ADB-MRIO	Asian Development Bank	2000, 2005-2008, and 2011	11	35 industries	https://www.adb.org/data/icp/input-output-tables
EXIOPOL	European Commission	2000 and 2007	43 +RoW	129 industries (base-year: 2000) and 163 industries (base-year: 2007)	http://www.exiobase.eu/

Source: Own elaboration.

The World Input-Output Database (WIOD) and the OECD-WTO Trade in Value-Added (TiVA) database are two of the most recent and advanced releases of IIO tables and are the main data sources used in this chapter for the construction of the stylized facts. That is because both constitute the maximal time and country coverage, as well as more elaborated methodologies regarding the issue of proportionality assumptions compared to previous data sources, increasing these database's reliability (KUMMRITZ; KUMMRITZ, 2015).

2.3.1 WIOD

The *World Input-Output Tables (WIOTs)* constitute the core product of the WIOD. Funded by the European Commission, the WIOD is the outcome of a joint initiative constructed within the *WIOD Project* that involved 11 European research institutions. Differently from other databases, all the data used in the WIOD are obtained from official national statistics and

are consistent with the original national accounts (DIETZENBACHER *et al.*, 2013)[84]. This avoids discrepancies due to different methods of IO construction across countries. To obtain a consistent time series, the WIOTs are benchmarked against output and final consumption series provided by national accounts, since supply and use tables are not available on an annual basis (KUMMRITZ, 2015). Linking a set of harmonized supply and use tables with bilateral data on international trade in goods and services, the database constructed intercountry (world) input-output tables that were launched in two releases.

The first one, *release 2013*[85], covers a set of 40 countries (27 European Union (EU) countries[86] and 13 major other countries[87]), plus a model for the remaining noncovered part of the world economy, *rest of the world (RoW)*, for the time period 1995-2011, in current basic prices and in basic prices of the previous year. All 40 countries together account for more than 85 percent of world GDP (TIMMER, MARCEL P *et al.*, 2014). The tables contain data for 35 industries (14 manufacturing industries and 17 services industries), reflecting how much of each of 59 products is produced and used by each industry. This high level of precision is resulted from an extended classification scheme of the Broad Economic Categories (BEC) to separate imports into intermediate and final goods, and then it considers proportionality assumptions to better allocate the products within the WIOTs' cells.

The second release, *release 2016*, provides WIOTs only in current prices[88], covering 43 countries[89] (28 EU countries and 15 major countries in the world) by 56 industries, for the period from 2000 to 2014. The full database is freely available at: http://www.wiod.org/database/index.htm.

[84] See Dietzenbacher *et al.* (2013) for more details on the construction of WIOTs.

[85] As part of the WIOD (*release 2013*), the *Socio-Economic Accounts* include industry-level data on capital stock, investment, wages, and employment (number of workers and educational attainment). In addition, the *Environmental Accounts* include industry-level data on gross and emission-relevant energy use, other air pollutants, as well as land, materials and water uses. The Socio-Economic Accounts, release 2016, are expected to be launched in December 2017.

[86] Austria, Belgium, Cyprus, Estonia, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Malta, Netherlands, Portugal, Slovak Republic, Slovenia, Spain, Bulgaria, Czech Republic, Denmark, Hungary, Latvia, Lithuania, Poland, Romania, Sweden, and UK.

[87] Australia, Brazil, Canada, China, India, Indonesia, Japan, Mexico, Russia, South Korea, Taiwan, Turkey, and the United States.

[88] The year-per-year tables still do not have an expected launching period.

[89] Adding Switzerland, Croatia and Norway. It is important to highlight that, as in the previous release, the selection of countries reflects data availability and their relative importance in the world economy.

2.3.2 OECD-WTO TiVA

The TiVA database was jointly developed by the OECD and WTO with the aim to better address the global production networks than is possible with conventional measures of international trade. Derived from the 2016 version of OECD's Inter-country Input-Output (ICIO) database, the latest version was released in December 2016 and includes two more countries (Morocco and Peru) compared to the previous version, covering a total of 63 economies and 34 industrial sectors (16 manufacturing and 14 services industries), for all years from 1995 to 2011. The TiVA database contains a list of indicators measuring the value added content of international trade and final demand, which are derived from the 2016 version of OECD's Inter-Country Input-Output (ICIO) Database.

In June 2017, the OECD-WTO initiative extended TiVA indicators to more recent years for 2012-2014 by using now-casting estimation techniques, named the *TiVA Nowcast Estimates.* Essentially, the approach estimates national IO tables by projecting relationships presented in the latest TiVA benchmark year (2011) into nowcast years (2012-2014) but constrained to official estimated of gross output and value-added and national accounts main aggregates of demand and trade, as well as supplemented by bilateral trade statistics[90].

2.3.3 Other IIO sources

The Eora Multi-Region IO Database (*Eora MRIO*) is compiled by the University of Sydney and provides a time series of IO tables with environmental and social satellite accounts for 187 countries. This database covers the period 1990 to 2012 and its raw data source is the UN's System of National Accounts, COMTRADE, Eurostat, IDE-Jetro, and various national agencies. This is the database with the most extensive country coverage of any IIO table; however, IO tables for many of these countries are not available and had to be estimated from the raw data sources. Besides the individual country IO tables for each country, this database provides the simplified *Eora26* model, which is a complete global MRIO table, plus environmental satellite account, in a harmonized 26-sector classification for 1990-2013, in basic prices and in purchaser's prices. The Eora26 is recommended for analysis requiring comparisons across countries and is easier to work, compared with the Full Eora, which is the complete Eora MRIO table[91].

[90] For more details, see: http://www.oecd.org/std/its/tiva-nowcast-methodology.pdf.
[91] For more details about the construction of Eora, see Lenzen *et al.* (2013).

The Global Trade Analysis Project (GTAP) is a global network that performs quantitative analysis of international policy issues and is coordinated by the Center for Global Trade Analysis in Purdue University's Department of Agricultural Economics. This database predates the other IIO tables and is updated every 2 to 4 years (from its first release in 1993 to the last on in May 2015, there were 9 releases in total), describing bilateral trade patterns, production, consumption and intermediate use of commodities and services. GTAP database main sources of raw data are: i) World Bank and IMF macroeconomic and Balance of Payment statistics; ii) United Nations Commodity Trade Statistics (Comtrade) database; and iii) IO tables based on national statistical sources. Its last release, the GTAP 9 Database, features 2004, 2007 and 2011 reference years, as well as 140 regions for all 57 GTAP commodities, and is commonly used into applied general equilibrium analysis of global economic issues (AGUIAR; NARAYANAN; MCDOUGALL, 2016). In that sense, it is important to highlight that the purpose of GTAP is not to provide IIO tables, but to facilitate the operation of economic simulation models. It is important to phrase that it is not a simple task to compile the IIO tables, since it requires a complex statistical work. However, several GVC studies used GTAP data in their own analysis, such as Johnson and Noguera (2012), and Koopman *et al.* (2010).

The Institute of Developing Economies (IDE) Japan External Trade Organization (JETRO) compiles the foremost Multiregional IO tables and the *2005 Asian International Input-Output Tables (AIIOTs)* is their latest freely available IIO that covers the industrial network extended over ten countries[92] and 76 sectors. This AIIOT was already available for the years of 1985, 1990, 1995, and 2000, and partially available for the year of 1975 (except for China and Taiwan). Beyond the AIIOTs, the IDE-JETRO also provides the 2005 BRICs International IIO table and the Transnational Interregional IO table for China, Japan and Korea. However, the IDE-JETRO AIIOTs are not appropriate to address global production fragmentation, because its coverage of countries is too restricted to Asian economies. Alongside, the *Asian Development Bank Multi-Regional Input-Output tables (ADB-MRIO)* is complementary to the WIOD (*release 2013*), which covers only 6 Asian economies, including 5 additional countries, i.e. Bangladesh, Malaysia, the Philippines, Thailand and Viet Nam, maintaining the same sector classification and available for the years of 2000, 2005-2008, and 2011[93]. Finally, the *EXIOPOL* (A New Environmental Accounting Framework using Externality Data and Input-Output Tools for Policy Analysis) is a project funded by the

[92] Namely, China, Indonesia, Korea, Malaysia, Taiwan, the Philippines, Singapore, Thailand, Japan, and the United States of America.
[93] For more details, see: http://www.wiod.org/otherdata/ADB/ADB_MRIO_SM.pdf.

European Commission that produces a Multi-Regional Environmentally Extended Supply and Use Table (MR EE SUT). The EXIOPOL database (EXIOBASE) covers 43 countries, and a "Rest of World" (the other countries in the world combined), distinguishing 129 industry sectors (base-year 2000) and 163 industry sectors for the reference year of 2007. By using this database, for instance, it is possible to analyze the amount of carbon emissions and resources embodied in trade[94].

It is worth mentioning a secondary database that has been recently developed and is processed on the basis of original IIO tables, the *UIBE GVC Index*. As the underlying IIO tables differ in countries, regions, sectors, and periods, and considering that the GVC accounting methods are fundamental for using these IIO tables, the Research Institute for Global Value Chains (RIGVC) at University of International Business and Economics (UIBE) developed an index system that integrates all previous measures of vertical specialization in the literature, such as VS, VS1, RCA, and VAX, into a unified framework. Their main idea is to facilitate the use of accounting results and to provide convenience for researchers, promoting studies on GVCs. For that purpose, they consider the accounting approaches developed by Koopman *et al.* (2014), Wang *et al.* (2013) and Wang *et al.* (2016).

At the moment, *UIBE GVC Index* includes five categories of indexes that one can choose after selecting your preferred IIO table. These indexes are as follows: i) *Index 1:* a series of indexes based on decomposition of sector value added (GDP by industry, forward linkage); ii) *Index 2*: a series of indexes based on decomposition of sector final product production (backward linkage); iii) *Index 3*: gross trade decomposition indexes, including gross exports, exports of intermediate goods and services, exports of final goods and services, gross imports, imports of intermediate goods and services, imports of final goods and services, and balance of trade at country and country-sector levels; iv) *Index 4:* a series of indexes based on decomposition of bilateral gross trade flows; v) *Index 5:* indexes proposed by Wang *et al.* (2016), including length and position of GVCs.[95] All the indicators can be derived from the underlying databases: i) WIOD 2013; ii) WIOD 2016; iii) OECD-ICIO; iv) GTAP; v) ADB-MRIO; and vi) EORA. The UIBE GVC Index is free to download[96].

[94] For more information, see: http://www.feem-project.net/exiopol/. Or: http://www.exiobase.eu.
[95] RIGVC UIBE, 2016, UIBE GVC Index: http://rigvc.uibe.edu.cn/english/D_E/database_database/index.htm.
[96] Download link: http://139.129.209.66:8000/d/daedafb854/.

2.4 Stylized facts

This section presents some stylized facts about the changing nature of international trade and the patterns of countries' integration into GVCs. For that purpose, it explores how OECD-WTO TiVA and WIOD databases can be used for measuring flows related to the value that is added by a country in the production of any good or service that is exported. As discussed, trade in value-added allows distinguishing between foreign and domestic value-added exports, addressing the multiple counting implicit in current gross flows of trade. Hence, this section uses some of the indicators previously discussed[97], as well as some TiVA ready-to-use indicators and an analysis of the value-added components of gross exports. Each stylized fact seeks to highlight a point of analysis, and in turn brings with it several other relevant features, not aiming to summarize the discussion but rather to bring light to certain aspects of the GVC analysis.

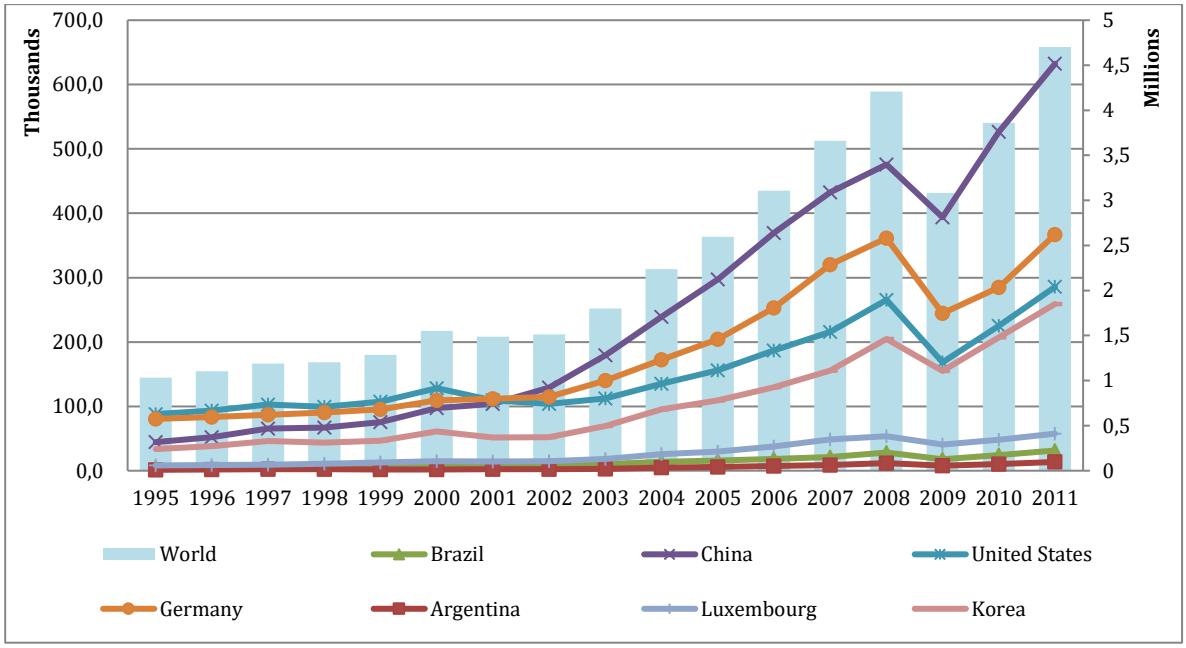
Fact 1. Analysis of gross export flows can be misleading in a vertical specialization scenario.

Traditional statistics based on gross exports tend to "double count" trade flows, as gross exports include the value of imported intermediates that are used in production, blurring the real distribution of value created within countries. In the absence of trade in intermediate inputs, this difference between gross and value added analyses would not be that relevant. Nevertheless, this statistical problem is represented in Figure 2.2, which shows the extent of the difference between gross exports and domestic value added for selected countries and the world[98] over 1995-2011.

The gap between measuring in gross terms and value-added trade continually increased over the period for all countries from the sample, with the exception of 2009, when the worldwide trade collapsed at the height of the recent global recession, as well as the import content of exports. However, this increase was more significant for China, Germany, United States, and Korea, respectively. This overall picture is a reflection of vertically fragmented production into international dispersed networks with countries focusing on specific activities and tasks, but the extent of the difference varies across countries depending on the extent of a country's involvement in GVCs.

[97] It is important to keep in mind that the same indicator, in theoretical terms, can show different empirical results whether based on the TiVA or WIOD database. This is a reflection of different approximations that are used to construct these IIO tables, as well as different data sources as discussed in the previous section.
[98] The average of the sum of all TiVA countries, including the proxy "ROW: rest of the World".

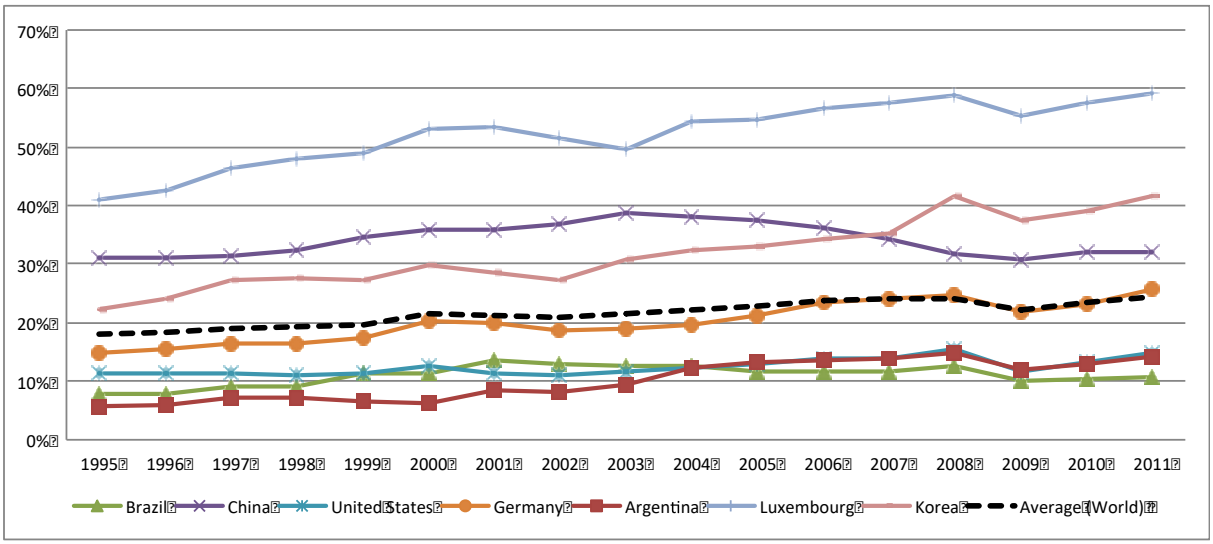
Figure 2.2 - Difference between Gross Exports and Domestic Value Added, selected countries (thousands US$) and world (millions US$), 1995-2011



Source: Own elaboration based on OECD-WTO TiVA database (December 2016).

Related to gross exports, the average difference was around 20% and it has increased over 1995 to 2011 (Figure 2.3). In that sense, Germany has a relative amount and behavior very similar to the world average. Luxembourg illustrated that this difference as a share of gross exports is more important the more integrated the country in GVCs. Although this difference was small in nominal terms, in proportion to the total value exported it is not negligible. In contrast, this gap was lower for those countries that are more intensive in commodities, such as Brazil and Argentina. In addition to the United States, these three countries showed that the extent of their differences related to gross exports are less prominent than the world average.

Figure 2.3 - Difference between Gross Exports and Domestic Value Added (% of gross exports), selected countries and world, 1995-2011



Source: Own elaboration based on OECD-WTO TiVA database (December 2016).

It is worth noting how the Chinese contribution to international trade flows is heavily overestimated when analyzed in gross terms. However, this difference as a share of gross exports has narrowed since 2003 (Figure 2.3). While most countries are relying less on domestic inputs for production, China is against this trend and is rising its ratio of domestic value added in exports to gross exports (DVAR). This intriguing exception has been showed by other studies (KEE; TANG, 2015; KOOPMAN; WANG; WEI, 2012). Investigating its potential causes, Kee and Tang (2015) [99] found that the rising in Chinese DVAR is due to individual processing exporters substituting domestic for imported materials in terms of volume and varieties[100], and this would mean that China became more competitive, especially in the intermediate input sectors.

Fact 2. Small open economies, in general, show higher participation in GVCs than larger countries, reflecting their lower domestic production of inputs.

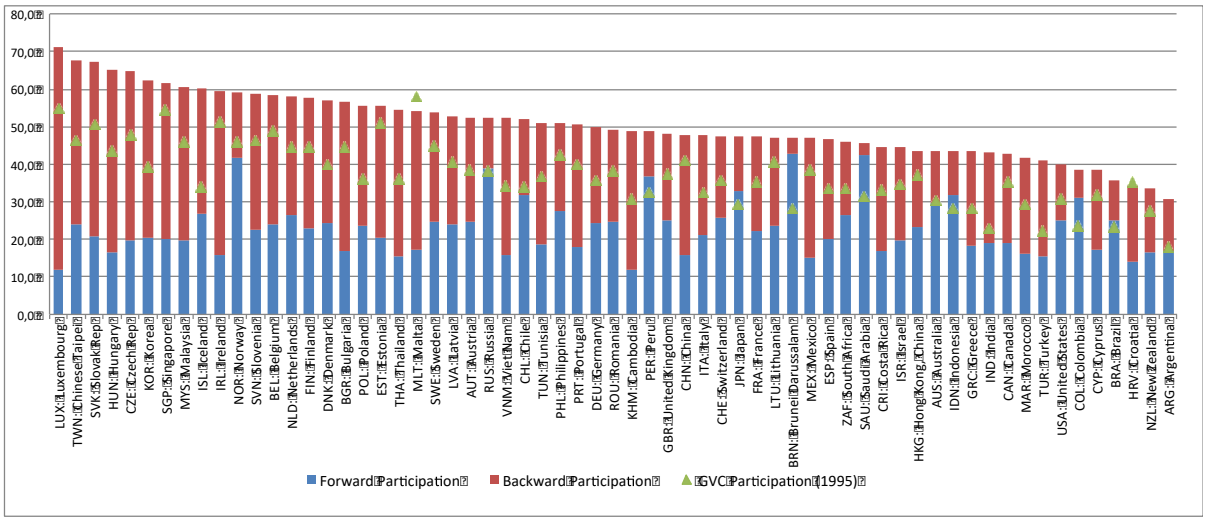
[99] The authors did not use IIO tables in their analysis but customs transaction-level data and firm survey data, measuring DVARs as the weighted averages of the firms' DVARs. This empirical strategy allowed them to embrace firm heterogeneity and overcome significant aggregation biases.

[100] According to Kee and Tang (2015), other potential causes are: i) a changing composition of Chinese exports, which would indicate that the Chinese comparative advantage is moving towards industries with high domestic content; and ii) an upsurge of Chinese domestic production costs. But following their model, both causes cannot explain this rising trend.

Countries increasingly rely on foreign value added for their own exports, which may then be further processed in partner countries. Figure 2.4 presents the magnitude of GVC participation across countries in 1995 and 2011 as proposed by Koopman *et al.* (2010, 2014). The GVC participation index combines both *backward* (the share of foreign inputs) and *forward* (domestically produced inputs that are used in third countries' exports) participation in GVCs, and is expressed as a percentage of gross exports. Looking at the change across time, all countries apart from Malta and Croatia increased their participation in GVCs. Iceland, Korea, Hungary, Chinese Taipei, and India increased their participation the most. A cross-country comparison reveals that the East-Asian economies as Korea, Singapore, and Malaysia showed relatively high GVC participation indexes. In that sense, although China's participation grew significantly over the period, it is relatively lower than the average of its Asian partners.

In 2011, the top positions with respect to GVC participation were held by small open economies, such as Luxembourg (71%), Taiwan (67.6%), the Slovak Republic (67.4%), Hungary (65.2%), Czech Republic (64.8%), and Korea (62.2%). All those countries increased their overall GVC participation mostly based on the expansion of the foreign value added share of their gross exports, i.e. reinforcing their role as buyers of foreign inputs (backward linkages). Compared to large economies, such as United States, India, and Brazil, these small countries have lower availability of domestically sourced intermediates, resulting in higher imports of intermediates. The data for Luxembourg and Hungary depicts that small countries can depend heavily on international trade whilst relying more on buying goods and services needed for production on the international market.

Figure 2.4 - The GVC Participation index[101] (% share in total gross exports), 1995 and 2011



Source: Own elaboration based on OECD-WTO TiVA database (December 2016).

In contrast, large markets show lower rates of participation in GVCs mostly because of lower backward participation, given its higher domestic production of inputs and thus relatively small need to seek for intermediate inputs from abroad. But this is only a partial view of GVCs, as the GVC participation index also takes into account their prominence as sellers of inputs into value chains (forward linkages). For example, the foreign content of Brazilian exports is 10.7% while Brazilian participation in GVCs increases to almost 36% when Brazilian intermediates in third countries' exports are considered. Among others, because raw materials are a relatively great part of its exports, Brazil tends to show a large share of domestic value added both sent to consumer economy (*direct* domestic value-added, "direct DVA") and sent to third countries (*indirect* domestic value-added, "indirect DVA") (Figure 2.5). Further on, the bottom positions in the overall GVC participation were occupied by Argentina (30.8%), New Zealand (33.4%), Croatia (34.1%), and Brazil (35.6%) in 2011.

To enrich this analysis, Figure 2.5 decomposes the sources of value-added in gross exports into four components by their destination: 1) domestic VA sent to consumer economy,

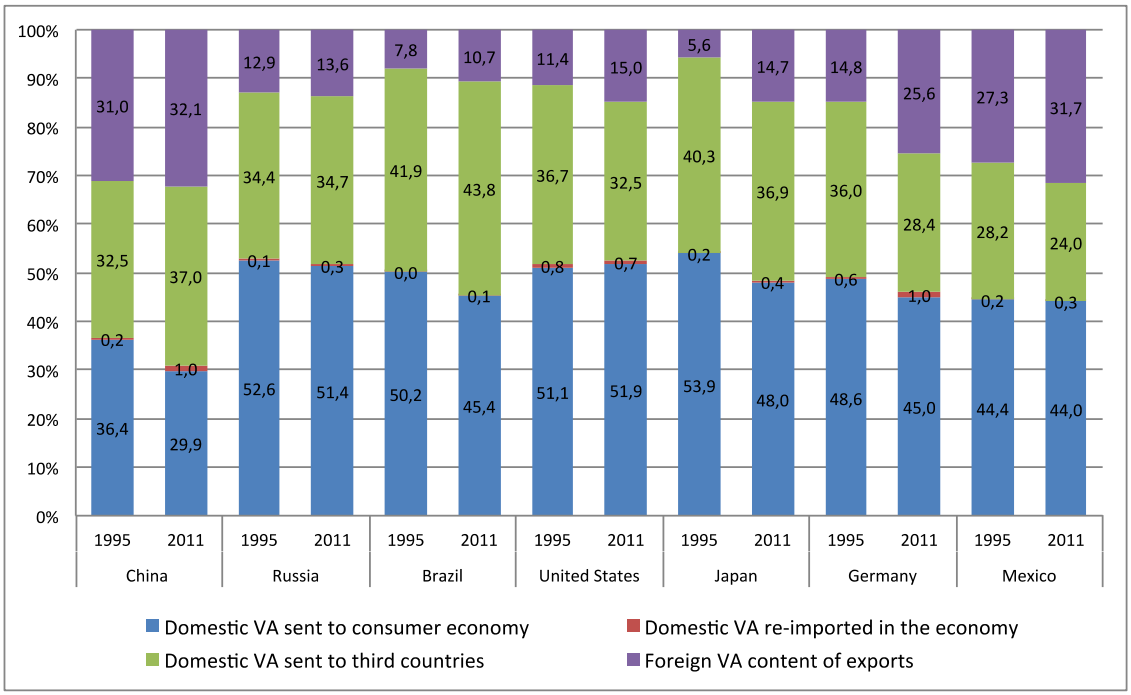
[101]Considering TiVA's nomenclature, the "forward participation in GVCs" is measured by the EXGR_DVAFXSH (c,i) presents country c, industry i, *domestic value added content of gross exports* by foreign countries as a percentage of total gross exports by country c, and the "backward participation in GVCs" is measured by the *foreign value added share of gross exports*, for domestic industry i in country c, EXGR_FVASH (c,i), defined as foreign value added embodied in gross exports EXGR_FVA (c,i), as a percentage of total gross exports, EXGR (c,i), which is a 'FVA intensity measure' often referred to as "import content of exports". Thus, the GVC participation index is the sum of both forward and backward participation in GVCs.

2) domestic VA sent to third countries, 3) domestic VA re-imported in the economy; and 4) foreign VA content of exports. Components (1) through (3) depict the value of gross exports that is created domestically and component (4) indicates the value of exports that is created abroad. Component (1) is not considered as value-added generated by supply chains, indicating how much of a country's exports are created as stand-alone exports, i.e. outside any supply chain (RAHMAN; ZHAO, 2013). Hence, it is important to note that, given the definition of the GVC participation index, only components (2) and (3), as *upstream* linkages, and component (4), as *downstream* linkages, are taken into consideration as value-added in exports generated by supply chains.

Overall, the role of supply chain linkages (components 2-4) increased over time. This was heavily driven by an increase in the domestic VA sent to third countries in the case of China (32.5% to 37%), but also for Russia and Brazil. While Japan, Germany, and Mexico showed larger decreases in that indicator, these countries most expanded the share of foreign VA in exports. Overall, foreign value added in exports is higher in countries where processing industries account for a significant part of exports, such as Mexico. Further on, the domestic VA re-imported in the economy as a share of gross exports increased for almost all countries, with the exception of the United States. This indicator reflects the value-added created in upstream domestic industries providing indirect intermediate inputs via international value-chains[102]. The United States are also an exception regarding the decreasing trend in domestic VA sent to consumer economy, showing a slight increase from 1995 to 2011.

[102] This indicator, by industry, provides a measure of how protectionist measures may affect domestic industries that provide inputs to imports. See Background Notes at: *http://www.oecd.org/sti/ind/TIVA_FAQ_Final.pdf.*

Figure 2.5 - The VA components of gross exports, selected countries, 1995 and 2011 (% share in total gross exports)

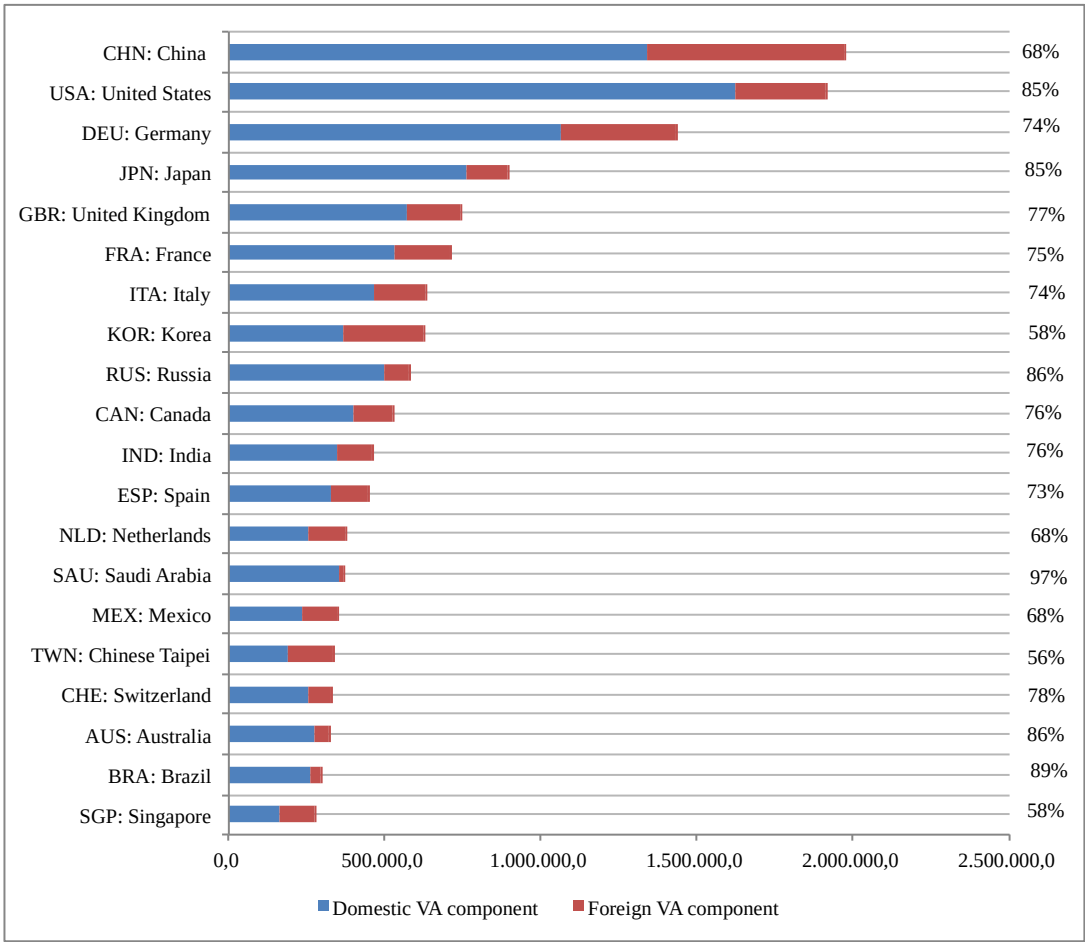


Source: Own elaboration based on OECD-WTO TiVA database (December 2016).

Considering the top 25 exporting economies in 2011, Figure 2.6 shows the decomposition of gross exports in domestic and foreign value added and its share of domestic value added in exports, i.e. the VAX ratio[103] (on the right side of the Figure). On the one hand, Saudi Arabia (97%), Brazil (89%), Russia (86%), Australia (86%), United States (85%), and Japan (85%) are the countries with the largest ratios of value added to gross exports (i.e. domestic content of exports). On the other hand, Taiwan (56%), Singapore (58%), and Korea (58%) are the top bottom countries regarding the shares of domestic value-added trade, showing that East and Southeast Asian countries have the highest shares of foreign value-added trade.

[103] Following the measure proposed by Johnson and Noguera (2012).

Figure 2.6 - Domestic value-added trade shares of the top 25 exporting economies, 2011



Source: Own elaboration based on OECD-WTO TiVA database (December 2016).

The involvement of countries as users of foreign inputs to produce exports varies across countries and regions. In part, this heterogeneity reflects differences in several factors[104], such as *geographical location* (i.e. proximity to neighboring markets), *economic size* (i.e. the ability to source intermediates from domestic suppliers and the ability to draw on larger domestic markets for their intermediates and final goods and services), *infrastructure aspects and domestic policies in the countries* (such as how open and liberal is the trade policy regime), as well as *different patterns of specialization* (countries that export a lot of raw materials commonly have a high degree of domestic value added, since they specialize in upstream activities (e.g. mining and agriculture) that are in the beginning of GVCs)

[104] See Kowalski *et al.* (2015) to an empirical analysis on the relationship between the characteristics of GVC participation and different factors, such as market size, level of development, openness to trade, and investment performance.

(CHENG; SENEVIRATNE; ZHANG, 2013; KOWALSKI *et al.*, 2015; UNCTAD, 2013b; WORLD BANK, 2014). However, this complex mix of determinants of a country's engagement in GVCs is not reflected in the GVC participation index, as one may find countries with structural differences regarding these features and similar degrees of participation.

Thus, one may ask whether countries are better off having a bigger share of domestic value added in their exports. However, there is no simple answer. The share of domestic value added in exports gives an indication of how a country is integrated into GVCs, but the goods and services that are being exported can be completely different, and so can be the benefits associated to them. In other words, increasing the portion of domestic value added in exports is not the same as upgrading. A country can present decreasing shares of domestic value added in exports and still be on an upgrading path, whether it participates in GVCs that create higher overall value, with higher levels of technological sophistication or higher wages and better labor conditions, even though it depends on increasing shares of foreign value added in exports.

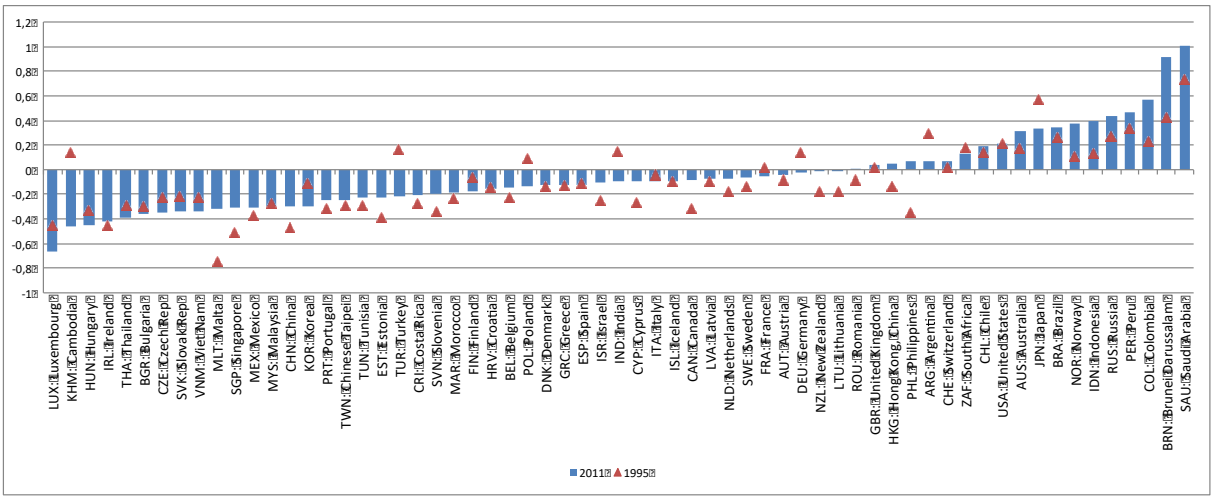
Fact 3. Upstreamness versus downstreamness: great changes in relative GVC position are unusual across time.

Upstreamness (or downstreamness) refers to where a country is located in a GVC. One measure, developed by Koopman *et al.* (2010), is the GVC position index. Countries with high forward relative to backward participation present a positive GVC position index, suggesting a country that lies upstream in a supply chain. Figure 2.7 illustrates whether a country remained specialized in the first (i.e. upstream stages) or last stages of production relative to the rest of the world.

Overall, there are no substantial changes among countries regarding their relative position on GVCs between 1995 and 2011. The Saudi Arabia, Brunei Darussalam, and Colombia, are the countries that lie relatively more upstream in 2011. As expected, other natural resource-abundant economies, such as Peru, Russia, Indonesia, Norway, and Brazil also lie upstream. On the other hand, Luxembourg, Cambodia, and Hungary are the most downstream. As it was expected, Asian emerging market economies, such as India, China, and Vietnam, are generally located downstream. Looking at the trajectories across time, only a few countries,

such as Turkey, Poland, India, and Cambodia, were able to move from being relatively upstream to downstream.

Figure 2.7 - GVC position index[105], 1995 and 2011



Source: Own elaboration based on OECD-WTO TiVA database (December 2016).

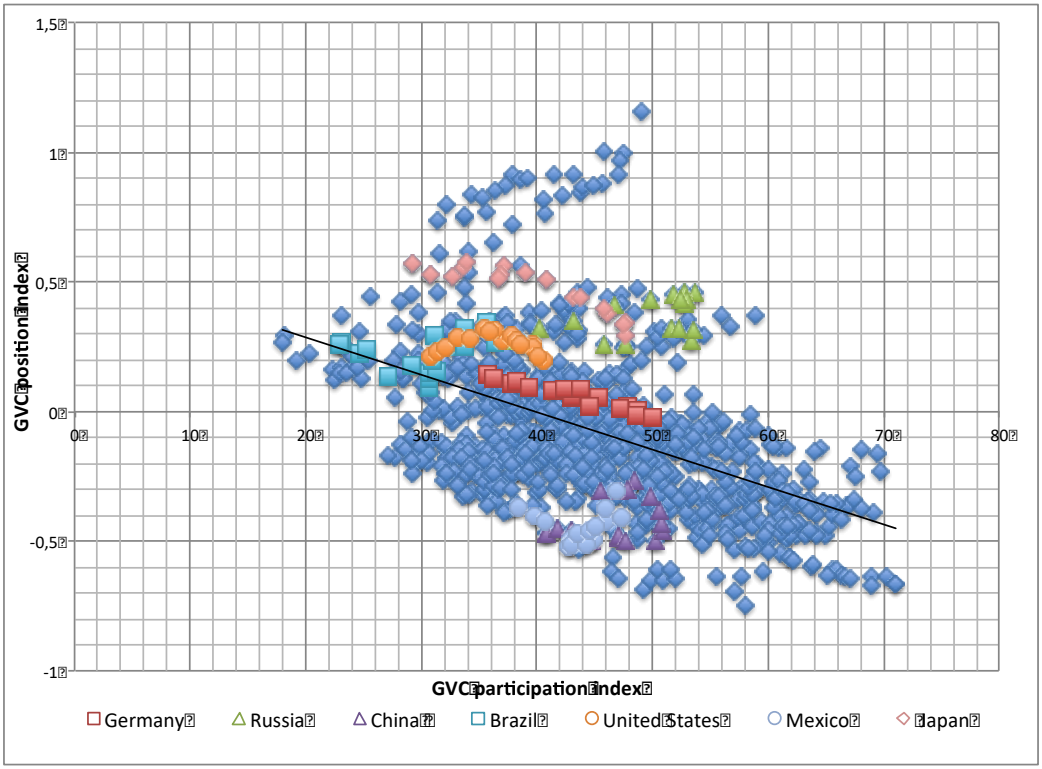
However, a few words need to be said about the limitations of this analysis. As already addressed in section 2.2, two countries can have identical GVC participation indexes but their position along the GVC may vary significantly, reflecting different patterns of specialization, i.e. more activities upstream or downstream in the production network. At the same time, two countries may clearly present similar GVC position indexes but very different degrees of participation in GVCs (KOOPMAN *et al.*, 2010). Brazil and Japan, for example, present very similar GVC position indexes and considerably different degrees of participation in GVCs. Furthermore, considering countries with similar forward participation index that are located upstream in the chain, one may observe that they can be specialized in completely different activities. For instance, the USA is upstream in the chain due to activities such as design, R&D, and branding, while countries like Brazil and Russia are also considered upstream but are exporting mostly primary sector commodities.

Figure 2.8 shows the GVC participation index on the x-axis and the GVC position index on the y-axis for all countries in OECD-WTO TiVA dataset from 1995 to 2011 (each dot represents a specific country in a specific year). The negative correlation between the two measures indicates that the countries specialized in downstream activities saw an increase in their participation rate. In other words, most countries are taking a deeper part in GVCs by

[105] Koopman *et al.* (2010) define the GVC position index as the log ratio of a country's supply of intermediates used in other countries' exports to the use of imported intermediate goods in its own production. See section 2.2.

trading inputs that are imported from abroad (*backward linkages*) rather than producing domestically goods and services that are being exported by third countries (*forward linkages*).

