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GEBZE TECHNICAL UNIVERSITY

INSTITUTE OF SOCIAL SCIENCES

ESSAYS ON SECTORAL TRADE POLICIES

Pınar TAT

DOCTORAL DISSERTATION

DEPARTMENT OF ECONOMICS

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GEBZE

2022

DOKTORA JÜRİ ONAY FORMU

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ÖZET

İletişim ve ulaşım teknolojilerindeki gelişmeler ve parçalı üretim sisteminde küresel ticaretin yaygınlaşmasıyla birlikte, iktisadi açıklık ve ekonomik büyüme arasındaki henüz uzlaşı sağlanamayan ilişki yeniden gündeme gelmiştir. Bunu analiz etmek için bu tez, iki ana ticari açıklık değişken grubunun büyüme etkilerini araştırmaktadır: (i) brüt ve katma değerli ticaret istatistikleri ve (ii) tarife oranları. Birinci bölüm, hem sektörün küresel değer zincirindeki konumunu hem de katılımın karmaşıklığını hesaba katarak, ticaret miktarının büyüklüğünü ölçen açıklık değişkenlerinin toplam faktör verimliliği ve katma değer büyümesi üzerindeki etkilerini araştırmaktadır. Bulgular, ticaret yoluyla öğrenme hipotezini desteklemekte ve artan sektörel verimlilik için küresel değer zincirlerine daha derin bir katılım ihtiyacına işaret etmektedir. İkinci bölüm, ikinci açıklık değişkenleri setinin, yani tarife oranlarının katma değer büyümesi üzerindeki etkilerini analiz etmektedir. Sonuçlarımız, uygulanan girdi tarifelerinin katma değer büyümesi üzerinde olumsuz etkisi olmasına rağmen, uygulanan çıktı tarifelerinin gelişmekte olan ülkelerdeki düşük teknolojili imalat sektörlerinin katma değerli büyümesini önemli ölçüde arttırdığını göstermektedir. Bu bulgu, ithal ikamesi politikası ve bebek endüstriler hipotezi için sağlam kanıt niteliği taşımaktadır. Küresel değer zincirine katılımın olumlu etkileri ve girdi tarifelerinin ticareti yapılan ara ürünler üzerindeki olumsuz etkileri göz önüne alındığında, üçüncü bölüm, küresel değer zincirine katılımın belirleyicileri başlığı altında, ara ürünlerin ticaretini, yani küresel değer zinciri katılımını ayrıntılı bir şekilde analiz etmektedir. Sonuçlar, hem piyasaya erişim hem de girdi tarife oranlarının sektörel küresel değer zinciri katılımı üzerindeki olumsuz etkilerini desteklemektedir. Her üç bölüm de araştırma-geliştirme içeren yeni üretim biçimleri, daha yüksek sermaye, doğrudan yabancı yatırım, beşeri sermaye ve daha kaliteli kurumsal yapı gibi faktörlerin önemine işaret etmektedir. Üç ayrı analizden elde edilen önemli kanıtlar ışığında, sektörlerin performanslarının artmasının büyük ölçüde küresel üretim süreçlerine etkin entegrasyonlarına ve kapasite arttırma becerilerine bağlı olduğunu söyleyebiliriz.

Anahtar Kelimeler: Toplam Faktör Verimliliği, Katma Değer, Küresel Değer Zincirine Katılım, İhracat, Küresel Değer Zincirleri, Tarifeler

SUMMARY

With the advances in communication and transportation technologies and the spread of global trade in the fragmented production system, the relationship between trade openness and economic growth, which has not yet been reconciled, has come to the fore again. To analyze the trade openness-growth nexus, this dissertation investigates the growth impacts of two main sets of trade openness measures: (i) gross and value-added trade statistics and (ii) tariff rates. The first chapter explores the impacts of trade volume measures on sectoral total factor productivity and output growth by taking both the position of the industry in the global value chain and the complexity of participation into account. The findings provide substantial evidence for the learning by trading hypothesis and point to the need of a deeper involvement in GVCs for higher sectoral productivity. The second chapter investigates the effects of the second set of openness measures, that is tariff rates on value-added growth. Our results show that while imposed input tariffs significantly reduce value-added growth, imposed output tariffs promote the value-added growth of low-tech manufacturing sectors of developing countries, which provides substantial evidence for the validity of import substitution policies and infant industry argument. Given the positive impacts of GVC participation and negative impacts of input tariffs in traded intermediates in general, the third chapter seeks to understand the determinants of GVC participation in a detailed way. The estimation results prove the negative impacts of both market access and input tariff rates on sectoral global value chain participation. All three chapters also point out the importance of factors such as new forms of production involving in research and development, higher physical capital, foreign direct investment, human capital, and better institutional quality. Given the substantial evidence obtained from the three separate analysis, we can safely argue that the successes of industries depend highly on their efficient integration to the global production process as well as their capacity-building capabilities.

Key Words: Total Factor Productivity, Value-Added, Global Value Chain Participation, Export, Global Value Chains, Tariffs

ACKNOWLEDGEMENTS

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LIST OF ABBREVIATIONS

Abbreviation		**Explanation**
ANBERD	:	Analytical Business Enterprise Research and Development Database
CEPII	:	Centre d'Etudes Prospectives et d'Informations Internationales
CGE	:	Computable General Equilibrium
EU	:	European Union
FDI	:	Foreign Direct Investment
FE	:	Fixed Effects
GATT	:	General Agreement on Tariffs and Trade
GDP	:	Gross Domestic Product
GFCF	:	Gross Fixed Capital Formation
GVCs	:	Global Value Chains
HDR	:	Human Development Report
HS	:	Harmonized System
ICIO	:	Inter-Country Input-Output
ISIC	:	International Standard Industrial Classification
OECD	:	Organization for Economic Co-operation and Development
OLS	:	Ordinary Least Squares
R&D	:	Research and Development
SGMM	:	System General Method of Moments
TFP	:	Total Factor Productivity
TiVA	:	Trade in Value-added
TRAINS	:	Trade Analysis Information Systems
UIBE	:	University of International Business and Economics
UNCTAD	:	United Nations Conference on Trade and Development

Abbreviation		**Explanation**
UNDP	:	United Nations Development Programme
WB	:	World Bank
WDI	:	World Development Indicators
WDR	:	World Development Report
WIOD	:	World Input-Output Database
WITS	:	World Integrated Trade Solution
WTO	:	World Trade Organization

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1 INTRODUCTION

Trade is basically emerged from unlimited human needs and scarce resources as well as the quantity and quality differences in the resources between two different countries. The terminology of trade has evolved from the form of barter, that is the transaction of goods for each other in the early times of the history, to the exchange of goods and services from the initial production stage to the consumption in return for money as a medium of exchange.

In modern times, trade theories offer systematic fundamental analyzes to explain both how and why trade occurs, as well as its dynamics. They conclude overall gains from trade openness, but for centuries, international trade has been the subject of intense debate. Since the beginning, while the benefits of trade for some groups and especially consumers have been observed, it has been noticed that some specific domestic groups do not benefit from trade openness and strongly oppose it. As Adam Smith (1937, I, 435-436) said,

"Not only the prejudices of the public, but what is much more unconquerable, the private interests of many individuals, irresistibly oppose it."

Therefore, countries apply different trade policies through the time. This situation reveals the dynamically changing structure of trade policies depending on countries, sectors, and periods which should be followed carefully. Over the years, we have witnessed the liberalization of the trade of final products, but especially in the last three decades, we have also witnessed the liberalization of intermediate goods and services. With the ever-increasing globalization, different stages of production processes localize at different countries. This concept including all the value-added activities ranging from the development of idea, design, production, sale, and distribution of a product is defined as global value chains (GVCs).

Therefore, in this introductory chapter, we first briefly review the main trade theories in the trade literature and then consider trade policies both conceptually and historically. We then explain our motivation, contribution, and the scope of the dissertation.

1.1 Trade Theories

Throughout the times, economists have developed a variety of different trade theories to understand how the global economy realize the transaction of goods and services. It can be stated that mercantilism, which was developed in the sixteenth century, is the starting point of these economic theories. In other words, it can be seen as an economic and political doctrine before the economic theory. According to this doctrine, the wealth of countries is determined by their gold or silver assets (Heckscher, 2013). Therefore, the main aim of the countries is to increase their gold and silver holdings by exporting more and importing less in return for gold or silver. In fact, the mercantilism depends on heavy government interventions to encourage surplus in international trade. This strategy can be called as protectionism and is still preserve its validity today. Almost all developed or developing countries have applied this kind of strategy to protect and develop their specific industries at one point in the history. For instance, the United Kingdom enforced tariffs and other trade restrictions known as the corn laws on imported food and corns to favor domestic producers in the period 1815-1846 (Fairlie, 1965). Until the middle of the 19th century, the trade policy of the German customs union could be described as restrained protectionist (Dedinger, 2006). In the 1960s, the countries such as South Korea, Taiwan, Singapore, and Hong Kong referred as four Asian tigers implemented the same development policy with also subsides for manufacturing industries and realized their industrialization (Lall, 1996). Thus, even if there are also some opponents of trade protection because of the possible rise in cost on consumers, mercantilism remains a part of modern economic thought.

With the Industrial Revolution, the need to find new markets for the sale of increased production began to conflict with the ideas of mercantilism and the classical liberalization evolved. In the year 1776, Adam Smith introduced the first scientific explanation of international trade, that is the trade theory called absolute advantage which focuses on the ability of countries to produce a product more efficiently compared to other countries. The theory is based on the arguments of specialization and division of labor. In this framework, if an economy can produce a product with the lowest cost, then it has an absolute advantage on the production of this product. By producing the products which the countries have absolute advantages, they can also specialize on the production of these products and enhance their productivities.