Figure 2.8 - GVC participation index and GVC position index, 1995-2011



Source: Own elaboration based on OECD-WTO TiVA database (December 2016).

Fact 4. The overall increase in the total foreign content was mainly driven by an increase of the double counted intermediate exports produced abroad.

Following Figure 2.1, there are three different components within the total foreign content (VS)[106], which are: i) *foreign value in final goods exports* (FVA_FIN); ii) *foreign value in intermediate goods exports* (FVA_INT); and iii) *double counted intermediate exports produced abroad* (FDC)[107]; each one with different economic meanings and illustrating different arrangements of cross-country production sharing (WANG; WEI; ZHU, 2014). According to the authors, a country with a large share of FVA_FIN may be engaged in final

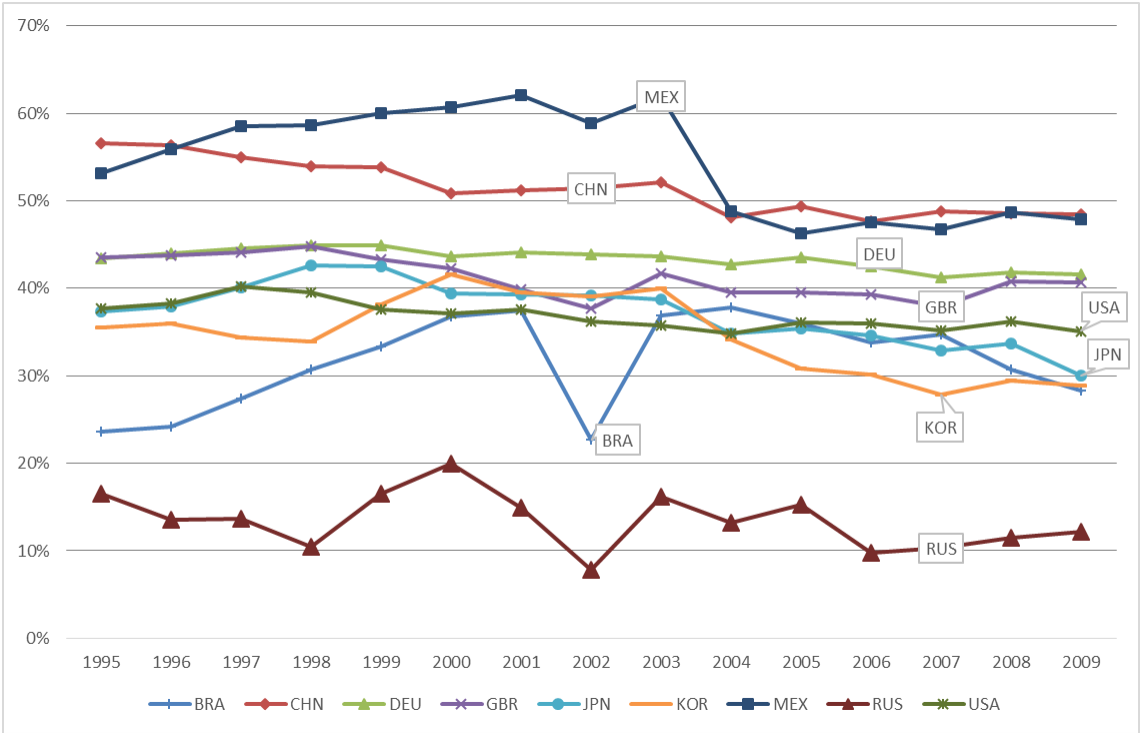
[106] It worth noting that "the difference between foreign value-added (FVA) and VS share is the share of pure double counting due to the back and forth intermediate goods trade originated from foreign countries" (WANG; WEI; ZHU, 2014, p. 34).
[107] FDC indicates the "pure double counting from foreign sources", which can be divided in MDC ("due to the direct importer exports production") and ODC ("due to other countries exports production"). See Box 2.2 (Annex 2.3).

assembling activities based on imported inputs, participating in cross-country production sharing mostly on the low end of a GVC, while an increasing FVA_INT may be a sign that the country is no longer at the beginning of the GVC.

To understand what is behind the general increase of VS in a country's gross exports, Figures 2.9, 2.10, and 2.11 show the relevance of each component and their trajectory over time. Figure 2.9 shows the share of FVA_FIN in VS for nine selected economies from 1995 to 2009. At the beginning of the series, China held the largest portion of FVA_FIN in VS relative to other countries. Since then, this indicator has been losing importance, in what can be understood as the advance of China's production to other stages located more at the beginning of the CGV. Meanwhile, Mexico has occupied a space previously occupied by China, increasing its presence at the low end of GVCs. Except for Brazil, all countries saw a decline of about 5% between 1995 and 2009, with China showing the largest decrease (8%).

Figure 2.10 shows the share of foreign value in intermediate goods exports in VS, and it suggests that only Mexico showed signs of being no longer at the bottom of the GVCs between 1995 and 2009. During that period, this indicator was almost constant for all selected countries, and considering the last two years of the series, all countries showed signs of upgrading its industries to start producing intermediate goods for other countries.

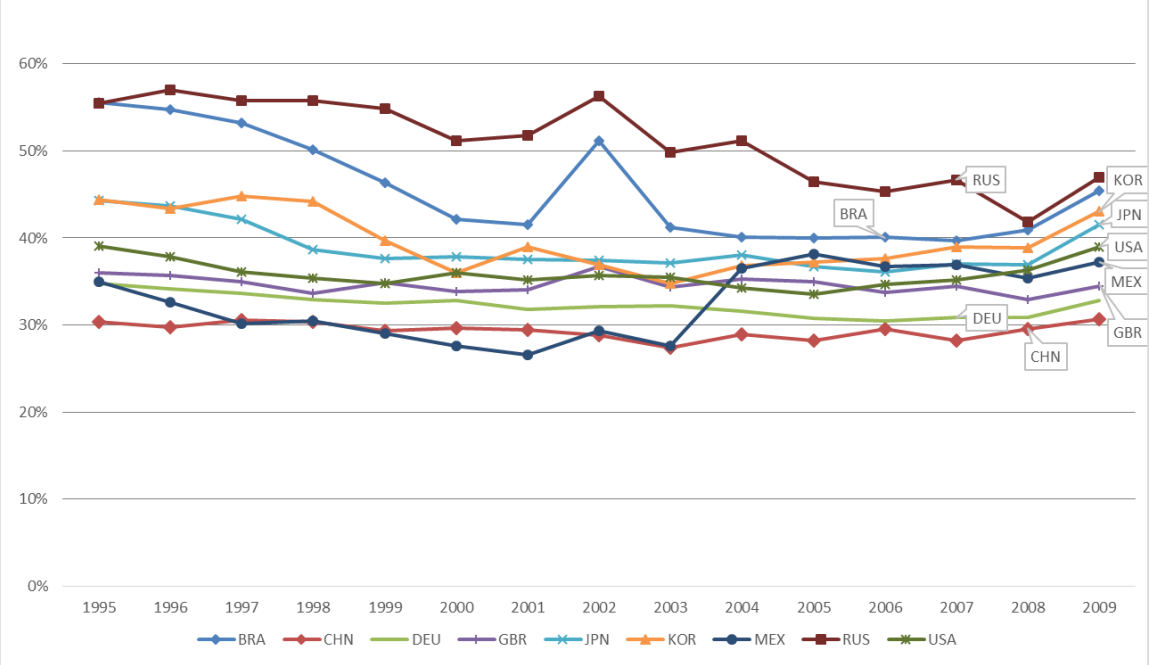
Figure 2.9 - Foreign value in final goods exports (FVA_FIN) as % of VS, selected major economies, 1995-2009



Source: Own elaboration based on WIOD (release 2013) data.

Note: We use Koopman *et al.* (2014) method of decomposition of gross exports, and *decompr* algorithm (QUAST; KUMMRITZ, 2015) applied in software R.

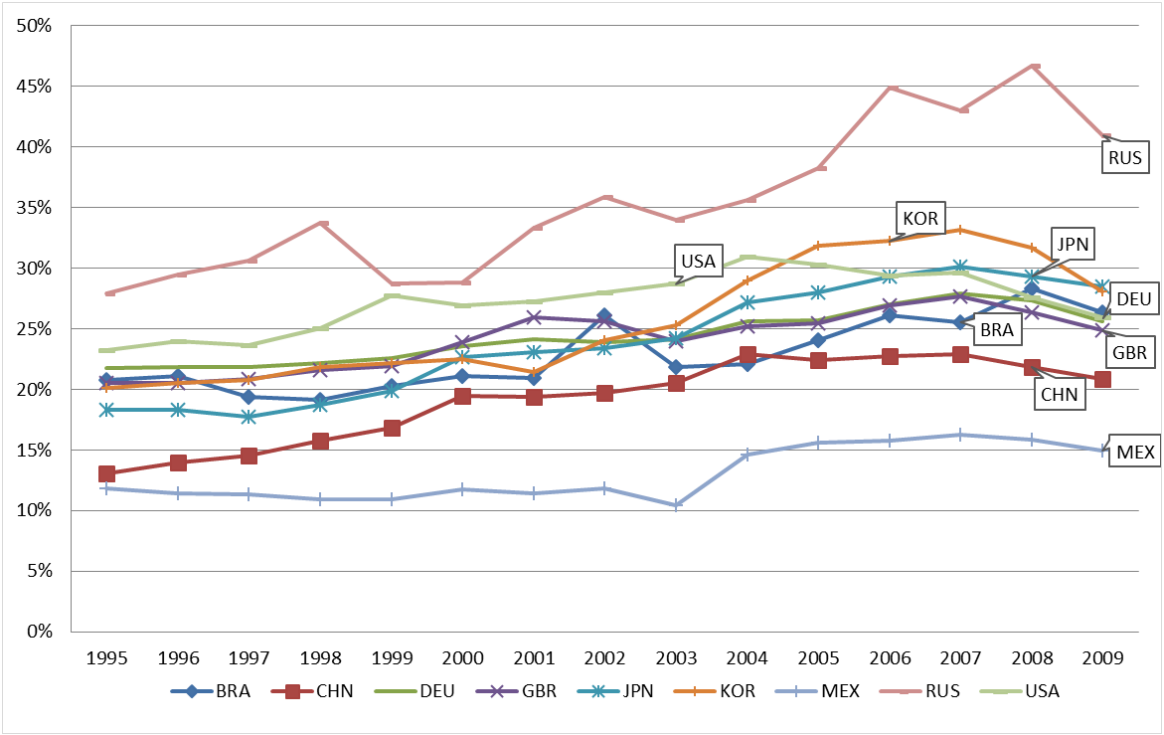
Figure 2.10 - Foreign value in intermediate goods exports (FVA_INT) as % of VS, selected major economies, 1995-2009



Source: own elaboration based on WIOD (release 2013) data.
Note: We use Koopman *et al.* (2014) method of decomposition of gross exports, and *decompr* algorithm (QUAST; KUMMRITZ, 2015) applied in software R.

Further on, a larger share of FDC in VS suggests that the country is deepening its importance on the cross-country production sharing, as FDC is a reflection of the back and forth trade of intermediate goods (WANG; WEI; ZHU, 2014). Overall, all selected countries increased their double counted intermediate exports produced abroad as a share of VS, of which Japan and Russia increased by around 10 percentage points between 1995 and 2009, with the latter in a considerably higher level than the other countries (Figure 2.11). It is also interesting to note that this indicator has showed signs of weakening trade in GVCs prior to the 2009 crisis. Therefore, the increase in the share of VS in exports was mainly driven by the increase in FDC share. However, this is clearly not a homogeneous process among countries and sectors. For China, it was driven by the increasing FDC, while FVA_INT stayed relatively stable and FVA_FIN decreased. For Brazil, both FVA_FIN and FDC shares increased during this period, while FVA_INT has declined, which may be consistent with moving from the upper stream part of the GVC to a downstream position. Finally, analyzing the structure of the VS adds new empirical evidence about a country´s position on GVCs.

Figure 2.11 - Double counted intermediate exports produced abroad (FDC) as % of VS, selected major economies, 1995-2009



Source: own elaboration based on WIOD (release 2013) data.
Note: We use Koopman *et al.* (2014) method of decomposition of gross exports, and *decompr* algorithm (QUAST; KUMMRITZ, 2015) applied in software R.

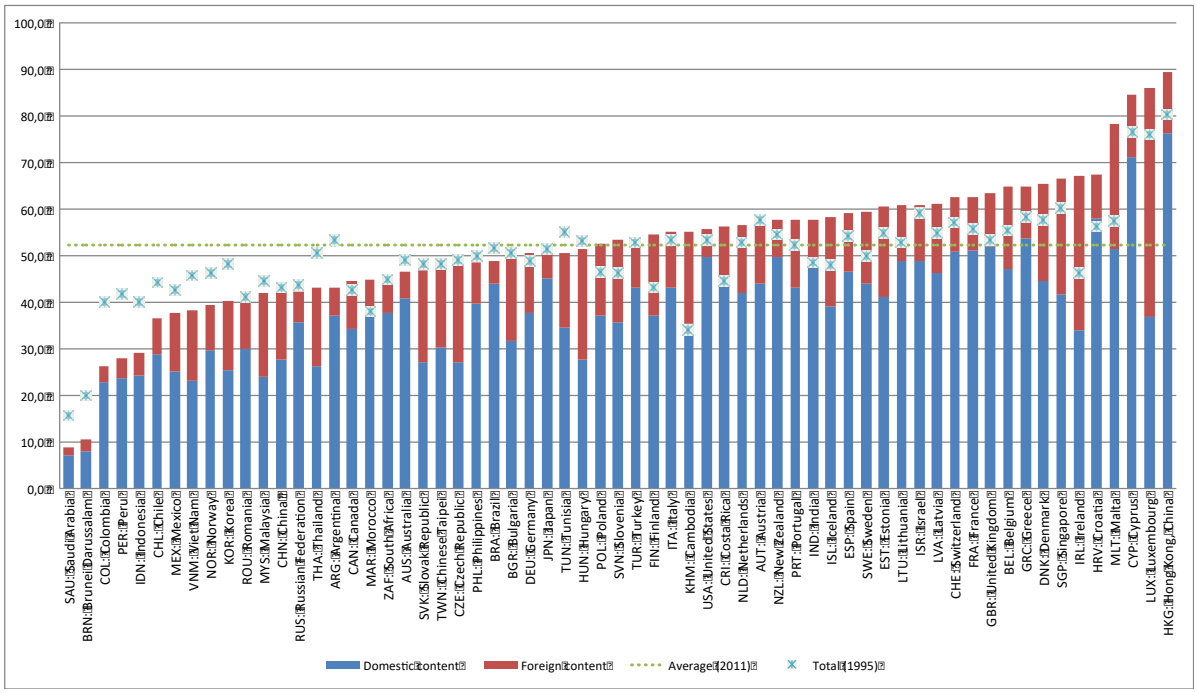
Fact 5. The servicification of GVCs is a multifaceted phenomenon that goes beyond the increasing reliance of the manufacturing sector on services.

Services in GVCs also reflect data limitations. For a long time, analyses based on gross terms have been underestimating the magnitude of cross-border services transactions in national economies. According to Ahmad (2013), services constitute about two-thirds of GDP in most developed economies, though trade in services is less than one-quarter of total trade in most countries, rather based on gross terms. This reflects the fact that some of the services are tradable, while others are not. But also indicates that the services sector is responsible for providing a considerable amount of intermediate inputs to domestic manufacturers.

More recently, the availability of IIO tables and the discussions about the impacts of services sector liberalization, as well as the negotiations to achieve such liberalization through trade agreements, has driven to analysis on measuring trade in services in terms of value-added. Figure 2.12 shows that services contribute with more than half of global value-added exports, though this varies significantly across countries. For instance, the share of

services value added in exports is over 50% in most OECD countries, while developing countries and large exporters of natural resources-intensive products show the lowest shares of services, reflecting its specialization patterns. Saudi Arabia (9%), Brunei (10%), and Colombia (26%) have the lowest shares of services. In India, however, the value of gross exports that originates in the services sector is about 5 per cent higher than the world average. Figure 2.12 reveals that most countries that already showed high degrees of service content of its exports had deepening their shares from 1995 to 2011, and the opposite pattern can be seen among the countries with the lowest shares of services.

Figure 2.12 - Services value-added, % of gross exports, 1995 and 2011



Source: Own elaboration based on OECD-WTO TiVA database (December 2016).

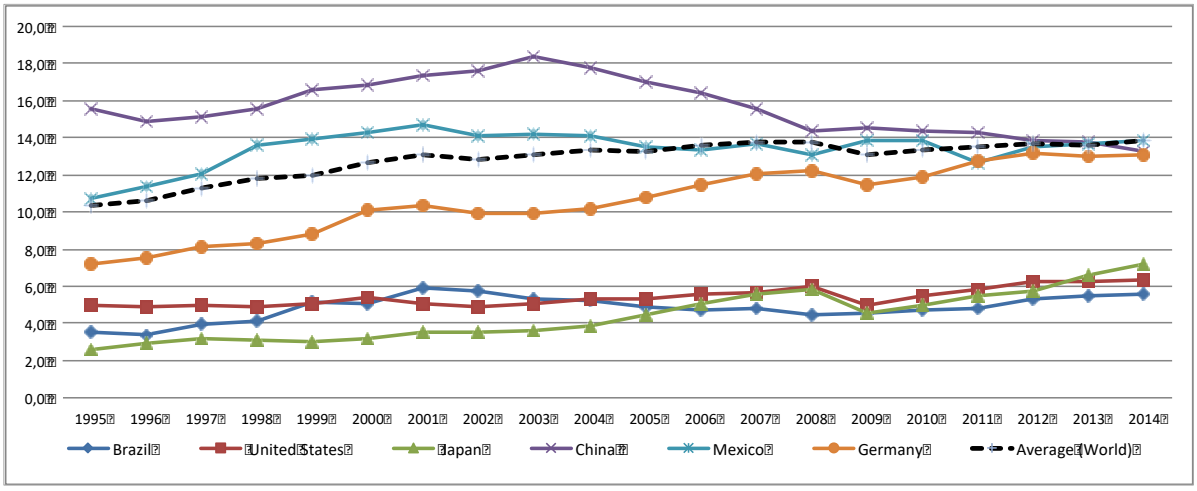
Further on, the services content of gross exports can be decomposed into domestic [108] and foreign shares. The difference between OECD countries and emerging economies can be partially explained by the relative higher degree of domestic outsourcing of services by manufacturers in OECD countries (AHMAD, 2013). However, the contribution of foreign service providers is not negligible. In the recent period, the share of foreign services

[108] The domestic part can be further decomposed into *direct* and *indirect* components, which are related to the value added from the exporting services sectors and the part embodied in other exporting industries, respectively.

VA in global exports is increasing, reflecting the internationalization of services in GVCs (Figure 2.13). Hence, services industries are also changing the way they operate[109].

Figure 2.13 reveals that Mexico and China showed higher foreign services value-added shares of gross exports, compared to the world average. Over time, the former has shown a more stable pattern, while the latter showed a marked fall since 2003. Even though China remains at a high level, China's entry into the World Trade Organization (WTO) in December 2001 does not correspond to a deeper Chinese integration into the world economy, at least not in terms of the internationalization of its services value-added. Germany shows a trajectory very similar to the world average, almost doubling its shares of foreign service VA between 1995 and 2011. Meanwhile, Japan overlapped among the top-bottom countries, leaving the last place in the ranking in 1995 and surpassing Brazil and USA in 2011 (2.6% to 7.2%).

Figure 2.13 - Foreign services value added, % of gross exports, selected countries and world, 1995-2014



Source: Own elaboration based on OECD-WTO TiVA database (December 2016) and TiVA Nowcast Estimates.

Services play a crucial role in GVCs, both through the activities needed for the development of value chains (*services as enablers in value chains*) and through the creation of their own value chains (*services as tasks in value chains*) (NATIONAL BOARD OF TRADE, 2013b)[110]. Communications, insurance, finance, and other business services are some of the

[109]Miroudot (2017) also pointed that companies have amplified the range of services that they provide and created new forms of relationship with customers, especially in the financial, transport, telecommunication, distribution and other businesses services sectors.

[110] Other concepts commonly used are "embodied services", which is defined as services whose product constitutes an input into the manufacture of a good (e.g. transport, telecommunications, and business services), and "embedded services", which constitute an input into the sale of a good (e.g. retail and after-sales support) (LOW, 2013). This is critical for statistical analysis, once the same service can enter value chains at different stages, and these categories are not clear distinctions between arm's length and non-arm's length transactions. In that sense,

enabling services (or facilitators or glue) in GVCs that support the creation of value chains. But services are also being unbundled and traded as separate tasks, e.g. data processing services and banking, which turned exporting services also susceptible to offshoring and outsourcing. Therefore, services are not only "the glue that holds supply chains together and ensures that they function in a fluid manner (…), they are also part of many production and sales processes" (LOW, 2013, p. 2). See Figure 2.14 for examples of services along the value chains.

Figure 2.14 - Examples of services along the value chain

Product development →	**Manufacturing →**	**Distribution →**	**Sales →**	**After-sale services**
Research and development	Manufacturing services	Warehousing	Legal services	Financial services
Engineering services	Management consulting	Logistics	Accounting services	Insurance services
Technical testing	Transport services	Transport services	Financial services	Rental/Leasing
Design services	Building-cleaning services	Printing, publishing	Advertising	Maintenance and repair
Market research	Telecommunications	Packaging	Wholesale and retail trade	Technical testing
Telecomunnications	Computer services			Information services
Computer services				

Source: Own elaboration based on WTO (2014).

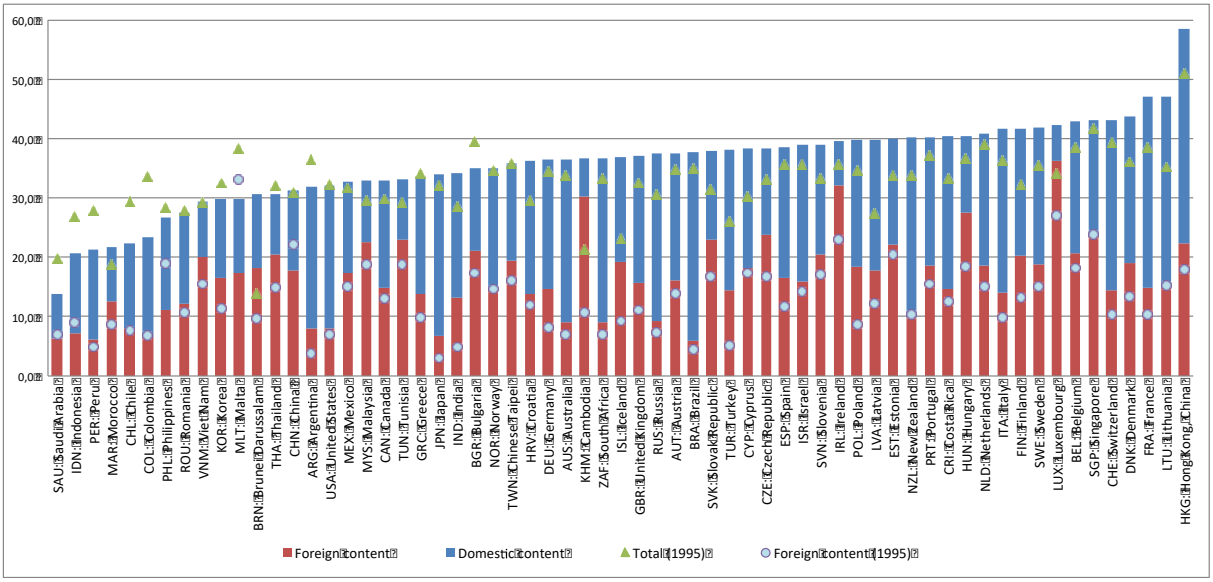
The manufacturing sector increasingly uses services as activities needed in production processes and sales, in a phenomenon that has been called "servicification" of manufacturing (LOW, 2013; WTO, 2014). Considering the interconnection between services and manufacturing activities in value chains, this phenomenon is closely related to GVCs. Production processes exhibit an increasing need to coordinate multiples stages of a global production chain, as GVCs have become more pervasive and intermediate goods are crossing borders multiple times. This led to a growing services content of manufactured goods, due to the need of linking stages and guarantee increased product diversity and customization of products (MAURER; DEGAIN, 2012). Consequently, services can take a much larger share in the domestic content of a manufactured product than manufacturing *per se*, what is more commonly seen in advanced countries.

the authors suggest that for statistical purposes is the contractual nature of the supply relationship that should be taken into consideration.

One way of capturing the increasing importance of services within manufactured goods is by measuring the service value added embodied in the exported good. Figure 2.15 shows the services value-added content of exports of manufacturing industries. On average[111], services value-added accounts for about one-third of manufacturing exports (32 per cent) in 1995, and it has increased over time (35 per cent in 2011).

The results confirm that the most developed countries (especially European economies) showed the highest shares of indirect services trade, while developing countries are among those with the lowest share of service value-added in manufacturing exports. Over time, developed economies have deepening the servicification of manufacturing. However, this trend is not verified for all countries. Among those with the lowest services content of manufacturing exports, as Saudi Arabia (19.9% in 1995 to 13.8% in 2011), Indonesia (27% to 20.7%), Peru (27.9% to 21.4%), and Chile (29.4% to 22.4%), one may observe that the services value-added shares of manufacturing exports have decreased.

Figure 2.15 - Services value-added content of manufacturing exports, as % of gross exports, 1995 and 2011



Source: Own elaboration based on OECD-WTO TiVA database (December 2016).

Another important feature of the servicification of manufacturing is the relocation of services activities from a domestic to a foreign economy, i.e. services offshoring. In that sense, the changes in the international backward linkages of manufacturing in relation to

[111] Beyond the 63 countries in the sample, we included the model for the "Rest of the World" (RoW) in TiVA database.

services pointed to an increasing share of foreign services value-added in manufacturing exports, from 13 to 16.4 per cent between 1995 and 2011.

There are other important dimensions of servicification. On the one hand, services are increasingly being sold bundled with goods (MIROUDOT, 2017). The author argued that most of the distinction between firms that are producing goods and firms producing services is largely artificial, because manufacturing firms are responsible for a great part of services sales and exports. Beyond that, the author considers in-house services within manufacturing firms a key feature of servicification (i.e. "servicification inside firms"). Heuser and Mattoo (2017) argued that the role of services as inputs in GVCs changed the notion of GVCs centered in arm's length market-based transactions to functions within the firm[112]. But this is a tricky feature, once those activities are difficult to measure and, when taken to the limit, only "can be identified as services in the sense that if they were outsourced they would belong to services industries" (MIROUDOT, 2017, p. 2).

Miroudot and Calestin (2017) estimated that about the in-house provision of services is about 18% of the value-added in exports. In that sense, the share of services in manufacturing exports would increase from one-third to half the value-added exports. Therefore, not only services in GVCs are becoming more international, but also there is a qualitative change in companies' behavior with services redefining how manufacturing firms produce value (MIROUDOT, 2017). Moreover, Baldwin, Forslid, and Ito (2015) argued that some of the potential causes of this phenomenon are: i) reclassification (what was once considered manufacturing, as it was produced in-house by manufacturing firms, now is classified as services); ii) changes in connecting services and goods, as well as in the nature of final manufactured goods; and iii) changes in the relative price of tasks, with some manufacturing tasks being offshored driven by lower-cost reasons. However, the causes behind servicification are still an open question in the literature.

Fact 6. China and Mexico are crossing roles regarding the use of intermediate imports as source of international competitiveness to their exports.

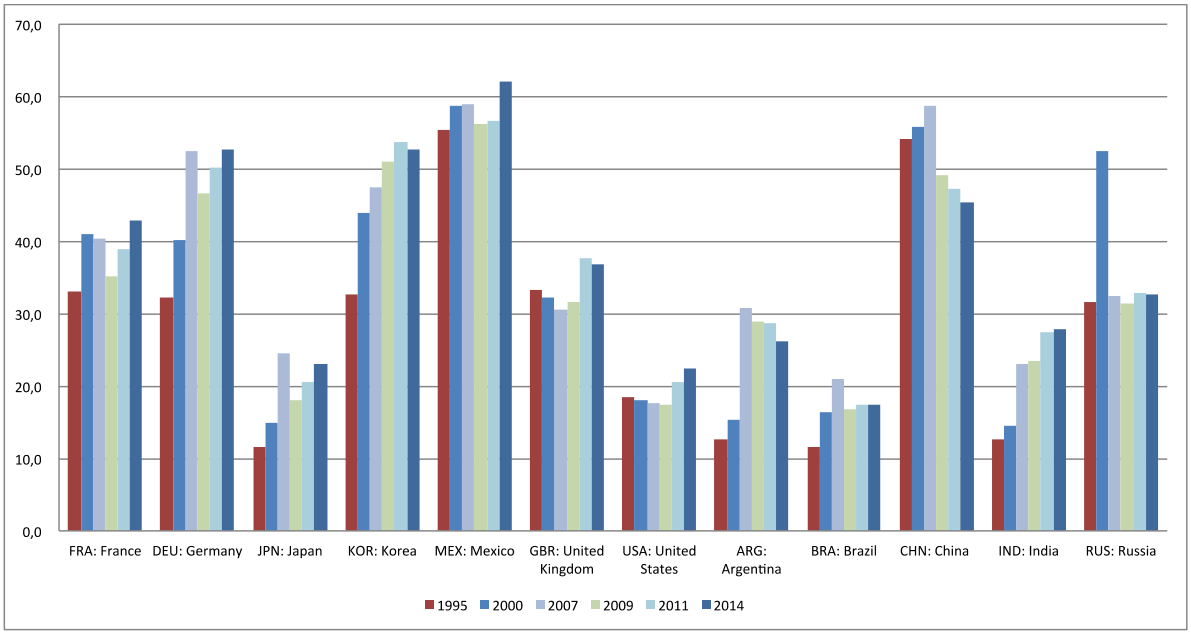
The increasing use of intermediate imports embodied in exports is usually posed as a source of international competitiveness. To assess the importance of intermediate imports to

[112] It is important to note that value-added analysis does not capture the contribution of in-house inputs in GVCs. To address this challenge, the authors point to the use of business functions, which have only recently started to be collected in national surveys.

produce goods and services for export, Figure 2.16 depicts the imported intermediate inputs embodied in exports as a share of total intermediate imports for selected countries in the years of 1995, 2000, 2007, 2009, 2011, and 2014. Among the selected countries, Germany, France, Japan, Mexico, India, and Korea showed an upsurge trend over most of the period. However, all countries suffered with the global trade shock during the financial crisis, except for UK and India that showed a slight increase, and Korea, which maintained a steady upward trend until 2011. Brazil, United States, and Japan are among the countries with the lowest levels.

This indicator has an economy size bias, since the smaller the country the larger the share of imported intermediates that are used in production as a share of total intermediate inputs. But this does not explain completely its magnitude or trend, as changes over time can also reflect changes in specialization. China and Mexico are the countries with the largest extensions, but they showed distinct behaviors over time, with Mexico becoming more dependent of intermediate imports embodied in their exports and China running in the opposite direction. The share of re-exported intermediate imports in China fell between 2007 and 2014, from 58.8% to 45.4%. Although this pattern differs across industries, overall China has declined its role as the final point in Factory Asia. This would be one of the key dimensions of a much broader structural transformation in China, which is mostly discussed in terms of its change from investment-led growth to consumption-led growth (LEE; PARK; SHIN, 2016). Further on, intermediate imports can play a crucial role as a determinant of export diversification, especially for producing products located downstream along the GVC (BENGURIA, 2014). Thus, the decline in re-exported intermediate imports in China may have impacts not only on the exports of Chinese trade partners, especially East and Southeast Asian economies, but on the Chinese capacity of producing new products.

Figure 2.16 - Re-exported intermediate imports as % of intermediate imports, selected major countries, 1995, 2000, 2007, 2009, 2011, and 2014



Source: Own elaboration based on OECD-WTO TiVA database (December 2016) and TiVA Nowcast Estimates.

Fact 7. A limited number of countries had the ability to become more integrated into GVCs hand in hand with upgrading in complexity of production.

The rise of measures of "economic complexity" has extended our ability to capture the new patterns in the structural transformation of countries. Even though there is a vast literature about the relationship between a country's productive structure and its ability to generate economic growth [113], emphasizing the importance of industrialization in its development strategies[114], most of the traditional metrics of a country's productive structure fail to capture the sophistication of the products into account. In that sense, the complexity of an economy, which is expressed in the composition of a country's productive output, is related to the multiplicity of useful knowledge embedded in it and reflects its capability set (HAUSMANN *et al.*, 2011). Put it simply, it is possible to measure a country's economic complexity from the mix of products that it is able to make[115].

[113] See recent work by Hartmann *et al.* (2017) on how productive structures of countries can be associated not only with economic growth, but also with a country's average level of income inequality.
[114] See Hirschman (1958), Rosenstein-Rodan (1943), Singer (1950), and Prebisch (1949).
[115] As one of the main concerns of the *Atlas of Economic Complexity* is to understand how complexity evolves over time and across countries, it is important to consider the limits of increasing the amount of knowledge embedded in an economy. Because this tacit knowledge is difficult to obtain and transfer, it is argued that new capabilities are easily accumulated whether they are combined with others that are already available. An intuitive implication is that countries tend to diversify towards products that require a similar set of capabilities. Instead of identifying the precise technical and institutional requirements of each product, which would require a large

Figure 2.17 shows a positive correlation between GVC participation and a country's economic complexity index (ECI)[116]. Among the selected countries, Japan is the economy with the highest level of economic complexity, followed by Germany and the United States, respectively. Curiously, Mexico is on a step above China in terms of the complexity of its production, which despite being more integrated into CGVs, has an ECI level relatively close to the Brazilian one.

Over time, the measure of economic complexity provides a broad indication of a country's upgrading relative to other countries (HAUSMANN *et al.*, 2011). Figure 2.18 shows the changes in ECI ranking (i.e. countries' relative upgrading in complexity of production) on the y-axis and changes in GVC participation index on the x-axis between 1995 and 2011.

South Korea almost doubled both its ECI and its GVC participation index over the period, leaping from 22nd to 7th place in the ECI ranking. Mexico has also climbed the ladder of complexity of production (from 25th to 22nd), while becoming more integrated into GVCs. Surprisingly, going against what the *sixth stylized fact* would lead us to believe, China became more integrated into world trade while advancing 15 places in the ECI ranking (from 42nd to 27th). This means that China has achieved a greater diversification of its exports, although relying less and less on imported inputs. However, Figure 2.18 shows that a limited number of countries had the ability to become more integrated into GVCs hand in hand with scaling them up.

The top-ranked countries invalidate a linear relationship between the two measures. Over time, Japan, Germany, and Switzerland saw its ECI fall in absolute terms, while increasing its GVC participation, but relative to other countries, they remained ranked as first, second, and third most of the period (Figure 2.18 and Figure 2.19). Other countries have experienced a similar process in which higher levels of GVC participation were not reflected in relative upgrading in complexity of production. For instance, France increased its GVC participation index by 12 per cent and fell from ninth to 14th in the ECI ranking, United Kingdom increased 11% and scaled down three places, and the United States increased 10% and dropped four places. Although Brazil and Germany experienced a similar ECI decrease in absolute terms, as

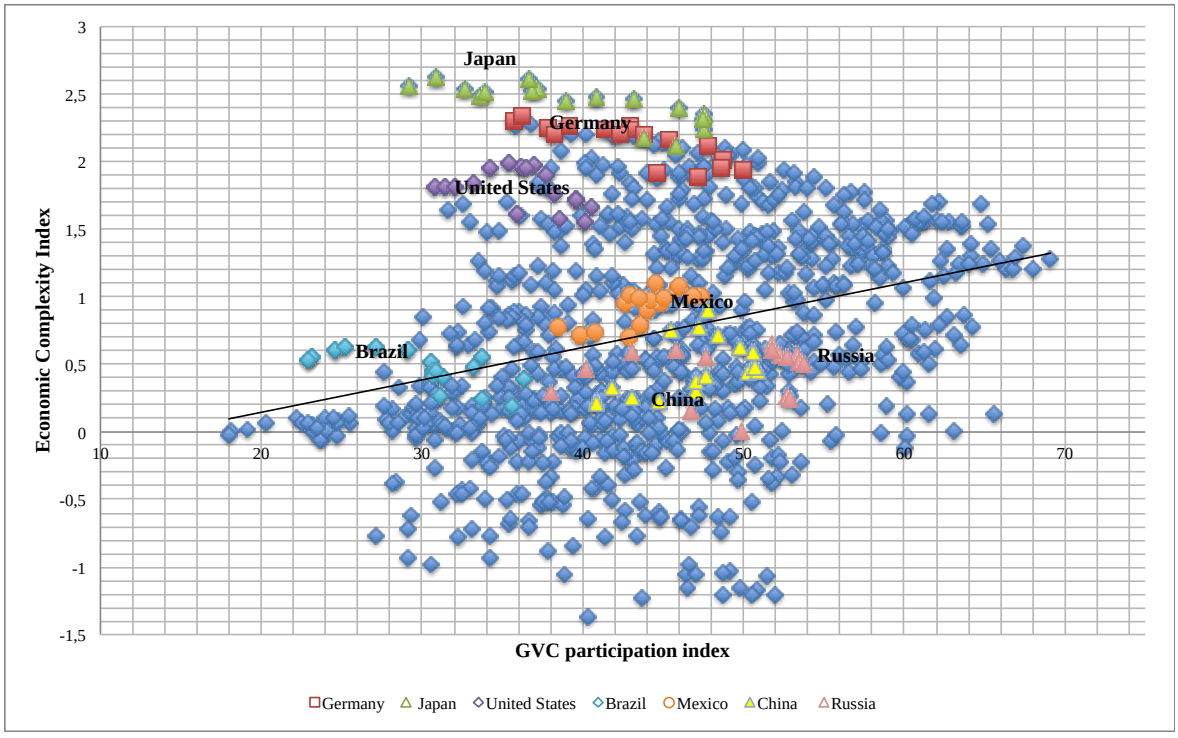
volume of information, the authors measure the *proximity* between all pairs of products in the dataset. The idea is that the probability of a pair of products to be co-exported reveals that they have related characteristics and, more importantly, require similar productive knowledge. Hence, the set of all proximities is a network that connects pairs of products highly likely to be jointly exported by several countries, which is named *product space*. A country's position in the product space reveals its current productive knowledge and its ability to learn by moving into other bordering products. One can analyze a country's position in the product space by measuring its *opportunity value*, i.e. the distance to alternative and more complex products. Overall, countries with low levels of ECI tend to produce products that are peripheral in the product space, showing a few opportunities available.

[116] See Box 1 for how the ECI is constructed by Hausmann *et al.* (2011).

well as a close increase in the GVC participation index, Brazil plunged 18 positions (from 30th to 48th) while Germany fell one place (2nd to 3rd). Therefore, it cannot be said that there is a simple positive association between larger GVC participation and upgrading, at least in terms of the complexity of production of the top-ranked countries.

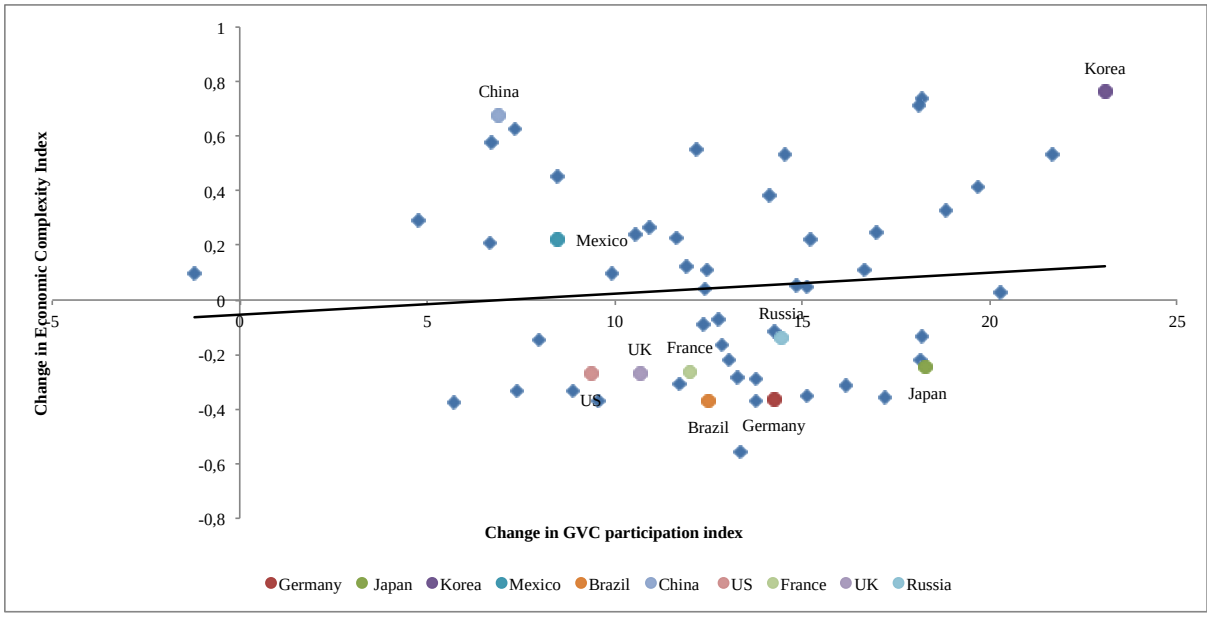
The relationship between economic complexity and the GVC participation index has to be interpreted carefully. First, the reader should not confuse such an association with a causal relationship. But beyond that, the ECI is based on gross trade statistics, so countries that integrate low-value processing tasks at the end of complex products will show higher economic complexity measures (AHMAD; PRIMI, 2017).