Therefore, the theory states that the government should not intervene in economies with regulations, trade barriers, and subsidies and the products should freely move across borders. All markets find their equilibrium levels via price mechanism called as invisible hand. According to Smith, international trade increases productivity of production factors via specialization and division of labor so that global production and wealth enhance. Therefore, both parties involved in trade activities benefit from trade openness. In order to grasp the basic characteristics of international trade, this model depends on simple framework with two countries and two goods.

However, even if a country does not have an absolute advantage in any product or has an absolute advantage in all the products, it does still conduct trade activities. To explain this, in the year 1817, David Ricardo introduced the theory of comparative advantages. The comparative advantage is realized if a country efficiently produces one specific product compared to other products that it can do. In other words, while the absolute advantage focuses on absolute productivity, the comparative advantage is relevant with relative productivity. This theory also simplifies the real world by several assumptions. The theory considers labor as an only constant cost item and ignores cost of capital, inputs, and resources. In addition, labor is seen as homogenous factor. The theory also assumes that labor cannot move from one country to another.

In the first half of the 1900s, Eli Heckscher and Bertil Ohlin contribute to the literature by analyzing both factor abundancy in country and factor intensity of traded products. These factors are capital, labor, and land. Their theory which depends on factor proportions is called the Heckscher-Ohlin theory. It argues that a country can gain from comparative advantage by exporting a product employing a factor that is an abundant factor in this country. In a similar manner, a country can import a product required a factor that is scarce in this country. There are three different theorems derived from the Heckscher-Ohlin theory: Factor price equalization, Stolper-Samuelson, and Rybczynski theorems. According to factor price equalization, free trade equalizes the prices of factors among countries similar to the free movements of factors. The Stolper-Samuelson theorem states that free trade increases the real income of factors which are abundant in countries and decreases the real income of factors which are scarce in countries. The Rybczynski theorem argues that under full employment, if the supply of only one factor increases, the production of the good that uses this factor intensively increases. Conversely, the production of the good, which intensively uses the factor whose supply remains constant, decreases in absolute terms.

In the early 1950s, the research of Wassily Leontief indicates that even if the United States is capital abundant country, it imports capital intensive products and exports labor intensive products, which contradicts the factor proportions theory. This case is known as the Leontief paradox. Leontief explains this paradox with the high productivity of workers in the Unites States compared to workers in other countries. Therefore, the United States exports high skilled labor embedded in its products. The research of Leontief also draws some criticisms. The first one is Leontief picks the period after war, which ultimately distorts the general picture. The second one is the unreliability of data on capital in his analysis. The third one is ignorance of natural resources. After this paradox, the new theories are then developed. These are skilled labor, technology gap, product cycle, similarity in preference, economies of scale, and monopolistic competition theories. In skilled labor theory, the Leontief paradox is explained by the skilled labors in the United States. Indeed, the United States has been a skilled labor abundant country and export these skill labor intensive products (Mutti and Morici, 1938). In technology gap theory, Michael Vivian Posner (1961) indicates that industrialized countries discovering new goods or production process become the first exporters of these products. However, through technology imitation, other countries can also start to produce these products even with a lower cost thanks to the cheap labor and resource abundancy in these countries. Therefore, these countries become the new exporters of these products because the initial producers cannot compete with them. In product cycle theory, Raymond Vernon (1966) argues that some countries specialize old products and other specialize the new products. When the new products become old products, the geography of production also changes. In similarity in preferences, Brunstam Linder (1961) discusses that trade of nonhomogeneous manufacturing products depend on tastes and preferences of countries, that is demand conditions rather than supply conditions. In economies of scale theory, the main argument is that the average costs of production depend on production scale. If the average cost of production decreases when the size of production increases, then the characteristics of decreasing production cost and increasing rate of return are valid. The monopolistic competition theory points out the importance of product differentiation for the trade between the same industries across nations.

While these theories have greatly helped researchers and policy makers to understand the mechanism of international trade, they somehow contradict with the real-life situation because they have strong assumptions to draw a simple framework.

Nevertheless, they are quite beneficial starting points which shed light on the future international trade theories incorporating especially globalization and high transaction of intermediates.

1.2 Trade Policies

Given the trade theories, we can deduce that free trade enables the efficient use of global resources and specialization so that the global production reaches its maximum value. Even though theoretical models point out the importance of trade liberalization, in real life, governments frequently apply trade barriers such as tariffs and non-tariff measures on some specific goods and services for some economic purposes such as increasing the pace of industrialization and realization of economic growth. Moreover, not every government intervention is to restrict trade. Countries do not only use trade-restrictive measures, but sometimes they can also make trade-enhancing policies. Some governments interventions can also be in the form of export subsidies. The other trade policies can be in the form of preferential trading agreements, regional/multilateral agreements, free trade association, custom union, common market, economic union, and the membership of international organizations as well. The ultimate and the most crucial aim of these interventions is sustaining economic growth and welfare. In other words, in general trade policies are seen as effective instruments for promoting economic growth.

In the mercantilist period, we have witnessed the most interventionist periods because governments strongly encourage exports but also discourage imports. Throughout the history while the newly industrialized countries are strong advocates for the protection of their infant manufacturing industries, industrialized economies favor for trade liberalization. According to the infant industry argument, industries that do not have adequate experience, technical knowledge, and economies of scale should be protected until they get mature. A striking point in this idea is that protection is not permanent but temporary in nature. The periods after the crisis years appear as the periods when protectionism is revived (the World War I and II, the Wall Street Crash of 1929). After the World War II, with the introduction of the Bretton Woods system in 1946, the establishments of General Agreement on Tariffs and Trade (GATT) in 1948, and European Coal and Steel Community in 1951, tariff rates significantly reduced, but still there has been substantial amount of trade barriers. The Uruguay

Round and the North American Free Trade Agreement in 1994, the establishment of World Trade Organization (WTO) in 1995, Chinese accession to WTO in 2001, launching the Euro zone in 2002, and enlargement of the European Union especially towards to east side of the continent successfully decrease these trade barriers and liberalize trade. The comprehensive economic and trade agreement between Canada and the European Union in 2016, the comprehensive and progressive agreement for Trans-Pacific partnership in 2018, and the European Union-Japan economic partnership agreements enter into force. These efforts to liberalize world trade on a global scale almost aim to make the world a single market. Recently, the Regional Comprehensive Economic Partnership (RCEP), a trade agreement between the 10-member Association of Southeast Asian Nations and China, Japan, South Korea, Australia, and New Zealand, is expected to decrease around 90% of trade tariffs within the bloc.

Throughout the globalization period, following detailed trade policy information as well as analyzing them are quite necessary because the overall impact of participating in trade activities can vary with respect to country, sector, and period. In this respect, first, it is important to reach the main sources of data which we observe real world trade policies. The second thing is the precise measurement of trade related variables and correct utilization of them in empirical analysis with the appropriate methodology to assess the true impact on global economies.

1.3 Motivation

In the several decades, there have been remarkable advances in knowledge, technology, and thereby information, communication, and transportation systems (Li et al., 2019) as well as political developments to fuel liberalization in transactions of goods and services. As a result of these efforts, the general trade, but especially the trade of intermediates has been enormously risen. Accordingly, the traditional production system has rapidly evolved into global production sharing activities. The global production sharing activities means that the production is fragmented into many tasks ranging from pre-production stages like design to post-production stages such as distribution and marketing which are conducted in different countries. In other words, the typical "Made in" labels change with "Made in the World" labels. This can be an example for an advanced form of division of labor which is first pointed out by Adam

Smith. In this form, not only each specific segment of products freely moves, but also the factors embedded in these segments freely move across nations and borders.

The trade of intermediates in general or value-added process in at least two different countries can be defined as participating in global value chains (GVCs) activities (Antràs, 2020). These transactions can be in the form of "spider" type where multiple intermediates are assembled or "snake" type where value-added is sequentially created (Baldwin and Venables, 2013; Antràs and De Gortari, 2020). The concept of global value chains is first formalized in Hummels et al. (2001). In their studies, GVCs is defined as foreign value-added embedded in production and specifically exported products (known as vertical specialization). Indeed, nowadays, two-thirds of international trade consists of intermediate goods and services, that is, participation in global value chains (World Development Report, 2020).

The main advantages of participating in global production sharing activities are obtaining cheaper inputs, hyper-specializing in a specific segment of production chain, acquiring finer division of labor, and advanced managerial skills in global market (Gereffi, 1994; Johnson and Noguera, 2012a, b; Koopman et al., 2014) so that countries can promote their economic growth. These are the ultimate goals of industries in all economies when they are participating into global value chains. The literature draws attention to the fact that these benefits will be realized through learning by importing and exporting mechanisms. The learning by importing hypothesis emphasizes that foreign technology and high-quality input diversity increase sectoral efficiency and ultimately sectoral production through research and development spillovers (Ethier, 1982; Romer, 1990; Grossman and Helpman, 1991; Taglioni and Felice, 2018). In empirical models where trade in intermediate goods, that is participation in global value chains, is the main focus of attention, reference is also made to the international division of labor as transmission channel (Grossman and Rossi-Hansberg, 2008; Baldwin and Yan, 2016; Jones et al., 2019; Ignatenko et al., 2019). Similarly, learning by exporting, which is assumed to increase sectoral performance by producing/learning draws attention to the benefits from economies of scale, learning in supply chain management, and better-managed operations in organizations (Feder, 1982; Baldwin and Gu, 2003; De Loecker, 2013; Bastos et al., 2016; De Marchi et al., 2018). Along with global value chains, transmission channels such as advanced specialization not only in products but also in different production segments and the competitive effects of the international market can be considered

further channels (Criscuolo and Timmis, 2017). Given these circumstances, several questions appear.

- Are these benefits being realized in terms of higher sectoral output or productivity growth and to what extent?
- If there are certain benefits of participating into global value chains, what are the determinants of sectoral participation levels?
- What are the drivers and potential threats for sectoral output growth and global value chain participation at both country and sector levels?

This dissertation primarily explores these questions and provides answers to them by investigating the impacts of a variety of different trade openness measures ranging from trade in value-added to tariff rates on sectoral performances in diverse sub-samples.

1.4 Contribution and Scope

In these interdependent world economies, traditional trade statistics are insufficient to draw an accurate picture of the true comparative advantages of countries or sectors in the international market. Gross trade statistics contain information on the value-added of many other countries (Koopman et al., 2014). In another saying, gross trade statistics include both domestic and foreign value-added. In contrast, indicators for global value chains through multi regional input-output tables enable us to follow and detect domestic value-added allocation in production chains. These measures provide novel insights to examine the relationship between sectoral trade openness and economic growth.

One important innovation of this thesis is investigation of sectoral growth effects of a variety of different trade openness measures in empirical models. To achieve this, we utilize the value-added accounting and decomposition methodology of Wang et al. (2017a, b) and calculate all the openness measures in gross and value-added terms. Both the gross and value-added trade statistics, that is the first set of trade openness measures, are also employed in calculation of tariff rates, that is the second set of trade openness measures by differentiating products as inputs and outputs. Regarding tariff rates, we contribute to the literature with calculation of input tariffs. In the literature,

input tariff is defined as a weighted average of tariffs on the intermediate goods by taking sectoral tariff rates into account (Bas, 2012; Johansson et al., 2014; Cruz and Bussolo, 2015; Liu et al., 2019). Since the sector level two-digit tariff rates are already weighted averages of tariffs imposed on both intermediates and finals that sector produces, these statistics are not accurate measures for input and output tariffs. Therefore, we choose to calculate input tariffs as well as output tariffs by utilizing six-digit products codes, related concordance tables, and input-output tables. Furthermore, we also track the simple tariff rate along with the global value chains by using the calculation methodology of Rouzet and Miroudot (2013) and reach cumulative tariff rate. We then utilize these measures in sector level empirical analysis, which are quite limited in the literature, thus seeking answers to the main research questions indicated in the previous part.

To this end, *the second chapter* aims to analyze the impacts of global value chain participation on total factor productivity and value-added growth of sectors for 40 developed and developing countries through 1996 to 2009. Our main motivation is that although almost all countries have increased their participation in GVCs, the integration levels across countries and sectors are quite different. While developed and large emerging countries mostly participate in complex GVCs, developing economies engage in simple transactions (World Development Report, 2020). The first contribution of this chapter is to analyze the effects of backward and forward GVC participations by considering both simple and complex parts, that is the first set of openness measures. While the simple part of GVC participation includes only the value-added that crosses border once, the complex part of GVC participation counts the value-added that crosses border more than once. The second contribution is the employment of position index in the empirical analysis. This index shows the relative forward length of sectors in a global value chain and indicates that how many times the products of these sectors are utilized as inputs in production processes. Adding this index into our empirical model is important to capture further sectoral information because a higher participation level does not necessarily mean deeper involvement. To gain a thorough understanding of the causes of productivity and output growth, it is worthwhile to control both the position of sectors along a value chain and the complexity of participation indices. The estimation result points out that productivity growth of manufacturing sectors is mainly attributable to higher forward involvement into GVCs whereas higher value-added growth of both manufacturing and service

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sectors is driven by all types of GVC participation regardless of backward/forward and simple/complex. These findings support the learning by trading hypothesis and show that the complexity of participation matters for sectoral productivity. As a result, our findings imply that sectoral upgrading is closely linked to the sophistication of both trade products. Apart from the main interest variable, we also show the importance of employment of high-skilled worker in value-added growth in our analysis. Therefore, we can assert that GVCs participation is one the main determinants of sectoral growth and hence industries should find a way to efficiently integrate into the global production system.

The third chapter analyzes the issue by focusing on the second set of openness measures, that is tariff rates, with the new database providing much larger coverage (153 countries) and longer time span from 1990 to 2015. Our main motivation is to provide new and better empirical evidence for the relationship between trade openness and economics growth in the highly liberalized world economies. The first contribution is to calculate product level tariff rates to differentiate input and output tariff rates. The second innovation is the utilization of gross and value-added trade statistics to take the weighted averages of these product level tariff rates to convert them into sectoral variables. The final contribution of this chapter is the introduction of two-phase model estimation: (i) value-added growth and (ii) extended gravity models. The empirical findings suggest that while imposed input tariffs are detrimental to growth of sectors, higher protection level on low-tech manufacturing final products is growth enhancing for these sectors. Given the widely exemption of tariff rates in many products especially for intermediates used in exporting purposes, that is the inward processing regime, the positive effect of tariff rates on the growth of final products is understandable for developing countries. Therefore, we claim that protectionism may be helpful for emergent industries in developing economies to nurture them and to prepare for the tough international competition. Regarding gravity models, our analysis strongly proves the negative impacts of any distractions on bilateral export. In fact, agriculture, mining, high-tech sectors as well as developing countries appear to be the most vulnerable groups for any sudden change in tariff policies. Our results also provide evidence for other drivers of sectoral performance such as gross fixed capital formation, human capital, and institutional quality. Hence, other sectoral policies are as important as trade policies for the sectors to develop themselves well and to open up to the international market.

Given the findings in the second and third chapters, we argue that there is no expected growth benefit of setting higher trade barriers in transaction of intermediates, that the GVCs part of trade. Therefore, analyzing the determinants of GVC participation by focusing especially on cumulative effects of tariff rates carries crucial information to understand the underlying mechanism. *In the fourth chapter*, as a novel part, we first calculate the cumulative tariff rates along with the global value chains and utilize them in our empirical model by employing the same dataset we employ in the second chapter. The descriptive statistics suggest that on average an approximately 12% of cumulative tariffs can be considered as indirect tariffs. Given the magnitude of such trade cost, our empirical analysis reveals that both simple tariffs and cumulative tariffs have negative impacts on total, forward, and backward GVC participations (simple and complex parts, too). The impacts are particularly present in manufacturing, low-tech sectors, developing economies, and the trade between developed and developed trading pairs. Similar to the previous chapters, capacity building at the sector and country level is also important in this chapter. Specifically, moving along with fabrication stages to pre- and post-fabrication stages by adding more function in the production process, investing in both physical capitals, attracting foreign direct investment, and encouraging individuals to get higher education are important policy determinants in addition to trade policies. As a policy-related debate, given the cascading impacts of these liberalization initiatives; autonomous, regional, and global liberalization efforts are critical for all sectors to reap the benefits from the global production system. While countries and sectors, in particular, are taking steps to improve these basic indicators, they should also turn to liberalization policies at the national and international level in order to take and advantage from the benefits of participating in the global value chain.

Overall, the fifth chapter summarizes the main findings of these three chapters with some policy discussions, limitations of analysis, further recommendations for studies and then concludes the thesis.

2 DOES THE COMPLEXITY OF GVC PARTICIPATION MATTER FOR PRODUCTIVITY AND OUTPUT GROWTH?

2.1 Introduction

This chapter seeks to examine the determinants of total factor productivity (TFP) and output growth by considering both the position of the industry in the value chain and the complexity of GVC participation. Given the ever-increasing nature of interdependence of the contemporary world economies, all countries and sectors inevitably participate in GVCs activities. Global value chain activities have steadily expanded especially after 1980s, which creates a greater deal of knowledge, technology spillovers/diffusions, specialization of specific segments, and adoption of best practices along the global supply chains. Indeed, the expansion of GVC creates greater output gains compared to a rise in traditional trade (Antrás et al., 2017a). Therefore, sectoral productivity and output growth cannot be considered apart from their successes in the global production and value chains. Since the degree of participation of sectors into GVCs differs in many ways across countries and sectors, they may not be able to benefit from the participation in GVCs at the same level. While developed countries and large emerging economies engage in complex GVC activities, many countries in the Central Asia and Latin America engage in simple manufacturing (the Word Development Report, 2020). Thus, it is highly crucial to consider the complexity of integration in the value chains to properly assess the benefits of participating in GVCs.

The current empirical literature generally focuses on the cumulative GVC participation indices without considering the depth of GVC indices. Moreover, the higher level of GVC participation does not necessarily mean that an industry is in a long and complex value chain. Therefore, controlling both the position of sectors along a value chain and the complexity of participation indices is worthwhile effort to obtain the comprehensive understanding of the determinants of productivity and output growth.

We first look at the effects of both backward and forward GVC participation indices on the sectoral performances by focusing on 40 developed and developing countries over the period of 1996-2009. We then investigate whether the impacts of

simple GVCs and complex GVCs activities on sectoral performance vary across sectors. Meanwhile, we utilize the calculation method as described in Wang et al. (2017a, b) for all GVCs related variables, which enables us to follow the footsteps of each sector within the value chains across countries and borders. To the best of our knowledge, although cumulative GVC participation indices are frequently employed in many studies as reviewed below, there is no empirical study investigating the roles of simple and complex GVC participation indices on productivity and output growth. Our second contribution is to analyze the validity of learning by trading hypothesis in the framework of GVCs. Our final contribution is due to the larger coverage of WIOD that we are also able to take into account the sectoral heterogeneity by dividing the sample as manufacturing and services industries.