Figure 2.17 - GVC participation index and Economic Complexity index, 1995-2011



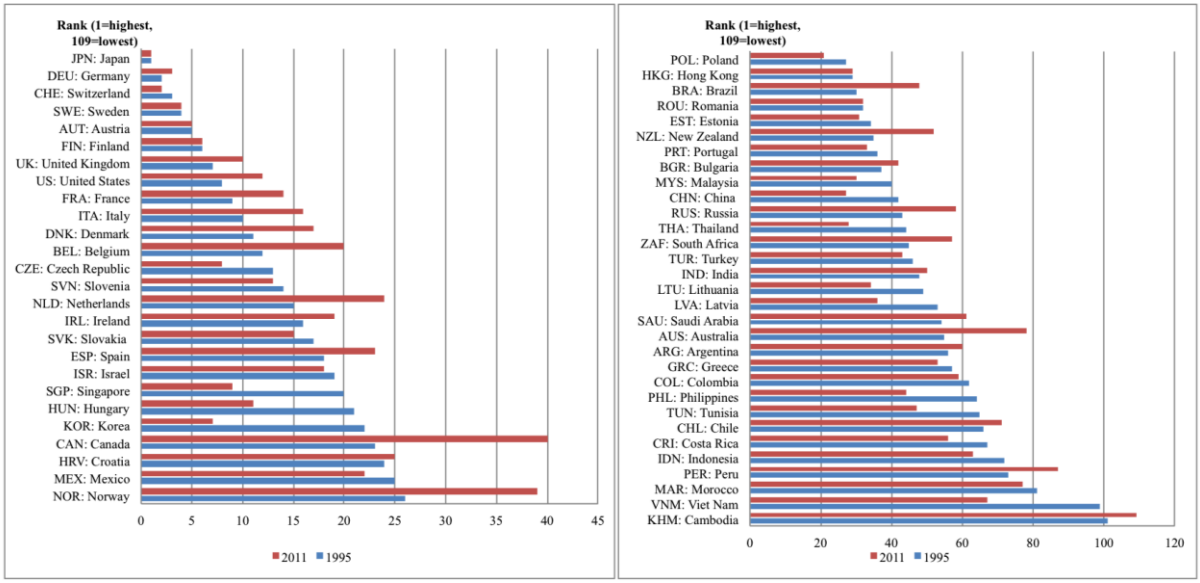
Source: Own elaboration based on OECD-WTO TiVA database (December 2016) and Simoes and Hidalgo (2011).
Notes: (1) each dot represents a country-year combination. Due to unavailability of ECI data, six countries (Taiwan, Malta, Cyprus, Brunei, Luxembourg, and Iceland) were withdrawn from the sample, which was based on all other TiVA countries.

Figure 2.18 - Change in the GVC participation index and change in economic complexity index between 1995 and 2011



Source: Own elaboration based on OECD-WTO TiVA database (December 2016) and Simoes and Hidalgo (2011).
Note: (1) due to unavailability of ECI data, six countries (Taiwan, Malta, Cyprus, Brunei, Luxembourg, and Iceland) were withdrawn from the sample, which was based on all other TiVA countries.

Figure 2.19 - Economic Complexity rankings, 1995 and 2011



Source: own elaboration based on Simoes and Hidalgo (2011).

Box 2.1 - The Economic Complexity Index

Hausmann *et al.* (2011) constructed a measure of economic complexity, which turned possible to compare the level of productive sophistication across countries. By using computational, network and complexity tools, their analysis is built on two simple concepts: the *ubiquity* of its products and the *diversity* of a country. Ubiquity is defined as the number of countries that make a product, revealing how much knowledge is required for its production, i.e. complex products require a large set of capabilities and then are less ubiquitous. However, low ubiquity can be originated in scarcity, such as rare natural resources like uranium and diamonds. To control for whether the low ubiquity is the result of scarcity or complexity of a given country, the authors compare it with its diversity, i.e. the number of distinct products that the makers of rare products are able to produce. The intuition behind this measure is that complex economies are able to produce a diverse set of products that, on average, have low ubiquity, given that these products involve large volumes of knowledge that only a few countries have available. For countries, this measure is named Economic Complexity Index (ECI) and the corresponding measure for products is the Product Complexity Index (PCI).

Defining M_{cp}= if country $_c$ produces product $_p$, and M_{cp}=0 otherwise:

$$\text{Diversity} = k_{c,0} = \sum_p M_{cp} \quad (1)$$
$$\text{Ubiquity} = k_{p,0} = \sum_c M_{cp} \quad (2)$$

Weighted values are generated through an iterative procedure:

$$k_{c,N} = \frac{1}{k_{c,0}} \sum_p M_{cp}.k_{p,N-1} \quad (3)$$
$$k_{p,N} = \frac{1}{k_{p,0}} \sum_c M_{cp}.k_{c,N-1} \quad (4)$$

Inserting equation (4) into (3) to obtain:

$$k_{c,N} = \frac{1}{k_{c,0}} \sum_p M_{cp}. \frac{1}{k_{p,0}} \sum_{c'} M_{c'p}.k_{c',N-2} \quad (5)$$
$$k_{c,N} = \sum_{c'} k_{c',N-2}.\sum \frac{M_{cp}M_{c'p}}{k_{c,0}k_{p,0}} \quad (6)$$

And it follows that:

$$k_{c,N} = \sum_{c'} \widetilde{M_{cc'}}\ k_{c',N-2} \quad (7)$$

Where,

$$\widetilde{M_{cc'}} = \sum \frac{M_{cp}M_{c'p}}{k_{c,0}k_{p,0}} \quad (8)$$

Equation (7) is satisfied when $k_{c,N}=k_{c,N-2}=1$. This is the eigenvector of $\widetilde{M_{cc'}}$ associated with the largest eigenvalue. Thereby, they look for the normalized eigenvector associated with the second largest eigenvalue, which is the eigenvector that captures the largest amount of variance in the system. The economic complexity index (ECI_c) for a given country $_c$ is then defined as:

$$ECI_c = \frac{\rho_c - <\rho>}{stdev\ (\rho)} \quad (9)$$

With < > representing an average and *stdev* indicating the standard deviation.

Source: Own elaboration based on Simoes and Hidalgo (2011).

Fact 8. Trade (im)balances in value-added terms: bilateral trade deficits or surpluses may not be exactly what it seems.

Bilateral trade balances between countries may considerably change whether measured in value-added terms. That is because it considers the actual origin of the intermediate

inputs, re-allocating the value-added of imports and exports. This means that the surpluses and deficits with trade partners are redistributed, while the total trade balance with the world does not change rather based on value-added or gross terms. Value added trade balance captures the difference between any two countries' domestic value added in foreign final demand and foreign value added in domestic final demand, discounting the double-counted part of trade flows. This stylized fact was already pronounced in earlier studies (JOHNSON; NOGUERA, 2012; KOOPMAN; WANG; WEI, 2008; NAGENGAST; STEHRER, 2015; WTO, 2013).

Figure 2.20 shows eight countries' bilateral trade balances, measured in gross and in value-added terms. Both goods and services are considered, and the trade balances are shown with respect to the five main trading partners in gross terms for the year of 2011. For example, Mexico's trade surplus with the United States is reduced by almost half if measured in value added terms, while its trade deficit with China is reduced to one third. China's trade rebalance reinforces its importance as a processing hub of imported intermediates from other countries. Considering the sum of Brazil's five main export-markets, the Brazilian trade deficit is reduced by almost 30 per cent in value-added terms. A similar change is felt by the US economy, considering its five main export markets but mostly driven by the trade rebalance with China. Further on, there is a considerable decrease in the trade surplus of East and Southeast Asian countries with China in value-added terms. Some countries showed higher balances with their trading partners if analyzed in value added terms, as is the case of Germany's surplus with the US and with the UK, as well as Korea and Japan's surplus with the US.

The different outcomes of bilateral trade balance in value added and gross terms are a reflection of the relative position of countries in GVCs (ANTRÀS *et al.*, 2012). Those countries that are most at the final stages of the GVC have their trade balances reshaped by the incorporation of foreign inputs, i.e. trade imbalances are created with the countries that act as suppliers of intermediate inputs to the final producer.

Moreover, bilateral trade imbalances illustrate how difficult is to analyze the real impact of currency devaluation or appreciation within GVCs[117]. According to Koopman *et al.* (2008), the lower the domestic value-added share in a country's gross exports, the smaller the effect of that country's currency appreciation on trade volume, other things being equal. Put it simply, having a high foreign value-added share in exports, currency depreciation turns exports of final goods cheaper at the same time it makes imported inputs more expensive for domestic producers (OECD, 2013). Overall, it is important to highlight that these results have serious

[117] Riad *et al.* (2011) shows that trade balance adjustment in response to exchange rate changes is weaker within the supply chain than outside it.

policy implications, such as the potentially distorted effects that protectionist measures may have in the context of complex interactions between foreign and domestic value added.

Figure 2.20 - Bilateral trade balances measured in value-added and gross terms, 2011 (US$ millions)

Source: Own elaboration based on OECD-WTO TiVA database (December 2016).

Fact 9. RCA in value added: not all countries that have deepen their domestic value added to their exports have gained competitiveness, but at least they remained competitive.

The revealed comparative advantage (RCA) is a widely used measure of sector competitiveness and specialization patterns. While the traditional measure of RCA is based on gross exports, the RCA in value-added terms nets out foreign value added imported into the economy. Based on domestic value added embodied in gross exports, as in Koopman *et al.* (2014), this indicator considers international production sharing and avoids the problems of multiple counting. Figure 2.21 computes the RCA index in gross and value-added terms at the country-sector level for all TiVA countries and four selected sectors (*machinery and equipment, nec*[118]*; electrical and optical equipment; transport equipment; and total business sector services*).

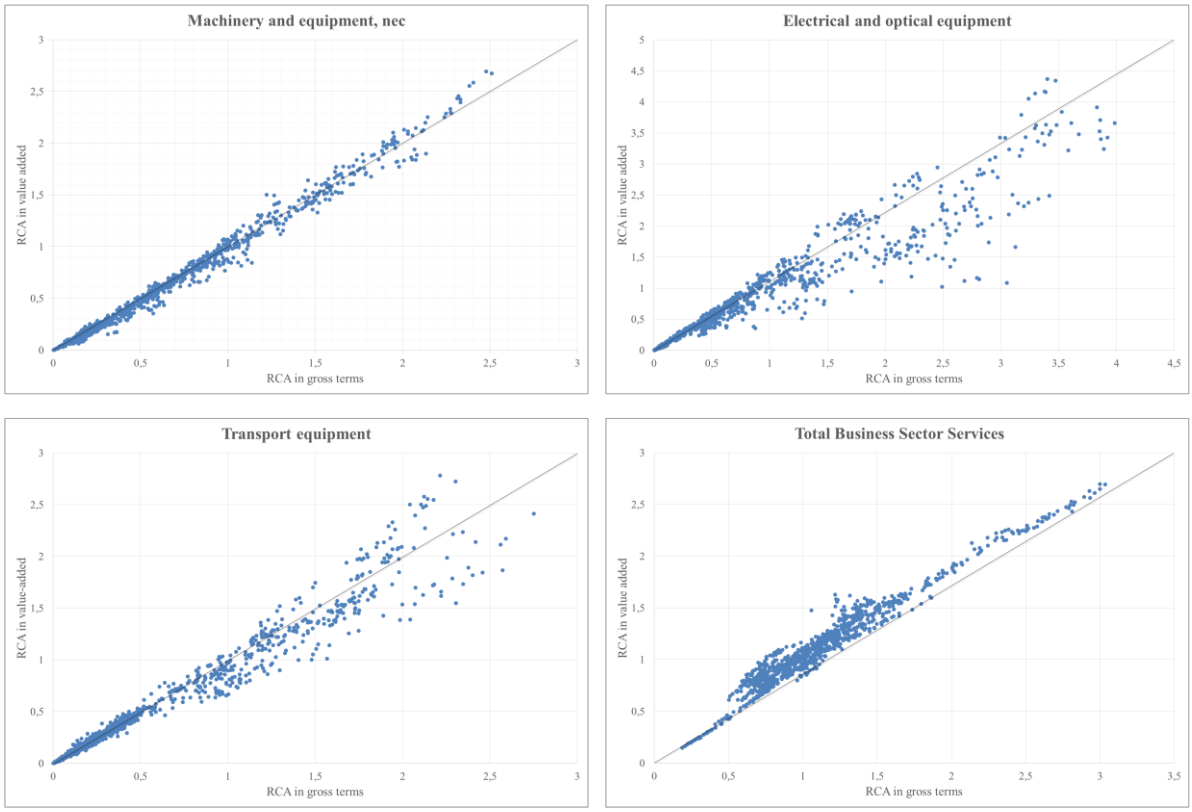
Comparing on a 45-degree diagram gross and value-added RCA indexes for the selected sectors, in which each dot represents a country-year combination, the considerable difference between such measures becomes perfectly clear. This difference varies according to the analyzed sector, being more significant in the sectors most influenced by GVCs, such as transport equipment and electrical and optical equipment. It is also true that such difference varies according to the country's position in the value chain. Countries located more in the downstream part of the value chain (i.e. closest to final demand) show higher values of RCA in gross terms than in value-added terms, falling to the bottom of the 45-degree line (ESCAITH, 2014). This reflects the problem of multiple counting of intermediate inputs, i.e. countries may incorporate in their apparent comparative advantage the re-exported value added of upstream suppliers (WTO, 2014). This is the case of the United States and Mexico in machinery and equipment, and transport equipment and electrical and optical equipment sectors for the latter country, and Japan in the total business sector services. On the other hand, countries show higher values of RCA in value-added terms whether located more upstream in the value chain (R&D; production of components). For instance, Germany and Japan in all selected sectors, except for business services for the latter, and Brazil in transport equipment and electrical and optical equipment.

Given such relationship with a country's position in the GVCs, and considering the first stylized fact, one may say that China has become more competitive in the production of

[118] Nec = not elsewhere classified.

components, since the country had higher RCA indexes in gross terms until 2001 (year that marked its entry into the WTO), and since then has had higher RCA indexes in value-added terms in all manufactured sectors.

Figure 2.21 - RCA in gross and value-added terms, selected industries, 1995-2011



Source: Own elaboration based on OECD-WTO TiVA database (December 2016).
Note: RCA indices are calculated for all TiVA countries, each dot represents a country-year combination.

By comparing the share of a given industry in a country´s export to the world share of the industry in world exports, a country is considered to have comparative advantage in a sector if its RCA is greater than one. Table 2.2 illustrates all TiVA countries that showed revealed comparative advantage in each analyzed sector in the year 2011. Among the largest countries, Germany, Japan, Korea, and Mexico reveal comparative advantage in all three manufacturing sectors. As it was expected, Asian countries stand out among those with comparative advantage in electrical and optical equipment. Based on gross exports [119], Germany, Sweden, Romania and Finland´s RCA index is lower than 1, but when domestic value-added is used it becomes greater than 1 in electrical and optical equipment, while Vietnam has comparative advantage in gross but not in value-added terms, reflecting the

[119] To synthesize the results found, table 2.1 presents only the results in value-added.

importance of intermediate imports. In the case of transport equipment, when the foreign content of exports is disregarded, Italy has comparative advantage, and on the contrary, Slovenia and Portugal no longer have RCA larger than 1. In the business sector services, Japan and Norway lost their comparative advantage whether it is calculated in value-added, while Bulgaria and Thailand show signs of becoming more specialized in that sector, and this latter country has also lost its fallacious comparative advantage in machinery and equipment. Further on, Table 2.3 reveals a considerably higher number of countries with comparative advantage in the case of total business services (34 of 63 countries in the sample).

Table 2.2 - Countries with RCA in value-added terms, 2011

Industry	**Countries with RCA in value-added terms (RCA>1)**
C29: Machinery and equipment, nec	Austria, Czeck Republic, Denmark, Finland, Germany, Hungary, Italy, Japan, Korea, Mexico, Slovakia, Slovenia, Sweeden, Switzerland, United States, China, Romania
C30T33: Electrical and optical equipment	Czech Republic, Estonia, Finland, Germany, Hungary, Israel, Japan, Korea, Mexico, Slovakia, Sweeden, Switzerland, China, Costa Rica, Malaysia, Philippines, Romania, Singapore, Taiwan, Thailand, Tunisia
C34T35: Transport equipment	Canada, Czeck Republic, France, Germany, Hungary, Italy, Japan, Korea, Mexico, Poland, Slovakia, Spain, Sweeden, Turkey, United Kingdom, United States, Argentina, Romania
C50T74: Total Business Sector Services	Austria, Belgium, Denmark, Estonia, France, Greece, Iceland, Ireland, Israel, Latvia, Luxembourg, Netherlands, New Zealand, Portugal, Spain, Sweeden, Switzerland, Turkey, United Kingdom, United States,Bulgaria, Cambodia, Costa Rica, Croatia, Cyprus, Hong Kong, India, Lithuania, Malta, Morocco, Philippines, Singapore, Thailand, Tunisia

Source: Own elaboration based on OECD-WTO TiVA database (December 2016).

The findings outlined in Table 2.3 show that comparative advantages change over time. It shows the difference between the RCA (traditional and value-added) in 2011 and 1995. Considering both gross and value-added RCA, countries such as Mexico, Indonesia, Germany, and India have become more specialized in all manufactured sectors analyzed, with the latter two also gaining in the business services sector. On the contrary, Belgium and Hong Kong have lost comparative advantage in manufacturing and gained in services sector. More importantly, Table 2.3 shows substantial changes in the distribution of RCA across countries and industries over time whether calculated based on gross or value-added terms (countries in bold indicate

variations between gains and losses). For example, according to the traditional measure, France lost RCA, however it has gained in value-added terms in machinery and equipment, as well as Demark, Finland, and Philippines in the case of electrical and optical equipment.

Table 2.3 - RCA gains and losses in gross and value-added terms, 1995-2011

Industry	Countries that gain RCA (in gross terms)	Countries that gain RCA (in value-added terms)	Countries that lose RCA (in gross terms)	Countries that lose RCA (in value-added terms)
C29: Machinery and equipment, nec	Austria, Canada, Chile, Czech Republic, Finland, Germany, Hungary, Iceland, Japan, Korea, Mexico, Netherlands, New Zealand, Norway, Poland, Portugal, Slovak Republic, Slovenia, Turkey, Brazil, Bulgaria, China , Croatia, India, Indonesia, Peru, Philippines, Romania, Saudi Arabia, Singapore, South Africa, Thailand, Tunisia, Viet Nam	Austria, Canada, Chile, Czech Republic, Finland, **France,** Germany, Hungary, Iceland, Japan, Korea, Mexico, Netherlands, New Zealand, Norway, Poland, Portugal, Slovak Republic, Slovenia, **Spain, Sweden,** Turkey, Brazil, Bulgaria, China , Croatia, India, Indonesia, **Malta,** Peru, Philippines, Romania, Saudi Arabia, Singapore, South Africa, Thailand, Tunisia, Viet Nam	Australia, Belgium, Denmark, **France,** Greece, Ireland, Israel, Italy, Latvia, Luxembourg, **Spain, Sweden,** Switzerland, United Kingdom, United States, Argentina, Brunei Darussalam, Cambodia, Colombia, Costa Rica, Cyprus, Hong Kong, Lithuania, Malaysia, **Malta,** Morocco, Russia, Taiwan	Australia, Belgium, Denmark, Greece, Ireland, Israel, Italy, Latvia, , Lithuania, Luxembourg, Switzerland, United Kingdom, United States, Argentina, Brunei Darussalam, Cambodia, Colombia, Costa Rica, Cyprus, Hong Kong, Lithuania, Malaysia, Morocco, Russia, Taiwan
C30T33: Electrical and optical equipment	Austria, **Canada,** Chile, Czech Republic, Estonia, Germany, Greece, Hungary, Iceland, Israel, Italy, Korea, Latvia, Luxembourg, Mexico, New Zealand, Norway, Poland, Slovak Republic, Slovenia, Switzerland, Turkey, Bulgaria, Costa Rica, Croatia, Cyprus, India, Indonesia, **Malaysia**, Morocco, Romania, Saudi Arabia, Taiwan, Tunisia, Viet Nam	Austria, Chile, Czech Republic, **Denmark,** Estonia, **Finland,** Germany, Greece, Hungary, Iceland, Israel, Italy, Korea, Latvia, Luxembourg, Mexico, New Zealand, Norway, Poland, Slovak Republic, Slovenia, **Sweden**, Switzerland, Turkey, Bulgaria, Costa Rica, Croatia, Cyprus, India, Indonesia, Morocco, Romania, Saudi Arabia, **Philippines**, Taiwan, Tunisia, Viet Nam	Australia, Belgium, **Denmark, Finland,** France, Ireland, Japan, Netherlands, New Zealand, Portugal, Spain, **Sweden**, United Kingdom, United States, Argentina, Brazil, Brunei Darussalam, Cambodia, Colombia, Hong Kong, Lithuania, Malta, Peru, **Philippines,** Singapore, Russia South Africa, Thailand	Australia, Belgium, **Canada,** France, Ireland, Japan, Netherlands, New Zealand, Portugal, Spain, United Kingdom, United States, Argentina, Brazil, Brunei Darussalam, Cambodia, Colombia, Hong Kong, Lithuania, Malta, Peru, **Malaysia**, Russia, Singapore, South Africa, Thailand,
C34T35: Transport equipment	Austria, Chile, Czech Republic, Estonia, France, Germany, Hungary, Israel, Italy, Japan, Korea, Luxembourg, Mexico, New Zealand, Poland, Slovakia, Slovenia, Switzerland, Turkey, United Kingdom, United States, Argentina, Bulgaria, Cambodia, China, Colombia, Costa Rica, Croatia, India, Indonesia, Morocco, Philippinnes, Romania, Saudi Arabia, Singapore, South Africa, Thailand, Tunisia, Viet Nam	Austria, Chile, Czech Republic, Estonia, France, Germany, Hungary, Israel, Italy, Japan, Korea, Luxembourg, Mexico, New Zealand, Poland, Slovakia, Slovenia, Switzerland, Turkey, United Kingdom, United States, Argentina, Bulgaria, Cambodia, China, Colombia, Costa Rica, Croatia, India, Indonesia, Morocco, Philippinnes, Romania, Saudi Arabia, Singapore, South Africa, Thailand, Tunisia, Viet Nam	Austria, Belgium, Canada, Denmark, Finland, Greece, Iceland, Ireland, Latvia, Netherlands, Norway, Portugal, Spain, Sweeden, Brazil, Brunei Darussalam, Cyprus, Hong Kong, Lithuania, Malaysia, Malta, Peru, Russia, Taiwan	Austria, Belgium, Canada, Denmark, Finland, Greece, Iceland, Ireland, Latvia, Netherlands, Norway, Portugal, Spain, Sweeden, Brazil, Brunei Darussalam, Cyprus, Hong Kong, Lithuania, Malaysia, Malta, Peru, Russia, Taiwan
C50T74: Total Business Sector Services	Belgium, Canada, Denmark, Estonia, Finland, France, Germany, Iceland, Ireland, Israel, Luxembourg, Netherlands, Portugal, Slovenia, Sweeden, Switzerland, United Kingdom, United States, Bulgaria, Cambodia, Costa Rica, Croatia, Cyprus, Hong Kong, India, Malta, Morroco, Philippines, Romania, Singapore, Taiwan,	Belgium, Canada, Denmark, Estonia, Finland, France, Germany, Iceland, Ireland, Israel, Luxembourg, Netherlands, **Poland**, Portugal, Slovenia, Sweeden, Switzerland, United Kingdom, United States, Bulgaria, Cambodia, Costa Rica, Croatia, Cyprus, Hong Kong, India, Malta, Morroco, Philippines, Romania, Singapore, Taiwan,	Australia, Austria, Chile, Hungary, Italy, Japan, Korea, Latvia, Mexico, New Zealand, Norway, **Poland,** Slokavia, Turkey, Argentina, Brazil, Brunei, China, Colombia, Indonesia, Lithuania, Malaysia, Peru, Russia, Saudi Arabia, South Africa, Thailand, Tunisia, Viet Nam	Australia, Austria, Chile, Hungary, Italy, Japan, Korea, Latvia, Mexico, New Zealand, Norway, Slokavia, Turkey, Argentina, Brazil, Brunei, China, Colombia, Indonesia, Lithuania, Malaysia, Peru, Russia, Saudi Arabia, South Africa, Thailand, Tunisia, Viet Nam

Source: Own elaboration based on OECD-WTO TiVA database (December 2016).
Note: (1) countries highlighted in bold indicate alternation of gain or loss depending on whether the RCA measure is in gross or value-added terms.

Further on, one of the questions that arises is whether higher levels of domestic value-added in gross exports are positively associated with higher levels of RCA. More specifically, are the countries that most added domestic value to their exports the ones that have made the most gains in sector competitiveness? Or would countries be doomed to gain competitiveness from higher imported content? Figure 2.22 shows RCA indexes in value-added terms for all TiVA countries and the four selected industries, with the year 1995 on the x-axis and 2011 on the y-axis, and the size of the bubble as the difference between domestic value-added content of sector's gross exports in 2011 and 1995.

The first countries in the RCA ranking for 2011, respectively, in the case of machinery and equipment, are Italy, Germany, and Japan. These countries are among those that added the highest domestic value in the period analyzed, although they already played a prominent role in the 1995 ranking. In addition, China has boosted its sector competitiveness, showing a considerable RCA gain (0.46 for 1.42) at the same time that it was the country that most added domestic value from the sample. It is interesting to note that other countries also added a substantial amount of domestic value in their exports, but failed to advance in the gains of specialization such as the Chinese example, as is the case of the US economy that remained practically with the same RCA index. Despite higher sums of DVA in 2011, most countries remained with low RCA indexes.

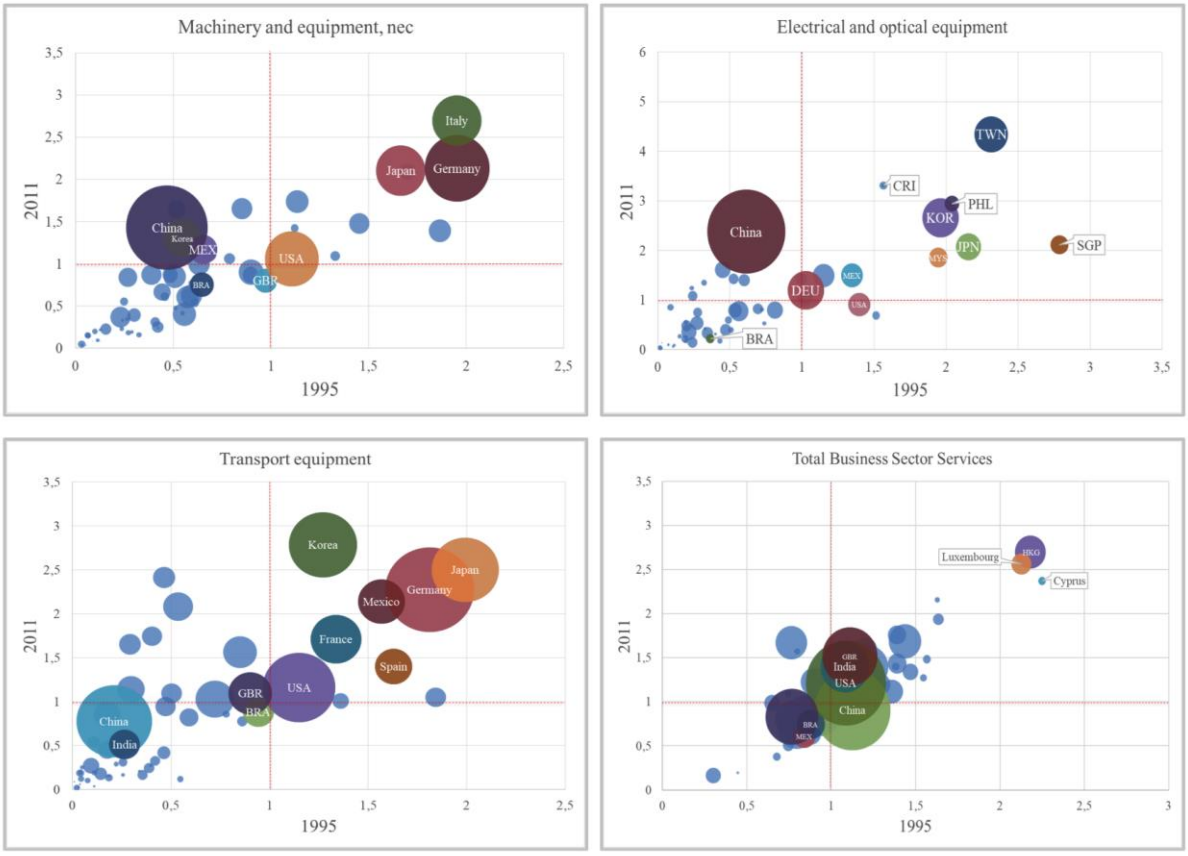
In the case of electrical and optical equipment, the countries of Southeast Asia occupy the first places of the ranking 1995 (Singapore, Taiwan, Japan, Philippines, Korea, and Malaysia). In 2011, Taiwan becomes the first in the ranking, followed by the one Latin American exception, Costa Rica, and other Asian countries - Philippines, Korea, China, Singapore, Japan, and Malaysia, respectively. Ireland and the United States are the only two countries that have lost RCA between 1995 and 2011. Once again, China becomes internationally competitive while adding enormous amounts of domestic value. Different from what happens in the sector of transport equipment, in which although the Chinese economy has a greater RCA index in 2011 when compared to 1995, it does not yet have an RCA greater than one. The United States, while considerably increasing its domestic value-added in exports, failed to translate this increase into competitiveness in the case of transport equipment. In that sector, Japan, Germany and Mexico are among the top five countries in the ranking of 1995 and 2011, and the countries with the highest increases in domestic value-added remained at RCA levels above one.

In total business sector services, the top three places are between Hong Kong, Luxembourg, and Cyprus, while most Latin American countries are lagging behind in terms of competitiveness gains. It also worth noting that this was the only sector in which China has dropped its RCA bellow one in 2011. In general, most countries were unable to move towards higher levels of RCA, even though there were considerable sums of domestic value being added.

Overall, the countries with the highest domestic value-added increases already had comparative advantages in the manufacturing sectors in 1995 and continued to have it in 2011, China aside. Therefore, countries are not doomed to resort to greater imported content to leverage their international competitiveness, but the positive relationship between higher levels

of domestic value-added and higher levels of RCA is a possibility restricted to a select group of countries.

Figure 2.22 - RCA in value-added terms and domestic value-added content of gross exports, selected industries, 1995 and 2011



Source: Own elaboration based on OECD-WTO TiVA database (December 2016).
Notes: (1) the size of the bubble is the difference between domestic value-added content of sector's gross exports in 2011 and 1995.

2.5 Partial concluding remarks

This chapter has explored some of the value-added trade measures to provide details about countries specialization patterns in vertically integrated production networks connected by international trade. It has illustrated the changing nature of international trade within GVCs, drawing on selected evidence since 1995 and discussing the degree and nature of countries' interaction within GVCs.

Firstly, this chapter has introduced a set of indicators based on value-added terms, presenting the two main strands in the literature, the GVC and the VS approaches, following the later with the calculations performed in this study. As it aimed to provide a comprehensive map of international transactions of goods and services based on IIO tables, the following

analysis presents the main IIO tables and the dilemmas behind their construction. Our main findings are as follows:

(i) When analyzed in gross terms, the contribution of a specific country to international trade flows proved to be heavily overestimated. That is because parts and components are crossing borders several times until they compose final goods, causing a multiple-counting effect, which clearly will blur the real picture of world trade and production to a greater or lesser extent depending on the participation and position of a country within GVCs.

(ii) Looking at the changes across time, countries increasingly relied on foreign value added for their own exports, which may then be further processed in partner countries. Countries with the largest GVC participation, which are mostly small countries and thus have lower availability of domestically sourced intermediates, expanded their overall GVC participation underpinning their role as buyers of foreign inputs (backward linkages).

(iii) When the sources of value-added in gross exports are decomposed considering their destinations, one may see that a considerable part of international trade has been overlooked by GVC metrics. Because the domestic GVC sent to consumer economy is not considered as part of GVC trade, it is not included in any indicator of participation in GVCs. Further on, the GVC participation index does not reflect the complex mix of determinants of a country´s engagement in GVCs, as it is possible to find countries with similar degrees of GVC participation and completely different geographical locations, economic sizes, infrastructure aspects and domestic policies, for instance. Finally, it cannot be assumed that the greater the share of domestic value added in exports, the better the country's situation in terms of gains from trade integration.

(iv) Southeast Asian economies have showed relatively high GVC participation indexes and are generally located downstream in a supply chain, boosting the importance of its backward linkages over time.

(v) China’s production has advanced to other stages located more at the beginning of the GVCs (*fact 4*), while it has deepening its importance on the cross-country production sharing (reflected by FDC) and becoming less dependent of intermediate imports embodied in its exports (*fact 6*). Differently from what could be expected, the decline in re-exported intermediate imports in China was not translated into a lesser diversification of its exports. On the contrary, China

has climbed the ladder of production complexity (*fact 7*), while becoming more integrated into world trade (*fact 2*) and relying less and less on imported inputs, as well as becoming more competitive in the production of components (*fact 9*).

(vi) Because it is fundamental to connect internationally dispersed stages of production processes, the services content of manufactured goods has increased over time. Although, the importance of services is a much broader phenomenon and the value-added perspective of trade provides new insights. Thus, services are not only enablers in value chains but also operate as their own value chains.

(vii) There is no linear relationship between a country´s GVC participation and the mix of products that it is able to make (i.e. its economic complexity), even though there is a positive association between both. Several countries have experienced higher levels of GVC participation meanwhile not experiencing any relative upgrading in complexity of production.

(viii) Traditionally, bilateral trade balances and RCA have been calculated in terms of final goods. When analyzed in value-added terms, the distorted outcomes are considered a reflection of both countries' relative position in GVCs and how the analyzed sector is influenced by GVC trade.

However, our analysis clearly has a number of limitations. To name a few, first, the country-level analysis imposes a number of limitations, since many characteristics are sector-specific. Therefore, in order to minimize this problem, we opted to analyze four selected sectors to measure the gains in competitiveness and specialization patterns. Second, although the convenience of operating with the ready-to-use TiVA indicators, the ability to develop a more detailed analysis is more limited precisely because they are pre-defined indicators. We seek to overcome such limitation using WIOD data decomposed by the method of Koopman *et al.* (2014). However, in order to avoid overlapping the various questions already answered with TiVA indicators, we have restricted this incorporation to the analysis of the different components within the total foreign content, illustrating different arrangements of cross-country production sharing. Third, there are several data limitations regarding services in GVCs, which limits our analysis of the servicification of GVCs.

Overall, our set of stylized facts based on domestic value-added exports illustrated the importance of the value-added framework to our understanding of global trade. Because a country's exports tend to embody a large share of other countries' value added, measures

consistent with the fragmentation of production processes and increasing vertical specialization in trade provide more meaningful information about countries' specialization patterns.

Until recently, evidence on countries specialization patterns has been based on gross trade data. As the last decades have witnessed significant changes on how the world production and international trade are organized, with countries becoming specialized in specific parts and tasks within GVCs, more empirical work is needed to present a comprehensive picture of these integrated global production systems. Without being restricted to case study works, several international organizations have developed new empirical evidence along GVCs primarily based on IIO tables. With this in mind, one can affirm that traditional indicators exclusively based on gross trade are becoming less and less informative and appropriate to support political discussions.

Annex

Annex 2.1 - Mathematical formulation of selected indicators

(i) Decomposing gross trade into value-added components and selected measures

Koopman *et al.* (2010, 2014) provide a method for decomposing gross trade into its value-added components, both in a simple two-country, one-sector case and in a general case with G countries and N sectors. For our purposes, we focus on the generalized case to any arbitrary number of countries. Despite recovering the details about how the process of decomposing gross exports can be reproduced, we aim to make it easier to understand the algebraic formulation behind the main measures in the value-added trade literature.

With A and B as the GNxGN matrices, where: A_{sr} is a NxN block input-output coefficient matrix, and B_{sr} denotes the NxN block Leontief inverse matrix, $(I-A)^{-1}$, i.e. the total requirement matrix that gives the amount of gross output in producing country *s* required for a one-unit increase in final demand in destination country *r*. Considering V and VB as GxGN matrices, where V_s represents a 1 by N row vector of direct value-added coefficient. Further on, a Nx1 gross output vector, X_{sr}, denotes the gross output produced in *s* and absorbed in *r*, where $X_s = \sum_r^G X_{sr}$ is also a Nx1 vector that gives country s' total gross output. And a Nx1 vector, Y_{sr}, denotes the final goods produced in *s* and consumed in *r*, and Y_s=$\sum_r^G Y_{sr}$ is also a Nx1 vector that gives the global use of s' final goods. Both the gross output decomposition and final demand matrix are GNxN matrices. Taking μ as a unit vector 1XN, and E_{s*} as a country's gross exports to the world, Koopman (2014) decompose a country's gross exports to its nine components as follows:

$$\mu E_{s*} = [\{\underbrace{V_s \sum_{r\neq s}^{G} B_{ss} Y_{sr}}_{(1)} + \underbrace{V_s \sum_{r\neq s}^{G} B_{sr} Y_{rr}}_{(2)} + \underbrace{V_s \sum_{r\neq s}^{G} \sum_{t\neq s,r}^{G} B_{sr} Y_{rt}}_{(3)} \}] \qquad (i)$$

$$+[\{\underbrace{V_s \sum_{r\neq s}^{G} B_{sr} Y_{rs}}_{(4)} + \underbrace{V_s \sum_{r\neq s}^{G} B_{sr} A_{rs} (I-A_{ss})^{-1} Y_{ss}}_{(5)}\}$$

$$+\underbrace{V_s \sum_{r\neq s}^{G} B_{sr} A_{rs} (I-A_{ss})^{-1} E_{s*}}_{(6)}] \qquad (ii)$$

(7) (8)

$$+[\{\sum_{t\neq s}^{G}\sum_{r\neq s}^{G} V_t B_{ts}\, Y_{sr} + \sum_{t\neq s}^{G}\sum_{r\neq s}^{G} V_t\, B_{ts} A_{sr}(I - A_{rr})^{-1} Y_{rr}\}$$

(9)

$$+\sum_{t\neq s}^{G} V_t B_{ts}\, A_{sr} \sum_{r\neq s}^{G}(I - A_{rr})^{-1} E_{r*}] \qquad (iii)$$

Therefore, the sum of the first three terms is called value-added exports, or *VAX*, as calculated by Johnson and Noguera (2012), which when divided by gross exports denotes *VAX ratio*. The second group, composed by (4), (5), and (6) represents the domestic content in intermediate exports that finally returns home, VS1*. The sum of (3), (4), (5), and (6) is labeled as VS1 by Hummels et al. (2001), while only the component (4) is taken as VS1* as proposed by Daudin et al. (2011). The sum of (1), (2), (3), (4), (5), and (6) is considered the domestic content of gross exports. Finally, the sum of the latter three terms, (7), (8), and (9) is labeled as VS by Hummels *et al.* (2001), and represents the foreign value-added in gross exports, which when divided by gross exports denotes the *VS share*[120]. Both (6) and (9) are considered double counted intermediate exports, with (6) being produced at home and (9) abroad.

Koopman (2010; 2014) added two new indicators that helps to gauge the extent to which a country-sector is integrated in the global production chain, the GVC participation index, and whether a country is more likely to be in the upstream or downstream of the GVC in a particular sector, the GVC position. By taking both the VS1 and the VS shares, these indicators for country *s* and industry *r* are:

$$GVC\ participation = \frac{IV_{sr}}{E_{sr}} + \frac{FV_{sr}}{E_{sr}}$$

$$GVC\ position = Ln\left(1 + \frac{IV_{sr}}{E_{sr}}\right) - Ln\,(1 + \frac{FV_{sr}}{E_{sr}})$$

The GVC participation index captures the domestic value added embodied as intermediate inputs in third countries' gross exports (IVA), i.e. the *VS1 share*, and the import content of exports (the foreign VA embodied in gross exports, FVA), i.e. the *VS share*. Thus, this indicator captures both forward and backward participation in GVCs, respectively. Considering the GVC position index, a country lies downstream (upstream) in a GVC when it uses a larger (smaller) portion of other countries intermediates to produce final goods for exports if compared to its exports of intermediates in that sector that are used by other countries.

[120] The algebraic formulation of the VS share can be reduced to: $\mu.A_M.(I - A^D)^{-1}$.

(ii) Length of GVCs and Distance to final demand

The index of the length of GVCs and the distance to final demand proposed by Fally (2012) are calculated as:

$$N = \mu(I - A)^{-1}$$

$$D = \mu(I - G)^{-1}$$

Where *N* and *D* are column vectors with the indexes for all countries *i* and industries *k*, μ is a column unit vector, *I* is an identity matrix, *A* is the matrix of technical coefficients, *G* is the matrix of output coefficients, $(I - A)^{-1}$ is the Leontief inverse, and $(I - G)^{-1}$ as the output inverse.

(iii) Revealed Comparative Advantage (RCA) index in gross and value-added terms

The RCA index in gross terms (RCA_{ij}) is based on Balassa's (1965) measure, and is calculated as:

$$RCA_{sj} = (E_{sj}/E_s)/(E_{wj}/E_w)$$

Where E_{sj} is exports of country *s* of sector *j*, E_s is total exports of country *s*, E_{wj} is world exports of sector *j*, and E_w is total world exports.

The RCA index in value-added terms (RCA_{VA}) is calculated as:

$$RCA_{VA} = \left(\frac{DVA_{sj}}{DVA_s}\right) \Big/ \left(\frac{DVA_{wj}}{DVA_w}\right)$$

Where DVA_{sj} is the domestic value-added of country *s* of sector *j*, DVA_s is the total domestic value-added of country *s*, DVA_{wj} is the domestic value-added of all countries of sector *j*, and DVA_w is the total domestic value-added of all countries in total gross exports.

(iv) Bilateral trade balance in value-added terms

The balance of trade in value-added terms is calculated by taking the values that are *consumed* in the two countries, while the gross version depends on values that are *shipped* between the two countries (JONES; POWERS; UBEE, 2013). Following their example, Canada-US trade balance in value-added terms is calculated as:

$$TB_{CAN\ US} = (0 \quad \cdots \quad 0 \quad V_{CAN} \quad 0 \cdots \quad 0) \begin{pmatrix} B_{11} & \cdots & B_{1G} \\ \vdots & \ddots & \vdots \\ B_{G1} & \cdots & B_{GG} \end{pmatrix} \begin{pmatrix} F_{1\ US} \\ \vdots \\ F_{G\ US} \end{pmatrix} -$$

$$(0 \quad \cdots \quad 0 \quad V_{USA} \quad 0 \cdots \quad 0) \begin{pmatrix} B_{11} & \cdots & B_{1G} \\ \vdots & \ddots & \vdots \\ B_{G1} & \cdots & B_{GG} \end{pmatrix} \begin{pmatrix} F_{1\ CAN} \\ \vdots \\ F_{G\ CAN} \end{pmatrix}$$

It estimates the value added by Canada in all final goods consumed in the US, including what is produced domestically with Canadian intermediate inputs, and its converse, where it uses a *1xGN* value-added matrix, the standard *GNxGN* Leontief inverse matrix, and a *GNx1* vector of final demand.

Annex 2.2 - Technical Annex on TiVA indicators

Following the GVC literature, a country's gross trade flow can be decomposed into two sources of value added, *domestic* and *foreign*. Considering TiVA's indicators, this means that the *gross exports of country c, by industry i and by partner country p* ($EXGR_{c,p,i}$)[121] is equal to the sum of the *domestic value added content of gross exports* (or "*domestic value added"*, $EXGR\_DVA_{c,p,i}$)[122] and the *foreign value added in gross exports* ($EXGR\_FVA_{c,p,i}$).

The $EXGR\_DVA_{c,p,i}$ represents the value of exports that is created domestically, i.e. the value created domestically that is absorbed abroad[123]. It can be split into three subcomponents according to where and how the value-added exports are absorbed[124]. The first subcomponent is defined as *direct domestic value added* ($EXGR\_DDC_{(c,i)}$)[125], and reflects the direct contribution made by industry *i* in country *c* to the production of goods and services for export. This measure represents the domestic value added embodied both in final or intermediate goods or services that is directly consumed by the importing country[126]. The second component is *indirect domestic value added* ($EXGR\_IDC_{(c,i)}$), and represents the domestic value added originating from other, upstream, industries (different from i*ndustry i*) in *country c* incorporated in the exports of *industry i.* In other words, it corresponds to the domestic value added embodied in intermediates (goods or services) exported to a partner country that re-exports them to another country in the form of other goods or services. This variable corresponds to the *forward GVC participation*[127]. Finally, the third component is the *re-*

[121] To avoid confusions, the original code used by TiVA is reported in parentheses after the name of the full name of the indicator.
[122] When following the method of decomposition of gross exports by Koopman *et al.* (2012, 2014), this indicator is equivalent to "value-added exports" (VT), and is also conceptually equivalent to the concept of *value-added exports* (*VAX*) developed by Johnson and Noguera (2012), indicating the value-added produced in a source country *s* and incorporated in destination country *r*.
[123] According to the "*TiVA 2016 indicators – definitions*", this measure includes the value added generated by the exporting industry during its production processes and also any value added coming from upstream domestic suppliers embodied in the exports.
[124] In terms of the method of decomposition of gross exports formulated by Koopman *et al.* (2012, 2014), the *domestic value added*, in TiVA's nomenclature, is equivalent to *value-added exports* (VT), which is also subdivided into three components: (1) in terms of the country's final goods exports; (2) it is value added in terms of the country's intermediate exports absorbed directly by the importing country, i.e. domestic value exported in intermediate goods that are used to produce final goods consumed by direct importers; and (3) domestic value added in intermediate exports that are used by the importing country to produce final goods to third countries, i.e. domestic value in intermediates re-exported to third countries. Thereby, both provide different, but closely related perspectives about the subcomponents of domestic value added.
[125] This indicator is presented as a single indicator of both (2) and (3) parts of value-added exports (VT) presented by Koopman *et al.* (2012, 2014).
[126] See exploratory notes. Available at:
<https://www.wto.org/english/res_e/statis_e/miwi_e/Explanatory_Notes_e.pdf> .
[127] See exploratory notes. Available at:
<https://www.wto.org/english/res_e/statis_e/miwi_e/Explanatory_Notes_e.pdf>

imported domestic value added content of exports (EXGR_RIM$_{(c,i)}$), and measures the domestic value added content of exported intermediates that is re-imported by the country of origin as embodied in other intermediates and used to produce exports [128]. Put it simply, these indicators represent, respectively: i) the domestic value added (VA) sent to consumer economy; ii) the domestic VA sent to third economies; and iii) the domestic VA re-imported in the economy.

The *foreign value added in gross exports* ($EXGR\_FVA_{c,p,i}$) corresponds to the value added of inputs that were imported in order to produce intermediate or final goods and services to be exported, and it is also commonly referred to as vertical specialization. This is one of the most discussed aspects of GVC participation, and it was essentially considered as the (direct and indirect) import content of a country's exports by Hummels *et al.* (2001), i.e. the domestic or foreign value added embodied in exports. Since then, several different metrics were developed in the GVC literature, as it was previously discussed. Following TiVA indicators, the *foreign value added intensity* measure, commonly referred to as "import content of exports", is the *foreign value added share of gross exports* ($EXGR\_FVASH_{c,i}$)[129]. This measure is defined as $EXGR\_FVA_{c,p,i}$ divided by the total gross exports, in percentage. According to the OECD-WTO TiVA database, it is a reliable measure of "backward linkages" in GVCs analyses, showing the "buyer" perspective, i.e. the sourcing perspective in GVCs.

Another TiVA indicator used in this study is the *Re-exported intermediate imports as a share of intermediate imports* ($IMGRINT\_REII_{c,i}$) that shows how much of the imports are exported. In addition, the value added trade balance ($BALVAFD_{c,p,i}$), which is the difference between domestic value added in foreign final demand (FFD_DVA) and foreign value added in domestic final demand (DFD_FVA), indicates for each country *c* its value added trade balance with country *p* for industry *i*.

[128] See exploratory notes. Available in: <https://www.wto.org/english/res_e/statis_e/miwi_e/Explanatory_Notes_e.pdf>

[129] $EXGR\_FVASH_{c,i} = \frac{\sum_p EXGR\_FVA_{c,p,i}}{\sum_p EXGR_{c,p,i}} x100$.

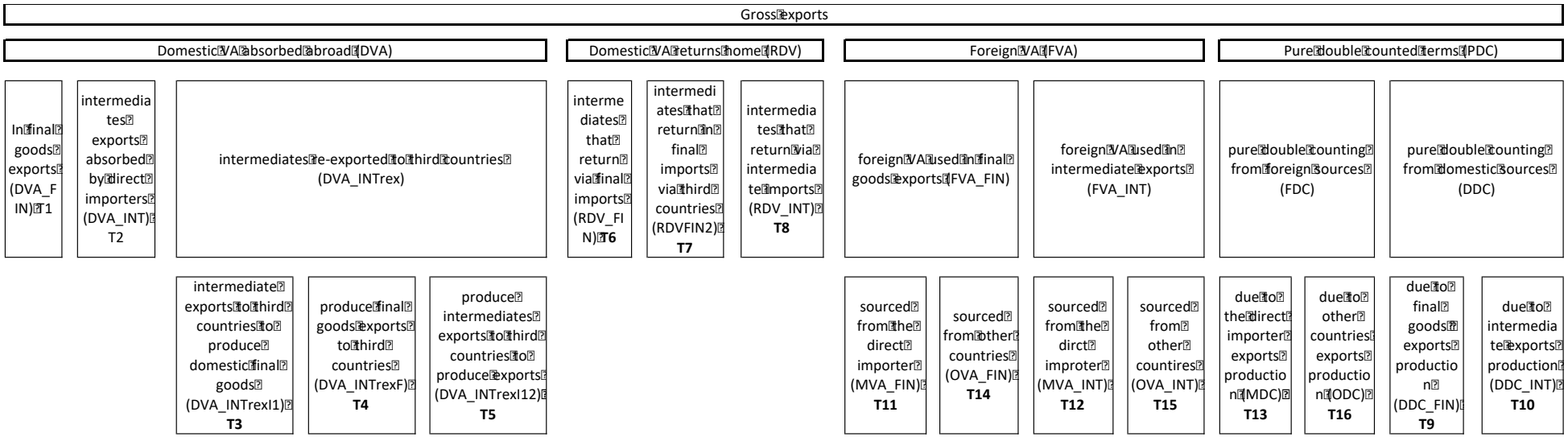
Annex 2.3

Box 2.2 - Variables correspondence

Aggregate Variables	Abbreviation	Concept	Wang *et al.* (2014)	Koopman *et al.* (2014)
Domestic value-added absorbed abroad (DVA)	DVA_FIN	In final goods exports	T1*	1
	DVA_INT	Intermediates exports absorbed by direct importers	T2	2
	DVA_INTrexI1	Intermediate exports to third countries to produce domestic final goods	T3	3
	DVA_INTrexF	Produce final goods exports to third countries	T4	3
	DVA_INTrexI2	Produce intermediate exports to third countries to produce exports	T5	3
Domestic value-added returns home (RDV)	RDV_INT	Intermediates that return via intermediate imports	T8	5
	RDV_FIN	Intermediates that return via final imports	T6	4
	RDV_FIN2	Intermediates that return in final imports via third countries	T7	4
Foreign value-added (FVA)	OVA_FIN	Sourced from other countries	T14	7
	MVA_FIN	Sourced from the direct importer	T11	7
	OVA_INT	Sourced from other countries	T15	8
	MVA_INT	Sourced from the direct importer	T12	8
Pure double counting (PDC)	DDC_FIN	Due to final goods exports production	T9	6
	DDC_INT	Due to intermediate exports production	T10	6
	ODC	Due to other countries exports Production	T16	9
	MDC	Due to the direct importer exports production	T13	9

Source: own elaboration.

Figure 2.23 - Gross exports accounting: major categories



Source: Own elaboration based on Wang, Wei and Zhu (2014).

Chapter 3. Regional dynamics in global production sharing: evidence on "Factory South America"

3.1. Introduction

Since the 1990s, the economic relations between countries has entered a new phase called hyperglobalization, which is characterized by rapid growth in cross-border flows of goods, services and capital (ECLAC, 2016; SUBRAMANIAN; KESSLER, 2013). Among other aspects[130], a major trend of this era of hyperglobalization has been the slicing up of the value-added chain. The surge of production fragmentation into various stages internationally dispersed has opened opportunities for many firms in developing countries to engage in activities without having to complete entire production processes. However, there is a general perception that this is not a worldwide process that involves every country or region across the globe.

In this chapter, we examine the regional linkages of global production sharing, considering value-added trade both inter and intra-regional blocs in the recent phase of hyperglobalization. Despite an extensive literature on three main regional blocs, known as *Factory Asia, Factory North America*, and *Factory Europe*, this chapter aims to contribute to this line of research by investigating another regional bloc that is not usually considered in the GVC literature, which we have called *Factory South America*. Our analysis thus proceeds by asking two questions: first, how is the pattern of participation of South America in value chains compared to other regional blocs? Second, what is the importance of interregional value-added trade with Asia for slackening South America intra-linkages? Or, more specifically, a further question to be explored is whether the intra-regional links that characterized the South American regional bloc have given rise to interregional links, especially with Factory Asia, which may culminate strengthening intra-regional bloc value-added linkages in Asia with China as hub.

[130] Subramanian and Kessler (2013) describe seven features of the most recent wave of globalization, known as hyperglobalization, focusing on its trade aspects: i) the rapid rise in trade integration since the 1990s ("hyperglobalization"); ii) the importance of services ("dematerialization of globalization); iii) the widespread embrace of openness ("democratic globalization"); iv) the similarity of North-to-South trade and investment flows with flows in the other direction ("crisscrossing globalization"); v) the rise of China as mega-trader; vi) the proliferation of regional trade agreements; and vii) the decline of barriers to trade in goods, although barriers to trade in services remain high. More broadly, ECLAC (2016) includes the surge in cross-border data flows since the 2000s as an important feature, and as the report investigate the dissatisfaction with hyperglobalization, it also relates this concept with the low presence of global public goods and international coordination mechanisms.

The motivation behind this chapter is manifold. First, the availability of IIO tables made it possible to analyze production fragmentation and specialization patterns in a way that was not previously feasible. Second, there is a recent trade literature that recognizes that global production networks are marked by regional blocs (BALDWIN, 2012; BALDWIN; FORSLID, 2014; BALDWIN; LOPEZ-GONZALEZ, 2013; ITO; VÉZINA, 2016; LOS; TIMMER; VRIES, 2013). However, despite the spurt of interest in regional value-chains, economists have not yet investigated the geographic distribution of South American countries' final consumption and production value added. Third, much is said about the expansion of China within bilateral trade of South American countries along the 2000s, although without further considerations about how, in the context of fragmented production and internationally dispersed value networks, this actually means strengthening other intra- regional bloc trade linkages. Last but not least, the GVC literature usually considers that a country participates in GVCs in two different ways - using imported intermediate inputs to produce exports and exporting intermediate goods that are used by others to produce their own exports -, disregarding the exported products that are consumed or processed for consumption in the first country that is importing them. Therefore, we aim to contribute to a better understanding of countries and regions' integration in the world production system through trade, and the export capacity on the supply side, and relative market dependence on the demand side.

We use newly-released Trade in Value-Added (TiVA) last updated in December 2016, which is a joint OECD-WTO initiative, to add evidence on regional blocs' intra and inter-linkages of value-added from 1995 to 2011. In our study we investigate Factory North America (United States, Canada, and Mexico), Factory Asia (Association of South East Asian Nations – ASEAN[131], and Eastern Asia – EASIA[132]), Factory Europe (European Union – EU28[133]) for comparisons, and more importantly for our purposes, Factory South America (Argentina, Brazil, Chile, Colombia, Brazil, and Peru)[134].

[131] Indonesia, Cambodia, Malaysia, Philippines, Brunei Darussalam, Singapore, Thailand, and Vietnam (*not* included here Lao PDR and Myanmar).
[132] Japan, Korea, China, Hong Kong (China), and Chinese Taipei (Taiwan).
[133] Following TiVA, we considered both EU 15 and EU13 member countries, i.e. Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden, United Kingdom, and Czech Republic, Estonia, Hungary, Poland, Slovak Republic, Slovenia, Bulgaria, Cyprus, Croatia, Lithuania, Latvia, Malta, Romania.
[134] The countries that build the South American regional bloc are in agreement with the list of TiVA countries, and represent together 350 million of people and about 87% of the GDP of all South American countries for the year 2016 (excluding Venezuela due to the absence of data for that year) (calculation based on the World Bank national accounts data, and OECD National Accounts data files).

Our analysis focuses on the integration pattern of South American countries, not Latin America (which would incorporate both Mexico and Costa Rica[135]), for some reasons. First, Mexico is commonly listed as one of the countries of Factory North America. Second, both Mexico and Costa Rica are more connected with North American supply chains in downstream stages, reflecting country-specific features that are quite different from South American countries. In other words, the regional blocs portrayed by the GVC literature reflect a series of region-specific characteristics, ranging from geographic distance, natural barriers, and the existence of regional integration agreements. In addition, South America is usually considered as a missing region in the era of global value chains, along with Sub-Saharan Africa, while several emerging markets are joining and taking advantage of becoming more integrated into international production networks. Therefore, considering the proximity and similarity of the South American countries' characteristics and the potential benefits usually associated with GVC integration, it seems reasonable to advance in studies about the GVC integration pattern of the region and its shifts over time. However, this is the first study based on IIO tables that we are aware of which deals specifically with the countries of South America as a regional bloc.

In our empirical work, we consider a series of measures in value-added terms to illustrate intra and inter-linkages of regional blocs. First, we characterize GVC participation of Factory South America and compare it with other regional-blocs based on the overall levels of participation and their regional, global and sectoral dimensions. Then we investigate the origin and destination of value-added trade through backward and forward linkages across different countries or regions. Further, we advance the understanding of the interdependence between countries and regions through the construction of a new version of the hub-ness indicator developed by Baldwin (2004). In this respect, we employ value-added trade data to proxy how hub-and-spoke arrangements have changed the degree of each country's relative market dependence on other countries within and across regions.

This chapter is organized as follows. In the next section we present a brief survey of the regional dynamics of global value chains. The third section presents some selected evidence on regional-blocs intra and inter linkages. In this section, we outline Factory South America and its signs of feebler intra-regional linkages compared to inter-regional, as well as how this reinforced the connections especially with Factory Asia and intra-Asia, and the relative market interdependence across countries. Section 4 summarizes our discussion and concludes.

[135] Considering the list of all Latin American countries available in TiVA database.

3.2. Related literature

This section cultivates some common ground for approaching the regionally segmentation of global value chains by tracking the development of relevant studies. As it was not designed to be an encyclopedic literature survey, it focuses only on studies that consider the input-output relations of cross-border production sharing, which is the backbone of GVC studies. Faced with the international fragmentation of value chains, a key research question is to what extent this process is mainly regional or global.

Los, Timmer, and de Vries (2015) investigated the contrasting forces toward regionalization versus toward globalization in the organization of production networks. To this end, they extended the fragmentation measure by Feenstra and Hanson (1999) and applied to the World Input-Output Database (2013 release) for the years 1995-2011. They found a dominant tendency of increasing global fragmentation, instead of more segmentation into regional blocs. This means that international fragmentation has occurred mainly within countries outside the regional blocs, in what they named "Factory World".

However, there is ample evidence from the literature on GVCs indicating strong regional dynamics in world production sharing. Baldwin (2006, 2011) suggests that the international dispersion of production stages, i.e. the second unbundling of globalization[136], is a regional process, and not global as it could be expected by taking the concept of "*global* value chains". It is argued that geography matters for joining a supply chain, which has become more complex and interconnected over time, turning it regionalized rather than globalized. Clearly, the geographical configuration of the second unbundling is not constant and its spatial scale may change over time (GEREFFI, 2014). In this sense, the author points to a possible change of orientation from global toward more regionally oriented supply chains since the 2008 global economic crisis and the following "great trade collapse", with emerging economies becoming an important end market. Degain, Meng and Wang (2017) calculated the weight of intraregional exports and imports in trade in intermediate and final manufactured goods between 1995 and 2015 for three regional blocs[137], and the rest of the world, and also found that GVCs are mainly organized at the regional level, despite the upsurge in globalization tendency before the recent

[136] Baldwin (2006) characterizes globalization as two great unbundlings. The first one occurs up to the mid or late 1980s and is considered a linear process driven by lower trade costs, in which consumption and production can be separated by great distances. The second unbundling is driven by the ICT revolution, which turned economically possible to unbundling factories in stages of production that are geographically separated and dispersed to low-wage economies.

[137] Although not based on IIO tables, it is worth mentioning this study because it is the only one that considers the regional bloc "the Americas", including both North and South America.

global financial crisis. Johnson and Noguera (2012) also support that geographical distance matters for bilateral trade in value added across countries, as well as trade agreements. In further studies, Baldwin and Lopez-Gonzalez (2013, 2015) describe "global value chains" as a buzzword that is inaccurate in aggregate and claim that proximity matters enormously even within regions.

By looking closely at the regional blocs, Baldwin and Lopez-Gonzalez (2015) found that Factory North America is responsible for the most intensive supply-chain trade relationships, as it is mainly a simple hub-spoke structure and the I2P[138] is mostly bilateral. In contrast, Factory Asia is not taken as a hub-and-spoke but as a network pattern, in which processing commonly occurs in multiple nations, generating the so-called "triangle trade". Overall, the US, Germany, and China act as hubs in their respective regions, and even though Japan shows a more regionalized supply-trade compared with the US, Germany, and China, it is not considered a hub in Factory Asia. When looking at the changes between 1995 and 2009, the authors found that supply-chain trade has changed heavily towards Factory Asia and away from Factory North America and Europe, with China increasing its role both as seller and buyer[139].

Baldwin and Forslid (2014) draw some facts concerning the development of Factory Asia. Regardless of whether it is measured in gross or value-added terms, the first noteworthy fact is the rapid (and uneven) growth of exports from the emerging East Asian countries. Second, most economies in Factory Asia saw their value-added export growth being driven by manufactured exports, while only three countries (Hong Kong, Singapore, and Japan) had services exports and other three countries (Brunei Darussalam, Vietnam, and Cambodia) had natural resource based export playing an important role in VA export growth. Overall, they show that Factory Asia has been deepening its participation in international supply chains, in a process that includes new nations such as Vietnam, and changing what was once a simple triangle trade (especially between low-wage nations) to a much more complex interconnection between Asian economies, where the "factory economies" became both makers and buyers of

[138] The authors consider three basic supply-chain trade concepts: i) *importing to produce (I2P)*, which encompasses all imported intermediate inputs used in the production of domestic goods; ii) *importing to export (I2E*), which considers the intermediates related to exporting; and iii) *value-added trade*, which is factor-content trade, i.e. the origin of all primary factor inputs in exports is identified as in Koopman *et al.* (2014), and Johnson and Noguera (2012), and differently from the previous concepts, it shows where the value was added along a supply-chain.

[139] In another study, Baldwin (2012) analyze the contrasting performance of intra-regional trade within Factory Asia and the almost complete absence of formal economic cooperation in the region. The author uses sequencing theory to draw the historical narrative of Europe's and Asia's sequencing, and extract some lessons from the integration sequences.

intermediate inputs. Walmsley *et al.* (2014) illustrated that almost 75 percent of intra-regional trade within Asia is composed by intermediate goods, while intermediates constitute almost half of Asian exports to outside Asia. This picture is in accordance with the general characterization of Factory Asia by Baldwin and Forslid (2014).

More recently, Ito and Vézina (2016) investigated the geographic extension of the value-added fragmentation of Factory Asia by decomposing the value-added content of its exports and also dissecting all of its final production, even if the final product is not exported. Their results show that the share of foreign value added embedded in Factory Asia's final production rose between 1990 and 2005, and that China's production of final goods is composed by a smaller share of foreign value added than any other Factory Asia country. Apparently, China turned to be one of the main sources of value added to other countries' production among Factory Asia countries. They also found that country-industries at the upstream and downstream extremities of the value chain actually embed larger shares of value added compared to intermediate stages, confirming the smile curve format at multi-sector international level. Even without using IIO tables, Zebregs' (2004) study on the key factors behind the rapid growth in intraregional trade is worth mentioning. That is because it found that intraregional trade in emerging Asia is mostly the outcome of the ongoing geographical dispersion of production processes, in which higher-wage countries are specializing in the production of components and low-wage countries become responsible for most of the assembly operations. This has risen trade in intermediate goods among emerging Asian countries, even though the EU, Japan, and the United States remain as the main export markets for final goods.

Another important lesson extracted from Baldwin and Lopez-Gonzalez (2015) is that there are important differences in the global patterns of intermediate industrial goods, raw materials, and services. More specifically, there is a greater regionalization of intermediate industrial goods' trade compared to the pattern of intermediate services, which is still more regionalized than the global pattern for raw materials. This adds important insights to thinking about the specialization pattern of Factory South America.

Different from our study, Cadestin *et al.* (2016) analyzed the extent of GVC participation of a set of selected Latin American countries, including Mexico and Costa Rica. As they aimed to investigate how the GVC integration of the region is affected by some trade policy-related measures, the first step was to characterize GVC participation in Latin America and compare it with other regions. The authors showed that the nature and degree of GVC

participation across the region are quite heterogeneous. That is because the study included the two countries that are more specialized in processing and exporting inputs as well as more integrated with North American supply chains in their analysis, i.e. Mexico and Costa Rica, while the rest of the pool of countries is more specialized in upstream mining and agricultural inputs that are mainly exported to Asian markets. The results are in agreement with those of other studies that find lower shares of intra-regional GVC participation compared to extra-regional links and particularly weak intra-regional links when compared to the rest of the developing world (BLYDE, 2014). These studies argued that Latin American countries strongly rely on natural resource-based inputs to integrate into GVCs, becoming considerable vulnerable to external shocks. Overall, Latin American countries seem to be below their potential for GVC integration, although it is important to note that measures of GVC participation and comparisons with other regions are not enough to conclude whether a country with higher participation index is doing better or worse in GVCs.

3.3. Evidence on regional-blocs intra and inter-linkages: "Factory South America"?

In this section, we present some of the most striking features regarding intra and inter-linkages in value-added trade of regional blocs. To characterize the pattern of participation of Factory South America in global and regional value chains and compared it with other regional blocs, the section draws on the OECD Trade in Value Added (TiVA) database for the period 1995-2011, which is the full span of the TiVA database.

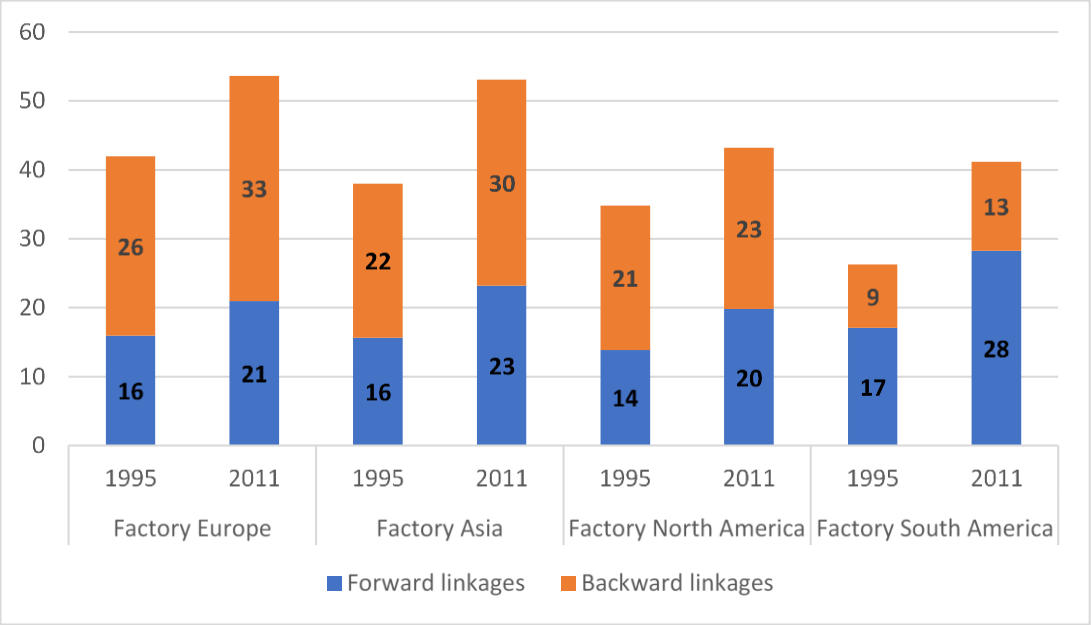
3.3.1. Participation in GVCs through backward and forward linkages

Figure 3.1 shows the overall participation in GVCs through backward and forward linkages across regional blocs in 1995 and 2011. Compared to other regional blocs, Factory South America is the least integrated to global value chains. In particular, Chile is the country with the strongest GVC links in 1995 and 2011 (33.9% and 52.1%), and is followed by Peru (48.7% in 2011), Colombia (38.6%), Brazil (35.6%), and Argentina (30.8%). However, Factory South America is also the regional bloc that has increased the most its total participation in GVCs considering both intra and interregional trade over the analyzed period. While region specialization in Factory Europe and Factory Asia is mainly in backward linkages, Factory South America acts as a supplier of inputs, especially primary products, to other countries exports. Despite the region continues to lag behind in GVC participation, its forward linkages

(i.e. the share of domestic value-added embodied in foreign exports) has increased more than any other region, and more than its backward linkages.

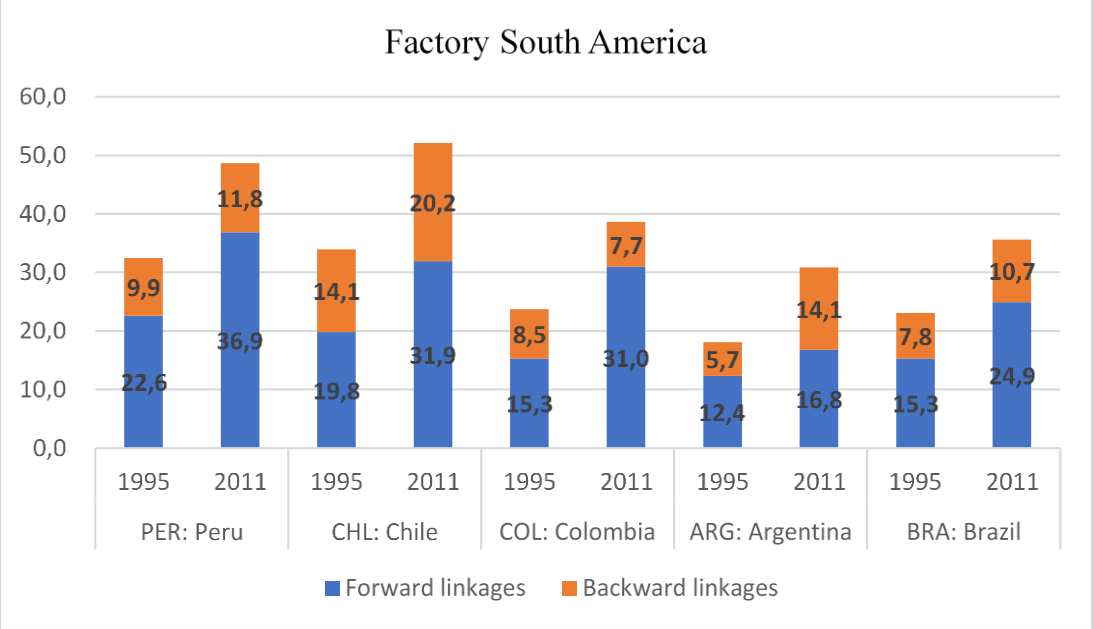
Therefore, when we assess the backward and forward linkages of each South American country separately (Figure 3.2), there is a great homogeneity across the region. All countries had higher forward linkages compared to backward linkages in 1995 and 2011. In contrast to the other countries in the region, Argentina presented a higher rate of growth of backward than forward linkages, revealing changes in its specialization pattern towards downstream activities of GVCs. Chile and Argentina are the countries with the highest GVC participation through backward linkages (20.2% and 14.1%, respectively), while Peru and Chile showed the highest forward participation ratios (36.9% and 31.9%, respectively) in 2011.

Figure 3.1 - Participation in global value chains through backward and forward linkages, regional blocs (in average), 1995 and 2011 (percentage of total gross exports)



Source: Own elaboration based on OECD-WTO TiVA database (December 2016).

Figure 3.2 - Backward and forward linkages of Factory South America's countries, 1995 and 2011 (percentage of total gross exports)



Source: Own elaboration based on OECD-WTO TiVA database (December 2016).

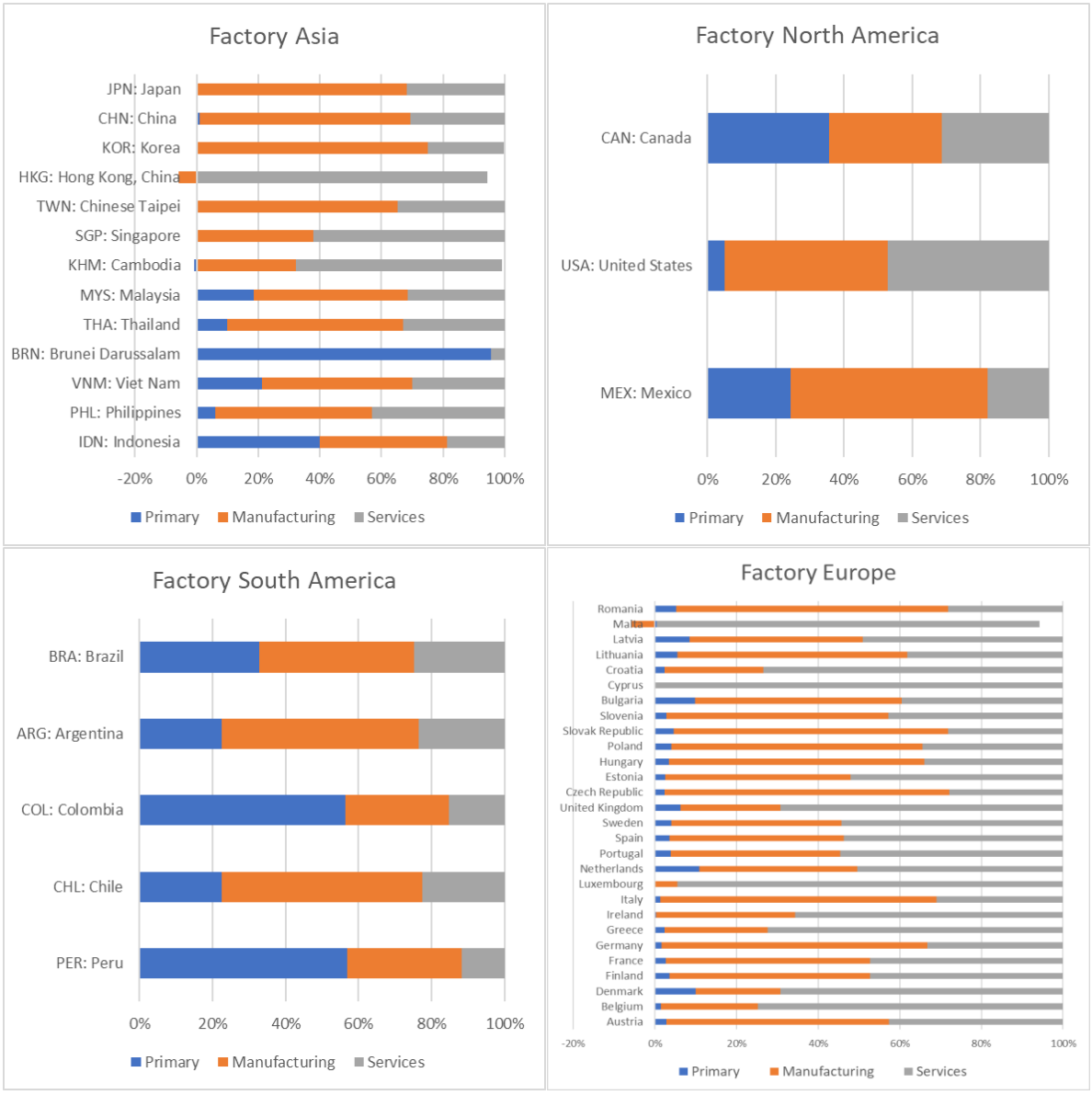
3.3.2. Decomposition of value-added export growth by broad sector

Figure 3.3 depicts the decomposition of value-added export growth from 1995 to 2011 by broad sector - focusing on primary, manufactured, and service exports. The up-left panel shows a wide diversity among the countries of Factory Asia, although manufactured exports remain as the main source of the growth for most of them. Broadly speaking, some emerging markets expanded their export growth mostly relying on the booming demand for commodities, while others accomplished it via manufactured goods (BALDWIN; FORSLID, 2014). Primary exports account for a large share of the value-added export growth of ASEAN countries, with the exception of Singapore, while the Eastern Asian countries - Japan, Korea, China, Hong Kong (China), and Chinese Taipei (Taiwan) - have seen their services exports playing an important role together with those of manufactured in VA export growth. Compared to other regional blocs, Factory South America is the one with the lowest diversity of sources of growth. Not only the importance of primary exports is visible, but also with that of manufactured, these exports account for about three quarters or more of the growth.

On average, Factory South America is the regional bloc where services exports are less significant to explain VA exports growth. The opposite is true for Factory Europe countries,

where services exports account for almost or even all of the growth, as is the case in smaller economies such as Luxembourg, Cyprus, and Malta. In the case of Factory North America, the contribution of services and manufacturing exports was very similar in the case of the United States (almost half and half), while primary and manufacturing together account for more than two thirds of the VA exports growth of Mexico and Canada.

Figure 3.3 - Decomposition of value-added export growth by broad sector, 1995-2011



Source: Own elaboration based on OECD-WTO TiVA database (December 2016).

Beyond portray different patterns of specialization across the four regional-blocs, Figure 3.3 illustrates a reflection of very different production structures and technological capacities. In that sense, as technology and production structures interact, the countries of

Factory South America become more vulnerable to falling into a "low-growth trap". This means that the heterogeneity of production structures and building capacities creates imbalances in international trade and as deficit countries, particularly of less diversified structures adverse to innovation as is the case of South American countries, respond with fiscal austerity and lowering real wages, not only aggregate demand collapses but also employment rates, resulting in greater inequality, which reinforces the recessionary bias in a vicious circle (ECLAC, 2016).

3.3.3. Regional and global dimensions of backward and forward linkages

The regional and global dimensions of GVC participation through backward and forward linkages are evident when the origin and destination of value-added trade is considered (Tables 3.1, 3.2, 3.3, and 3.4).

Tables 3.1 and 3.2 presents the GVC participation through backward linkages across different countries or regions. Each entry represents the origin of VA embodied in column nation's gross exports – for instance, where row country Brazil meets column (partner) country Argentina the 0.9% indicates the share of value-added that Argentina uses from Brazil to produce a unit of gross exports and 5.7% is the total foreign value-added embodied in Argentina's gross exports, while 94.3% accounts for its domestic value-added (Table 3.1).

Overall, South American countries show generally weaker backward linkages within the region, mainly from Argentina and Brazil, than with other regional blocs. Most of the foreign value-added used by Factory South America countries to produce a gross exports unit comes from Factory North America, more specifically the United States, and from Factory Europe. In some cases, such as in Argentina and Brazil, the United States represents more than 85% of the value added from Factory North America. But this picture has changed. Brazil's intraregional links as a source of value-added within the region has increased considerably during the period analyzed. For example, Brazil provided 0.9% and 0.7% of value-added to Argentina and Chile's exports in 1995, respectively, and these shares have risen to 3.4% and 2.4% in 2011. In fact, the whole group of South American countries has increased their presence as sources of foreign VA within the region, apart Argentina.

Considering the role of Factory Asia as a supplier of inputs for export processing across the South American region, the backward links with the Eastern Asian countries are higher compared to ASEAN countries (see the empty quadrant between ASEAN and South American countries). Among the Asian countries, Japan is no longer the main supplier of value-added to Factory South America, a role now occupied by China. As addressed by Cadestin *et*

al. (2016), the rise of China as an input provider is a major development at the global level over 1995 and 2011, and as we have seen also at the regional level. But the countries of South America, on average, still use larger shares of value added from Brazil than from China to produce a unit of gross exports. Although all selected South American countries had greater backward linkages with Brazil compared to China in 1995, Peru and Colombia started to use more Chinese value-added in their exports than from Brazil.

Considering the role of Factory South America as a supplier of inputs for export processing across Factory Asian countries, it is evident that both regions have become more interconnected. The role played by Factory South America as a source of foreign value-added to Asian gross exports is more relevant than the contrary, which partially reflects the composition of production and trade of both regions and their GVC positions. Furthermore, Factory Asia has also showed strong GVC links through backward participation within the region. As can be seen by the red highlight[140] marked in table 3.1 and 3.2, while Japan was the main hub of backward participation for Factory Asia as a whole in 1995, China has become the country with the highest GVC participation through backward linkages within Factory Asia's countries in 2011. Thereby, the greater inter-regional linkages with South America were followed by stronger intra-regional bloc value-added linkages in Asia with China as hub.

Tables 3.3 and 3.4 show the GVC participation through forward linkages with regional and global partners. Each entry represents the destination of VA embodied in row nation's gross exports – for instance, where row country Brazil meets column (partner) country China the 4.8% indicates the share of Brazilian value-added embodied in Brazil's gross exports that is used by China for China's own exports, and 24.9% for row country Brazil indicates the share of Brazilian value added that is used by all its trading partners for their exports, i.e. the overall forward linkage, while the 75.1% is Brazil's value added that is directly exported (Table 3.4). Following Cadestin *et al.* (2016), we also find signs of the continuing expansion of GVC trade, as the shares of exports for further processing and export have increased and the share of direct exports[141] are falling worldwide. Among the regional blocs, this decline was even greater within the countries of Factory South America, illustrating the expansion of GVC trade in the region.