Our dynamic panel data estimations imply that while all measures of forward GVC participations boost the total factor productivity growth of manufacturing industries, none of the participation indices affects the productivity of service sectors. Moreover, our results indicate that almost all measures of both backward and forward GVC participations have significantly positive impacts on the output growth of both manufacturing and service sectors. These estimations thus provide substantial evidence for the learning by trading hypothesis and demonstrate the importance of intra-product specialization for sectoral productivity. Therefore, our results suggest that industrial upgrading is tied to the enlarging sophistication and diversification of both import and export of intermediates. Rising competition in international intermediates markets and discipline of the world economy are accounted for the rise of the productivities and outputs of industries.

This chapter is organized as follows. The next section discusses the relevant literature. The third section describes the datasets and measures used in the study. The fourth section explains the empirical methodology. The fifth section reports the empirical results. The final section presents concluding remarks and policy recommendations.

2.2 Literature Review

Declining communication and transportation costs via technological improvements alters the geographical locations of production activities so that the nature and patterns of trade have been profoundly changed. Accordingly, the large literature has been evolving to express, measure, and evaluate competent fragmented production and distribution systems across borders in the global world (Porter, 1985; Gereffi, 1994; Trefler and Zhu, 2010; Johnson and Noguera, 2012a, b; Koopman et al., 2010, 2014). Studies investigating the relationship between GVC participation and productivity are rapidly growing (Kummritz, 2016; Taglioni and Winkler, 2016; Formai and Vergara Caffarelli, 2016; Constantinescu et al., 2019; Jona-Lasinio and Meliciani, 2019; Yanikkaya and Altun, 2019, 2020). Kummritz (2016) finds that increases in backward and forward GVC participation lead to higher domestic value-added and labor productivity for 54 countries, which are mainly developed countries and 20 industries over the years 1995–2011. Pahl and Timmer (2018) find the positive effects of GVC participation for developing countries employing data since 1970. Jona-Lasinio and Meliciani (2019) report that the effect of GVC participation on productivity growth is higher in industries having greater intangible capital intensity by utilizing the mediating effect of investment in intangible assets for nine European economies in 1998–2013. Constantinescu et al. (2019) suggest that backward GVC participation is significant driver for productivity by using the sample of WIOD database covering 13 sectors from 40 countries through 15 years. Yanikkaya and Altun (2019) find that while backward participation reduces TFP growth, forward participation raises TFP growth of developed countries for the period 1995–2014. Kılıçaslan et al. (2019) contribute the literature by analyzing the effects of participation in GVCs for Turkish firms. They figure out that supplier position of firms has negative effects on the domestic market and no effect on global value chains. Yanikkaya and Altun (2020) also find that both backward and forward GVC participation increases value-added and total factor productivity growth for industries in 14 EU and US.

Another strand of the literature examines the idea of counting production stages by utilizing a length notion. Dietzenbacher and Romero (2007) initially propose the concept of average propagation length. To measure the average number of production stages, Antrás and Chor (2013) then suggest the similar measure so called as the downstreamness index. These two indices describe the extent of backward

connectedness of industries. Fally (2012) proposes an index based on forward linkages, which is called as an upstreamness and measures the how many stages up to final demand. Later, Wang et al. (2017b) divide production lengths into domestic, traditional, simple GVC, and complex GVC parts. Combining both backward and forward lengths, they suggest a relative upstreamness index called a position index. This index is defined as the ratio of forward length to backward length. Although these new indices are utilized by many institutions and scholars, these studies are mostly descriptive studies. For instance, the forward length calculated by Fally (2012) are utilized in many studies (Ye and Voigt, 2014; Chor et al., 2014; Suganuma, 2016; Hagemejer and Ghodsi, 2017; Hagemejer, 2018). Moreover, Peng and Zhang (2020) find that the GVC position of manufacturing industry enhances the domestic technology content of Chinese exports.

2.3 Data and Graphical Representation

2.3.1 Variables

This chapter employs two main databases: The 2013 release of World Input Output Databases (Timmer et al., 2015) and the OECD's Analytical Business Enterprise Research and Development (ANBERD) database (Web 1, 2020). The variables regarding value-added, output, capital stock, number of employees, and skill variables are directly taken from the Socio-Economic Accounts (WIOD).[1] By closely following the Wang's value-added and final demand decomposition structure, we compute a large variety of sectoral value-added trade variables by utilizing the WIOD (Web 2, Web 3, Web 4, 2020). The computations are done by utilizing R software (see R Core Team, 2019).

Since sectoral total factor productivity is expressed as a function of sectors' own R&D level (see Cameron, 2005; Cameron et al., 2005; Khan, 2006; Bournakis, 2012; Bournakis et al., 2018), we utilize the data on R&D expenditures from the ANBERD, Business enterprise R&D expenditure by industry (Web 1, 2020) because the WIOD

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[1] We also utilize the EU KLEMS (Jäger, 2016) and the 2016 release of TiVA (OECD, 2016) databases. Because of the smaller number of cross sectional units (14 and 17 sectors of 14 European countries and the USA for the 1996-2011 and 2005-2015, respectively) and lack of human capital variables, we prefer to use the WIOD sample. The OLS, FE, and SGMM estimations are quite parallel with those from the WIOD.

does not report information on R&D activities. Variables in national currencies are converted into the US dollars via employing exchange rates from the WIOD and deflated using related price indices provided in the same dataset. These two databases are merged directly via their sector codes because all sector codes in two databases are reported according to International Standard Industrial Classification of All Economic Activities (ISIC) Revision 3.

As an operational sample, in the output growth analysis, we have 14 manufacturing and 16 service sectors (see the Appendix A) of 40 developed and large developing countries for the years 1996-2009. Even if the year coverage of the dataset includes the period of 1995-2011, we have period 1996-2009 as an operational sample because price indices and skill variables are not available for the years 2010 and 2011. In fact, the year coverage is quite optimal since the 2008 Global Financial Crisis makes the relationship between trade and output variables less clear. In the WIOD 2016 release, education variables are missing and the year coverage of this dataset, the period 2005-2014 includes 2008 Global Financial Crisis and global downturn after that. Even though the OLS and fixed effects results are roughly the same with the first period, our sample on 43 countries and 19 manufacturing/31 service sectors renders S-GMM estimations impossible. The countries in our sample are Australia, Austria, Belgium, Bulgaria, Brazil, Canada, China, Cyprus, Czech Republic, Germany, Denmark, Spain, Estonia, Finland, France, United Kingdom, Grece, Hungary, Indonesia, India, Ireland, Italy, Japan, Korea, Republic of Lithuania, Luxemburg, Latvia, Mexico, Malta, Netherlands, Poland, Portugal, Romania, Russia, Slovak Republic, Slovenia, Sweden, Turkey, Taiwan, and USA. In the TFP growth analysis, due to the lack of data on R&D, we end up with 14 manufacturing and 2 service sectors (hotels and restaurants and financial intermediation) of 28 developed and developing countries for the same period. Countries having no data for R&D expenditures are Bulgaria, Brazil, Cyprus, Denmark, Indonesia, India, Lithuania, Luxemburg, Latvia, Malta, Sweden, and Taiwan. Since R&D data are only available for 28 countries in our sample, we also repeat the output growth analysis for this restricted group. Our conclusions do not change meaningfully in this restricted group at all.

For the industry level trade variables, we utilize the Input Output Tables (Timmer et al., 2015). Wang et al. (2017a) propose the decomposition of backward and forward linkages utilized by the user and seller perspectives, respectively. It is

important to note that our value-added measures (following the OECD) also include taxes of sectors as opposed to the Wang's calculations. Thanks to this disaggregation methodology, we are able to calculate backward/forward simple and complex GVC participation indices. Backward simple GVC participation is defined as a share of foreign intermediate products for production of domestic products (cross border only once). Backward complex GVC participation is defined as a share of foreign intermediate products for production of exported products (cross border more than once). Similarly, forward simple GVC participation is defined as a share of domestic intermediate products for production of foreign products (cross border only once). Forward complex GVC participation is defined as a share of domestic intermediate products for production of other countries' exported products (cross border more than once).

Distance to final use, that is so called the upstreamness index, is proposed by Fally (2012). The index is defined as the row sum of the Ghosh inverse matrix (Antrás et al., 2012; Johnson, 2018). It means forward linkages and measures the number of stages before the goods or services are attained by the final consumers. Wang et al. (2017b) propose decomposition of forward linkages utilized by the seller perspective. The important point is the fact that the total index based on forward industrial linkages is mathematically identical to the upstreamness index represented by Fally (2012) and Antrás et al. (2012). To reiterate, the novel part of this index is decomposition of production activities into a variety of segments.

The distance to final demand is computed in the following way:

$$\mathrm{PLv} = \mathrm{colsum}(\widehat{V}_c LL\widehat{Y})/\mathrm{colsum}(\widehat{V}_c L\widehat{Y}) \tag{2.1}$$

where PLv represents the number of forward production stages, $\widehat{V}_c$ is diagonal matrix of value-added over output ratio of sectors. L is Leontief inverse matrix, $\widehat{Y}$ is diagonal matrix of final products. PLv is the ratio of domestic sales, traditional trade, and GVC related domestic value-added to output of sectors. Further calculations and derivations of these formulations can be found in Wang et al. (2017b).