The forward linkages within South American countries are weaker than with other regional-blocs, of which Factories Europe and North America used to be the main partners

[140] Backward linkages ratios larger than 5% are marked by red highlight.
[141] I.e. exported products that are consumed or processed for consumption in the first country that is importing them.

though Factory Asian countries, mainly China, have taken an increasingly important place. But the shares of exporting intermediate goods from Factory South America that are used as inputs by South American countries to produce their own exports – intra-regional forward linkages - are increasing between 1995 to 2011, on average. By looking by the lenses of forward linkages, the only exception is Argentina. This loss of forward and backward linkages of Argentina with other countries of its own region-bloc acted as a sign to investigate more deeply the relationship between South American and Asian countries and its changes over time. At the same time that Argentina became more distant from its South American partners, the country has strengthened its forward linkages with the Asian economies, and relatively more than with other regional blocs, such as Factory North America and Factory Europe.

Actually, this re-orientation towards Asia is comparable to all Factory South America. Whether we investigate Factory South America as a whole, we find that the regional-bloc is becoming more engaged in GVCs as suppliers of value-added to Asian countries' exports than for countries within its own region or from the European Union. All South American countries showed higher increases in their forward links with Factory Asia as a whole (not only China but also East and Southeast Asia), whether compared to the growth with Factory Europe and Factory North America, respectively, although Factory Europe remains as an important hub of forward participation for the region. For instance, the shares of domestic value-added embodied in Peru and Chile's gross exports that is used by China as inputs for China's exports is 6.6% and 9.3%, respectively, in 2011 (Table 3.4), while it was 1.0% and 1.3% in 1995 (Table 3.3).

Even if compared to the countries within Factory Asia, the growth of the shares of South American countries value-added embodied in South American gross exports that are used by Asian countries' exports is higher, on average. Despite this trend, it is not possible to overlook the magnitude of the forward linkages between Asian countries and China, as highlighted by the red marking in China's column. Therefore, the Chinese role in shaping the GVC participation through forward linkages of not only Asian but also South American countries has become more pronounced over time. This means that China has been acting as a "headquarter" economy, whereas its influence overcomes regional boundaries (BALDWIN; LOPEZ-GONZALEZ, 2013). Korea and Japan have also increased their capacity to coordinate regional production of the Asian region – especially of the ASEAN countries – and the South American economies. Finally, although it cannot be said that Factory South America is becoming less integrated in GVCs through backward and forward linkages within the region,

the regional-bloc has become more and more oriented towards Asian countries, especially from a supplier perspective (i.e. forward GVC participation). In that sense, the rise of inter-regional linkages with Factory Asia, especially China but also with other Asian countries, is an important sign of the changing interconnections between regional blocs.

Table 3.1 - Backward linkages across countries or regions, 1995

		Partner country																		
		PER	CHL	COL	ARG	BRA	IDN	PHL	VNM	BRN	THA	MYS	KHM	SGP	TWN	HKG	KOR	CHN	JPN	USA	DEU
From	PER		0,2	0,1		0,1		0,1				0,1			0,1			0,1			
	CHL	0,3		0,1	0,2	0,3	0,1	0,1			0,1	0,2		0,1	0,3		0,2	0,2	0,1		0,1
	COL	1,1	0,1																	0,1	
	ARG	0,6	1,6	0,1		0,5	0,1				0,1	0,1			0,1			0,1			
	BRA	0,5	0,7	0,3	0,9		0,1	0,2	0,1		0,2	0,2		0,2	0,2	0,1	0,2	0,2	0,1	0,1	0,1
	IDN		0,1					0,6	0,5	0,2	0,4	0,7	0,4	1,2	0,7	0,2	0,7	0,6	0,2	0,1	0,1
	PHL						0,1		0,1	0,1	0,2	0,2	0,1	0,4	0,2	0,2	0,1	0,1	0,1	0,1	
	VNM							0,2			0,1	0,1	0,3	0,2							
	BRN										0,1			0,1			0,1				
	THA		0,1				0,2	0,5	1,0	0,2		0,8	1,7	1,1	0,4	0,4	0,2	0,4	0,1	0,1	0,1
	MYS		0,1				0,3	0,5	0,6	1,0	0,8		0,5	2,7	0,6	0,3	0,4	0,4	0,1	0,2	0,1
	KHM										0,1										
	SGP		0,1			0,1	0,5	0,9	1,3	0,8	0,9	1,7	0,4		0,6	0,6	0,3	0,4	0,1	0,2	0,1
	TWN	0,2	0,1	0,1	0,1	0,1	0,5	1,5	2,4	0,2	1,0	1,3	1,2	1,2		1,4	0,5	2,9	0,2	0,4	0,2
	HKG		0,2				0,1	0,5	0,3	0,1	0,3	0,6	0,5	0,8	0,5		0,2	1,5	0,1	0,1	0,1
	KOR	0,2	0,3	0,2	0,1	0,1	0,8	1,9	3,2	0,3	1,0	1,3	1,2	1,8	1,5	1,5		2,7	0,3	0,5	0,2
	CHN	0,2	0,1	0,1	0,1		0,3	0,4	0,8	0,2	0,5	0,6	0,6	0,7	0,7	3,8	0,8		0,2	0,3	0,1
	JPN	0,5	0,8	0,5	0,3	0,4	2,4	8,8	4,6	1,1	6,3	7,5	1,8	9,5	10,0	4,2	5,7	7,4		2,7	1,0
	Factory North America	3,0	3,8	3,3	1,5	2,0	1,6	6,1	1,2	0,7	3,4	4,3	1,0	8,3	5,7	3,2	4,5	4,3	1,5	2,1	1,5
	USA	2,5	3,0	2,8	1,3	1,7	1,3	5,7	1,1	0,6	3,0	3,7	0,8	7,8	5,1	2,6	4,0	3,7	1,3		1,3
	Factory Europe	1,8	3,5	1,9	1,7	2,2	2,6	4,1	2,8	1,6	4,5	6,1	1,9	6,7	4,7	3,4	3,4	5,3	1,2	2,7	8,7
	DEU	0,5	0,8	0,6	0,4	0,7	0,8	1,2	0,7	0,4	1,3	1,6	0,3	1,5	1,6	0,7	1,0	1,6	0,3	0,8	
	Domestic	90,2	85,9	91,5	94,3	92,2	88,0	70,2	78,4	92,7	75,8	69,6	87,3	57,9	69,4	78,4	77,7	69,0	94,4	88,6	85,2
	Foreign	9,8	14,1	8,5	5,7	7,8	12,0	29,8	21,6	7,3	24,2	30,4	12,7	42,1	30,7	21,6	22,3	31,0	5,6	11,4	14,8

Source: Own elaboration based on OECD-WTO TiVA database (December 2016). *Note:* red-marked entries indicate backward linkages higher than 5.0%; and null linkages are shown in blank.

Table 3.2 - Backward linkages across countries or regions, 2011

		Partner country																		
		PER	CHL	COL	ARG	BRA	IDN	PHL	VNM	BRN	THA	MYS	KHM	SGP	TWN	HKG	KOR	CHN	JPN	USA	DEU
From	PER		1,3	0,2	0,1	0,1		0,2	0,1		0,1				0,1		0,3	0,2	0,1	0,1	0,1
	CHL	0,3		0,1	0,4	0,3	0,1	0,1	0,2		0,2	0,2	0,1	0,1	0,4	0,1	0,4	0,4	0,2	0,1	0,1
	COL	0,5	1,8		0,1	0,1			0,1		0,1	0,1		0,1	0,1		0,1	0,1		0,3	0,1
	ARG	0,4	1,2	0,2		0,4	0,1		0,2		0,2	0,2	0,1	0,2			0,1	0,1		0,1	0,1
	BRA	0,9	2,4	0,4	3,4		0,2	0,2	0,5		0,5	0,5	0,2	0,6	0,5	0,2	0,6	0,7	0,2	0,3	0,4
	IDN	0,1	0,1		0,1	0,1		1,1	1,2	0,1	1,4	2,4	0,6	1,7	1,5	0,4	1,5	0,7	0,7	0,1	0,1
	PHL						0,1		0,3		0,4	0,4	0,2	0,4	0,4	0,1	0,2	0,3	0,1		0,1
	VNM						0,1	0,2			0,3	0,6	1,9	0,2	0,2	0,1	0,3	0,2	0,1		
	BRN						0,2		0,3		0,1		0,1				0,2		0,1		
	THA		0,1		0,1	0,1	0,4	0,6	1,5	0,1		1,4	1,8	0,7	0,4	0,2	0,3	0,5	0,2	0,1	0,1
	MYS		0,1		0,1	0,1	0,6	0,6	1,2	0,5	1,4		1,0	1,3	1,0	0,2	0,6	0,8	0,4	0,1	0,1
	KHM								0,1												
	SGP				0,1	0,1	0,5	0,9	0,8	0,5	1,1	2,5	0,7		0,8	0,9	0,5	0,6	0,2	0,1	0,2
	TWN	0,1	0,1	0,1	0,1	0,1	0,2	0,9	1,6	0,1	1,0	1,5	3,6	1,0		0,7	0,8	1,9	0,3	0,2	0,2
	HKG		0,1				0,1	0,2	0,2	0,1	0,3	0,4	1,0	0,7	0,4		0,3	0,5	0,1	0,1	0,1
	KOR	0,2	0,2	0,2	0,2	0,2	0,6	1,2	2,9	0,1	1,3	1,4	2,0	1,2	2,0	0,7		2,7	0,6	0,4	0,3
	CHN	1,0	1,3	0,7	0,8	0,8	1,3	2,4	6,3	0,4	4,0	4,5	12,0	3,1	4,9	5,3	4,7		2,2	1,6	1,3
	JPN	0,3	0,4	0,3	0,3	0,3	1,0	2,5	3,7	0,4	6,0	4,8	1,5	3,0	7,3	1,8	5,0	4,7		1,0	0,8
	Factory North America	3,2	4,4	2,7	2,4	2,2	0,9	2,6	2,5	0,8	3,2	4,8	2,3	5,8	4,6	2,8	4,5	3,7	1,9	3,5	2,5
	USA	2,4	3,5	1,9	1,9	1,9	0,7	2,4	2,1	0,7	2,7	4,2	2,0	5,1	3,8	2,3	3,6	3,0	1,6		2,1
	Factory Europe	1,2	3,1	1,3	2,3	2,2	1,1	1,8	3,8	0,7	4,6	5,5	2,9	8,0	4,3	3,3	4,6	5,5	1,9	3,0	12,4
	DEU	0,3	0,6	0,3	0,6	0,6	0,3	0,5	0,9	0,1	1,2	1,6	0,5	1,4	1,3	0,7	1,5	1,8	0,5	0,8	
	Domestic	88,2	79,8	92,4	85,9	89,3	88,0	76,5	63,7	95,7	61,1	59,4	63,2	58,3	56,5	79,6	58,4	67,9	85,3	85,0	74,4
	Foreign	11,8	20,2	7,7	14,1	10,7	12,0	23,5	36,3	4,3	39,0	40,6	36,8	41,7	43,5	20,4	41,6	32,1	14,7	15,0	25,6

Source: Own elaboration based on OECD-WTO TiVA database (December 2016). *Note:* red-marked entries indicate backward linkages higher than 5.0%; and null linkages are shown in blank.

Table 3.3 - Forward linkages across countries or regions, 1995

		Partner country																						
		PER	CHL	COL	ARG	BRA	IDN	PHL	VNM	BRN	THA	MYS	KHM	SGP	TWN	HKG	KOR	CHN	JPN	Factory North America	USA	Factory Europe	DEU	*Total forward linkages*	*Direct exports*
From	PER		0,5	0,1	0,1	0,6	0,1	0,6	0,1		0,1	1,2		0,2	1,2	0,1	0,7	1,2	1,0	3,0	2,1	8,2	0,9	22,6	77,4
	CHL	0,1		0,1	0,2	0,7	0,2	0,1			0,3	0,5		0,4	2,0	0,1	1,5	1,1	1,3	2,5	1,7	7,0	1,5	19,8	80,2
	COL	0,6	0,2			0,1					0,1	0,1		0,1	0,1		0,1	0,1	0,2	4,3	3,3	5,1	1,0	15,3	84,7
	ARG	0,2	1,3	0,1		1,2	0,1				0,2	0,4		0,1	0,3	0,1	0,2	0,4	0,3	1,2	0,9	3,8	0,5	12,4	87,6
	BRA	0,1	0,2	0,1	0,4		0,1	0,1			0,2	0,3		0,3	0,4	0,1	0,5	0,5	0,6	2,7	1,8	5,9	1,0	15,3	84,7
	IDN		0,1					0,3	0,1		0,4	0,8		1,8	1,4	0,2	1,8	1,4	1,9	1,7	1,3	3,2	0,6	16,4	83,6
	PHL						0,1				0,5	0,4		1,2	1,0	0,4	0,8	0,5	0,9	3,1	2,6	3,1	0,7	12,8	87,3
	VNM						0,2	0,6			1,0	0,7	0,1	1,9	0,7	0,2	0,7	0,9	1,4	0,6	0,4	2,3	0,5	12,6	87,4
	BRN						0,2	0,1	0,1		3,0	0,7		3,4	1,1	0,5	4,5	0,6	4,3	0,7	0,5	1,0	0,3	20,9	79,1
	THA						0,2	0,2	0,1			0,8		1,4	0,7	0,3	0,4	0,8	0,8	2,0	1,5	3,2	0,7	12,0	88,0
	MYS						0,2	0,2	0,1		0,8			3,4	1,1	0,2	0,8	0,9	0,9	2,5	2,0	3,4	0,6	15,5	84,5
	KHM						0,1		0,3		9,2	2,2		0,5	0,7	0,3	0,2	0,8	0,3	0,5	0,4	1,5	0,3	17,9	82,1
	SGP						0,3	0,3	0,1		0,7	1,3			0,8	0,3	0,5	0,7	0,6	2,5	2,1	3,1	0,5	12,3	87,7
	TWN						0,2	0,3	0,1		0,6	0,7		0,9		0,6	0,6	3,4	0,8	3,3	2,6	2,8	0,6	15,5	84,5
	HKG		0,1				0,1	0,3			0,4	0,8		1,3	1,1		0,5	4,0	0,6	1,5	1,1	2,9	0,5	15,4	84,6
	KOR		0,1				0,3	0,3	0,2		0,4	0,6		1,1	1,2	0,5		2,6	1,0	3,5	2,6	3,2	0,7	16,8	83,2
	CHN						0,1	0,1			0,3	0,3		0,4	0,6	1,4	0,8		0,8	1,8	1,4	2,4	0,5	9,9	90,1
	JPN					0,1	0,3	0,5	0,1		0,9	1,0		1,7	2,6	0,5	1,8	2,2		5,6	4,4	4,9	1,1	23,6	76,4
	USA		0,1			0,1	0,1	0,2			0,3	0,3		0,9	0,8	0,2	0,8	0,7	0,8	5,8		6,3	0,9	19,3	80,7
	DEU					0,1	0,1	0,1			0,2	0,2		0,2	0,4	0,1	0,3	0,4	0,3	1,6	1,1	14,2		20,9	79,1

Source: Own elaboration based on OECD-WTO TiVA database (December 2016). *Note:* red-marked entries indicate backward linkages higher than 5.0%; and null linkages are shown in blank.

Table 3.4 - Forward linkages across countries or regions, 2011

		Partner country																						
		PER	CHL	COL	ARG	BRA	IDN	PHL	VNM	BRN	THA	MYS	KHM	SGP	TWN	HKG	KOR	CHN	JPN	Factory North America	USA	Factory Europe	DEU	*Total forward linkages*	*Direct exports*
From	PER		2,4	0,2	0,1	0,7	0,1	0,2	0,2		0,6	0,2		0,2	0,7	0,1	3,6	6,6	1,3	8,4	2,9	9,2	1,7	36,9	63,1
	CHL	0,1		0,1	0,4	0,9	0,2	0,1	0,2		0,5	0,4		0,3	1,5	0,1	2,8	9,3	1,5	4,2	2,1	6,7	1,5	31,9	68,1
	COL	0,4	2,7		0,2	0,5	0,1		0,1		0,2	0,3		0,4	0,4		0,7	2,6	0,3	9,6	8,0	8,9	1,7	31,0	69,0
	ARG	0,2	1,2	0,1		1,1	0,1		0,2		0,4	0,5		0,5	0,2		0,6	2,0	0,2	2,9	1,0	4,1	0,9	16,8	83,2
	BRA	0,1	0,8	0,1	1,1		0,1		0,2		0,4	0,5		0,6	0,6	0,1	1,2	4,8	0,7	3,2	2,0	6,9	1,8	24,9	75,1
	IDN		0,1			0,1		0,4	0,5		1,5	2,8		2,1	2,2	0,2	4,3	5,8	2,6	1,6	1,0	3,5	0,7	31,6	68,4
	PHL					0,1	0,2		0,4		1,4	1,4		1,4	1,8	0,2	2,1	8,9	1,5	2,1	1,1	3,7	1,1	27,5	72,5
	VNM						0,2	0,1			0,8	1,6	0,1	0,5	0,5	0,1	1,6	3,4	1,0	1,2	0,8	2,6	0,6	16,0	84,0
	BRN					0,1	3,7	0,1	1,9		1,2	0,9		0,7	0,9	0,1	8,7	4,1	6,6	0,9	0,5	1,8	0,4	42,7	57,3
	THA					0,1	0,3	0,2	0,6			1,4	0,1	0,7	0,6	0,1	0,8	4,2	0,8	1,2	0,7	2,3	0,6	15,5	84,6
	MYS					0,1	0,5	0,2	0,5		1,3			1,4	1,2	0,1	1,5	5,9	1,2	1,3	0,7	2,4	0,6	19,9	80,1
	KHM						0,1		1,4		1,2	0,6		0,7	0,2		0,4	2,0	0,3	1,3	0,8	2,4	0,4	12,0	88,1
	SGP					0,1	0,4	0,2	0,3		1,0	2,4			1,0	0,4	1,2	4,2	0,6	1,3	0,9	4,3	0,9	20,0	80,1
	TWN					0,1	0,2	0,2	0,4		0,7	1,2	0,1	0,8		0,3	1,6	11,3	0,9	2,2	1,3	2,9	0,6	24,1	75,9
	HKG					0,1	0,2	0,1	0,2		0,7	0,9	0,1	1,6	1,1		1,2	7,9	0,6	1,6	1,0	4,5	1,0	23,2	76,8
	KOR					0,1	0,2	0,1	0,5		0,5	0,6		0,5	1,1	0,1		8,4	0,9	2,2	1,2	3,0	0,8	20,5	79,5
	CHN		0,1			0,1	0,1	0,1	0,3		0,5	0,6		0,4	0,8	0,3	1,5		1,0	2,7	1,6	4,4	1,0	15,7	84,3
	JPN					0,1	0,3	0,2	0,4		1,7	1,4		0,9	2,7	0,3	3,5	10,4		3,8	2,2	4,4	1,3	32,8	67,2
	USA	0,1	0,2	0,1	0,1	0,3	0,1	0,1	0,1		0,4	0,6		0,7	0,7	0,2	1,2	3,1	0,7	4,7		8,7	1,6	25,2	74,8
	DEU					0,1			0,1		0,2	0,3		0,3	0,3	0,1	0,6	2,5	0,3	1,8	1,1	14,0		24,4	75,7

Source: Own elaboration based on OECD-WTO TiVA database (December 2016). *Note:* red-marked entries indicate backward linkages higher than 5.0%; and null linkages are shown in blank.

3.3.4. Hubness measure from the perspective of value-added trade

Baldwin (2004) developed a hubness measure to illustrate the degree of relative market interdependence between countries from the perspective of international trade, as follows:

$$HM_{AB} = EX^{*}_{AB}(1 - IM^{*}_{AB})$$

Where HM_{AB} is the hubness of nation B from A's point of view, EX^{*}_{AB} is the exports from A to B as a share of A's total exports, and IM^{*}_{AB} is B's imports from A as a share of its total imports. Ranging from 0 to 1, the closer this proxy is to 1, the deeper the dependence of A's exports on B's market. This measure was used by Chen and De Lombaerde (2014) to compare the hubness between the BRICs and their neighbor countries.

With that in mind, we developed a new version of this proxy to illustrate the degree of relative market interdependence between countries within and across Factory Asia, Factory Europe, Factory North America, and Factory South America from the perspective of value-added trade.

$$HM\_VA_{AB} = FFD\_DVApSH_{AB,i}(1 - DFD\_FVApSH_{BA,i})$$

Where HM_VA_{AB} is the hubness of nation B from A's point of view in value-added terms, $FFD\_DVApSH_{AB,i}$ shows domestic value added generated by industry *i* in country *A* embodied in final demand of country *B* as a percentage of total domestic value added from industry *i* in total foreign final demand, i.e. $FFD\_DVA_{AB,i}/FFD\_DVA_{A,total,i}$, and gives a value-added perspective of domestic industries' relative connectedness with other countries and regions, independently of whether domestic (upstream) industries are (or not) direct exporters. In particular, $FFD\_DVA_{AB,i}$ captures the domestic value added of country *A* embodied in foreign (country *B*) final demand both *directly*, through exports of final goods or services, and *indirectly* via exports of intermediates that encompass foreign final consumers through other countries, and, putting it simply, can be interpreted as "*exports of value added*". Compared to B's imports from A as a share of its total imports in gross terms, its value-added equivalent, $DFD\_FVApSH_{BA,i}$, shows foreign value added generated by industry *i* in country *A* embodied in domestic final demand of country *B* as a percentage of total foreign value added from industry *i* in B's domestic final demand, i.e. $DFD\_FVA_{AB,i}/DFD\_FVA_{A,total,i}$, indicating a domestic economy's relative connectedness to production in other countries and regions, whether or not there are direct imports from foreign (upstream) industries. In particular, $DFD\_FVA_{AB,i}$ can be

interpreted as "*imports of value-added",* as it shows how industries abroad (upstream in a value-chain) are connected to consumers at home, even when no direct trade relationship exists.

Tables 3.5 and 3.6 present a matrix with hubness measures between countries based on the value-added trade flows of total industries in 1995 and 2011, respectively. We combined all economies within Factory South America and with Factory Asia, as well as Factory North America's countries and the main hub-nation of Factory Europe, Germany.

One of the most striking developments is the emergence of China as a hub-nation. In 1995, the Chinese market influence was mostly limited to a single neighbor country, Hong Kong (Table 3.5). Over time, China was able to expand its influence across all Factory Asia countries, dominating a space that was occupied regionally by Japan and globally by the United States during the 1990s.

Similar to Chen and De Lombaerde (2014)'s results based on gross trade values, our findings show that the United States has decreased its influence in the Asian region, in a process that has contributed to the two-hub formation of regionalism especially in the Eastern Asia. Except for Japan, China has overtaken the United States as their most important trade partner. Looking at the regional production sharing network of Factory Asia, Table 3.6 corroborates Baldwin (2004)'s "bicycle" system of hub-and-spoke arrangements composed by a "Chinese wheel" and a "Japanese wheel". However, it looks like the Japanese tire is depleting, given the weaker Japanese influence than the trade connections with the Chinese-hub. Considering the economic ties between the two hub nations, Japan is no longer a hub-nation from China's perspective, though China became a hub from Japan's perspective.

As in Baldwin and Lopez-Gonzalez (2015), we also found that the supply-chain trade relationships across countries of Factory North America are mainly in the form of a hub-to-spoke structure. The United States acts as the main hub-nation, though its influence has slightly diminished over time. Another interesting finding is that China's influence has overflow beyond the Asian region, and together with the United States, it has been acting as an important hub-nation for Factory South America as a whole.

In comparison, the hub index is calculated for each pair of South American countries. As expected, we find that the intra-regional economic interdependence in Factory South America is weaker than in Factory Asia. Brazil is the country with the greatest influence within the region, acting as hub for Argentina, i.e. deepening dependence of Argentina's exports on the Brazilian domestic market. In fact, considering the connection between South American

and Asian economies, Brazil has shown the highest degrees of relative market interdependence. Meanwhile, Argentina has lost influence and Chile gained with Korea and China as partners.

Overall, most countries worldwide have increased its interdependence on Brazil's domestic final demand. Comparing Brazil's column with its row, our results indicate that the country has greater relative influence in GVCs from the importance of its domestic market than from its exports. Tying the hubness findings to our characterization of the pattern of participation of Factory South America in global and regional value chains, it seems likely that Brazil has become more integrated from the externalization of its final demand and not simply through its production that is further exported. Therefore, if we consider this measure of relative interdependence between markets, one may say that Brazil's trade integration is greater than is usually portrayed by GVC indicators. However, such integration occurs through its domestic market and not through its domestic production.

Table 3.5 - Hubness index in value-added trade flows between countries, 1995

		Partner country																			
		PER	CHL	COL	ARG	BRA	IDN	PHL	VNM	BRN	THA	MYS	KHM	SGP	TWN	HKG	KOR	CHN	JPN	USA	CAN	MEX	DEU
From	PER		0,01	0,02	0,01	0,03		0,01				0,01			0,02		0,02	0,02	0,08	0,19	0,01	0,01	0,04
	CHL	0,01		0,01	0,03	0,05	0,02				0,01	0,01		0,01	0,04		0,05	0,02	0,18	0,15	0,01	0,01	0,06
	COL	0,03	0,01		0,01	0,01											0,01		0,04	0,32	0,02	0,01	0,09
	ARG	0,01	0,05	0,01		0,18	0,01				0,01	0,01			0,01		0,01	0,01	0,04	0,13	0,01	0,01	0,05
	BRA	0,01	0,01	0,01	0,05		0,01				0,01	0,01			0,01		0,02	0,01	0,07	0,19	0,02	0,01	0,06
	IDN					0,01		0,01			0,02	0,02		0,03	0,03	0,01	0,06	0,02	0,27	0,16	0,01		0,05
	PHL					0,01	0,01				0,02	0,01		0,01	0,03	0,02	0,04	0,02	0,17	0,33	0,03	0,01	0,06
	VNM						0,03	0,03			0,05	0,03		0,02	0,03	0,01	0,04	0,04	0,30	0,06	0,01		0,06
	BRN						0,01				0,11	0,02		0,02	0,03	0,02	0,11	0,01	0,50	0,05			0,02
	THA				0,01	0,01	0,02	0,01	0,01			0,03		0,02	0,03	0,02	0,02	0,02	0,18	0,21	0,02	0,01	0,06
	MYS					0,01	0,02	0,01	0,01		0,04			0,05	0,03	0,02	0,04	0,03	0,17	0,18	0,02	0,01	0,05
	KHM						0,01		0,02		0,35	0,05		0,01	0,03	0,01	0,01	0,02	0,09	0,05			0,03
	SGP				0,01	0,01	0,04	0,02	0,01		0,04	0,05			0,03	0,03	0,03	0,03	0,12	0,21	0,02	0,01	0,05
	TWN					0,01	0,02	0,01	0,01		0,03	0,02		0,01		0,03	0,02	0,06	0,15	0,27	0,02	0,01	0,05
	HKG					0,01	0,01	0,02			0,02	0,02		0,02	0,07		0,03	0,12	0,13	0,17	0,02		0,04
	KOR					0,01	0,02	0,01	0,01		0,02	0,02		0,01	0,02	0,02		0,04	0,17	0,23	0,03	0,01	0,04
	CHN						0,01				0,01	0,01		0,01	0,03	0,08	0,04		0,20	0,23	0,02		0,05
	JPN					0,01	0,02	0,01			0,03	0,02		0,01	0,04	0,02	0,05	0,03		0,25	0,02	0,01	0,06
	USA			0,01	0,01	0,02	0,01	0,01			0,01	0,01		0,01	0,02	0,01	0,03	0,01	0,11		0,05	0,02	0,06
	CAN					0,01	0,01								0,01	0,01	0,02	0,01	0,07	0,55		0,01	0,03
	MEX		0,01	0,01	0,01	0,01									0,01		0,01		0,03	0,64	0,04		0,02
	DEU					0,01	0,01				0,01	0,01			0,01		0,01	0,01	0,04	0,10	0,01	0,01	

Source: Own elaboration based on OECD-WTO TiVA database (December 2016). Note: Red-marked entries indicate HM_VA_{AB}> 0,1; and values lower than 0,005 are blank.

Table 3.6 - Hubness index in value-added trade flows between countries, 2011

		Partner country																				
		PER	CHL	COL	ARG	BRA	IDN	PHL	VNM	BRN	THA	MYS	KHM	SGP	TWN	HKG	KOR	CHN	JPN	USA	CAN	MEX	DEU
From	PER		0,03	0,02	0,01	0,04	0,01	0,01			0,01				0,01		0,04	0,17	0,08	0,19	0,06	0,02	0,03
	CHL	0,01		0,01	0,02	0,06	0,01				0,01				0,01		0,04	0,15	**0,10**	**0,14**	0,02	0,02	0,03
	COL	0,02	0,03		0,01	0,03											0,01	0,05	0,03	0,37	0,03	0,02	0,04
	ARG	0,01	0,04	0,02		**0,16**	0,02		0,01		0,01	0,01		0,01			0,01	0,06	0,02	**0,09**	0,02	0,01	0,03
	BRA	0,01	0,02	0,01	0,05		0,01				0,01	0,01			0,01		0,02	0,13	0,05	**0,15**	0,02	0,02	0,04
	IDN					0,01		0,01	0,01		0,03	0,03		0,02	0,02	0,01	0,05	0,13	**0,15**	**0,11**	0,01	0,01	0,02
	PHL					0,02	0,03		0,01		0,04	0,02		0,01	0,02	0,01	0,05	0,16	**0,12**	**0,17**	0,02	0,01	0,03
	VNM					0,01	0,03	0,01			0,03	0,02	0,01	0,01	0,01		0,06	0,12	**0,11**	0,18	0,02	0,01	0,04
	BRN					0,01	0,08		0,03		**0,02**	0,01			0,01		0,07	0,08	**0,35**	0,06			0,01
	THA					0,01	0,05	0,01	0,02			0,03		0,01	0,01	0,01	0,03	0,12	**0,10**	**0,11**	0,01	0,01	0,02
	MYS					0,01	0,05	0,01	0,01		0,03			0,02	0,02	0,01	0,03	0,16	**0,11**	**0,12**	0,01	0,01	0,02
	KHM					0,01	0,01		0,04		**0,04**	0,01		0,02	0,01		0,02	0,05	0,06	0,28	0,06	0,01	0,05
	SGP					0,02	0,05	0,01	0,01		0,03	0,04			0,02	0,03	0,03	0,10	**0,07**	**0,14**	0,01	0,01	0,03
	TWN					0,02	0,02	0,01	0,01		0,02	0,02		0,01		0,02	0,03	0,24	**0,08**	**0,18**	0,02	0,01	0,02
	HKG					0,01	0,02	0,01			0,02	0,02		0,02	0,02		0,03	0,27	**0,06**	**0,15**	0,02		0,02
	KOR		0,01			0,02	0,02	0,01	0,01		0,01	0,01		0,01	0,02	0,01		0,18	**0,08**	**0,16**	0,02	0,02	0,03
	CHN		0,01			0,02	0,02		0,01		0,01	0,01		0,01	0,01	0,01	0,03		**0,08**	**0,19**	0,03	0,01	0,04
	JPN					0,01	0,02	0,01	0,01		0,02	0,01		0,01	0,03	0,01	0,05	0,16		**0,19**	0,02	0,02	0,03
	USA		0,01	0,01	0,01	0,03	0,01				0,01	0,01		0,01	0,01	0,01	0,03	0,06	**0,06**		0,07	0,04	0,04
	CAN					0,01	0,01										0,02	0,05	0,04	**0,52**		0,03	0,02
	MEX	0,01	0,01	0,02	0,01	0,02											0,01	0,03	0,02	**0,58**	0,06		0,01
	DEU					0,02									0,01		0,01	0,06	0,02	0,10	0,01	0,01	

Source: Own elaboration based on OECD-WTO TiVA database (December 2016). Note: Red-marked entries indicate HM_VA_{AB}> 0,1; and values lower than 0,005 are blank. The indices in bold indicate values higher than 0.1 in 1995 and which fell in 2011.

3.4. Partial concluding remarks

In this chapter we have analyzed the regional dynamics in global production sharing, adding evidence on the geography of global value chains and its regionalization. For the purposes of this study, we have investigated the different regional patterns in GVCs, especially the regional bloc of South America, and its changing structures regarding value-added exports and relative market dependence.

Apart from the opportunities for developing countries to participate in global and regional systems created by the slicing up of value chains, the degree of trade integration of Factory South America is considerable lower compared to the other regional blocs. However, we have found that the South American region has diminishing this gap during the late 1990s and throughout the 2000s. The degree of participation, of course, varies between sectors and between countries. But Factory South America as a whole has been acting mainly as a supplier of inputs, especially primary products, to other countries' exports. Together with poor technological capacities, the absence of a diversified production structure has turned the regional-bloc more exposed to falling into a "low-growth trap" compared to other regional-blocs. In summary, we verified the deepening of the pattern of trade integration verified historically and traditionally from gross value measures for South American countries.

GVC trade has taken the place of direct exports, expanding even more considerably between South American countries. With respect to the origin and destination of value-added trade, most South American countries have been using more and more foreign value-added from other South American countries to produce a unit of gross export, i.e. the intra-regional trade through backward linkages have grown stronger over time. But compared to the growth of inter-regional links, we have found lower levels of intra-regional backward links, except for Chile and Argentina that have been using increasingly higher shares of Brazilian value-added in their gross exports. Surprisingly, we have found that the inter-regional backward linkages between Factories Asia and South America with the former as user of South American value-added to produce a unit of gross exports has grown stronger than the intra-Factory Asian links. One of the most striking feature is the upsurge of China as a source of foreign value-added at the global and regional level, becoming the main source of value-added within Factory Asia and lagging behind only from the United States in the relationship with Factory South America.

Meanwhile, we have also found signs of stronger forward linkages within Factory South America, but more importantly the regional-bloc has become more and more oriented towards Asian countries. In addition, the Chinese role in shaping the GVC participation through

forward linkages of not only Asian but also South American countries has become more pronounced over time. Thereby, the stronger inter-regional forward linkages between Factory South America and Factory Asian countries were followed by the strengthening of intra-regional bloc value-added linkages in Asia with China as a main source of inputs. In that sense, one of the most striking developments was the increasing Chinese influence on the production arrangements within its regional partners and beyond its regional boundaries. The role played by China in this changing scenario hides two important movements: the strengthening of intra-regional trade links among Asian countries, with economic benefits in terms of productivity, diversification and sophistication of production; and the rupture of South America intra-regional interconnections, with the decrease in the densification of its production structure without the economic benefits associated with GVCs participation.

Although we cannot say that there is a tendency of weakening the South American back and forward intra-linkages in absolute terms, we have found that the interregional links were much stronger, providing insights to a possible change in the regional dynamics of global production towards Asia with China as a main hub in the context of vertically fragmented production.

Further, we consider the interconnection through trade linkages across countries beyond the traditional indicators of participation in the GVCs. In that sense, we have created a proxy of the degree of relative market interdependence from the perspective of value-added trade. As we addressed the hierarchical organization of the production network around "hubs", we believe that the analysis of global and regional value chains configuration can gain from the development of this new hubness measure, given its simplicity compared to applying social network analysis. Our findings confirm the rise of China as a hub-nation at the regional and global level. In particular, China has deepened its relative market interdependence mainly with other Asian economies but also with South American countries. At the same time, the United States have lost importance as a hub with both regions.

A closer look at the South American region shows that the Brazilian economy is the only country with potential to become a hub. In fact, when looking at the Brazilian pattern of GVC participation and its relative importance in intra-regional trade, we showed that the externalization of its domestic demand has played a key role on deepening its integration into GVCs and not simply by the forward and backward linkages of its value-added exports. Our findings helped to illustrate the complexity behind the political discourse that advocates for greater integration into global value chains. Hence, the greater possibilities of gains for

countries from regions typically taken as poorly integrated in GVCs may come from the creation of regional value chains, which does not appear to be a process that is guided by natural forces independent of domestic policies.

SECTION III. THE EFFECTS OF GLOBAL VALUE CHAINS

Chapter 4. The trade-income relationship: the role of Global Value Chain participation

4.1. Introduction

The recent changes in the relationship between external trade and income have raised several questions concerning its causes and consequences for the long-term economic growth dynamics across countries. The world trade-income elasticity[142] increased between the mid-1980s and the mid-1990s, and then it declined in the 2000s. Hence, several scholars started to question whether this change is a result of cyclical or structural factors. This issue has received new attention given the recent sluggish performance of world trade. Although some authors argue that the signs of a deeper change in the trade-income relationship were already posed by the much more pronounced (also sudden and synchronized) drop in world trade than the world output collapse in the aftermath of the Global Financial Crisis (BALDWIN, 2009; CHEUNG; GUICHARD, 2009; ESCAITH; LINDENBERG; MIROUDOT, 2010a; GANGNES; MA; ASSCHE, 2012).

The historical relationship between growth in imports and global economic activity reveals a remarkable anemic phase of trade growth in more recent years (see Figure B1). While the reasons for the weakness in global trade growth are still unclear, it is also uncertain what is exactly behind the recent changes in the relationship between trade and economic growth. Thereby, several explanations concerning the causes of the recent trade slowdown are tied to an investigation about the decline in global trade elasticities. The inner feature of this debate is usually depicted by the global trade-to-output ratio. In the 1990s, the volume of world merchandise trade grew more than three times faster than world output; however, the ratio of trade growth to GDP growth has fallen to 1:1 since the financial crisis, and more recently, it has dropped below 1 (see Figure B2). Although this ratio is a good indicator of the changing economic scenario (i.e. rising economic openness), it is not possible to imply any causality on the relationship between trade and income only by taking the *apparent* trade response (simple ratio of growth rates). In order to do so, we have to measure the independent effect of changes

[142]In a nutshell, the recent literature about the current slowdown in global trade uses the term "trade elasticity" to refer to the long-term responsiveness of imports to changes in income or in relative prices. As we are interested in the relationship between trade and income, we will use the term "trade elasticity" to refer to the long-term elasticity of imports to changes in income.

in income on trade after accounting for other explanatory variables, i.e. the *estimated* income elasticity.

Estimating trade elasticities to changes in income and relative prices is a critical issue for several empirical studies in different theoretical approaches. Apart from the potential different role of income and prices in the determination of trade, trade elasticity is considered crucial for both economic forecasting and policy analysis. For instance, trade elasticity captures the extent of the welfare effects of trade liberalization, the impact of real exchange rates changes on trade flows[143], the fidelity of a country's consumers to domestic goods and the relative resilience of exporters in face of a deterioration in their competitive position (HONG, 1999; IMBS; MÉJEAN, 2010; POGANY; DONNELLY, 1998). Beyond the traditional emphasis on price elasticity, one of the first econometric studies of international trade to investigate income elasticities underline the importance of their estimation especially in the context of a growing economy (HOUTHAKKER; MAGEE, 1969). In a considerably different economic context, the latest studies have focused on the changing behavior of world trade elasticity to income seeking to understand the causes of the current trade slowdown and whether the diminishing trade growth constitute a "new normal" for global trade growth patterns.

This chapter aims to investigate the changes in the trade-income relationship between cyclical and structural factors under an import demand function framework, using a broad sample of advanced economies (AE) and developing and emerging countries (EME). In particular, the focus is on the effects of countries' participation in global value chains (GVC) on the behavior of the long-term trade elasticity. The chapter seeks to answer the following questions: are there more structural factors operating in the recent behavior of trade elasticities? How has trade elasticity varied over time, and between both groups of AE and EME? How is the behavior of trade elasticities associated with countries' participation in global value chains?

To address these questions, we estimate a dynamic panel error correction model, focusing on two sets of issues. Firstly, we investigate the responsiveness of imports to changes in income and whether structural factors have played a leading role in trade elasticities' behavior, using annual data in gross terms from the IMF WEO (2017) over the period 1989-2014. In this first attempt, we estimate the global trade to income elasticity and, to test whether the deeper shift in the trade-income responsiveness in the 2000s is homogeneous between AE

[143] Trade elasticity to changes in relative prices is usually used to address countries' external performance, providing some sense of a country's ability to compete internationally. In this sense, Senhadji and Montenegro (1998) argue that the higher the price elasticities of exports, the more competitive country's exports are in the international market.

and EME, we run the model separately for these two groups of countries. Secondly, we inquiry if the difference found in the first model is associated with countries patterns of GVC participation. For that purpose, we advance the import demand function by further accounting for the contribution of both backward and forward participation in GVC.

This disaggregated version of the traditional GVC participation index developed by Koopman *et al.* (2014) is derived from their gross trade accounting framework, using the *decompr* algorithm developed by Quast and Kummritz (2015) based on trade in value added data from the WIOD 2013 over the period 1995-2011. We take advantage of this method of decomposition but also go beyond considering two versions of forward participation, besides the backward participation (i.e. the total foreign value added in gross exports), which we named: i) *narrow* forward participation: measures the domestic value added in intermediates re-exported to third countries; and ii) *broad* forward participation: includes the domestic value added in final and intermediates goods absorbed by direct importers.

Our main contributions may be summarized as follows. With regard to the first question of interest, whether there are more structural factors operating in the responsiveness of imports to income, we find evidence pointing to greater importance of longer-term drivers for advanced economies than emerging and developing countries in the recent years of trade slowdown. Our findings suggest that the weakness in aggregate demand, most notably in the Eurozone but also more recently in China, may explain a larger share of EME's imports-GDP responsiveness, as well as a compositional change in aggregate demand towards the less import-intensive components, especially given the Chinese expanding in-house production of capital and intermediate goods. Regarding our second question, we find that the global trade elasticity has decreased in the 2000s, i.e. trade has become less sensitive to changes in income. However, when both groups of AE and EME are taken separately, the long-run trade elasticity is slightly higher for the former group and lower for the latter in the long 2000s compared to the 1990s. In addition, we find lower trade elasticities for EME than AE, and more importantly, this difference between both groups' trade elasticities becomes larger in more recent years. Lastly, considering the variables of GVC participation, we find a decrease in the long-term trade elasticities of AE and EME over time, suggesting that the lower responsiveness of trade to income is associated with the slower pace of global value chains participation. Thereby, we can find strong evidences that different patterns of GVC participation are associated with different behaviors of trade elasticities in the more recent years.

The remainder of the paper is as follows. In section 2, we review the related literature on the cyclical and structural factors behind the decline in trade elasticities and related current trade slowdown, emphasizing the main structural arguments, and more importantly for our interests, the apparent slowdown in the pace of international fragmentation of production processes. Section 3 discusses the error correction dynamic panel model approach and section 4 presents our main empirical results. Section 5 concludes.

4.2. Related literature

This section revisits several studies that estimate the changes in the trade-income relationship under an import demand function framework. In that regard, we summarize the related literature in two strands: i) a set of research that estimates the changes in the long-run trade elasticity to income (*the "magnitude" of changes*), and ii) those studies that investigate the cyclical and structural factors behind the current trade slowdown, and related decline in global trade elasticities (*the "causes" of changes*). Undoubtedly, some studies on the stylized facts and the determinants of these phenomena have complementary questions and overlapped aspects, becoming only a rhetorical resource for our purposes. As we are interested in the role of GVC participation in trade elasticities trajectories for both AE and EME, we highlight the analysis that focus on the developments of GVC.

Our work relates to the first set of papers that analyze the behavior of the long-run relationship between trade and income. Irwin (2002) examines the behavior of global trade elasticity between 1870 and 2000 and indicates that trade has been more responsive to income since the mid-1980s[144]. Later on, Escaith *et al.* (2010a) evidenced higher long-term trade elasticity in the 1990s (from 1.6 to 3.0) followed by a decline (2.3) in the late 2000s, as it reached a new (higher level) steady state around 2004[145]. Similarly, Constantinescu *et al.* (2015) show that the long-term trade elasticity to income was 1.3 (1970-1985), increased to 2.2 in the long 1990s (1986-2000) and reverted back to 1.3 in the 2000s. In the post-2008 (2008-2013, based on quarterly data), the long-run trade elasticity fell even lower (0.7), i.e. for each

[144] Despite pointing to changes in trade policy regimes and in the composition of trade from primary commodity to manufactured goods, their findings are inconclusive concerning the causes for the increased trade elasticity.
[145] According to the authors, the 1990-2000 period marked a transaction to a new steady state where the share of trade in GDP is higher. After a transition phase where trade elasticity rose, it returned back to the long-term equilibrium level. As a matter of fact, they highlight that the concept of steady-state equilibrium implies that the causative factor of this change (e.g., vertical integration) do not affect trade elasticity but only the level of trade relative to GDP. Furthermore, only for comparison, the estimated world trade elasticity is 2.28 for the whole period of 1980 to 2009.

percentage growth of world income, imports were growing only 0.7%. Taking a longer historical perspective, Freund (2009) estimates what appears to be a monotonic increase in world trade elasticity (from 1.94 in the 1960s to 3.69 in the 2000s) and finds that the responsiveness of trade to changes in income seems to be higher during recessions. Using different measures of global GDP, Ollivaud and Schwellnus (2015)'s findings based on a PPP-based measure of global GDP are consistent with Constantinescu *et al.* (2015)'s view that the long-run trade elasticity returned to a lower level in the 2000s. However, when the global GDP at market exchange rates is considered, the result is a more stable trade elasticity around 2 over the recent period.

Another strand of the literature related to our paper includes the studies that aim to explain why the trade-income relationship has changed over time. In that regard, and considering that the lower long-term trade elasticity helps explain the current global trade slowdown, several studies have identified the determinants behind these changes in terms of cyclical and structural factors[146].

4.2.1. Cyclical factors

In a nutshell, cyclical factors would be responsible for changes in trade elasticities that would dissipate after the recovery of the weak economic environment. Along these lines, in addition to weak demand, the decline in the long-term income elasticity of global trade has been attributed to a compositional change in aggregate demand towards the less import-intensive components.

Focusing on the demand channel, Bussière *et al.* (2013) developed an empirical model based on an import intensity-adjusted demand (IAD) measure of aggregate demand. The authors highlight that each component (consumption, government expenditure, exports, and fixed capital investment) has both differences in trade intensity and in the degree of procyclicality, which are crucial to understanding the cyclical dynamics of trade flows. Based on OECD input-output tables for 18 advanced economies, they suggest that the most procyclical components of aggregate demand[147], especially *investment* but also *exports*, are also highly

[146] We follow Constantinescu *et al.* (2015)'s decomposition of the growth rate of imports into its cyclical and structural components. In a nutshell, the cyclical component is associated to the short-run factors (i.e. the impact growth and the speed of adjustment to the long-run equilibrium of trade), and the structural component to the long run relationship between imports and GDP.

[147] Whereas public spending is an acyclical or countercyclical and less import-intensive component, as it mostly includes nontradables and a high share of domestically produced goods, it remains crucial for supporting the recovery of GDP but it does not have a dampen effect in the fall of imports.

import-intensive categories, explaining the greater decline in imports relative to GDP during recessions[148]. Therefore, their findings support the view that changes in the composition of demand may lead to changes in trade elasticity.

Following Bussière *et al.* (2013), Boz *et al.* (2015)'s findings for advanced economies suggest that most of the recent trade slowdown, which is more pronounced in the Eurozone, is explained by cyclical factors, i.e. weak demand. In similar lines, Ollivaud and Schwellnus (2015) and ECB (2015) consider that most of the trade slowdown reflects cyclical factors rather than structural factors, highlighting the role played by weak demand in the Eurozone and the higher levels of uncertainty. However, it is argued that the trade slowdown in intra-euro area accounts for only a small part of the lower global trade elasticity (ECB, 2015). Constantinescu *et al.* (2015) agree that a prolonged reduction in the most trade-intensive components of GDP may lead to a decline in the long-run trade elasticity. Although the weak investment can help to explain the lower elasticity in the afterward of the 2008-2009 financial crisis, the authors consider that it cannot be taken as the main factor behind the recent changes in elasticity. Otherwise, one would also have to consider that the global trade elasticity should have been increasing in the pre-crisis period throughout the 2000s, as the share of investment in aggregate demand was rising, but this was not the case.

Based on an extended pool of advanced and emerging countries, Borin *et al.* (2016) argue that the behavior of income elasticity is mostly affected by business cycle conditions[149]. In addition to a long-run trend, they find that trade elasticity is lower when business conditions are weak and this result may help to explain the recent trade slowdown. Based on a general equilibrium model, the IMF (2016) indicates that the overall sluggish economic recovery and changes in the composition of aggregate demand explains about 60 percent of the 2012-2015 decrease in the imports-to-GDP growth ratio, with the demand compositional shifts playing a larger role in the trade slowdown of AE relative to that in EME. However, this result may be biased, since it considers only the growth rate of goods, excluding services. Later on, following Bussière *et al.* (2013) methodology, the IMF (2016) reveals that up to three-fourths of the trade slowdown is explained mostly by the overall weakness in economic activity, particularly in investments. However, they argue that other factors are also weighing on trade, highlighting

[148] More specifically, they focus on the dynamics of world trade in the aftermath of the 2008-2009 global financial crisis (namely the "Global Trade Collapse", GTC (BALDWIN; TAGLIONI, 2009)).

[149] They argue that income elasticity is itself a cyclical variable, given two standard features of real trade flows: high volatility and high pro-cyclicality relate to real GDP. In that sense, the higher trade volatility is given by its different composition relative to GDP, i.e. trade is more intensive in the more volatile categories (capital goods and manufactured goods).

the role of the recent slowdown in the growth of global value chains, as we will further discuss[150].

4.2.2. Structural factors

The dismal performance of global trade growth in more recent years has called attention to the possibility that a deeper and longer-term change established in the relationship between economic growth and trade. For the sake of simplicity, we summarize the structural arguments in the related literature in terms of: i) regional changes in global economic activity and trade; ii) sectoral changes in global trade; iii) changes in trade policies; and iv) changes in the developments of global value chains.

The first structural factor behind the decline in trade growth is characterized by the changes in relative growth and trade from advanced economies (AE) toward emerging and developing economies (EME) during the mid-2000s. By decomposing the long-run global trade elasticity into a weighted average of regions' (or countries') trade elasticities, Constantinescu *et al.* (2015) consider that an increase in the import share and in the relative economic growth of regions with lower trade elasticity helps to explain the lowering in the global trade elasticity, as well as the decrease in their import-GDP elasticity. The authors investigate the combination of these three factors separately for advanced and emerging and developing economies, finding that the responsiveness of trade to income decreased for both groups of countries in the 2000s.

Following a similar accounting exercise, Slopek (2015) demonstrates that the changes in relative national real GDP growth from AE to EME have contributed to great part of the recent decline in global trade elasticity, given that the EME usually exhibit lower income elasticities of imports. These findings are in line with the estimates by the IMF (2016) and the IRC Trade Task Force (2016), for which the AE presented higher import-income elasticity than the EME, on average. In addition, the magnitude of the decline in trade elasticities is greater for EME than AE between the periods 1980-2007 and 2012-2015 (1.5 to 0.8, and 2.1 to 1.8, respectively) (IRC TRADE TASK FORCE, 2016)[151]. In a much more simple exercise,

[150] Some studies argue that other cyclical factors, such as weak trade finance mechanisms, may also play a role in the recent trade dynamics, especially in the earlier collapse in world trade, once a trade credit crunch has a more severe impact on international trade when it is based on GVC (MILBERG; WINKLER, 2010), but not that much in the decline in trade elasticity (CHEUNG; GUICHARD, 2009; ECB, 2015).

[151] It should be noted that their research re-named the categories used to explain the recent trade slowdown. Instead of using "cyclical" factor to refer to the demand channel, and "structural" factor for the changes in GVC, trade policies and regional or sectoral trade (as most of the literature), they re-named the former as "compositional factors", encompassing the changes in geographical, sectoral and demand composition of economic activity, while the later ("structural developments") includes the role of GVC, transportation costs, trade protectionism, foreign

Nakajima *et al.* (2016) associate the current trade slowdown to the weaker performance of real imports growth rates in EME if compared to the pre-crisis period.

Even though the global elasticity could change in the absence of changes in individual countries' elasticities, this does not seem to be the case in the recent years. By focusing on the contribution of specific countries, Constantinescu *et al.* (2015) suggest that a few countries with a larger share in world trade and/or faster economic growth relative to the rest of the world have played an important role in the recent shift in global elasticity. For instance, China accounts for 13 and 32 percent of the change in the world trade elasticity in the long 1990s and in the 2000s, respectively, while the United States accounts for 20 and 8 percent. In particular, China has played an important role in the recent trade slowdown, with its trade elasticity sharply decreasing from 1.8 (1980-2007) to 0.8 (2012-2015) (IRC TRADE TASK FORCE, 2016).

Despite the Chinese robust economic activity, the current weakness in China's import growth can be seen as the result of changes in their national development strategy. On the one hand, China has appreciated its currency and has diminished its expansion process of export markets in recent years (IRC TRADE TASK FORCE, 2016). On the other hand, China is rebalancing away from investment and exports toward more consumption-led growth. Considering that investment is more trade-intensive than consumption and the size of the Chinese economy, this process may have contributed to the current sluggish in world import growth (BOZ; BUSSIÈRE; MARSILLI, 2015; IMF, 2016). In particular, the Chinese expanding in-house production of capital and intermediate goods, which is illustrated by the increasing domestic value added in Chinese firms, is an important phenomenon behind the recent weak global trade dynamics (IMF, 2015; KEE; TANG, 2015; NAKAJIMA *et al.*, 2016). Therefore, Timmer *et al.* (2016) observe that the "China-factor", i.e. the Chinese movement towards services and products finalized domestically, should be considered with caution, given that the import intensity of Chinese demand has been falling since the early 2000s.

The second factor is related to the changing composition of world trade towards a trade category with lower trade elasticity. Constantinescu *et al.* (2015) estimate separately the income elasticity of services trade and of goods trade, finding that the decrease of the later in the 2000s has mainly contributed to the decline of world trade elasticity and not the changing composition of world trade towards services. More specifically, they find that the long-run

direct investment, and the trade-finance nexus. As the overall findings suggest that the compositional effects explain most of the decline in global trade elasticity, this change in categories cannot be ignored.

income elasticity of manufacturing trade fell (from 2.6 to 0.8) and services trade elasticity actually increased (from 1.8 to 2.2) between the 1990s and the 2000s. It is also important to note that the share of trade in goods in relation to total trade has been considerable stable and services trade slowed less than goods in the 2012-2015 period (IMF, 2016). Thereby, the role of sectoral changes from goods to services is pointed as the less certain, although more difficult to assess, of the compositional factors (CONSTANTINESCU; MATTOO; RUTA, 2015; IRC TRADE TASK FORCE, 2016).

The third structural argument refers to the rising trade protectionism, with an even more recent wave of this phenomenon named "Trumpism" given Trump's trade protectionist promises, or also a slowdown in the pace of trade liberalization if compared to prior periods. The widespread trade liberalization and reduction of global tariffs that marked global trade in the 1990s and early 2000s were replaced by a relative stagnation of trade liberalization and a rise in non-tariff measures (EVENETT; FRITZ, 2015). In that sense, some studies argue that the pace of trade liberalization is an important factor in the current trade slowdown (BOZ; BUSSIÈRE; MARSILLI, 2015; HAUGH *et al.*, 2016). By using a measure that accounts for both tariff and non-tariff barriers[152], Haugh *et al.* (2016) find that the pace of trade liberalization is responsible for one-quarter of the slowdown in global trade growth. On the other hand, some studies emphasize that the rise in protectionism is perhaps a factor at the margin concerning its effects in lowering trade elasticities. Although it cannot be fully disregarded, it should not be overvalued, given that the rise in trade barriers in the 2000s has not been quiet substantial nor has the share of world trade affected by the upsurge of restrictive trade measures become higher (CONSTANTINESCU; MATTOO; RUTA, 2015; ECB, 2015; IMF, 2016; NAKAJIMA *et al.*, 2016; OLLIVAUD; SCHWELLNUS, 2015; WTO, 2014)[153]. Therefore, the contrasting results reflect both differences in the measures of trade policy and methodology applied in these studies.

i) The role of Global Value Chains

The fourth structural argument is about the changes in the pace of global value

[152] The authors use the index of global trade liberalization from the Fraser Institute for Economic Freedom.

[153] By adding a variable that captures the level of trade barriers in their model, Constantinescu *et al.* (2015) estimated no considerable change in the long-run trade elasticity to income in China, as well as this variable of protectionism is not significant. The story in the case of the United States is slightly different, suggesting that an increase in protectionism may have played a (although minor) role in the responsiveness of imports of the United States to changes in income. However, these results should be taken with caution, once their model does not capture many changes in non-tariff measures and given the remarkable difficulties of measuring protectionism.

chains, i.e. the vertical specialization of production processes. While the rapid expansion of GVC trade throughout the 1990s was accompanied by an increase in global income elasticity[154], it seems reasonable to consider potential changes in the pace of expansion of GVC as an explanatory factor for the most recent change in the trade-income relationship. Although, regardless of the period analyzed, a key question is whether and through which specific channels the emergence of GVC has affected the responsiveness of trade to changes in income. In that regard, the related literature points to three possible ways: i) *the composition effect*; ii) *the supply chain effect*, and iii) *the bullwhip effect*.[155]

Considering these three potential effects, it should be noted that the first and second effects are related to the impact of a country's backward GVC participation in trade-income elasticities, while the third effect is about the impact of forward participation in GVC[156](GANGNES; ASSCHE, 2016). Therefore, the more recent lower trade elasticity could be explained by a lower share of durable goods in gross exports (*compositional effect*, explained by structural or cyclical factors) or by a general drawback from GVC production arrangements (*supply side effects*) (GANGNES; ASSCHE, 2016). While it does not appear to be the case for the first explanation, as the share of durable goods has remained stable (GANGNES; MA; ASSCHE, 2015), the second argument appears to have a more important role in explaining the trade elasticities falloff and the current trade slowdown.

In general lines, the GVC driver is posed as the slower pace of international fragmentation of production processes or, in this respect, a slowdown in offshoring (foreign outsourcing). Considering that the expansion of GVC may have reached its peak, some studies emphasize that the regional distribution of value chains rather than globally is an important feature for explaining the recent slowdown (CROZET; EMLINGER; JEAN, 2015; ECB, 2015; HAUGH *et al.*, 2016; KEE; TANG, 2015). However, it is still hard to assess the slowdown in GVC or its role in the lower trade elasticity because of the absence of up-to-date international input-output tables (IOT). Furthermore, the causes of the apparent slowdown in the pace of international fragmentation of production processes are even harder to determine. For instance,

[154] It is important to highlight that it is not the globalization of production *per se* what influences the increase in trade elasticities, but the rising sensitivity of trade to changes in GDP, i.e. the nature of GVC and not larger trade openness (MILBERG; WINKLER, 2010). Although it is also important to note that part of this effect is due to how trade is measured in gross terms, which results in double-counting errors of intermediate inputs.

[155] See Box 4.1 in Annex 4.1

[156] In general terms, the GVC literature considers that a country may participate in GVC in two distinct ways: i) using imported intermediate inputs to produce exports; and ii) exporting intermediate goods that are used as inputs by another country to produce goods for exports. The concepts and metrics to understand how countries are interconnected in the context of GVC are discussed in the next section.

one may point to the deceleration in the decline in trade costs, potential higher obstacles to cross-border investment, the presence of distorted policies, a natural maturation of existing GVC, a profit-led decision of business managers to shorten supply chains, and the adoption of new technologies (BALDWIN; VENABLES, 2013; CROZET; EMLINGER; JEAN, 2015; FERRANTINO; TAGLIONI, 2014; IMF, 2016).

Some recent studies attempt to overcome this challenge by using different measures of GVC participation based on different databases. Considering a simple decomposition of the import growth into structural and cyclical factors, Haugh *et al.* (2016) suggest that structural factors account for around two-thirds of the unexpected trade slowdown in the 2011-2015 period. The authors use the ratio of intermediate goods imports to final domestic demand as proxy of GVC participation, considering the connection between trade of intermediate goods and vertical specialization. This indicator, restricted to the perspective of the backward participation in GVC, is corrected for cyclicality and commodity price effects and then computed at a global aggregate level in a regression of the world trade elasticity. Their results indicate that the GVC slowdown contributed with almost half of the decline in the world trade elasticity.

By using a measure based on the gross export decomposition of Koopman *et al.* (2014) based on the Eora MRIO database, the IMF (2016) finds an important, but less pronounced if compared with Haugh *et al.* (2016), role of the decline in GVC participation (both backward and forward perspectives) in the observed global trade slowdown. Moreover, the study suggests that both trade policies and GVC participation play a more important role in the EME's trade slowdown. On the whole, the study suggests that a slower pace of GVC participation (and a slower growth in the coverage of free trade agreements) is associated[157] with lower import growth. By using a gravity model, Crozet *et al.* (2015) show that the recent trade slowdown may mark the end of an era of widespread expansion of GVC. More than solely the rebalancing of the Chinese economy, the authors find that the slowdown was greater for trade flows where GVC participation are more widespread.

The seminal study by Constantinescu *et al.* (2015) argues that both cyclical effects and structural factors have played an important role in explaining the recent world trade slowdown. In that regard, cyclical factors, mostly explained by weak global demand, were dominant during the financial crisis, and structural factors, especially the changes in vertical specialization, appear to play a major role in the most recent sluggish rates of world trade

[157] It should be noted that this analysis does not attempt to identify causation, only association.

growth. In particular, they suggest that the recent decline in the long-term trade elasticity may reflect the absorption of the technology shock of the long 1990s and a slowing pace of international fragmentation of production processes. Instead of using a control variable for the impact of GVC participation, the authors estimate the long-run elasticities of value added to changes in income and compare the results with the estimated trade elasticities based on gross trade. As they expected, they found that the gap between both elasticities decreased over time, converging to a value closer to the (lower and more stable) trade elasticities in value added terms in light of the role played by the slowdown in the expansion of vertical specialization.

To shed some light on different explanations for the recent trade slowdown in the same framework, Timmer *et al.* (2016) emphasize both the changes in the composition of final demand and in the structure of production. They present evidence that international production fragmentation has contributed to the upsurge in global import intensity, which is a concept developed by the authors to measure the imports needed in any stage of production. This phenomenon has been reinforced by the change in global demand towards goods and services that are highly fragmented, such as consumer durables and investment products. Although, not only the process of fragmentation has come to a standstill since 2011 but also global demand has shifted towards services associated with much less trade intensive production processes. Thereby, the outcome was a great decrease in the global import intensity in the period 2011-2014. However, these results are based on nominal input-output tables and then caution is needed when considering them.

By adding a control variable of GVC participation in their import demand model, Al-Haschimi *et al.* (2015) investigate the effect of GVC participation[158] accompanied by demand growth for the behavior of income elasticity of imports for two groups of countries, emerging and advanced economies. Their findings suggest that trade elasticity of emerging countries tend to be higher than for advanced economies, and imports react more strongly when are followed by stronger GVC participation in both emerging and advanced countries. However, this additional effect on trade growth appears to be weaker since the mid-2000s, suggesting that the process of GVC integration may have recently reached its peak. Beyond that, trade elasticity increased since the recent financial crisis for advanced economies, while it has declined for emerging economies. Following a similar line, but considering other

[158] Their measure of GVC participation is based on the decomposition of trade flows proposed in Koopman *et al.* (2014), which is discussed in further sections.

variables[159] besides the GVC participation index, the IRC Trade Force (2016) shows that GVC participation was globally increasing in the period between 1996 and the 2008-2009 crisis and, while the emerging economies were leading this process, this trend had already changed for those countries prior to the crisis. Overall, they find that the changes in GVC participation have played a role in the behavior of global trade elasticity, however this contribution has diminished after the Great Recession.

Based on a measure of the average number of border crossings for each unit of imported final good developed by Fally (2012), Ollivard and Schwellnus (2015) find no evidence that the international production fragmentation experienced a structural break. They find that the international production fragmentation accelerates when the global GDP is growing, and this procyclicality may reflect Ferrantino and Taglioni (2014)'s findings of a compositional change of trade towards products with shorter value chains during economic downturns or even the postponement of investment projects related to international outsourcing. Overall, one could say that the broad spectrum of results is a reflection of the use of different metrics, resulting in the absence of consensus regarding the deceleration of the pace of GVC and its role in the falling trade elasticity.

4.3. The trade-income relationship: econometric appraisal and data

Our empirical analysis starts with a simple import demand equation that has been used in the empirical trade literature under the theoretical underpinning of the standard constant elasticity of substitution (CES) demand system, under which import demand is a function of aggregate demand[160]. We adopt a dynamic panel error correction model to account for both short and long run determinants of import volumes by dealing with non-stationary heterogeneous panels of a broad sample of AE and EME. Instead of estimating the long-run elasticity for each country separately by using a time-series model, the panel ECM is preferable because both cross-section and time dimensions present a moderated size. Considering a panel cointegrating framework, all the variables in the system are endogenous with each one of them expressed as a linear function of its own lagged values and the lagged values of all the other variables considered. Thereby, the manipulation of this system produces an error correction

[159] Their analysis considers two groups of factors driving the recent weakness in global trade: compositional factors and structural developments. The first group involves the changing composition in terms of regions, sectors and composition of aggregate demand. Secondly, the structural developments are posed in terms of dwindling global value chain participation, waning reductions in transportation costs, in trade liberalization and in trade finance.
[160] Similar empirical approach is used by Bussière *et al.* (2013) , Constantinescu *et al.* (2015), Escaith *et al.* (2010a), and Milberg and Winkler (2010).

equation in which differenced vector terms are explained as lagged differenced vector variables plus lagged levels terms that represents the error correction phenomenon. In our first empirical exercise, we assume the following equation[161]:

$$\Delta m_{i,t} = \alpha_{ot} + \gamma m_{i,t-1} + \beta \Delta y_{i,t} + \delta y_{i,t-1} + \eta \Delta rer_{i,t} + \theta rer_{i,t-1} + \varepsilon_{i,t}$$

where Δ denotes first differences, the subscripts *t* and *i* denotes time and country, respectively; $m_{i,t}$ is the import series in volume terms; $y_{i,t}$ is the real GDP; $rer_{i,t}$ is the real exchange rates, as a proxy for relative prices and competitiveness changes. All variables are expresses in natural log-form, and we add the lagged values of trade (m_{t-1}), GDP (y_{t-1}) and exchange rate ($rer_{i,t-1}$). Further, γ captures the lagged adjustment, i.e. the speed at which imports adjust to trade, and β captures the short-term trade elasticity. The long-run trade elasticity is estimated from the coefficients: $-\delta/\gamma$.

As we are interested in common long-run trade elasticities, we used a pooled mean group (PMG) estimator. Following Martinez-Martins (2016), we adopt the mean group estimation, which means that the group parameters are the unweighted mean of the *N* individual regression coefficients. Hence, we have estimated a traditional dynamic fixed-effects model restricting the coefficients of the cointegrating vector to be equal across all panels. Further, to test the hypotheses that the trade-income responsiveness is not constant over time and it is not homogeneous between both groups of countries, we estimate separately the long-run trade elasticity for AE and EME.

Following Constantinescu *et al.* (2015), we then use the estimated coefficients to the actual data in order to obtain the import growth predicted by our model and decompose the import growth rate into its cyclical and structural components for both groups of countries. The cyclical component of import growth (short-run factors) is associated with the impact elasticity and the speed of adjustment to the long-run equilibrium of trade, and it is obtained from subtracting the predicted long-run growth of imports from the import growth predicted by the model.

Annual data were used from the IMF World Economic Outlook (2017) over the period 1989-2014 for 44 selected countries (23 advanced economies and 21 emerging market and developing countries). The data, in constant prices, is consistent with controlling for

[161] Recently, this econometric approach was explored to estimate trade elasticities by Martinez-Martin (2016) but considering different variables.

changes in relative price. As it is considered desirable for estimating income elasticities, we also use real exchange rates as one of the controlling variables following McCombie (1997) and Cimoli, Porcile and Rovira (2009). In that sense, we use data for countries' GDP price indices available in the Penn World Table 9.0 (FEENSTRA; INKLAAR; TIMMER, 2015).

Our second empirical strategy is based on an extension of the previous import demand function to account for the effect of GVC participation on trade elasticities of AE and EME. Considering that the vertically fragmentation of production processes creates additional linkages across countries, which affects the trade-income responsiveness, we propose to take a closer look at the contribution of both backward and forward participation in GVC under a panel cointegrating framework based on international input-output data. To test the hypotheses that the different patterns in trade elasticities between AE and EME are associated with different patterns of GVC participation, we use a disaggregated version of the GVC participation index developed by Koopman *et al.* (2014).

In general terms, a country may participate in GVC in two distinct ways: i) using imported intermediate inputs to produce exports; and ii) exporting intermediate goods that are used as inputs by another country to produce goods for exports. To quantify the extent of a country-sector GVC participation, two broad measures have been used widely in the literature: i) *VS:* measure the value of imported contents embodied in a country's exports, and ii) *VS1*: measure the value of intermediate exports sent indirectly through other countries to final destinations, i.e. the percentage of exported intermediate goods and services that are used as inputs to produce other countries' exports (HUMMELS; ISHII; YI, 2001). The VS share estimates the importance of *upstream links*, providing a metric of the involvement of a country-industry as a user of foreign inputs (i.e. *backward participation).* The VS1 share estimates the importance of *downstream links*, measuring the involvement in GVCs from a supplier perspective (i.e. *forward participation*) (BACKER; MIROUDOT, 2013; CADESTIN; GOURDON; KOWALSKI, 2016).

Hence, instead of using the original formulation of the GVC participation index[162] developed by Koopman *et al.* (2014) to account for the overall GVC participation, we choose to use both backward and forward participation measures separately. Taking advantage of their method of decomposition of gross trade, the measures are as follows: i) *backward participation:* measures the total foreign value added in gross exports; ii) *narrow forward participation:*

[162] The GVC participation index developed by Koopman *et al.* (2014) is defined as the sum of the VS1 share (i.e. forward participation) and the VS share (i.e. backward participation).

measures the domestic value added in intermediates re-exported to third countries; and ii) *broad forward participation:* includes the domestic value added in final and intermediates goods absorbed by direct importers. As we also aim to consider a broad vision of how a country can contribute with its domestic value added into the global production networks, we use the two measures of forward participation. This is consistent with a detailed analysis of how the different patterns of GVC integration[163] of both groups of AE and EME are related to different trade-income responsiveness in the recent years.

To assess whether both groups of countries experienced a recent decline in trade elasticity, we estimate a panel ECM by dealing with a non-stationary panel of 21 advanced countries and 11 emerging countries at the disaggregated level of 35 sectors. By combining time series with panel data considering the set of sectors of each country, we have a more informative model, with greater variability and less collinearity between variables, more degrees of freedom and more efficiency. In other words, this model is more adequate to study the dynamics of changes in trade elasticities since it reduces the bias that results from the aggregation of sectors.

Annual data were used from the World Input-Ouput Database (WIOD) release of 2013 over the period 1995-2009. The sample period for trade in value added is more limited due to data availability and being split into two periods: 1995-2009 and 2000-2009, in order to assess the developments of trade elasticities over time. The data for trade in value added are processed based on the method of decomposition formulated by Koopman *et al.* (2014), using the *decompr* algorithm developed by Quast and Kummritz (2015).

We use the following panel ECM specifications to investigate the behavior of real GDP ($y_{i,t}$) and import volumes ($m_{i,t}$):

$$(1)\ \Delta m_{i,t} = \alpha_{ot} + \delta_1 m_{i,t-1} + \delta_2 \Delta y_{i,t} + \delta_3 y_{i,t-1} + \delta_4 back\_part_{i,t-1} + \delta_5 rer_{i,t-1} + \varepsilon_{i,t}$$

$$(2)\ \Delta m_{i,t} = \alpha_{ot} + \delta_1 m_{i,t-1} + \delta_2 \Delta y_{\square,t} + \delta_3 y_{i,t-1} + \delta_4 forw\_narrow_{i,t-1} + \delta_5 rer_{i,t} + \varepsilon_{i,t}$$

$$(3)\ \Delta m_{i,t} = \alpha_{ot} + \delta_1 m_{i,t-1} + \delta_2 \Delta y_{i,t} + \delta_3 y_{i,t-1} + \delta_4 forw\_broad_{i,t-1} + \delta_5 rer_{i,t} + \varepsilon_{i,t}$$

$$(4)\ \Delta m_{i,t} = \alpha_{ot} + \delta_1 m_{i,t-1} + \delta_2 \Delta y_{i,t} + \delta_3 y_{i,t-1} + \delta_4 back\_part_{i,t-1} + \delta_5 forw\_narrow_{i,t-1} + \delta_6 rer_{i,t} + \delta_7 rer_{i,t-1}\ \varepsilon_{i,t}$$

$$(5)\ \Delta m_{i,t} = \alpha_{ot} + \delta_1 m_{i,t-1} + \delta_2 \Delta y_{i,t} + \delta_3 y_{i,t-1} + \delta_4 back\_part_{i,t-1} + \delta_5 forw\_broad_{i,t-1} + \delta_6 rer_{i,t} + \delta_7 rer_{i,t-1}\ \varepsilon_{i,t}$$

[163] In that regard, EME are usually known for having a bigger share of domestic value added in third country exports (forward participation) if compared to their foreign value added in exports (backward participation).

where Δ denotes first differences, the subscripts *t* denotes time, and i country; $rer_{i,t}$ is the real exchange rates, $back\_part_{i,t-1}$ is the backward participation; $forw\_narrow_{i,t-1}$ is the measure of narrow forward participation, and $forw\_broad_{i,t-1}$ is the broad forward participation. Both empirical exercises are estimated by the generalized method of moments (GMM) (ARELLANO; BOND, 1991; ARELLANO; BOVER, 1995).

Finally, in order to estimate the model, we checked the degree of integration running ADF - Fisher Chi-square and PP - Fisher Chi-square unit root tests for the panel with null hypothesis of individual unit root process. Our findings suggested that m and y have unit roots in level, but not in first differences, both being thus I (1). We then performed a Fisher-Johansen test of cointegration, which is a system based test, that showed that the rank of cointegration of m and y is equal to one. Finally, to verify the suitability of the model, we tested for the normality distribution of the residuals (Jarque-Bera statistic), and for serial correlation and for autoregressive conditional heteroskedasticity (ARCH) effects in the residuals in all estimations. The results, though, should be interpreted with caution, once the model does not capture the structural complexity of the trade-GDP nexus.

4.4. Empirical results

Table 1 shows the results of estimations of our first empirical exercise. For the entire sample, we find that the long-run trade elasticity decreased during the long 2000s, i.e. trade has become less sensitive to changes in income. In the period 1989-1999, a 1 percent increase in world real GDP is associated with a 2.83 percent increase in the volume of global imports. The responsiveness of trade to changes in income becomes lower in the subsequent period (2000-2014), as the long-run trade elasticity fell to 2.43. Hence, by splitting the full sample of 44 countries between advanced economies (23 countries) and emerging and developing economies (21 countries), the long-run trade elasticity is slightly higher for the former group and lower for the latter in the long 2000s.

When comparing both groups of countries, our results are in line with the seminal study by Houthakker and Magee (1969) and the related literature that found lower trade elasticities for EME than AE. We also find that the difference between both groups' trade elasticities decreased throughout the 1990s, and more importantly, this processes was interrupted in the 2000s. In this respect, for both sub-periods, emerging economies tended to have lower trade elasticities than advanced economies, and the difference between both groups becomes larger over time. To sum up, we have adopted the two different periods based on

Martinez-Martin (2016)'s findings that obtained a structural breakpoint in 2000, which they suggest can be related to the incorporation of China into the global economy.

Table 4.1 - First empirical exercise: results of estimations

Dependent variable: import demand	Emerging and developing countries		Advanced economies		Total	
	1989-1999	2000-2014	1989-1999	2000-2014	1989-1999	2000-2014
Import demand (lag) (γ)	-0,79*	-1,19*	-1,02*	-1,19*	-0,94*	-1,21*
	(0,08)	(0,09)	(0,05)	(0,04)	(0,02)	(0,02)
GDP (β)	2,79*	0,86	2,18*	2,08*	2,72*	1,90*
	(0.30)	(0,68)	(0,19)	(0,17)	(0,14)	(0,11)
GDP (lag) (δ)	1,86**	1,86*	2,56*	3,21*	2,67*	2,96*
	(0,91)	(0,75)	(0,22)	(0,21)	(0,18)	(0,16)
rer (η)	68,03*	29,33	7,09	18,11*	24,56*	20,29*
	(26,36)	(22,45)	(5,72)	(2,40)	(3,90)	3,50
rer (lag) (θ)	-1,93	-35,57*	1,37***	-4,37	0,08	-12,73*
	(18,11)	(5,50)	(2,61)	(1,49)	(2,26)	(1,82)
Long-run trade elasticity (-δ/γ)	2,36**	1,56*	2,52*	2,68*	2,83*	2,43*
R-squared	0,71	0,55	0,67	0,57	0,74	0,69
Observations	173	198	273	197	446	395

Source: Author's calculations based on IMF (WEO). Notes: standard errors in parenthesis; * indicates a significance level of 1%, ** of 5%, and *** of 10%.

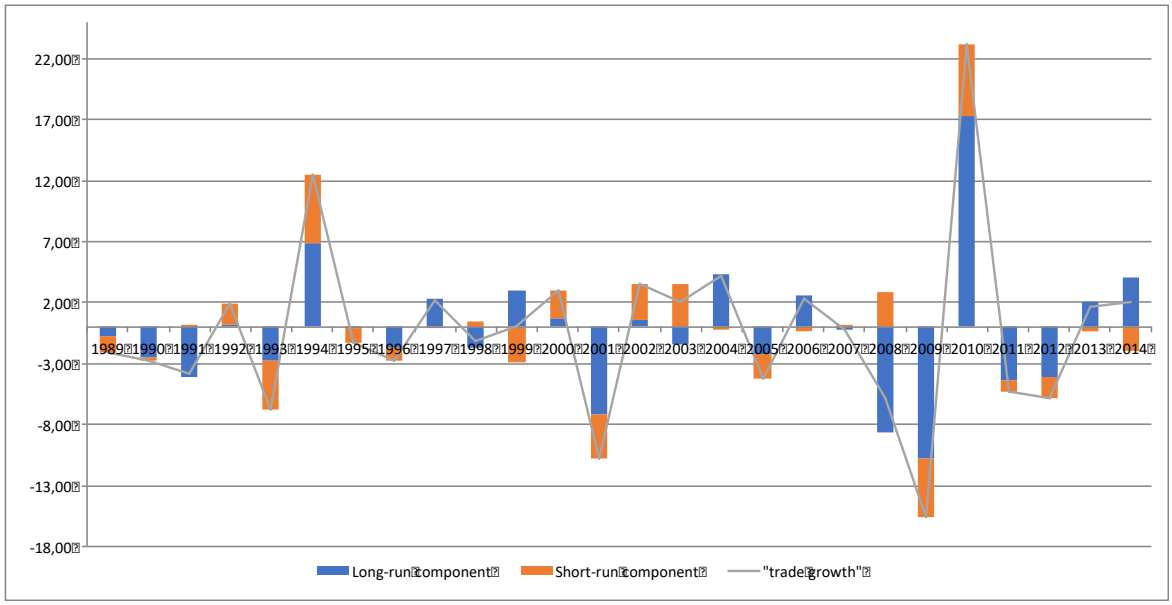
In addition, the short-run elasticity (β) also decreased over time: for the entire sample, from 2.72 for the first period to 1.90 for the period 2000-2014, and this change in the short-run dynamics is greatest for the EME, although not statistically significant. Unlike the long-term trade elasticity, the short-run dynamics between trade and income varied in the same direction for both AE and EME, decreasing over time. One should note that the literature on the great trade collapse that followed the global financial crisis discuss the mechanisms through which vertical specialization is related to the changing short-term responsiveness of trade to GDP (discussed in Box A1). Overall, the short-term responsiveness of trade to GDP has decreased for both AE and EME in the 2000s, however, this decline is much stronger for the later. While changes in world income had a decreasing short-term impact on world trade, the speed of adjustment (γ) of trade to its long-run equilibrium varied more monotonically between EME and AE over the two periods, being higher in the long 2000s.

As can be seen for the entire sample, imports in the 2000-2014 period would be reduced by 1.21 percent to restore the long-run equilibrium relationship between trade and

income, if the volume of imports in the 1989-1999 period was 1 percent higher than the level predicted by the long-run relationship. The real exchange rate (*rer*) is positively correlated with real imports, which suggests that when the exchange rate of the country appreciates (i.e. *rer* increases), imports become cheaper and increase in real terms. In Table 1, time *t rer* is statistically significant when the total of countries is considered for both periods, while it is not always statically significant if AE and EME are taken separately.

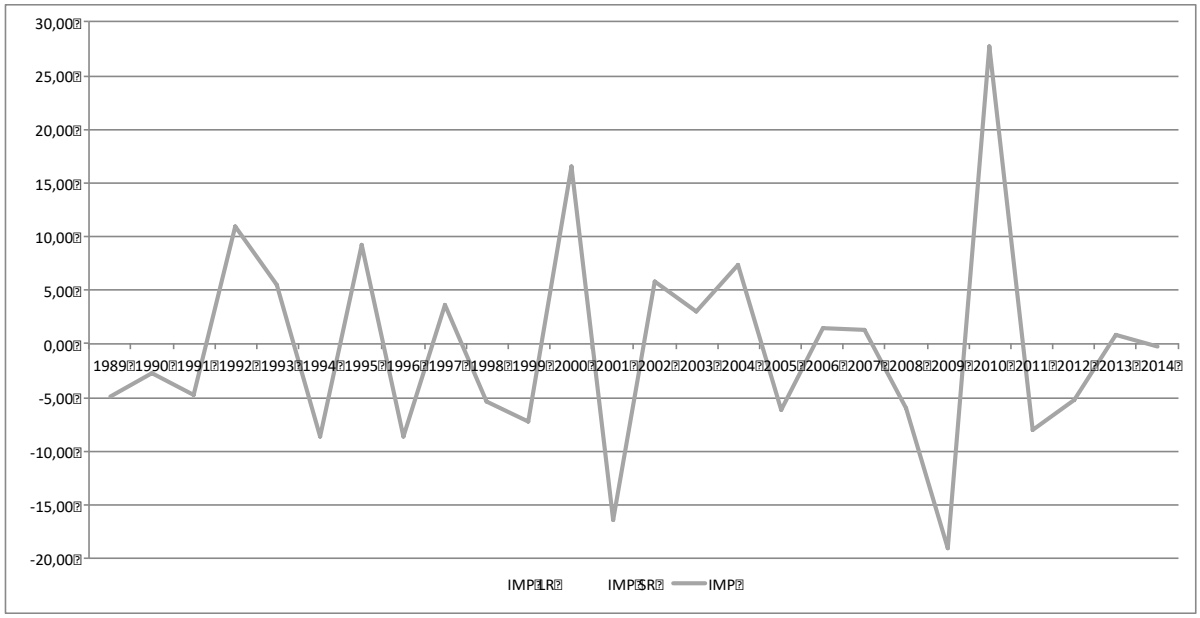
To examine whether there are more structural factors operating in the recent behavior of trade elasticities, Figures 1 and 2 reproduce the decomposition of imports growth into its short-run and long-run components for advanced economies and emerging countries, respectively. The blue bards capture the long-run component of import growth predicted by the model, while the orange bars indicate the predicted short-run component of import growth.