Length of GVC is introduced and calculated as an index for the number of production stages by Antrás and Chor (2013). The index takes the value of 1 if there is single production stage, otherwise takes the value higher than 1 depending on how many stages are passed or how many inputs are used regardless of domestic or foreign. It is defined as the column sum of Leontief inverse matrix (Johnson, 2018). Wang et

al. (2017a) propose an advanced accounting framework, which decomposes the backward linkages utilized by the user perspective.

$$X = AX + Y \tag{2.2}$$

where X is gross output, Y is final products and A is the input coefficient matrix calculated dividing each entry of intermediate input matrix by output of sectors.

$$X = (I - A)^{-1}Y \tag{2.3}$$

where $(I - A)^{-1}$ is defined as Leontief Inverse Matrix.

In Input-Output matrix form, the length of GVC, that is number of production stages, is computed according to this formula:

$$PLy = \text{rowsum}(\widehat{V_c}LL\widehat{Y})/\text{rowsum}(\widehat{V_c}L\widehat{Y}) \tag{2.4}$$

where PLy represents the number of backward production stages, $\widehat{V_c}$ is diagonal matrix of value-added over output ratio of sectors. L is Leontief inverse matrix, $\widehat{Y}$ is diagonal matrix of final products. PLy is the ratio of foreign buying, traditional trade, and GVC related foreign value-added to output of sectors.

Furthermore, depending on the length measures based on both backward and forward linkages, Wang et al. (2017b) propose a position index, which intends to solve the inconsistency in the ranking of countries/sectors in terms of backward and forward linkages. Position index can be stated as follows:

$$\text{Position index} = \frac{PLv}{PLy} \tag{2.5}$$

where PLv represents the number of forward production stages, that is the number of stages before the goods or services are attained by the final consumers in another country-sector. In other words, this index counts how many times value-added is induced as an output in global value chain. PLy denotes the number of backward production stages. This index counts how many stages are passed or how many times primary inputs or intermediates are used regardless of domestic or foreign, that is the number of production stages embodied in the goods or services. The position index is defined as ratio of forward linkages over backward linkages, that is the division of distance of particular production stage to ending stage by the distance from starting stage. If a sector thus has fewer backward production stages relative to forward production stages, it is classified as a relatively upstream industry, and vice versa.

Table 2.1 provides the summary statistics of all measures employed in our estimates. On average, it seems that while manufacturing industries participate relatively more in simple part of forward GVCs, they depend relatively more on complex backward linkages. However, service sectors participate relatively more in simple parts of GVCs for both backward and forward transactions.

Table 2.1: Summary statistics

	Manufacturing		Services	
Variables	# of Obs.	Mean	# of Obs.	Mean
TFP growth	7,376	-0.04	8,452	-0.02
Output growth	7,806	0.02	8,931	0.03
Capital stock per worker (log)	7,734	10.49	8,865	10.83
R&D/Value-added	4,890	0.03	591	0.00
Position	8,363	0.92	9,570	1.08
Backward GVC participation	8,370	0.30	9,570	0.14
Backward simple GVC participation	8,370	0.13	9,570	0.09
Backward complex GVC participation	8,370	0.18	9,570	0.05
Forward GVC participation	8,363	0.30	9,570	0.17
Forward simple GVC participation	8,363	0.18	9,570	0.12
Forward complex GVC participation	8,363	0.12	9,570	0.06
Y_GVC/Output	8,363	0.13	9,570	0.07
Y_GVC_S/Output	8,363	0.05	9,570	0.05
Y_GVC_C/Output	8,363	0.08	9,570	0.02
V_GVC/Output	8,363	0.10	9,570	0.09
V_GVC_S/ Output	8,363	0.06	9,570	0.06
V_GVC_C/ Output	8,363	0.04	9,570	0.03
High-skilled hours share	8,400	0.13	9,570	0.24
Medium-skilled hours share	8,400	0.50	9,570	0.50

Notes: "Y" stands for the share of backward related volumes in output and "V" stands for the share of forward related volumes in output.

2.3.2 Graphical Representation

Before investigating the subject empirically, some basic descriptive statistics and graphical relationships are necessary to compose and provide an initial judgment regarding sectoral level backward and forward linkages. Figure 2.1 shows backward linkages and sectoral performance variables for the years 1996, 2002, and 2009 for manufacturing sectors. The bottom columns represent the GVC participation index, the middle columns represent simple GVC participation, and the top columns stand for complex GVC participation. The highest backward GVC and simple GVC participations are observed in coke, refined petroleum and nuclear fuel sector, which means that this sector typically depends on imported intermediates. Electrical and transport equipment sectors have the largest complex GVC participations among manufacturing sectors. Even if we do not observe any clear-cut patterns in two-way relationship between backward GVC participation and sectoral performance variables; coke, refined petroleum and nuclear fuel sector has also the highest TFP and output growth. For all sectors, TFP and output growth show declines because of the effects of the 2008 Financial turmoil and Eurozone debt crisis.

Figure 2.2 shows the forward GVC participation and sectoral performance variables for the years 1996, 2002, and 2009. The highest simple and complex GVC participations are observed in basic metals and fabricated metal, which means that outputs of this sector are highly used as intermediates in international markets. As expectedly, sectors such as food, beverages and tobacco and leather, leather and footwear have lower forward GVC participations compared to other manufacturing sectors. Similar to Figure 2.1, even if we do not observe any strict patterns between GVC participation and sectoral performance variables, the high values of sectoral performance variables are notable in chemicals and chemical; rubber and plastics; and other non-metallic mineral, which have relatively higher forward participations.

Similarly, Figure 2.3 shows the backward linkages and sectoral performance variables for service sectors. The highest complex backward GVC participation is observed in water and air transportation sectors. When we look at the Figure 2.4 presenting the forward linkages of service sectors, relatively higher simple and complex GVC participation ratios are observed in water, air transportation, and other supporting and auxiliary transport sectors.

It is important to note that calculating volumes and lengths of trade linkages are complementary analysis to each other. As expectedly, if industries have high complex participation ratios, they supposedly have higher production lengths. In other words, the length of these transactions thus inevitably becomes higher (more than once). When we think the other way around, higher length does not necessarily mean higher complex participation ratio because traded volumes may be less even if these traded goods and services cross border more than once. In order to show this, we calculate backward/forward lengths and report Table 2.2. As can be seen from Table 2.2, regarding both backward and forward linkages, sectors with higher complex GVC participation ratios have also longer lengths, and vice versa on average (country-year average). Therefore, one can argue that complexity has two main dimensions: lengths and volumes. To refer this, we have already calculated both forward and backward lengths and include their ratios, that is position index, in our model. However, our main focus is participation indices in this chapter because in the trade/GVCs literature theoretical explanations are constructed regarding trade volumes, not lengths.
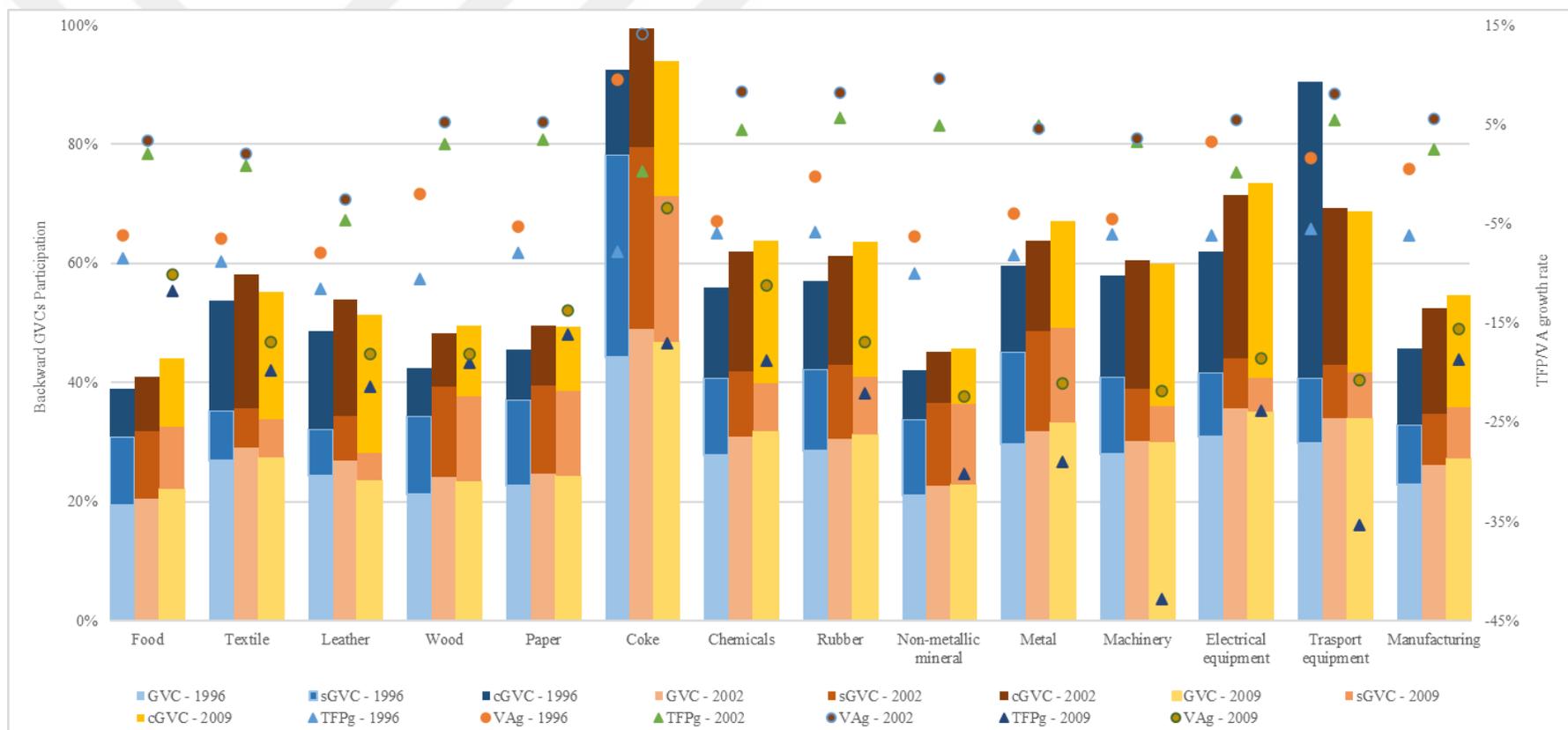
Figure 2.1: Backward linkages and performance of manufacturing sectors (1996, 2002, 2009)

Notes: The bottom columns represent the GVC participation index, the middle columns represent simple GVC participation, and the top columns stand for complex GVC participation.
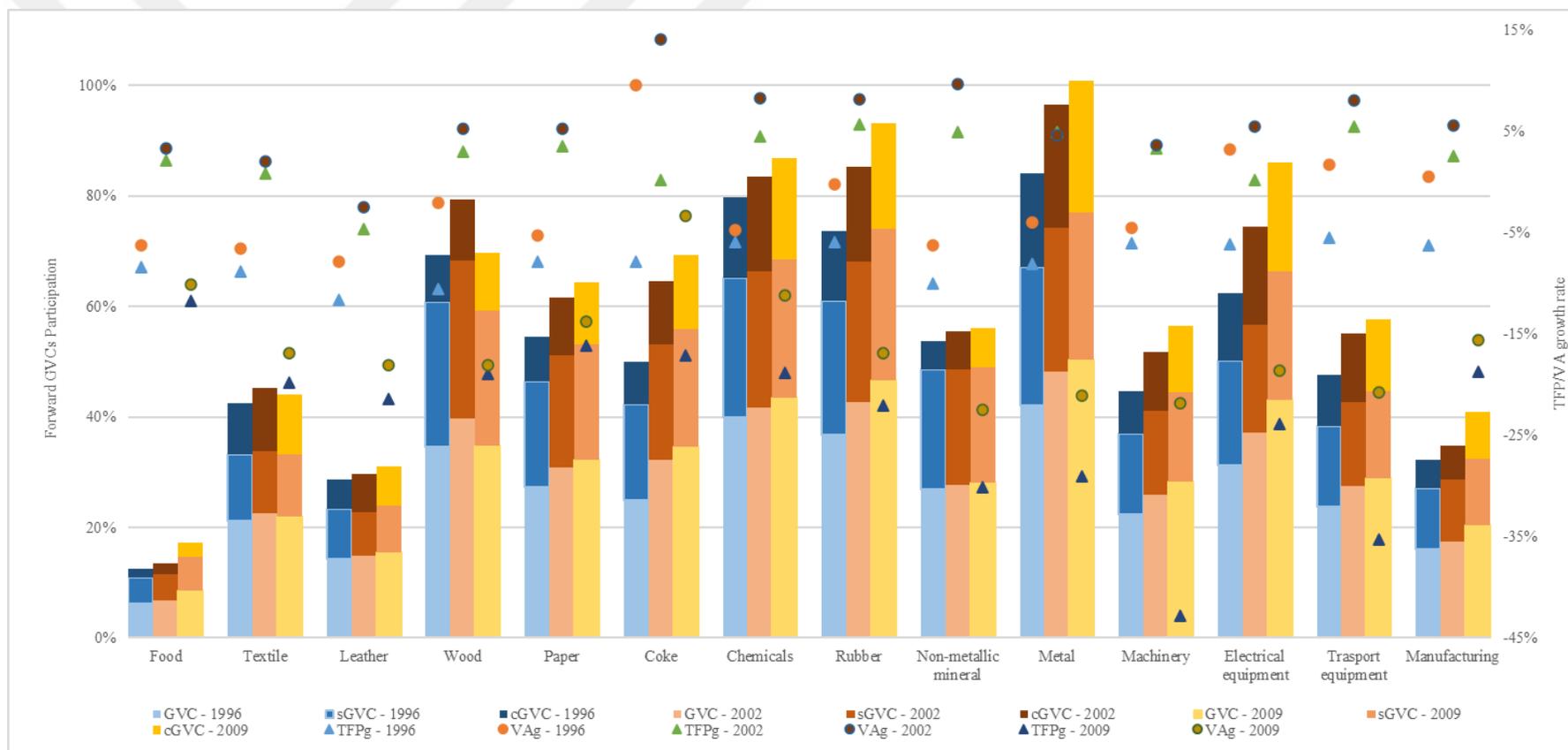
Figure 2.2: Forward linkages and performance of manufacturing sectors (1996, 2002, 2009)

Notes: See Notes in Figure 2.1.
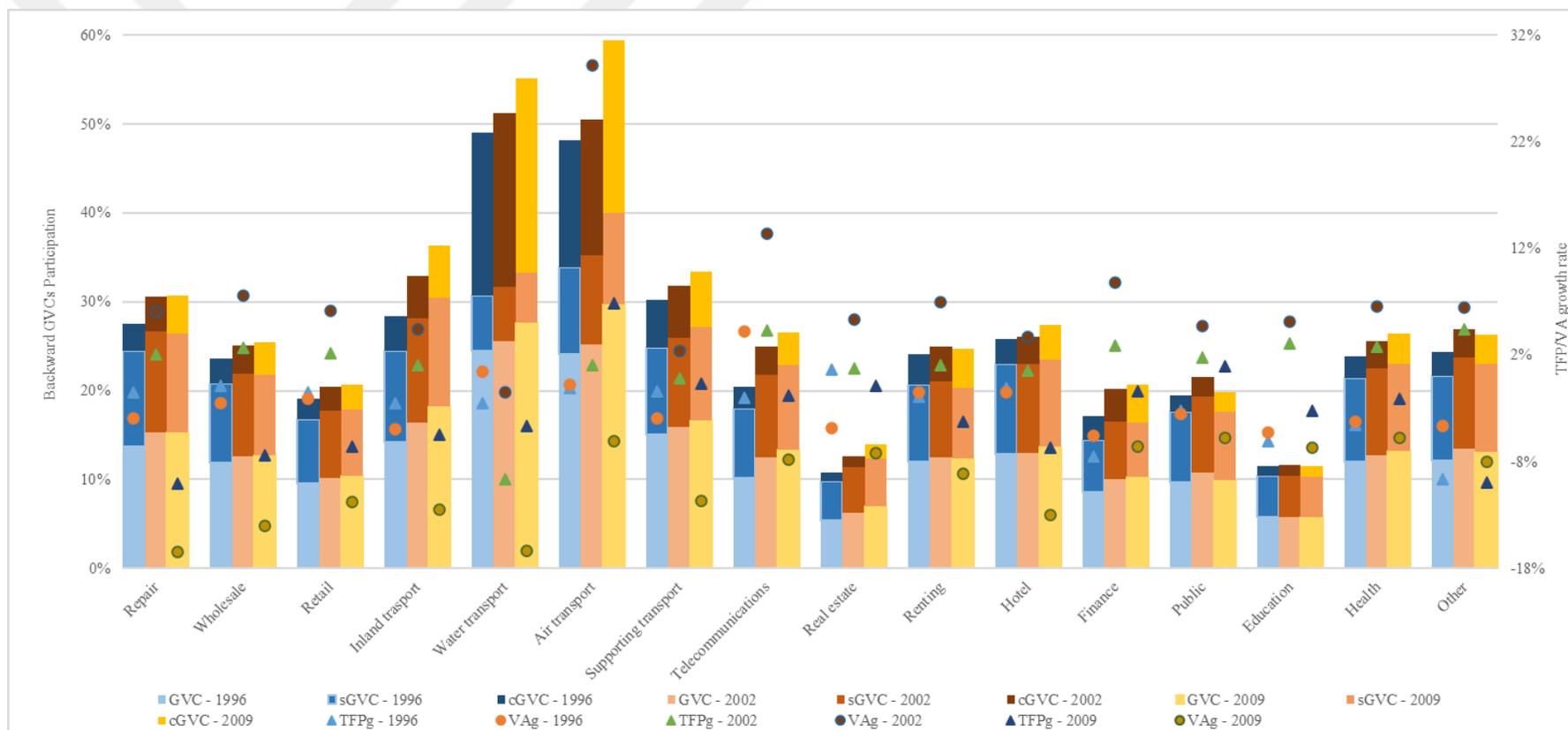
Figure 2.3: Backward linkages and performance of service sectors (1996, 2002, 2009)