Figure 4.1 - Decomposition of trade growth into its short-run and long-run components, advanced economies (1989-2014)



Source: Authors' calculations based on IMF (WEO).

Figure 4.2 - Decomposition of trade growth into its short-run and long-run components, emerging and developing economies (1989-2014)



Source: Authors' calculations based on IMF (WEO).

The figures above show that both cyclical and structural factors are operating in the current trade slowdown for both EME and AE. However, in the case of EME, the short-term component explains a larger share of the behavior of import growth in the afterwards of the 2008-2009 financial crisis, as well as during periods of economic turmoil such as the Asian Crisis and the financial crisis. Besides weak global demand, one of the potential explanations, as discussed in the literature review, is a compositional effect regarding the contribution of the sharp decrease in the Chinese trade elasticity, which reflects the expanding in-house production of capital and intermediate goods already in the early 2000s. Thereby, the Chinese transition toward more consumption-led growth has been lowering import demand in emerging economies.

In the case of AE, the long-run component, capturing structural effects, dominates most of the historical trade growth behavior, including periods of crisis and especially in the last two years of the current scenario of sluggish trade growth. Therefore, considering the set of structural drivers of the current trade slowdown, we aim to further investigate how different patterns of GVC participation could underlie the changing trade-income responsiveness in the 2000s.

To examine how the behavior of trade elasticity is associated with GVC participation, our second empirical strategy, based on the estimation of a dynamic panel ECM

that accounts for the measures of forward and backward GVC participation in value added terms, provide some useful insights (Table 2 and 3).

Table 4.2 - Second empirical exercise: results of estimations, emerging and developing countries

	First sub-period					Second sub-period				
Dependent variable: Amt	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
imports (lag)	-1,17*	-1,15*	-1,54*	-1,20*	-1,36*	-1,18*	-1,55*	-1,56*	-1,55*	-1,53*
	(0,25)	(0,37)	(0,23)	(0,13)	(0,19)	(0,16)	(0,15)	(0,15)	(0,12)	(0,10)
gdp	2,12*	5,06	3,82*	2,58*	5,02*	2,60*	3,48*	3,49*	3,48*	4,05*
	(0,43)	(2,30)	(0,73)	(0,87)	(1,66)	(0,50)	(0,82)	(0,57)	(0,68)	(0,89)
gdp (lag)	2,65***	3,68*	3,70*	3,07*	4,75*	2,50**	2,96***	3,26*	3,29*	4,55*
	(1,46)	(1,16)	(1,02)	(0,77)	(1,27)	(1,25)	(1,56)	(0,92)	(1,244)	(1,37)
rer			4,15	16,35	-26,41					
			(13,82)	(38,86)	(51,25)		2,06	4,34	6,023	-9,64
							15,39	(11,92)	34,018	(48,01)
rer (lag)	-17,16**	-3,719		-24,20	41,89					
	(7,83)	(11,536)		(39,41)	(51,77)	-9,44			-0,48	18,94
						(7,47)			33,20	39,64
back_part (lag)	-15,19			-46,64*	198,66					
	(10,64)			(15,06)	(126,01)	-13,36			-29,80	228,36
						(10,65)			21,58	(139,34)
forw_narrow (lag)		104,25		-88,26*						
		(101,63)		(24,36)			46,52		-42,80	
							140,48		43,72	
forw_broad (lag)			20,84**		173,59					
			(10,09)		(94,34)			15,70		191,50***
								(10,39)		(109,28)
Long-run trade elasticity	**2,27**	**3,21**	**2,40**	**2,56**	**3,50**	**2,12**	**1,91**	**2,09**	**2,12**	**2,98**
R-squared	0,73	0,47	0,65	0,70	0.570332	0,78	0,70	0,70	0.71	0,71
Number of observations	121	121	121	121	121	121	121	121	121	121

Source: Authors' calculations. Notes: Standard errors in parenthesis; * indicates a significance level of 1%, ** of 5%, and ***of 10%. First sub-period: 1995-2009, and second sub-period: 2000-2009.

Table 4.3 - Second empirical exercise: results of estimations, advanced economies

	First sub-period					Second sub-period				
Dependent variable: Δmt	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
imports (-1 lag)	-0,842*	-0,843*	-0,842*	-0,820*	-0,808*	-0,824*	-0,827*	-0,824*	-0,841*	-0,810*
	(0,0952)	(0,0961)	(0,095)	(0,076)	(0,081)	(0,101)	(0,102)	(0,101)	(0,095)	(0,100)
gdp	3,527*	3,532*	3,529*	2,475*	2,296*	3,049*	3,047*	3,055*	1,555***	1,395***
	(0,596)	(0,599)	(0,597)	(0,629)	(0,677)	(0,580)	(0,583)	(0,582)	(0,885)	(0,869)
gdp (-1 lag)	2,630*	2,622*	2,631*	2,073*	2,005*	2,295*	2,290*	2,296*	1,653*	1,603*
	(0,553)	0,564377	(0,553)	(0,403)	(0,392)	(0,484)	(0,487)	(0,486)	(0,488)	(0,444)
rer	7,457***	8,090***	7,378	70,080*	59,868*	4,011	4,539	3,954	70,860*	62,612*
	(4,752)	(4,988)	(4,740)	(17,747)	(14,611)	(3,804)	(3,930)	(3,809)	(20,374)	(17,442)
rer (-1 lag)				-59,954*	-54,357*				-64,717*	-60,417*
				(16,126)	(14,776)				(19,431)	(17,528)
back_part (-1 lag)	3,518*			-30,989*	105,131**	3,186*			-31,062*	99,667**
	(0,617)			(9,208)	(46,923)	(0,530)			(10,066)	(48,306)
forw_narrow (-1 lag)		-13,379*		-130,875*			-13,136*		-129,927*	
		(4,533)		(37,666)			(3,299)		(39,434)	
forw_broad (-1 lag)			-2,857*		86,655**			-2,538*		82,378**
			(0,543)		(38,983)			(0,503)		(40,425)
Long-run trade elasticity (1-δ3/δ1)	3,12	3,11	3,13	2,53	2,48	2,78	2,77	2,79	1,97	1,98
Number of observations	286	286	286	286	286	220	220	220	220	220
R-squared	0,65	0,65	0,65	0,54	0,58	0,69	0,69	0,69	0,53	0,56

Source: Authors' calculations. Notes: Standard errors in parenthesis; * indicates a significance level of 1%, ** of 5%, and ***of 10%. First sub-period: 1995-2009; Second sub-period: 2000-2009.

The vertical specialization variables slightly increase the goodness-of-fit of the model for both groups of countries, but they are not always significant. The estimation of the distinct equations regarding the indicators of backward and forward (broad and narrow) participation as taken together or separately shows that the overall result is of a lower trade elasticity in the second sub-period for both advanced economies and emerging countries. Hence, when based in value added terms and considering the variables of GVC participation, there is evidence of a falling response of imports to GDP for both AE and EME over time, and, more importantly, this lower responsiveness of trade to income is associated with the slower pace of global value chains participation. As pointed in the literature review, this may be the result of a maturation of the process of fragmenting production processes internationally, given the increase in emerging economies' labor costs and firms' decisions to "re-shore" production. Hence, the absence of further expansion of GVC changes drastically the previous scenario of increasing trade elasticities that marked the 1990s. Meanwhile, other structural factors may also have played a role in the falling trade elasticities. Moreover, considering the differences between both groups of countries and taking both measures of GVC participation separately, our results

are in line with the previous literature and with our first empirical exercise that found lower trade elasticities for EME than AE[164]. Yet, in the light of these results, the difference between both groups has increased over time.

Another important insight is that EME's trade elasticity varies more than AE's whether one consider the narrow or the broad measure of forward participation. The intuition behind these results is that the dynamics of trade elasticities reflects the patterns of GVC participation. In fact, the results are consistent with the EME's pattern of GVC participation that is based on a bigger share of domestic value added in third country exports (narrow forward participation) *and* in goods absorbed by direct importers (broad forward participation) rather than the foreign value added in exports (backward participation). However, when both measures of GVC integration are taken together, even though trade elasticities are decreasing over time, the EME's level is higher than AE in both sub-periods.

4.5. Partial concluding remarks

This chapter reviews the key drivers behind the falling long-term trade elasticity and the related global trade slowdown. Our empirical results suggest that the diminishing growth of trade after the Global Crisis is due not only to weak global demand (cyclical factors) but also because trade has become less responsive to income (structural factors). On the one hand, cyclical factors explain a larger share of the imports-GDP responsiveness in the case of EME, for instance, the weakness in aggregate demand, most notably in the Eurozone but also more recently in China, and a compositional change in aggregate demand towards the less import-intensive components, especially given the Chinese expanding in-house production of capital and intermediate goods. On the other hand, structural factors have played a more important role for advanced economies than emerging and developing countries in the recent slowdown in global trade.

This means that longer-term factors are changing the fundamental relationship between trade and economic activity but not symmetrically between advanced and emerging economies. In that regard, we have emphasized the role of GVC participation on explaining the decline in the long-term trade elasticities. When based on trade in value added terms, our empirical exercises suggest that the long-run trade elasticity has decreased in the 2000s for both advanced economies and developing and emerging countries. Nevertheless, this finding is

[164] With the one exception that trade elasticity is slightly higher for EME in the first sub-period of our second model than AE's.

consistent with both estimations that consider the GVC participation indexes separately and together. Indeed, our estimations indicate the slower pace of global value chains as an important factor behind the falling trade elasticities.

Finally, future research may want to explore a broader set of variables about the causes of the falling trade elasticities, including, for instance, variables of trade protectionism, foreign direct investment and trade finance. Further, our findings encourage further research about the causes of cross-country differences regarding trade elasticities and on whether the falling trade elasticity has different implications for advanced economies' and emerging and developing countries' economic growth. In that regard, the remarkable anemic phase of trade growth in more recent years, and the falling long-term trade elasticities, may constitute a "new normal" of global trade dynamics, affecting countries' growth prospects through limiting export opportunities and with several implications for their ability to emulate development strategies.

Annex 4.1

Box 4.1 - The effects of vertical specialization in the responsiveness of trade to income

The literature on the GTC discussed several mechanisms through which vertical specialization may change the short-term relationship between trade and GDP.

The *composition effect* suggests that GVC trade is concentrated especially in durable goods industries, which are more sensitive to foreign income fluctuations, making countries that rely largely on imported inputs for their exports to present higher income elasticities. Durables and capital goods are more sensitive to income shocks, what means that households and companies disproportionately delay new purchases of those goods in economic downturns (GANGNES; MA; ASSCHE, 2014). In that regard, Eaton *et al.* (2011) find that less spending on durable goods during 2008-2009 was one of the key intensified effects of the economic downturn. Further, Gangnes *et al.* (2014) estimate how the rise in the Chinese backward participation into GVC affected trade elasticity to income. The authors suggest that the bigger share of durable goods in gross exports, which are much more sensitive to foreign income shocks than non-durables (nearly four

times)[165], resulted in *higher* trade elasticities. This composition effect was felt especially in three industries: machinery, textiles, and non-manufactures.

As noted by several authors, the GTC illustrates the income-trade relationship beyond the traditional macroeconomic effects (AHMAD, 2013; ESCAITH; LINDENBERG; MIROUDOT, 2010b; GANGNES; MA; ASSCHE, 2014, 2015; INTERNATIONAL MONETARY FUND, 2013). Part of the peculiarity of this synchronization of business cycles across regions is connected to the fact that the demand shock was large but highly concentrated in a narrow category of goods (machinery, electronic and telecommunications equipment, automotive products) and intermediate products (WORLD TRADE ORGANIZATION, 2014a). Not by chance, several studies have documented the role of composition of trade, notably that of durable goods, in the volatility of trade. Put it simply, GVC trade alters the composition of trade and turn aggregate trade more sensitive to foreign income shocks (BEMS; JOHNSON; YI, 2010; EATON *et al.*, 2011; GANGNES; MA; ASSCHE, 2014).

The *supply chain effect* addresses that the characteristics inherent to the borderless production systems, i.e. GVC itself, increase the responsiveness of trade to changes in income (ALESSANDRIA; KABOSKI; MIDRIGAN, 2013; GANGNES; ASSCHE, 2016; GANGNES; MA; ASSCHE, 2014). Thereby, the income elasticity of demand would be higher for GVC trade than for non-GVC trade. As it has been discussed, the simplistic world where imports depend on national income and exports depend upon foreign income gives place to a world with increasing imports of intermediate inputs into exports, where foreign demand can determine both exports and imports of several nations (BALDWIN, RICHARD; TAGLIONI, 2009). Given this tighter connection between imported intermediate linkages and vertical specialization, Bems, Johnson and Yi (2009) argued that a country's exports and imports tend to move in the same direction in response to changes in both domestic and foreign demand. The general idea is that the magnitude and timing of international transmission of macroeconomic shocks along the supply chain may then differ from traditional demand shocks on final goods (ESCAITH; LINDENBERG; MIROUDOT, 2010b).

[165] According to Gangnes *et al.* (2014), there are no shred of evidences that durable goods exports have different price elasticity than non-durables.

The hypothesis of a potential different responsiveness of GVC trade to variations in demand has been tested from different perspectives. By using a dataset covering China's trade by custom regime, Gangnes *et al.* (2014) evaluate the existence of both supply chain and composition effects in Chinese exports and finds no evidences of the former. They suggest that the supply chain effect may occur only under certain circumstances, such as the degree of demand uncertainty, and suggest that further research is necessary to assess which are the particular conditions for this effect. Considering the performance of trade in intermediates and the hierarchies of firms belonging to the same multinational groups, Altomonte *et al.* (2012) find evidences of a different performance of trade in intermediates, which has been shown to be the main determinant of the magnitude of the recent GTC. They also show a specific dynamic in intra-group trade with initially faster reaction to negative demand shocks followed by faster recovering if compared with arm's length trade. Part of the explanation given for those findings applied to the French firms is consistent with the research of Alessandria *et al.* (2013) for the United Sates case. Both studies highlighted the *adjustment in inventories* during the Great Recession of 2008-2009.

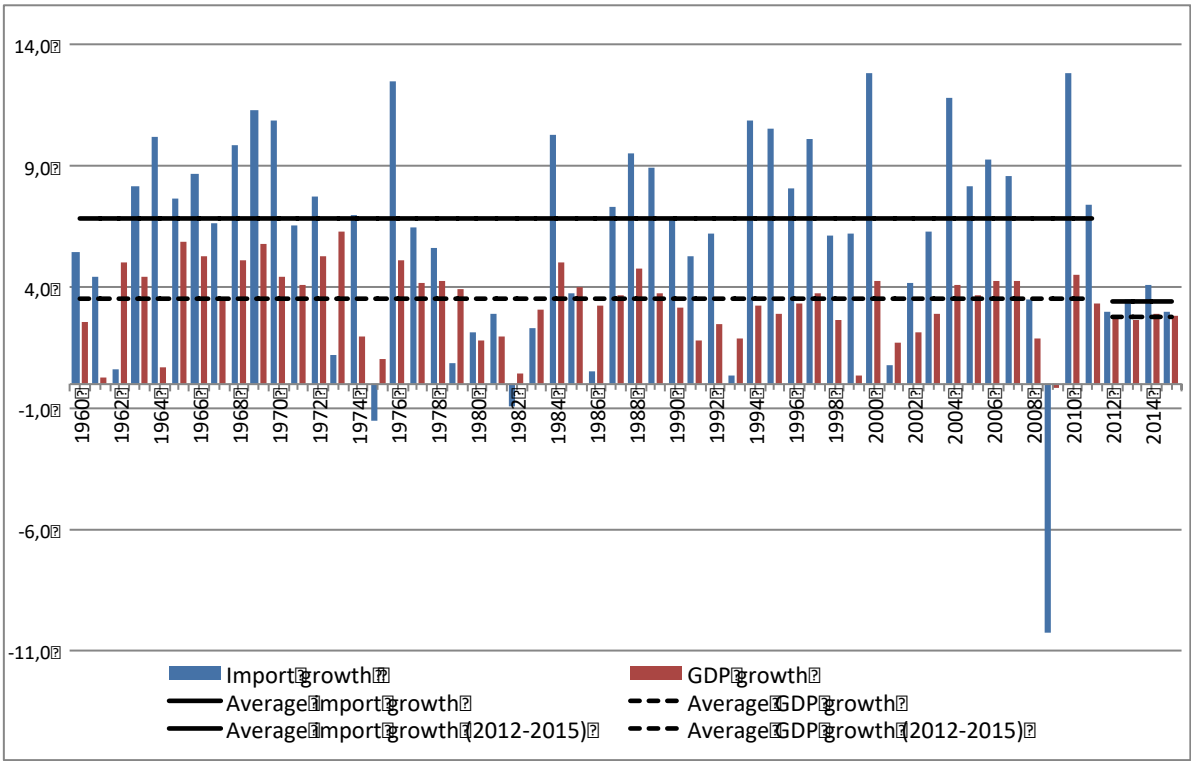
There are empirical and theoretical reasons for considering the inventory management decisions as a key determinant of amplified fluctuations of trade to income. This has been called *bullwhip effect*[166] and refers to how small changes in final demand can cause a relevant change in the demand for intermediate goods along the value chain (LEE, HAU L.; PADMANABHAN; WHANG, 1997; WORLD TRADE ORGANIZATION, 2014b). Put it simply, the traditional macroeconomic effect on inventories was amplified on the microeconomic side by structural changes in world production and the increasing international vertical integration (ESCAITH; LINDENBERG; MIROUDOT, 2010b). As large players keep their inventories at a minimum level (buffer stocks) in order to face the usual risks of international transportation, the "just-in-time" management of internationally fragmented value chains makes them pressure their suppliers to maintain large stocks in order to quickly respond upon request. The result is significant levels of inventories in importing firms that operate within GVC. In an economic downturn, the purchases of new imported inputs are reduced and the

[166] The "bullwhip effect" is also referred to as the "whiplash" or "whipsaw" effect (WTO, 2014).

production process has to continue by drawing down these large inventories that firms used to hold, what would pressure upstream exporters within GVC and result in an increased sensitivity of trade to foreign income shocks (AL-HASCHIMI *et al.*, 2015; GANGNES; MA; ASSCHE, 2014). Therefore, upstream firms are forced to keep greater levels of stock to face the greater demand volatility. In other words, would be an extension of an initial demand shock along the GVC due to an adjustment of production and stocks to new expectations (ALTOMONTE *et al.*, 2012).

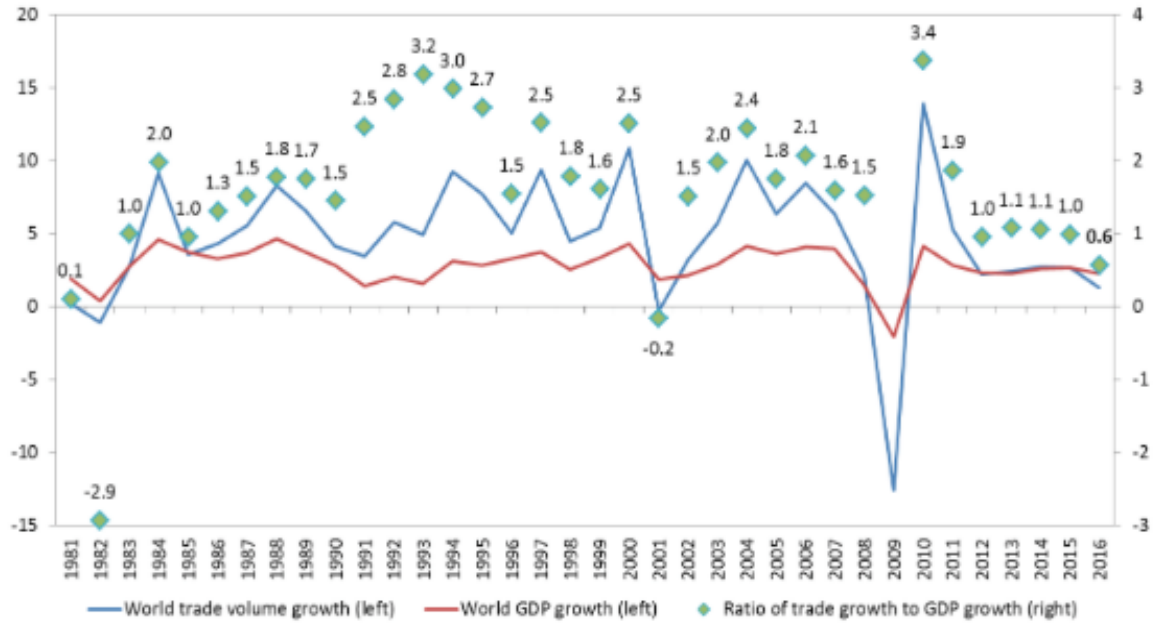
Source: own elaboration.

Figure 4.3 - World real import and GDP growth (1960-2015)



Source: IMF World Economic Outlook (October 2016).

Figure 4.4 - Ratio of world merchandise trade volume growth to world real GDP growth, 1981-2016 (% change and ratio)



Source: WTO.

Concluding Remarks

This research aimed to investigate the conceptual and methodological aspects of trade integration in the context of vertically fragmented production and the emergence of global and regional value chains, to evaluate different patterns of specialization, as well as to understand how trade's responsiveness to income has changed at the current phase of globalization.

In the first chapter, we presented some of the key concepts in GVC theorization to further analyze the manifold outcomes usually associated with participating in GVCs, contributing to the organization of a formal theoretical apparatus within the GVC literature. We have documented the three strands of network- and chain-based research that are relevant to describe the new patterns of global production and trade organization, as well as its main drivers. Beyond being considered an analytical tool, we argued that GVC has also become a practical and useful explanatory framework for understanding how firms and countries are engaged in the process of value creation, distribution and capture.

We have documented part of the growing literature on GVCs, reviewing the concepts and measures of one particular dimension of the GVC analysis that is two-fold: the economic and social upgrading. While economic upgrading is mostly seen regarding the efficiency of production processes and the peculiarities of products and tasks developed by producers, social upgrading is commonly analyzed regarding the effects of GVC participation on living standards and conditions of employment. This chapter highlighted that the economic gains from greater integration in GVCs may not automatically translate into improvements in living standards. For that reason, it focused on how both dimensions are related to each other in recent analysis. Overall, we emphasized the important diversity of definitions and measures within the GVC literature, considering it as a reflection, to a certain extent, of the absence of a systematic theoretical apparatus in the GVC literature.

The second section of this research has quantified a country's engagement in GVCs during the second wave of globalization, as well as the regional trade dynamics of global production sharing, using value-added trade metrics built from international input-output tables rather than using traditional trade metrics based on gross values.

Chapter 2 has explored a vast set of indicators based on value-added trade to provide a comprehensive picture of the patterns of specialization in vertically integrated

production networks connected by international trade. In general, our empirical findings confirm our previous assumption that the vertically fragmentation of production has changed our ability to analyze countries' patterns of specialization based on gross trade flows. That is because parts and components are crossing borders several times until they compose final goods, causing a multiple-counting effect.

Overall, countries have increasingly relied on foreign value added for their own exports, which may then be further processed in partner countries, but there were no substantial changes among countries regarding their relative position on GVCs between 1995 and 2011. Vertical specialization was mainly driven by an increase in the double counted intermediate exports produced abroad, as a reflection of the multiple-border crossing and the back-and-forth aspects of production processes. Furthermore, we found that a limited number of countries had the ability to become more integrated into GVCs hand in hand with scaling them up.

In particular, we have shown that countries with the largest GVC participation were mostly small economies, which have lower availability of domestically sourced intermediates, and have expanded their overall GVC participation underpinning their role as buyers of foreign inputs. For instance, Southeast Asian economies showed relatively high GVC participation indexes and were generally located downstream in a supply chain, boosting the importance of its backward linkages rather than its forward linkages over time. Most countries have increasingly used intermediate imports as source of international competitiveness to their exports. But we have found no linear relationship between GVC participation and a country's relative upgrading in complexity of production.

Chapter 2 also showed how the use of traditional trade statistics can lead to errors in estimating bilateral trade balance and the gains of international competitiveness at the sector-level. While the gaps between bilateral trade balance in value added and gross terms are a reflection of the relative position of countries in GVCs, it is also true that the differences in terms of international competitiveness and specialization patterns vary according to the specific sector, becoming more significant in those most influenced by GVCs. In particular, we found no evidence of a worldwide positive association between higher levels of domestic value-added in gross exports and gains in sector competitiveness. But, more importantly, we found that the countries that already showed relative gains in international competitiveness among manufacturing sectors in 1995, and continued to show it in 2011, are those that most increased the domestically added value of exports throughout this period. This leads us to believe that countries are not doomed to gain competitiveness in manufacturing from higher import content.

One country has proved to be an exception in terms of the changing patterns of trade specialization, that is China. While most countries are relying less and less on domestic inputs for production, China is against this trend and it is increasingly adding domestic value to its exports. In addition, China showed signs of advancing its production to other stages located more at the beginning of the GVC, while becoming more competitive especially in the production of components. China has declined its role as the final point in Factory Asia, which is a key dimension of a much broader structural transformation in China. Although some argue that this process could affect negatively the Chinese capacity of producing new products, our analysis showed that China has achieved a greater diversification of its exports, while relying less and less on imported inputs as a way to gain international competitiveness. But the relevance of China as a processing hub of imported intermediates from other countries should not be underestimated, as it was illustrated by China's trade rebalance in value-added terms.

Chapter 3 has investigated the regional dynamics of global production sharing, analyzing inter and intra-regional blocs' value-added trade and relative market interdependences. Our contributions to the literature on the geography of global value chains and its regionalization are centered on the analysis of the pattern of participation of South America in value chains compared to other regional blocs. Factory South America has been acting as a supplier of inputs, especially primary products, to other countries exports. Although Factory South America is the least integrated to global value chains compared to other regional blocs, it is also the regional bloc that has increased the most its total participation in GVCs. A closer look to its value-added export growth showed that Factory South America is the regional-bloc with the lowest diversity of growth sources, mainly based on primary products but also on manufacturing. This lack of a diversified production structure together with poor technological capacities turned the regional-bloc more exposed to falling into a "low-growth trap" compared to other regional-blocs. In summary, we found evidence of the deepening of the pattern of trade integration verified historically and traditionally from gross value measures for South American countries.

As we have showed, GVC trade has taken the place of direct exports, expanding even more considerably between South American countries. Our analysis based on the origin and destination of value-added through backward and forward linkages across different countries has revealed that South American countries had weaker backward and forward linkages within Factory South America rather than with other regional-blocs. Factory North America, and more specifically the United Sates, and Factory Europe are still the main partners

of South American backward and forward linkages. But we have showed signs of stronger intra-regional linkages and, more importantly, Factory South America has become more and more oriented towards Asian countries, especially from a supplier perspective (i.e. forward GVC participation). Another major development was the increasing Chinese influence on the production arrangements within its regional partners and beyond its regional boundaries. Thus, although we cannot say that there is a tendency of weakening the South American intra-linkages, we have found that the interregional links were much stronger, providing insights to a possible change in the regional dynamics of global production towards Asia with China as a main hub in the context of vertically fragmented production.

Further, one of our contributions was the creation of a hubness measure in terms of added value. By measuring the degree of relative market interdependence, we have created a simple way to assess the hierarchical organization of global and regional production network around hubs. Our findings illustrated the rise of China as a hub-nation at the regional and global level. In particular, China has deepened its relative market interdependence mainly with other Asian economies but also with South American countries, meanwhile the United States have lost importance as a hub with both regions.

Brazil has emerged as the only country in South America with the potential to become a hub-nation. More interestingly, our hubness index has shown that the pattern of Brazil's participation in value chains is very much grounded in the externalization of its domestic demand and not purely and simply in the forward and backward linkages of its value-added exports. These findings may help to illustrate how simplistic it can be to take a country's participation in the current production-trade arrangements only from the traditional indicators of GVC participation. Despite the merit of being more consistent with the fragmentation of production and the emergence of global and regional value chains, these are purely anchored in a country's exports and do not capture other critical phenomena that have political and economic developments, such as the externalization of domestic demand as a result of feebler intra-regional and domestic production linkages.

Despite our contributions in this third chapter towards capturing the degree and nature of trade interactions along global and regional value chains, this research can be deepened in many different ways. To name a few, first, the country-level analysis imposes a number of limitations, since many characteristics are sector-specific. Second, by choosing to use the ready-to-use TiVA indicators, the ability to develop a more detailed analysis that goes beyond the pre-defined indicators is partially left out. Further on, GVC indicators capture only

a fraction of cross-border trade flows. Since the domestic value-added trade sent to consumer economy is not considered as part of GVC trade, and so it has not been included in the most used indexes of participation in GVCs. In addition, the GVC indicators only partially portray a country's trade integration, not adding any causal link, as many scholars often want to impute. In other words, there is a complex mix of determinants of a country´s engagement in GVCs that is not reflected by GVC indicators nor one can assume that the greater the share of domestic value added in exports, the better the country's situation regarding the gains from trade integration.

The third section of this research has analyzed one of the multidimensional impacts of countries' integration into GVCs, which is the responsiveness of trade to changes in income in the current phase of globalization.

We have seen a remarkable anemic phase of trade growth in more recent years, as illustrated by the historical relationship between growth in imports and global economic activity. This dismal performance of world trade has raised questions concerning a potential deeper and longer-term change in the trade-income relationship, which has been estimated in terms of the elasticity of imports to changes in income. However, we have showed that the empirical evidence on the drivers of this shift still remains inconclusive. In that sense, we have reviewed the related literature on both cyclical and structural factors behind the decline in trade elasticities, and related current trade slowdown.

We have shown that for some scholars the behavior of trade elasticities is a reflection of the economic environment, and its decline would be therefore a purely cyclical phenomenon that would dissipate after the weak economic environment recovers. This means that the weak demand, especially in the Eurozone and more recently in China, as well as a compositional change in aggregate demand towards the less import-intensive components, would be the main determinants of the decline in the long-term income elasticity of global trade. On the other hand, some studies argued that there are structural or longer-term factors acting in this phenomenon. The main arguments in this regard are: i) regional changes in economic activity and trade; ii) changes in the composition of trade (from goods to services); iii) changes in trade policies (increased protectionism); and iv) changes in the pace of international fragmentation of production processes, i.e. deceleration of GVCs.

Further, our empirical exercise was based on a dynamic error correction model to examine the short-run and long-run dynamics of the import-income relationship for a broad sample of advanced economies (AE) and developing and emerging countries (EME). We found

that the global long-run trade elasticity decreased during the long 2000s, i.e. trade has become less sensitive to changes in income in recent years. When considering the behavior of the long-run trade elasticity for both groups of countries separately, we found that it became lower for developing and emerging countries over time. When comparing both groups of countries, we showed that the difference between both groups' trade elasticities decreased throughout the 1990s, but this process was interrupted in the 2000s, and that the trade elasticity of EME was lower than AE's.

As we aimed to examine whether there are more structural factors operating in the recent behavior of trade elasticities, we have decomposed the imports growth into its short-run and long run components for advanced economies and emerging countries, respectively. In the case of EME, our findings showed that cyclical factors explain a larger share of the behavior of imports growth in the afterwards of the 2008-2009 financial crisis, as well as during periods of economic turmoil such as the Asian Crisis. Besides weak global demand, we have suggested that another explanation could be a compositional effect concerning the contribution of a recent sharp decrease in the Chinese trade elasticity as China is expanding its in-house production of capital and intermediate goods, which was also illustrated in the second section of this research. In that sense, the Chinese transition towards more consumption-led growth has been lowering import demand in emerging economies. Meanwhile, the long-run component, capturing structural effects, dominates most of the historical trade growth behavior, including moments of economic crisis and especially in the last two years marked by the global trade slowdown.

More importantly, the changes in the relationship between trade and income may indicate that development strategies anchored in greater trade integration may not achieve the same results as in the past. The symbiotic relationship between trade and economic growth is one of the bases of these development strategies, especially for emerging and developing economies. Thus, our findings shed light to potential consequences for the long-term economic growth dynamics of these countries, since we have found that trade has become less sensitive to changes in income. Furthermore, the difference between EME and AE's degree of trade responsiveness to income may suggest that the strategies based on GVC integration for promoting long-term economic growth may not have the same results, with EMEs, once again, showing up as the weak side.

Therefore, considering the set of structural drivers of the current trade slowdown, we aimed to further investigate the particular role played by vertically fragmented production across global value chains in the behavior of trade's responsiveness to income in the 2000s. In

that sense, in our second empirical exercise, in this final chapter, we have expanded the import demand function by further accounting for the GVC participation index concerning both buying and selling perspectives. We have added new nuances on the selling perspective by creating two versions of the forward participation measure. Besides the traditional measure in the GVC literature, which we have named *narrow* forward participation, we accounted for the domestic value-added in final and intermediates goods absorbed by direct importers, named *broad* forward participation. This has helped to avoid underestimating the role of GVC participation of countries with large domestic consumer markets, such as Brazil and China.

We have found lower trade elasticities for both AE and EME countries over time. More importantly, this lower responsiveness of trade to income may be associated with a slower pace of international fragmentation of production processes. As pointed in the literature review, this may be the result of a maturation of the process of fragmenting production processes internationally, given the increase in emerging economies' labor costs and firms' decisions to "re-shore" production. Clearly, other structural factors may also have played a role in the falling trade elasticities. When taking both measures of GVC participation separately, our second empirical exercise has also showed lower trade elasticities for EME than AE, and that the difference between both groups has increased over time.

In summary, the changing trade-income relationship has posed some challenges that may have consequences for the long-term economic growth dynamics across countries, being even more important for developing and emerging economies, and ultimately can transform the idea that trade integration can promote economic growth in a fallacy. Moreover, we have reinforced the need for measurement tools that encompasses the increasingly complex economic reality within GVCs and can guide strategic policy responses for trade integration to ensure economy-wide benefits and sustained economic growth. Therefore, an important development of this discussion lies in revealing the obsolescence of the label "made in" and the policies that involve it.

More recently, a backlash against trade has been the tonic of anti-globalization narratives that have been multiplying throughout the world, and mainly in developed economies. From offshoring (as outsourcing or insourcing) to "reshoring", the rumors about the world's largest manufacturers been returning home are highly political and controversial. As we have shown, countries are specializing in different stages of production processes within GVCs, and measuring the real participation of individual countries and the gains from trade

integration has become less straightforward. Therefore, anti-globalization discourses can be just as simple as a completely misleading strategy in the face of such a complex picture.

The cross-border activity can spur several benefits, but it is also true that trade, such as technological advances, can skew the distribution of income (MALLABY, 2016). However, the answer to inequality does not lie in protectionism. Actually, spending policies and taxing, as well as tax reform, are some of the key steps to put forward the redistribution of the overall gains to those who are damaged by trade. Binary protectionist responses in the sense of "us" versus "them" may end up in different outcomes from what is expected. Superficial in their analytical form, such discussions reached the profound discontentment and feeling of non-belonging of a large part of the population. Despite the lack of analytical robustness, the electoral appeal of these discussions captured frustration and converted it into votes. Therefore, it is not a matter of responding to these discontents with policies shaped in the midst of economic scenarios from the past. To the extent that shortcuts should be avoided, we argued that the paralysis of policymakers, in the face of the complexity of trade transactions in a vertically fragmented structure, is also not a possible way out, especially not for those that aim to have a bigger share of the gains.

Of course, the economic scenario portrayed is constantly changing. Hence, it is certain that a number of issues that have arisen throughout its construction have not been fully addressed here. Just to name a few, the relationship between participation in GVCs and the income inequality across countries; an empirical analysis that estimates the determinants behind participation in GVCs; an empirical research that addresses the relationship between trade integration and social upgrading, particularly with regard to job creation and labor conditions (especially in countries where anti-globalization movements have been stronger, such as the United States); the risen movement of reshoring, its determinants, and effects in terms of social and economic upgrading; among others. A wide range of national policies areas, such as trade, labor market, innovation, education, infrastructure, and investment regulations, can affect the chances of success in GVCs. Hence, another field that deserved to be further developed is the policy options to guarantee the mechanisms through which countries can maximize the benefits from GVC participation.

Finally, this research sought to contribute to a research agenda that showed to be even more comprehensive than one could expect. Although the GVC literature has often been associated with some particular political propositions of dubious character, it can also be a fruitful field of research with several contributions in positive terms and potential applications

for future work in several areas of economics. Despite its limitations, which should act more as a stimulus for future work than as an obstacle, there is an important field for those who want to endeavor through these research paths.

References

AGUIAR, Angel; NARAYANAN, Badri; MCDOUGALL, Robert. An Overview of the GTAP 9 Data Base. **Journal of Global Economic Analysis,** v. 1, n. 1, p. 181–208, 2016.

AHMAD, Nadim. Estimating trade in value-added: why and how? In: ELMS, Deborah K.; LOW, Patrick (Orgs.). **Global value chains in a changing world**. Switzerland: WTO Publications, p. 85–108, 2013.

AHMAD, NADIM; PRIMI, ANNALISA. From domestic to regional to global: Factory Africa and Factory Latin America? **Measuring and analyzing the impact of GVCs on economic development**. Washington, D.C.: The World Bank, p. 69–96, 2017.

AL-HASCHIMI, Alexander *et al*. The trade and demand nexus: Do global value chains matter? In: AMADOR, João; MAURO, Filippo Di (Orgs.). **The Age of Global Value Chains: Maps and Policy Issues**. London: CEPR Press, p. 132–147, 2015.

ALESSANDRIA, George; KABOSKI, Joseph P.; MIDRIGAN, Virgiliu. US trade and inventory dynamics, p.303–307, 2011.

ALESSANDRIA, George; KABOSKI, Joseph; MIDRIGAN, Virgiliu. Trade wedges, inventories, and international business cycles. **Journal of Monetary Economics** v. 60, p. 1–20, 2013.

ALTOMONTE, Carlo et al. **Global Value Chains During the Great Trade Collapse: A Bullwhip Effect?** , nº 1131. London: [s.n.], 2012.

AMADOR, J.; CABRAL, S. Global Value Chains: surveying drivers and measures. Working Paper Series, n. 1739, European Central Bank, Frankfurt, 2014.

AMADOR, João; MAURO, Filippo Di. Introduction. In: AMADOR, João; MAURO, Filippo Di (Orgs.). **The Age of Global Value Chains: Maps and Policy Issues**. London: CEPR Press, 2015. p. 13–23.

ANTRÀS, Pol. **Firms, contracts, and global production**, CREI Lectures in Macroeconomics. [S.l: s.n.], 2013.

ANTRÀS, Pol. 2015. **Global Production: Firms, Contracts, and Trade Structure**. Princeton, NJ: Princeton University Press.

ANTRÀS, Pol *et al.* Measuring the upstreamness of production and trade flows. **American Economic Review** v. 102, n. 3, p. 412–416, 2012.

ANTRÀS, P.; HELPMAN, E. Global sourcing. Journal of Political Economy, vol. 112, n. 3, 2004.

ARELLANO, Manuel; BOND, Stephen. Some Tests of Specification for Panel Carlo Application to Data : Evidence and an Employment Equations. The Review of Economic Studies v. 58, n. 2, p. 277–297, 1991.

ARELLANO, M.; BOVER, O. Another look at the instrumental variable estimation of error-components models. Journal of Econometrics, vol. 68, isue 1, p. 29-51, 1995.

ARNDT, Sven; KIERZKOWSKI, Henryk. Fragmentation: New Production Patterns in the World Economy. **CMC Faculty Books**, 2001.

ATHUKORALA, Prema-chandra. Product Fragmentation and Trade Patterns in East Asia. **Asian Economic Papers** v. 4, p. 1–27, 2005.

BACKER, Koen De; MIROUDOT, Sébastien. Mapping Global Value Chains. **OECD Trade Policy Papers,** n. 159, OECD Publishing, p. 1–46, 2013.

BACKER. Koen De; MIROUDOT. Sébastien. **Mapping global value chains**, The competitiveness research network, nº 1677, European Central Bank, 2014.

BAIR, Jennifer. Global Capitalism and Commodity Chains: Looking Back , Going Forward. **Competition and Change** v. 9, n. 2, p. 153–180 , 2005.

BALASSA, B. Trade liberalisation and "Revealed" comparative advantage. **The Manchester School**, vol. 33, issue 2, p. 99-123, 1965.