Notes: See Notes in Figure 2.1.
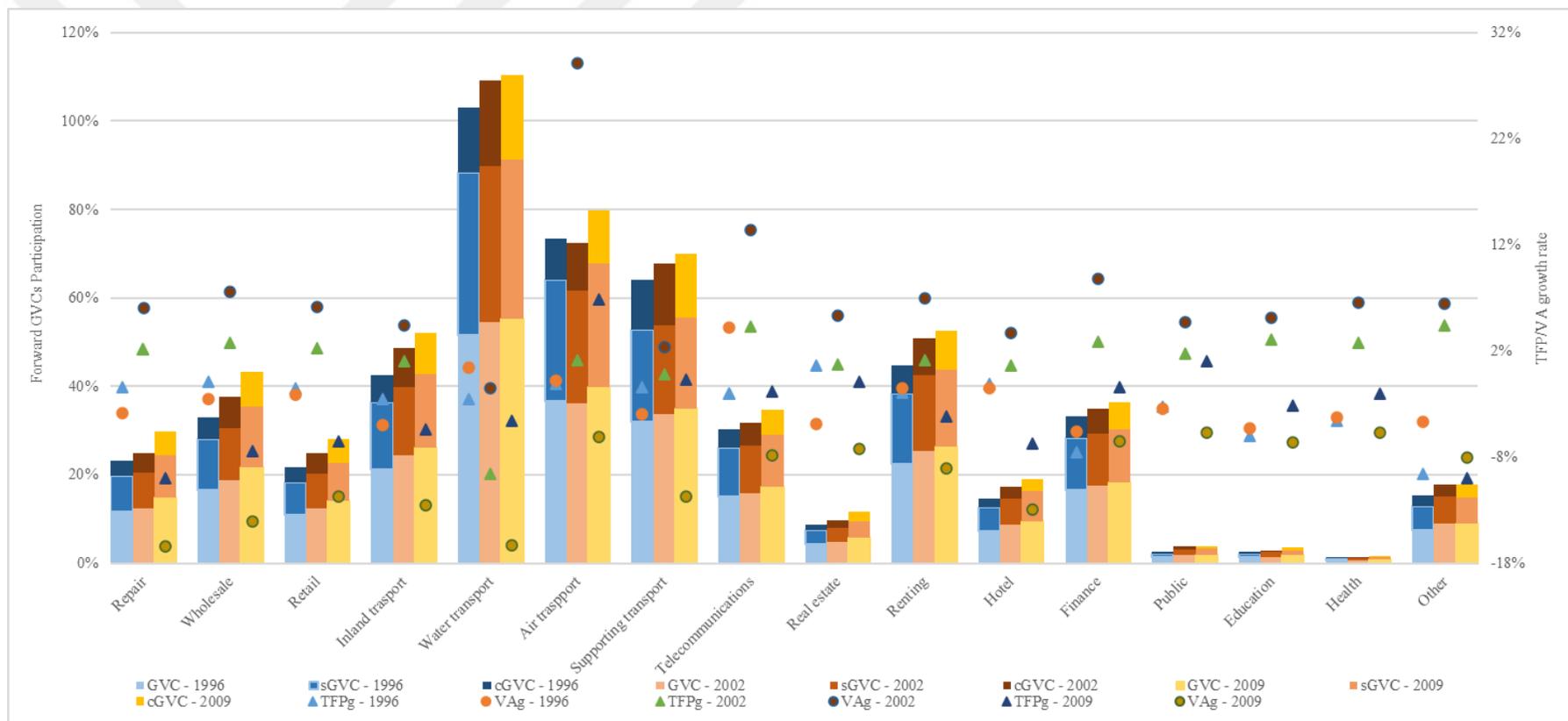
Figure 2.4: Forward linkages and performance of service sectors (1996, 2002, 2009)

Notes: See Notes in Figure 2.1.

Table 2.2: Backward and forward lengths & GVC participation ratios

Backward				Forward			
Sectors	Length	Simple	Complex	Sectors	Length	Simple	Complex
34t35	2.62	0.09	0.29	C	3.22	0.24	0.15
30t33	2.54	0.09	0.27	27t28	2.97	0.26	0.23
27t28	2.54	0.18	0.17	20	2.69	0.27	0.11
15t16	2.47	0.11	0.10	71t74	2.68	0.17	0.08
29	2.45	0.09	0.23	21t22	2.66	0.20	0.10
23	2.45	0.29	0.21	25	2.65	0.26	0.17
25	2.45	0.13	0.19	63	2.64	0.20	0.13
24	2.42	0.11	0.20	61	2.59	0.36	0.18
19	2.41	0.07	0.19	24	2.53	0.25	0.18
20	2.41	0.16	0.09	26	2.52	0.21	0.07
17t18	2.39	0.07	0.22	E	2.52	0.10	0.06
36t37	2.39	0.09	0.18	23	2.47	0.21	0.11
62	2.34	0.10	0.17	60	2.40	0.16	0.09
21t22	2.32	0.15	0.10	J	2.38	0.12	0.06
61	2.30	0.06	0.20	64	2.35	0.11	0.05
F	2.29	0.16	0.05	62	2.29	0.27	0.11
26	2.26	0.14	0.09	51	2.20	0.12	0.07
E	2.12	0.19	0.05	30t33	2.19	0.21	0.18
63	2.04	0.10	0.06	50	2.05	0.09	0.05
H	2.00	0.10	0.03	52	2.00	0.08	0.05
60	1.96	0.12	0.05	29	1.94	0.16	0.11
C	1.91	0.16	0.08	34t35	1.82	0.15	0.12
O	1.88	0.10	0.03	17t18	1.76	0.11	0.11
50	1.88	0.11	0.04	36t37	1.75	0.12	0.07
71t74	1.82	0.09	0.04	O	1.69	0.06	0.03
64	1.82	0.09	0.03	70	1.61	0.03	0.02
51	1.81	0.09	0.04	15t16	1.57	0.05	0.02
N	1.74	0.10	0.03	19	1.54	0.08	0.07
J	1.72	0.06	0.04	H	1.51	0.06	0.03
52	1.72	0.08	0.03	F	1.46	0.02	0.01
L	1.67	0.08	0.02	L	1.14	0.01	0.01
70	1.50	0.05	0.01	M	1.12	0.01	0.00
M	1.43	0.05	0.01	N	1.10	0.01	0.00

Notes: The descriptions of the sectors can be found in the Appendix A. The table above includes two panels. In the left (right) panel, backward (forward) linkages are presented. In each panel, sectors are ranked according to their length scores (from highest to lowest). We take the simple average of variables across all countries and years to reach the global average values for each individual sector.

2.4 Estimation Methodology

2.4.1 Growth Accounting Framework

In the theoretical literature, trade in intermediate inputs is mainly considered in innovation driven growth models after Romer's (1990) idea of technological progress thanks to variety of inputs. In other words, intermediate inputs have been discussed in the framework of R&D driven endogenous technological change (Grossman and Helpman, 1991). In this framework, inputs are not symmetric in terms of their technological levels. They suggest that sectoral productivity can be enhanced thanks to foreign R&D spillovers via trade. Later, Coe and Helpman (1995) and Keller (1997) introduce differentiated intermediate inputs into their models. Therefore, we basically follow the Coe and Helpman's (1995) theoretical framework. We assume that world economy is composed of c number of countries, i number of sectors, each one of them produces both intermediate and final goods or services. Gross output of sectors is given by $Y_{c,i,t}$. Capital stock ($K_{c,i,t}$), number of employees ($L_{c,i,t}$), and intermediate inputs ($X_{c,i,t}$), regardless of whether they are bought from the same or different industries (countries). Accordingly, the Cobb-Douglas production function can be expressed as below (The detailed derivation of the theory can be found in Grossman and Helpman, 1991). To specify sectoral total factor productivity (TFP) and output growth, we utilize the sectoral production function is given as follows:

$$Y_{c,i,t} = A_{c,i,t} K_{c,i,t}^{\alpha} L_{c,i,t}^{(1-\alpha)} X_{c,i,t}^{\alpha} \tag{2.6}$$

where $A_{c,i,t}$ stands for Hicks-neutral technology parameters. In fact, this approach only takes into account the direct linkages of trade. However, in the input-output framework, there are some indirect linkages across countries and industries (Krammer, 2010). For instance, if country A imports from another country B, which has already imported from another country C, the realized R&D spillover should be larger than Keller's calculation because technology spillover from country C to country B is not counted in it. Nishioka and Ripoll (2012) enhance the Coe and Helpman framework by utilizing input-output matrix and propose both direct and indirect R&D channels for productivity accounting. In our model, since we are not mainly interested in R&D spillovers, we ignore this part and mainly focus on the intermediate inputs. Equation (2.6) allows a differentiation of intermediate inputs regarding their country of origin.

Therefore, it means that productivity increases as a result of employing both imported intermediates and domestically produced intermediates.

Under the constant returns to scale assumption for capital and labor, TFP growth can be calculated by taking the logarithms and derivatives of Equation (2.6):

$$\text{TFP}_{c,i,t} = \Delta \ln Y_{c,i,t} - v_{c,i,t}^K \Delta \ln K_{c,i,t} - v_{c,i,t}^L \Delta \ln L_{c,i,t} = \Delta \ln A_{c,i,t} + \Delta \ln X_{c,i,t} \qquad (2.7)$$

where v is the two-period average share of the input in the value of output. Since we have opportunity to observe types of labor in terms of both workhour and labor compensation, we utilize this heterogeneity of the labor force in calculation of total factor productivity in a way Timmer et al. (2007) suggest.

$$\Delta L_{c,i,t} = \sum v_{c,i,t} \Delta \ln H_{c,i,t}^l \qquad (2.8)$$

where $\Delta \ln H_{c,i,t}$ represents the growth of hours worked by labor type l and v is again the two-period average share of the input in the value of labor compensation.