BALDWIN. Richard. **The Spoke Trap: hub and spoke bilateralism in East Asia**. , CNAEC Research Series., nº 4–2, Seoul, 2004.

BALDWIN, Richard. Globalisation: the great unbundling (s). **Globalisation Challenges for Europe and Finland,** p. 1–51, 2006

BALDWIN, Richard. The great trade collapse: what caused it and what does it mean? In: BALDWIN, Richard (Org.). **The Great Trade Collapse: Causes, Consequences and Prospects**. London: VoxEU.org Publication, 2009. p. 1–14.

BALDWIN. Richard. **Trade and industrialisation after globalisation's 2nd unbundling: how building and joining a supply chain are different and why it matters**, NBER working paper series., nº 17716. Cambridge, 2011.

BALDWIN, Richard. Sequencing Asian Regionalism: Theory and Lessons from Europe. **Journal of Economic Integration** v. 27, n. 1, p. 1–32, 2012.

BALDWIN, Richard. Global supple chains: why they emerged, why they matter, and where they are going. In: ELMS, Deborah K.; LOW, Patrick (Orgs.). **Global value chains in a changing world**. Geneva: WTO Publications, 2013. p. 13–60.

BALDWIN, Richard; FORSLID, Rikard. The development and future of Factory Asia. In: FERRARINI, Benno; HUMMELS, David (Orgs.). **Asia and Global Production Networks: implications for Trade, Incomes and Economic Vulnerability**. Massachusetts: Edward Elgar Publishing, 2014.

BALDWIN. Richard; FORSLID. R.; ITO. T. **Unveiling the Evolving Sources of Value Added in Exports**, IDE–JETRO Joint Research Program Series., nº 161, 2015.

BALDWIN, Richard; LOPEZ-GONZALEZ, Javier. **Supply-chain trade: a portrait of global patterns and several testable hypotheses**, NBER Working Paper Series, nº 18957, Cambridge, 2013.

BALDWIN, Richard; LOPEZ-GONZALEZ, Javier. Supply-chain Trade: A Portrait of Global Patterns and Several Testable Hypotheses. **World Economy,** v. 38, n. 11, p. 1682–1721, 2015.

BALDWIN, Richard; TAGLIONI, Daria. The great trade collapse and trade imbalances. In: BALDWIN, Richard (Org.). **The Great Trade Collapse: causes, consequences and prospects**. London: VoxEU.org Publication, 2009. p. 47–58.

BALDWIN, Richard; VENABLES, Anthony. Spiders and snakes: offshoring and agglomeration in the global economy. **Journal of International Economics** v. 90, n. 2, p. 245–254, 2013.

BARRIENTOS, Stephanie; GEREFFI, Gary; ROSSI, Arianna. Economic and social upgrading in global production networks: developing a framework for analysis. **Capturing**

the Gains Working paper, n. 3, p. 1–25, 2010.

BARRIENTOS, Stephanie; SMITH, Sally. Do workers benefit from ethical trade? Assessing codes of labour practice in global production systems. **Third World Quarterly** v. 28, n. 4, p. 713–729, 2007.

BEMS, Rudolfs; JOHNSON, Robert C; YI, Kei-Mu. **Demand Spillovers and the Collapse of Trade in the Global Recession**. **IMF Working Paper**, IMF Working Paper., nº 142, 2010.

BENGURIA, Felipe. Imported Intermediate Inputs and Export Diversification in Low-Income Countries. 2014, Washington, 2014. p.30.

BERNHARDT, Thomas. **Developing countries in the global apparel value chain: a tale of upgrading and downgrading experiences**, Capturing the Gains: economic and social upgrading in global production networks., nº 22. [S.l: s.n.], 2013.

BERNHARDT, Thomas; MILBERG, William. **Economic and social upgrading in global value chains: analysis of horticulture, apparel , tourism and mobile telephones**, nº 6. New York, 2011.

BERNHARDT, Thomas; POLLAK, Ruth. **Economic and social upgrading dynamics in global manufacturing value chains : A comparative analysis**, FIW Working Paper., nº 150. [S.l: s.n.], 2015.

BHATIA, Ujal Singh. The globalization of supply chains – policy challenges for developing countries. In: ELMS, Deborah; LOW, Patrick (Orgs.). **Global value chains in a changing world**. Geneva: WTO Publications, p. 313–328, 2013.

BLYDE, Juan. **Synchronized Factories: Latin America and the Caribbean in the Era of Global Value Chains**. Washington, D.C.: Springer, 2014.

BORIN, Alessandro *et al.* **The cyclicality of the income elasticity of trade**, MPRA paper, nº 73000, 2016.

BOZ, Emine; BUSSIÈRE, Matthieu; MARSILLI, Clément. Recent slowdown in global trade: Cyclical or structural? In: HOEKMAN, Bernard (Org.). **The Global Trade Slowdown: a new normal?** VoxEU.org publication, 2015.

BULLÓN, David *et al.* **Using the Input-Output Approach to Measure Participation in GVCs: the Case of Costa Rica**. Rotterdam, 2014.

BUSSE, Matthias; SPIELMANN, Christian. Gender Inequality and Trade. **Review of International Economics** v. 14, n. 3, p. 362–379, 2006.

BUSSIÈRE, Matthieu *et al.* Estimating trade elasticities: Demand composition and the trade collapse of 2008-2009. **American Economic Journal: Macroeconomics** v. 5, n. 3, p. 118–151 , 2013.

CADESTIN, Charles; GOURDON, Julien; KOWALSKI, Przemyslaw. Participation in Global Value Chains in Latin America. **OECD Trade Policy Papers,** v. 192, 2016.

CATTANEO, O. *et al.* Joining, upgrading and being competitive in global value chains: a strategic framework. **Policy Research Working Paper,** n.6406, p. 1–50 , 2013.

CHEN, Lurong; DE LOMBAERDE, Philippe. Testing the relationships between globalization, regionalization and the regional hubness of the BRICs. **Journal of Policy Modeling**, v. 36, n.1, p. 111–131, 2014.

CHENG, Kevin; SENEVIRATNE, Dulani; ZHANG, Shiny. Reaping the Benefits from Global Value Chains. **Regional Economic Outlook: Asia and Pacific** p. 73–92, 2013.

CHEUNG, Calista; GUICHARD, Stéphanie. **Understanding the world trade collapse**. **Economic Department Working Paper**, Economics Department Working Papers, nº 729, Paris, 2009.

CIMOLI, Mario; PORCILE, Gabriel; ROVIRA, Sebastián. Structural change and the BOP-constraint: Why did Latin America fail to converge? **Cambridge Journal of Economics** v. 34, n. 2, p. 389–411, 2009.

COE, Neil M *et al.* "Globalizing" regional development: a global production networks perspective. **Transactions of the Institute of British Geographers** v. 29, p. 468–484, 2004.

COE, Neil M.; DICKEN, Peter; HESS, Martin. Global production networks: realizing the potential. **Journal of Economic Geography** v. 8, n. 3, p. 271–295, 2008a.

COE, Neil M.; DICKEN, Peter; HESS, Martin. Introduction: global production networks - debates and challenges. **Journal of Economic Geography** v. 8, n. 3, p. 267–269 , 2008b.

CONSTANTINESCU, Cristina; MATTOO, Aaditya; RUTA, Michele. The Global Trade Slowdown : Cyclical or Structural ? **IMF Working Paper,** n. 6 , 2015.

CROZET, Matthieu; EMLINGER, Charlotte; JEAN, Sébastien. On the gravity of world trade's slowdown. In: HOEKMAN, Bernard (Org.). **The Age of Global Value Chains: Maps and Policy Issues**. London: CEPR Press, 2015.

DAUDIN, Guillaume; RIFFLART, Christine; DANIELLE, Schweisguth. Who produces for whom in the world economy? **Canadian Journal of Economics,** v. 44, n. 4, p. 1403–1437, 2011.

DE BACKER, K.; YAMANO, N. The Measurement of Globalisation using International Input-Output Tables. p. 32, 2007.

DEDRICK, Jason; KRAEMER, Kenneth L.; LINDEN, Greg. Who profits from innovation in global value chains?: A study of the iPod and notebook PCs. **Industrial and Corporate Change** v. 19, n. 1, p. 81–116, 2009.

DEGAIN, CHRISTOPHE; MENG, BO; WANG, ZHI. Recent trends in global trade and global value chains. **Measuring and analyzing the impact of GVCs on economic development**. Washington, D.C.: World Bank Publications, 2017. p. 37–68.

DI GIOVANNI, Julian; LEVCHENKO, Andrei a. Putting the Parts Together: Trade, Vertical Linkages, and Business Cycle Comovement. **American Economic Journal: Macroeconomics** v. 2, n. 2, p. 95–124, 2010.

DICKEN, Peter. **Global shift: mapping the changing contours of the World Economy**. Sixth edit ed. London: The Guilford Press, 2011.

DICKEN, Peter *et al.* Chains and networks, territories and scales: towards a relational framework for analysing the global economy. **Global Networks** v. 1, n. 2, p. 89–112, 2001.

DIETZENBACHER, Erik *et al.* The construction of World Input-Output Tables in the WIOD Project. **Economic Systems Research** v. 25, n. 1, p. 71–98, 2013.

DIETZENBACHER, Erik. Vertical specialization in an intercountry input-output. p. 127–136, 2010.

EATON, Jonathan *et al.* **Trade and Global Recession**. **NBER Working Paper Series**,

NBER WORKING PAPER SERIES., nº 16666. Cambridge, MA: [s.n.], 2011.

ECB. Understanding the weakness in global trade. **ECB Economic Bulletin** n. 3, p. 1–10 , 2015.

ECLAC - ECONOMIC COMMISSION FOR LATIN AMERICA AND THE CARIBBEAN. **Latin America and the Caribbean in the World Economy**. Santiago: United Nations Publication, 2016. 168 p.

ECLAC - ECONOMIC COMMISSION FOR LATIN AMERICA AND THE CARIBBEAN. **Strengthening value chains as an industrial policy instrument: methodology and experience of ECLAC in Central America**. Santiago: United Nations publication, 2014. 354 p.

EGGER, Hartmut; EGGER, Peter. Cross-border sourcing and outward processing in EU manufacturing. **The North American Journal of Economics and Finance** v. 12, n. 3, p. 243–256, 2001.

ERNST, Dieter. Global Production Networks and the Changing Geography of Innovation Systems:implications for Developing Countries. **Economics of Innovation & New Technology** v. 11, n. 6, p. 497–523, 2002.

ESCAITH, Hubert. Mapping global value chains and measuring trade in tasks. In: FERRARINI, B.; HUMMELS, D. (Org.). **Asia and Global Production Neworks: implications for trade, incomes and economic vulnerability**. Cheltenham, UK, and Northampton, MA, USA: Edward Elgar Publishing, 2014. p. 287–338.

ESCAITH, Hubert; LINDENBERG, Nannette; MIROUDOT, Sébastien. Global Value Chains and the Crisis: Reshaping International Trade Elasticity? In: CATTANEO, Olivier; GEREFFI, Gary; STARITZ, Cornelia (Orgs.). **Global Value Chains in a Postcrisis World: a development perspective**. Washington, D.C.: The International Bank for Reconstruction and Development / The World Bank, 2010a. p. 73–124.

ESCAITH, Hubert; LINDENBERG, Nannette; MIROUDOT, Sébastien. **International Supply Chains and Trade Elasticity in Times of Global Crisis**, nº 20478. [S.l: s.n.], 2010b.

EVENETT, Simon J; FRITZ, Johannes. **The Tide Turns? Trade, protectionism, and slowing global growth**. London: [s.n.], 2015.

FALLY, T. Production staging: measurement and facts. **Discussion paper**, University of Colorado-Boulder, 2012.

FAROLE, Thomas. Do global value chains create jobs? **IZA World of Labor** p. 1–11, 2016.

FEENSTRA, R. C. Integration of trade and disintegration of production in the global economy. **Journal of Economic Perspectives** v. 12, n. 4, p. 31–50, 1998.

FEENSTRA, R.C.; HANSON, Gordon H. The Impact of Outsourcing and High-Technology Capital on Wages: Estimates for the United States, 1979-1990. **The Quarterly Journal of Economics** v. 114, n. 3, p. 907–940, 1999.

FEENSTRA, Robert C.; INKLAAR, Robert; TIMMER, Marcel P. The Next Generation of the Penn World Table. **American Economic Review** v. 105, n. 10, p. 3150–3182, 2015.

FERNANDEZ-STARK, Karina; BAMBER, Penny; GEREFFI, Gary. Global value chains in Latin America: a development perspective. In: HERNÁNDEZ, René A.; MARTÍNEZ-PIVA, Jorge Mario; MULDER, Nanno (Orgs.). **Global value chains and world trade - prospects and challenges for Latin America**. Santiago, Chile: United Nations Publication, 2014.

FERRANTINO, Michael J; TAGLIONI, Daria. Global Value Chains in the Current Trade Slowdown. **World Bank-Economic Premise,** n. 138, p. 1–6, 2014.

FONTANA, M. The gender effects of trade liberalization in developing countries: a review of the literature. In: BUSSOLO, Maurizio; HOYOS, Rafael E. De (Orgs.). **Gender Aspects of the Trade and Poverty Nexus: A Macro-Micro Approach**. Washington: The World Bank, 2009.

FREDERICK, Stacey. **Combining the global value chain and global I-O approaches**. **International Conference on the Measurement of International Trade and Economic Globalization** Aguascalientes: [s.n.], 2014.

FREUND, Caroline. **The trade response to global downturns: historical evidence**. **Policy Research Working Paper 5015** Washington: [s.n.], 2009.

GANGNES, Byron; ASSCHE. Ari Van. **Global Value Chains and changing Trade Elasticities**, UHERO Working Paper, nº 11. Honolulu: [s.n.], 2016.

GANGNES, Byron; MA, Alyson C; ASSCHE, Ari Van. Global value chains and the trade-income relationship: implications for the recent trade slowdown. In: HOEKMAN, Bernard (Org.). **The Global Trade Slowdown: a new normal?** London: CEPR Press, 2015. p. 111–126.

GANGNES, Byron; MA, Alyson C; ASSCHE, Ari Van. **Global Value Chains and the Transmission of Business Cycle Shocks**. ADB Economics Working Paper Series. [S.l: s.n.], 2012.

GANGNES, Byron; MA, Alyson C; ASSCHE, Ari Van. Global value chains and trade elasticities. **Economics Letters** v. 124, n. 3, p. 482–486, 2014.

GEREFFI, Gary. The Organization of Buyer-Driven Global Commodity Chains: How U.S. Retailers Shape Overseas Production Networks. In: GEREFFI, G.; KORZENIEWICZ, M. (Orgs.). **Commodity Chains and Global Capitalism**. Wesport: Praeger, 1994. p. 95–122.

GEREFFI, Gary. The Global Economy: Organization, Governance and Development. In: SMELSER, Neil J.; SWEDBERG, Richard (Orgs.). **Handbook of Economic Sociology**. 2. ed. Princeton, NJ: Princeton University Press and Russell Sage Foundation, 2005. p. 160–182.

GEREFFI, Gary. Global value chains in a post-Washington Consensus world. **Review of International Political Economy** v. 21, n. 1, p. 9–37, 2014.

GEREFFI, Gary; FERNANDEZ-STARK, Karina. **Global Value Chain Analysis: A Primer**. **Center on Globalization, Governance and Competitiveness,** Durham, USA: [s.n.], 2011.

GEREFFI, Gary; HUMPHREY, J; STURGEON, Timothy J. The governance of global value chains. **Review of international political**, 2005.

GEREFFI, Gary; KAPLINSKY, Raphael. The Value of Value Chains: spreading the gains from globalisation. **IDS Bulletin** v. 32, n. 3, p. 2–3, 2001.

GEREFFI, Gary; LEE, Joonkoo. Why the World Suddenly Cares About Global Supply Chains. **Journal of Supply Chain Management** v. 48, n. 3, p. 24–32, 2012.

GEREFFI, Gary; LUO, Xubei. Risks and Opportunities of Participation in Global Value Chains. **Journal of Banking and Financial Economics** v. 2, n. 4, p. 51–63, 2015.

GEREFFI, Gary; MEMEDOVIC. Olga. **The Global Apparel Value Chain: what prospects for upgrading by developing countries**. **Sectoral studies series** Vienna: [s.n.], 2003.

GHAI, Dharam. Decent work: Concept and indicators. **International Labour Review, Vol. 142, No. 2** v. 142, n. 2, p. 113–145, 2003.

GIULIANI, Elisa; PIETROBELLI, Carlo; RABELLOTTI, Roberta. Upgrading in Global Value Chains: Lessons from Latin American Clusters. **World Development** v. 33, n. 4, p. 549–573, 2005.

GONZALEZ, Javier Lopez; KOWALSKI, Przemyslaw; ACHARD, Pascal. Trade, global value chains and wage-income inequality. **OECD Trade Policy Papers No. 182, OECD Publishing, Paris,** n. 182, 2015.

GTAI - GERMANY TRADE AND INVEST. Industrie 4.0: smart manufscturing for the future, Germany Trade and Invest Publisher: Berlin, 2016.

HAGEN, Markéta Von. **Trade and Gender – exploring a reciprocal relationship**. Pulchowk, Lalitpur: Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH, 2014. 49 p.

HAUGH, David *et al.* **Cardiac arrest or dizzy spell: why is world trade so weak and what can policy do about it? OECD Economic Policy Paper**, nº 18. [S.l: s.n.], 2016.

HAUSMANN, R. *et al.* **The Atlas of Economic Complexity: mapping Paths to Prosperity**. Cambridge, MA: Harvard University, 2011. 368 p.

HENDERSON, Jeffrey *et al.* Global production networks and the analysis of economic development. **Review of International Political Economy** v. 9, n. 3, p. 436–464 , 2002.

HEUSER, C.; MATTOO, A. Services trade and Global Value Chains, Policy Research Working Paper, n. 8126, World Bank, Washington, D.C. World Bank, 2017.

HILLBERRY, Russell. Causes of International Production Fragmentation: Some Evidence. **Global Value Chains: Impacts and Implications. Trade Policy Research 2011** p. 77–102, 2011.

HONG. Pingfan. **Import elasticities revisited**. , DESA Discussion paper series., nº 10. [S.l: s.n.], 1999.

HOPKINS, Terence K.; WALLERSTEIN, Immanuel. Commodity chains in the world economy prior to 1800. **Review** v. 10, n. 1, p. 157–170, 1986.

HOPKINS, Terence K.; WALLERSTEIN, Immanuel. Patterns of development of the modern world-system. **Review** v. 1, n. 2, p. 111–145, 1977.

HOROWITZ, Jeffrey; RIKER, David. Measuring Shifts in Brazil's Trade Using International Input-Output Tables. **Journal of International Commerce and Economics**, p. 1–13, 2014.

HOUTHAKKER, H. S.; MAGEE, Stephen P. Income and Price Elasticities in World Trade. **The Review of Economics and Statistics** v. 51, n. 2, p. 111–125, 1969.

HUMMELS, David; ISHII, Jun; YI, Kei-Mu. The nature and growth of vertical specialisation in world trade. **Journal of International Economics** v. 54, n. 1, p. 75–96, 2001.

HUMPHREY, John; SCHMITZ, Hubert. How does insertion in global value chains affect upgrading in industrial clusters? **Regional Studies**, v. 36, n. 9, p. 16, 2002.

ILIUTEANU, Maura Ada. Deepening and Expanding Global Value Chain Participation across Asia and Europe. In: PRAKASH, Anita (Org.). **Asia–Europe Connectivity Vision 2025: Challenges and Opportunities**. [S.l.]: Economic Research Institute for ASEAN and East Asia, 2016. p. 127–136.

ILO. Measurement of decent work. 2008, Geneva: [s.n.], 2008.

IMBS. Jean; MÉJEAN. Isabelle. **Trade Elasticities: a final report for the European Commission**. , nº 432. Brussels: [s.n.], 2010.

IMF - INTERNATIONAL MONETARY FUND. Trade Interconnectedness: The World with Global Value Chains. **IMF Policy Paper**, 2013.

IMF - INTERNATIONAL MONETARY FUND. **World Economic Outlook: Uneven Growth—Short- and Long-Term Factors**. Washington: [s.n.], 2015.

IMF - INTERNATIONAL MONETARY FUND. **World Economic Outlook: subdued demand: symptoms and remedies,** Washington: [s.n.], 2016.

IMF - INTERNATIONAL MONETARY FUND. **Global trade: what's behind the slowdown?** [S.l: s.n.], 2016.

INTERNATIONAL MONETARY FUND; THE WORLD BANK; WORLD TRADE ORGANIZATION. Making trade an engine of growth for all: the case for trade and for policies to facilitate adjustment. Frankfurt, 2017.

IRC TRADE TASK FORCE. **Understanding the weakness in global trade: what is the new normal ?** Occasional Paper Series., nº 178. [S.l: s.n.], 2016.

IRWIN, D. Long-run trends in world trade and income. **World Trade Review** v. 1, n. 1, p. 89–100, 2002.

ITO, Tadashi; VÉZINA, Pierre-Louis. Production fragmentation, upstreamness, and value added: Evidence from Factory Asia 1990–2005. **Journal of the Japanese and International Economies**, v. 42, p. 1–9, 2016.

JIANG, Xiao; MILBERG, William. Vertical specialization and industrial upgrading: a preliminary note. **Capturing the Gains,** 2012.

JOHNSON, Robert C. Five Facts about Value-Added Exports and Implications for Macroeconomics and Trade Research. **Journal of Economic Perspectives** v. 28, n. 2, p. 119–142 , 2014.

JOHNSON, Robert C.; NOGUERA, Guillermo. Accounting for intermediates: Production sharing and trade in value added. **Journal of International Economics** v. 86, n. 2, p. 224–236, 2012.

JOHNSON. Robert C; NOGUERA. Guillermo. **Accounting for intermediates: Production sharing and trade in value added**. Berkeley: [s.n.], 2009.

JONES, Lin; POWERS, William; UBEE, Ravinder. **Making Global Value Chain research more accessible**. , Office of Economics Working Paper., nº 2013–10A. Washington, D.C.: [s.n.], 2013.

JONES, Ronald W.; KIERZKOWSKI, H. A Framework for Fragmentation. In: ARNDT, Sven; KIERZKOWSKI, H (Orgs.). **Fragmentation: New Production Patterns in the World Economy**. New York: Oxford University Press, 2001. p. 17–34.

KAPLINSKY, Raphael. Globalisation and unequalisation: What can be learned from value chain analysis. **Journal of Development Studies** v. 37, n. 2, p. 117–146, 2000.

KAPLINSKY, Raphael; FAROOKI, Masuma. Global value chains, the crisis, and the shift of markets from north to south. In: CATTANEO, O; GEREFFI, Gary; STARITZ, Cornelia (Orgs.). **Global Value Chains in a Postcrisis World**. Washington D.C.: The World Bank,

2010. p. 125–153.

KAPLINSKY, Raphael; MORRIS, Mike. **A Handbook for Value Chain Research**. Brighton, UK: [s.n.], 2003.

KAPLINSKY, Raphael; READMAN, Jeff. Globalization and upgrading: What can (and cannot) be learnt from international trade statistics in the wood furniture sector? **Industrial and Corporate Change** v. 14, n. 4, p. 679–703, 2005.

KAPLINSKY, Raphael; READMAN, Jeff. How Can Sme Producers Serve Global Markets and Sustain Income Growth ? n. April, p. 1–71, 2001.

KEE. Hiau Looi; TANG. Heiwai. **Domestic Value Added in Exports : theory and firm evidence from China**, Policy Research Working Paper, nº 7491. [S.l: s.n.], 2015.

KOOPMAN. Robert *et al*. **Give credit where credit is due: tracing value added in global production chains**. **NBER Working Paper**, nº 16426. Cambridge, MA: [s.n.], 2010.

KOOPMAN, Robert; WANG, Zhi. The Value-added Structure of Gross Exports and Global Production Network. **Final WIOD Conference "Causes and Consequences of Globalization" April 24-26, 2012** p. 1–43, 2012.

KOOPMAN, Robert; WANG, Zhi; WEI, Shang-jin. **How much of chinese exports is really made in China? Assessing foreign and domestic value-added in gross exports**, nº 2008–03–B. Washington: [s.n.], 2008.

KOOPMAN, Robert; WANG, Zhi; WEI, Shang-Jin. **Tracing value-added and double counting in gross exports**, NBER WORKING PAPER SERIES., nº 18579. Cambridge: [s.n.], 2012.

KOOPMAN, Robert; WANG, Zhi; WEI, Shang Jin. Tracing value-added and double counting in gross exports. **American Economic Review** v. 104, n. 2, p. 459–494, 2014.

KOWALSKI, Przemyslaw *et al.* Participation of Developing Countries in Global Value Chains. OECD Trade Polic Papers, n. 179, OECD Publishing, Paris, 2015.

KRUGMAN, Paul. Growing World Trade: Causes and Consequences. **Brookings Papers on Economic Activity** n. 1, p. 327–377, 1995.

KUMMRITZ, Victor; KUMMRITZ, Victor. Global Value Chains : Benefiting the Domestic Economy? IHEID Working Papers, n.2, Economics Section, The Graduate Institute of International Studies, 2015.

LAZONICK, William; O'SULLIVAN, Mary. Maximizing shareholder value: a new ideology for corporate governance. **Economy and Society** v. 29, n. 1, p. 13–35, 2000.

LEE, Hau L.; PADMANABHAN, V; WHANG, Seungjin. The bullwhip effect in supply chains. **MIT Sloan Management review** v. 38, n. 3, p. 93–102, 1997.

LEE. Hyun-hoon; PARK. Donghyun; SHIN. Kwanho. **Effects of the Peoples's Republic of China's structural change on the exports of East and Southeast Asian economies**. ADB Economics working paper series, nº 492. Mandaluyong City: [s.n.], 2016.

LENZEN, Manfred; MORAN, Daniel; KANEMOTO, Keiichiro. Building Eora: a Global Multi-Region Input–Output Database at high country and sector resolution. **Economic Systems Research** v. 12, n. 1, p. 37–41, 2013.

LEVY, David L. Political contestation in global production networks. **Academy of Management Review** v. 33, n. 4, p. 943–963, 2008.

LOS, Bart; TIMMER, Marcel P; VRIES, Gaaitzen J De. **Made in Europe ? Trends in International Production Fragmentation**, GGDC RESEARCH MEMORANDUM 131., nº 131. Groningen: [s.n.], 2013.

LOS, Bart; TIMMER, Marcel P.; DE VRIES, Gaaitzen J. How global are global value chains? A new approach to measure international fragmentation. **Journal of Regional Science** v. 55, n. 1, p. 66–92, 2015.

LOW, Patrick. The role of services in global value chains. In: ELMS, Deborah K.; LOW, Patrick (Orgs.). **Global value chains in a changing world**. Geneva: WTO Publications, 2013. p. 61–81.

MALLABY, Sebastian. Globalization Resets: the retrenchment in cross-border capital flows and trade may be less dire than it seems. **Finance and Development** v. 53, n. 4, p. 6–11, 2016.

MANKIW, N Gregory. Principles of Microeconomics. **Cengage Learning** p. 533, 2006.

MARTINEZ-MARTIN. Jaime. **Breaking down world trade elasticities: a panel ECM approach**, Working paper., nº 275. [S.l: s.n.], 2016.

MAURER. ANDREAS; DEGAIN. CHRISTOPHE. **Globalization and Trade Flows: What You See Is Not What You Get! Journal of International Commerce, Economics and Policy**, nº 12. [S.l: s.n.], 2012.

MCCOMBIE, John. On the empirics of balance-of-payments-contrained growth. **Journal of Post Keynesian Economics** v. 19, n. 3, p. 345–375, 1997.

MCKINSEY & COMPANY . Manufacturing the future: the next era of global growth and innovation. McKinsey Global Institute, 2012.

MCKINSEY & COMPANY. Industry 4.0: how to navigate digitalization of the manufacturing sector. McKinsey Global Institute, 2015.

MENG. Bo; FANG. Yong; YAMANO. Norihiko. **Measuring Global Value Chains and Regional Economic Integration: an International Input-Output Approach**. **IDE Discussion Paper** Chiba-Shi: [s.n.], 2012.

MILBERG, William; WINKLER, Deborah. Trade, crisis, and recovery: restructuring Global Value Chains. In: CATTANEO, Olivier; GEREFFI, Gary; STARITZ, Cornelia (Orgs.). **Global Value Chains in a Postcrisis World**. Washington D.C.: Thw World Bank, 2010. p. 23–72.

MILBERG, William; WINKLER, Deborah. Economic and Social Upgarding in Global Production Networks: Problems of theory and measurement. **International Labour Review** v. 150, n. 3–4, p. 341–365, 2011.

MILBERG, William; WINKLER, Deborah. **Outsourcing economics: global value chains in capitalist development**. New York: Cambridge University Press, 2013.

MIROUDOT, Sébastien. The servicification of Global Value Chains: evidence and policy implications. 2017, Geneva, Switzerland: [s.n.], 2017.

MIROUDOT, Sébastien; CADESTIN, Charles. Services in Global Value Chains: From Inputs to Value-Creating Activities. **OECD Trade Policy Papers** v. 197, p. 59, 2017.

MIROUDOT, Sébastien; LANZ, Rainer; RAGOUSSIS, Alexandros. **Trade in intermediate goods and services**. OECD Trade Policy Working Paper, nº 93. Paris: [s.n.], 2009.

MORRISON, Andrea; PIETROBELLI, Carlo; RABELLOTTI, Roberta. **Global Value Chains and Technological Capabilities: A Framework to Study Learning and Innovation in Developing Countries**. **SLPTMD Working Paper Series** [S.l: s.n.], 2007.

NADVI, K. Globalisation and poverty: How can global value chain research inform the policy debate? **IDS Bulletin,** v. 35, n. 1, p. 20–30 , 2004.

NAGENGAST, Arne; STEHRER, Robert. On the interpretation of trade imbalances. In: AMADOR, João; DI MAURO, F. (Orgs.). **The Age of Global Value Chains: Maps and Policy Issues**. [S.l.]: CEPR Press, 2015. p. 163–173.

NAKAJIMA, Jouchi *et al.* **Slow Trade: structural and cyclical factors in Global Trade Slowdown**. [S.l: s.n.], 2016.

NATHAN, D.; SARKAR, S. **Innovation and upgrading in global production network**. **Capturing the Gains 2013**, Capturing the gains., nº 23. [S.l: s.n.], 2013.

NATIONAL BOARD OF TRADE. **Global Value Chains and Developing Countries: an introduction**. Stockholm: [s.n.], 2013a.

NATIONAL BOARD OF TRADE. **Global Value Chains and services: an introduction**. Stockholm: [s.n.], 2013b.

NEILSON, Jeffrey; PRITCHARD, Bill; YEUNG, Henry Wai-chung. Global value chains and global production networks in the changing international political economy: An introduction. **Review of International Political Economy** v. 21, n. 1, p. 1–8, 2014.

ODDONE, Nahuel; PÉREZ, Ramón Padilla; ANTUNES, Bruno. Methodology of the ECLAC-GIZ project for the design of value chain strengthening strategies. In: PÉREZ, Ramón Padilla (Org.). . **Strengthening value chains as an industrial policy instrument Methodology and experience of ECLAC in Central America**. Santiago, Chile: ECLAC Books, 2014. p. 71–2014.

OECD. **Interconnected Economies: Benefiting from Global Value Chains**. [S.l: s.n.], 2013.

OECD; WTO; UNCTAD. Implications of Global Value Chains for Trade , Investment , Development and Jobs. Saint Petersburg, p. 1–29, 2013.

OECD; WORLD BANK GROUP. **Inclusive Global Value Chains: policy options in trade and complementary areas for GVC integration by small and medium enterprises and low-income developing countries**. Istanbul: [s.n.], 2015.

OLLIVAUD, Patrice; SCHWELLNUS, Cyrille. Does the post-Crisis weakness of global trade solely reflect weak demand? In: HOEKMAN, Bernard (Org.). **The Global Trade Slowdown: A New Normal?** London: CEPR Press, 2015. p. 71–92.

PIERMARTINI, Roberta; RUBÍNOVÁ, Stela. **Knowledge spillovers through international supply chains**, WTO working paper., nº 11. [S.l: s.n.], 2014.

POGANY, Peter; DONNELLY, William A. **The Income Elasticity of Trade: Theory, Evidence, and Implications**. , Office of economic working paper., nº 98. [S.l: s.n.], 1998.

PORTER, Michael. **Competitive Advantage: Creating and Sustaining Superior Performance**. 1 edition ed. New York: Free Press, 1985. 592 p.

POTRAFKE, Niklas. Globalization and labor market institutions: International empirical evidence. **Journal of Comparative Economics** v. 41, n. 3, p. 829–842, 2013.

POWERS, W. The Value of Value Added: measuring global engagement with gross and value-added trade. **World Economics** v. 13, n. 4, p. 19–38, 2012.

QUAST, Bastiaan; KUMMRITZ, Victor. **DECOMPR: Global Value Chain decomposition in R**. **CTEI Working Paper**, nº 1. [S.l: s.n.], 2015.

QUIBRIA, M.G. **Growth and Poverty: Lessons from the East Asian Miracle Revisited**. **ADB Institute Reserarch Paper Series** Tokyo: [s.n.], 2002.

RAHMAN, Jesmin; ZHAO, Tianli. Export Performance in Europe: What Do We Know from Supply Links? p. 1–51, 2013.

RIAD, Nagwa; ERRICO, Luca; HENN, Christian; SABOROWSKI, Christian; SAITO, Mika; TURNUNEN, Jarkko. **Changing Patterns of Global Trade**. [S.l: s.n.], 2011.

ROMERO, Isidoro; DIETZENBACHER, Erik; HEWINGS, Geoffrey. Fragmentation and complexity: analyzing structural change in the Chicago regional economy. **Revista de Economía Mundial** v. 23, p. 263–282, 2009.

ROSSI, Arianna. Does Economic Upgrading Lead to Social Upgrading in Global Production Networks? Evidence from Morocco. **World Development** v. 46, p. 223–233 , 2013.

SALIDO, Joaquín; BELLHOUSE, Tom. **Economic and Social Upgrading : Definitions , connections and exploring means of measurement**. [S.l: s.n.], 2016.

SANTONI, Gianluca; TAGLIONI, Daria. Networks and Structural Integration in Global Value Chains. In: AMADOR, Joao; MAURO, Filippo Di (Orgs.). **The Age of Global Value Chains: Maps and Policy Issues**. Washington, DC: Center for Economic and Policy Research and VOXEU, 2015. p. 68–84.

SEN, Amartya. **Development as Freedom**. Oxford: Companhia das letras, 1999. 409 p.

SENHADJI. Abdelhak; MONTENEGRO. Claudio. **Time series analysis of exports demand equations: a cross-country analysis**. , IMF working paper., nº 149. [S.l: s.n.], 1998.

SHEPHERD, Ben. Global Value Chains, technology transfers and innovation. **ASIA-PACIFIC TRADE AND INVESTMENT REPORT 2015**. [S.l.]: United Nations Publication, 2015. p. 147–161.

SHINGAL. Anirudh. **Labour market effects of integration into GVCs: review of literature**, R4D Working Paper, nº 10. [S.l: s.n.], 2015.

SLOPEK, U. Why has the income elasticity of global trade declined? Deutsche Bundesbank Mimeo, 2015.

SIMOES, A; HIDALGO, C. The Economic Complexity Observatory: An Analytical Tool for Understanding the Dynamics of Economic Development. 2011, [S.l: s.n.], 2011.

STARITZ, Cornelia. Global Value Chains, Economic Upgrading, and Gender. In: STARITZ, Cornelia; REIS, José Guilherme (Orgs.). **Global Value Chains, Economic Upgrading and Gender: case studies of the Horticulture, Tourism and Call Center Industries**. Washington: The World Bank, 2013. p. 1–10.

STEHRER. Robert. **Accounting relations in bilateral value added trade**. , nº 14. Vienna: [s.n.], 2013.

STURGEON, T. **From Commodity Chains to Value Chains: interdisciplinary theory building in an age of globalization**. **MIT Working Paper Series** Cambridge, MA: [s.n.], 2008.

STURGEON, Timothy J. How do we define value chains and production networks? **IDS Bulletin** v. 32, n. 3, p. 9–18, 2001.

STURGEON, Timothy J; MEMEDOVIC, Olga. **Mapping Global Value Chains: intermediate goods trade and structual ghange in the world economy**, nº 5. Vienna: [s.n.], 2011.

STURGEON, Timothy J; VAN BIESEBROECK, Johannes; GEREFFI, Gary. **Value chains, networks and clusters: Reframing the global automotive industry**. **MIT Working Paper Series** Cambridge, MA: [s.n.], 2008.

SUBRAMANIAN, Arvind; KESSLER, Martin. The Hyperglobalization of Trade and Its Future. **Working Paper: Peterson Institute for Interntional Economics** v. 41, n. 202, p. 1–66, 2013.

TAGLIONI, Daria; WINKLER, Deborah. **Making Global Value Chains Work for Development**. Washington, D.C.: The World Bank, 2016. 289 p.

TEJANI, S.; MILBERG, W. Global defeminization? Industrial upgrading, occupational segmentation and manufacturing employment in Middle-Income countries. Working paper n.3, Economic Policy Analysis, The New School, 2010.

TIMMER, M. *et al.* An Illustrated User Guide to the World Input–Output Database: the Case of Global Automotive Production. **Review of International Economics** v. 23, n. 3, p. 575–605, 2015.

TIMMER, M. et al. **An Anatomy of the Global Trade Slowdown based on the WIOD 2016 Release**. , GGDC research memorandum., nº 162. [S.l: s.n.], 2016.

TIMMER, M. *et al.* Slicing Up Global Value Chains. **Journal of Economic Perspectives** v. 28, n. 2, p. 99–118, 2014.

UNCTAD. **Global Value Chains: Investment and Trade for Development**. New York and Geneva: United Nations Publication, 2013a.

UNCTAD. **World Investment Report 2013: Global Value Chains: Investment and Trade for Development**. [S.l: s.n.], 2013b. 9-10 p.

UNESCAP. **Asia-Pacific Trade and Investment Report 2015: supporting participation in value chains**. Thailand: United Nations Publication, 2015. 168 p.

UNIDO. Agro-Value Chain Analysis and Development: The UNIDO Approach. **United Nations Industrial Development Organisation,** Vienna, 2009a.

UNIDO. **Value Chain Diagnostics for Industrial Development - bulding blocks for a holistic and rapid analytical tool**. **UNIDO Working Paper** Vienna: [s.n.], 2009b.

UNIDO. **Global Value Chains and Development: UNIDO's Support towards Inclusive and Sustainable Industrial Development**. Vienna: [s.n.], 2015.

URRY, J. **Global Complexity**. Cambridge: Polity Press, 2003.

WALMSLEY, Terrie L.; HERTEL, Thomas; HUMMELS, David. Developing a GTAP-based multi- region, input–output framework for supply chain analysis. In: FERRARINI, Benno; HUMMELS, David (Orgs.). **Asia and Global Production Networks: implications for Trade, Incomes and Economic Vulnerability**. Northampton: Edward Elgar Publishing, 2014. p. 16–80.

WANG, Zhi *et al*. **Characterizing Global Value Chains**, nº 578. Stanford: [s.n.], 2016.

WANG, Zhi; WEI, Shang-Jin; ZHU, Kunfu. **Quantifying International Production Sharing At The Bilateral And Sector Level**. , NBER Working Paper, nº 19677. [S.l: s.n.], 2013.

WANG, Zhi; WEI, Shang-Jin; ZHU, Kunfu. **Quantifying International Production Sharing at the Bilateral and Sector Levels**. Office of Economics Working Paper, nº 2014–04A. Washington, D.C.: [s.n.], 2014.

WERNER, Marion; BAIR, Jennifer; FERNÁNDEZ, Victor Ramiro. Linking Up to Development? Global Value Chains and the Making of a Post-Washington Consensus. **Development and Change** v. 45, n. 6, p. 1219–1247 , 2014.

WINKLER, Deborah; MILBERG, William. **Errors from the "proportionality assumption" in the measurement of offshoring Application to German labor demand**. **SCEPA Working Paper**, SCEPA Working paper., nº 12. New York: [s.n.], 2009.

WORLD BANK. Connected jobs agendas. **World Development Report 2013**. Washington: [s.n.], 2013. p. 232–255.

WORLD BANK. **Implications of a changing China for Brazil: a new window of opportunity?** Washington: [s.n.], 2014.

WTO - WORLD TRADE ORGANIZATION. **World Trade Report 2013 - factors shaping the future of world trade**. Geneva: [s.n.], 2013.

WTO - WORLD TRADE ORGANIZATION. **World Trade Report 2014**. **Trade and development: recent trends and the role of the WTO** Geneva: WTO Publications, 2014a.

YE, M.; MENG, B.; WEI, S. **Measuring Smile Curves in Global Value Chains**. **IDE Discussion Paper**, IDE Discussion Paper, nº 530 [S.l: s.n.], 2015.

YEUNG, Henry Wai-chung; COE, Neil M. Toward a Dynamic Theory of Global Production Networks abstract. **Economic Geography** v. 91, n. 1, p. 29–58, 2015.

ZEBREGS, Harm. **Intraregional Trade in Emerging Asia**. **IMF Policy Discussion Paper**, IMF Policy Discussion Paper Asia., nº 4. Washington, D.C.: [s.n.], 2004.