Equation (2.7) suggests that TFP growth depends on both country-sector specific technology parameters and intermediate inputs. Since intermediate inputs consist of both domestic and foreign parts, the Equation (2.7) can also be written like that:

$$\text{TFP}_{c,i,t} = \Delta \ln A_{c,i,t} + \Delta \ln X_{c,i,t}^D + \Delta \ln X_{c,i,t}^F \qquad (2.9)$$

where X^D and X^F represent domestic and foreign intermediate goods, respectively.

Moreover, sectoral output growth can be also derived by taking the logarithms and derivatives of Equation (2.6):

$$\Delta \ln Y_{c,i,t} = \Delta \ln A_{c,i,t} + \Delta \ln K_{c,i,t} + \Delta \ln L_{c,i,t} + \Delta \ln X_{c,i,t} \qquad (2.10)$$

Equation (2.10) implies that output growth depends on both country-sector specific technology parameters, capital, labor, and intermediate inputs. Inspiring from the growth accounting exercises above, we principally investigate the learning by trading hypothesis. We have a two-tier strategy. First, we study the learning by importing hypothesis, that is, there is an input-augmenting technological change, which is presumed to enhance sectoral output and productivity growth via foreign technology and R&D spillovers from high quality and diversity of inputs (Ethier, 1982; Romer, 1990; Grossman and Helpman, 1991; Tajoli and Felice, 2018). In theoretical models where participation in GVCs is the main interest, the transmission channels are enlarged such as finer international division of labor (Grossman and Rossi-Hansberg,

2008; Baldwin and Yan, 2016; Jones et al., 2019; Ignatenko et al., 2019). In order to understand whether these gains can be materialized, the quantity of imported intermediate inputs is firstly proxied by backward GVC participations, which is then differentiated as simple and complex parts in order to see the difference in growth effects if any.

Similarly, our second hypothesis considers the learning by exporting effect, which is assumed to enhance sectoral performance through learning by doing, economies of scale effect, learning in supply chain management, and finer operations in organizations (Feder, 1982; Baldwin and Gu, 2003; De Loecker, 2013; Bastos et al., 2016; De Marchi et al., 2018). Similarly, the transmission channels are extended such as high level of specialization on different segments of production, not just on products and pro-competitive effects of international market (Li and Liu, 2014; Criscuolo and Timmis, 2017). Exporting activities are primarily measured by forward GVC participations which is then differentiated as simple and complex parts.

2.4.2 Empirical Model

Within the light of growth accounting exercises above, a standard growth model is augmented with various measures of GVC participation. Specifically, TFP growth is regressed on its lagged value (to reflect the dynamic nature of growth), R&D as a proxy for sectoral technology level, measures of backward/forward GVC participation, and position index. To assess the two hypotheses discussed above, we basically specify the total factor productivity model as follows:

$$TFP_{c,i,t} = \beta_0 + \beta_1 TFP_{c,i,t-1} + \beta_2 R\&D_{c,i,t-1} + \beta_3 Pos_{c,i,t-1} + \beta_4 Pos^2_{c,i,t-1} +$$
$$\beta_5 X_{c,i,t-1} + \beta_6 T_t + \varepsilon_{c,i,t} \tag{2.11}$$

where T_t stands for time dummies and c and i stands for countries and sectors, respectively. $TFP_{c,i,t}$ stands for the total factor productivity growth. In addition to the lagged dependent variable, we employ the one-year lag values of the all right-hand side variables by following studies such as Miller and Upadhyay (2000), Yanikkaya (2003), Keller and Yeaple (2003), and Szymczak and Wolszczak-Derlacz (2019). We also prefer to employ the lagged values of explanatory variables in our growth estimation model to take the dynamic nature and speed of technology creation and spillover into account and to mitigate the problem of reverse causality. $R\&D_{c,i,t-1}$ is

the ratio of R&D expenditure to value-added. $\text{Pos}_{c,i,t-1}$ represents the position of industries. $\text{Pos}^2_{c,i,t-1}$ represents the square of the position index. We include the square of position index because basic scatter plot suggests that value-added growth decreases when position index approaches to 1, but then increases once sectors have higher/lower relative position. $X_{c,i,t-1}$ represents backward (forward) GVC participation indices. In the sensitivity analysis, $X_{c,i,t-1}$ is related to backward (forward) volumes and expressed as shares of sectoral outputs: domestic (re-imported) and foreign value-added in intermediate imports from all sectors which are both domestically used and exported (Y_GVC/Output) and domestic value-added of sector used in exported intermediate products including production sharing between two or more countries (V_GVC/Output).

To estimate output growth, we employ a slightly different model. By following the standard growth model such as in Equation 6, output growth is regressed on its lagged value, capital intensity measure, measures of backward/forward GVC participation, position index, and skill variables.

$$Y_{c,i,t} = \beta_0 + \beta_1 Y_{c,i,t-1} + \beta_2 K_{c,i,t-1} + \beta_3 \text{Pos}_{c,i,t-1} + \beta_4 \text{Pos}^2_{c,i,t-1} + \beta_5 X_{c,i,t-1} +$$
$$\beta_6 E_{c,i,t-1} + \beta_7 T_t + \varepsilon_{c,i,t} \tag{2.12}$$

where, $Y_{c,i,t}$ stands for sectoral output growth. $K_{c,i,t-1}$ is capital stock per worker (Wang et al., 2017a). $E_{c,i,t-1}$ is the skill vector representing the share of hours worked by high and medium skilled persons in total hours. The other variables are exactly the same as in the TFP growth analysis.

The empirical growth model above is estimated in a dynamic panel setting through the System Generalized Methods of Moments (SGMM) for industries to investigate the association between integration of GVCs and sectoral performance.[2] SGMM is employed to overcome endogeneity issue, time-invariant heterogeneity across sectors, the simultaneity bias, and further endogenous variables among both regressors and the control variables (Arellano and Bover, 1991). SGMM estimator is also capable of overcoming the problems like fixed effects, over-identification, and

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[2] In the empirical literature, studies generally employ the OLS estimation methodology. We also exercise our analysis with the OLS. In this analysis, we add not only time dummies but also country and sectoral dummies into our models. In this context, Roodman (2009) asserts that employing fixed effects dummies into SGMM is mistake because it might cause bias especially if time dimension is very small. Comparing the OLS and SGMM estimations, we find very similar results and get the similar conclusions though.

validity. In this technique, the number of instruments should be fewer than or equal to the number of sectors and the Hansen test checks the validity of instruments used in the model. In all the estimations, high p values are observed for the Hansen tests, which proves the validity and power of the instruments. In addition, autocorrelation is tested by Arellano-Bond tests.

2.5 Results

In order to investigate the association between the integration into GVCs and sectoral performance outcomes, this paper employs the system GMM estimation technique. Tables 2.3 to 2.6 and Tables 2.7 to 2.10 present the estimation results for the total factor productivity and output growth, respectively.

2.5.1 Total Factor Productivity Growth

Tables 2.3 and 2.4 present the estimations for the impact of participating into GVCs on total factor productivity growth for both the manufacturing and service sectors, separately. In the first two columns of Table 2.3, backward and forward GVC participation indices are employed individually.[3] In next two columns, we repeat the same exercise for simple GVC participation. In the last two columns, the effects of complex GVC participation are investigated.[4] For the manufacturing industries, sectoral TFP highly depends on its lagged value. The estimation results also indicate that there is no significant effect of R&D expenditures on total factor productivity. This may be related to low variation in R&D series across cross sectional units in our panel data. We cannot also observe any significant relationship between the position and productivity of manufacturing industries.

When we look at our main interest variables, unlike backward participation, forward participation has significantly positive impact on total factor productivity growth. In the third and fourth columns investigating the relationship for simple GVC,

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[3] When we employ both backward and forward participation ratios together in our model, the significance of these variables continues to exist in almost all specifications.

[4] Indeed, we also measure only foreign part of backward complex participation index by omitting domestic value-added returning home from intermediate inputs. Similarly, we consider only foreign part of forward complex participation index by dropping domestic value-added embodied in intermediate goods exports used for production of re-exports that finally returns to source country. The results are parallel with the GVC part because domestic part of complex GVC index is very fractional (nearly 0.001 percentage in total output).

we find the same results with the previous two columns. In the columns 5 and 6, the impacts of complex GVC are investigated and both variables are found to be positively significant. The positive effect of forward GVC participation on TFP growth provides substantial evidence for the learning by exporting hypothesis. Indeed, significantly positive impact of complex part of GVC means that manufacturing sectors producing and exporting advanced and innovative products have much higher TFP growth. This also implies that how global production depends on some key intermediate products of manufacturing industries, which are probably located in relatively upstream part of the production chain. We can argue that knowledge transfers and obligation to adopt international standards enable industries to reach higher level of productivity. Furthermore, the result may also be driven by high level of concentration of multinational firms and self-selection effect of firms in sectors.[5] Similarly, the significantly and positively estimated coefficient on backward complex GVC participation suggests that imported intermediates used in production of exported products rather than used in final products stimulate productivity. This also indicates the importance of complexity of participating importing activities for productivity of sectors, providing strong evidence for the learning by importing hypothesis.

For the service sectors, in Table 2.4, we find no evidence for learning by importing and exporting hypotheses because the estimated coefficients are all insignificant. However, note that we have data only for two sectors in services because of the data limitation, the results thus are not representative for whole service sectors.

In Tables 2.5 and 2.6, we utilize related intermediate imports and exports values as a share of output to check the robustness of our results. In fact, the only difference

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[5] We also utilize OECD's Analytical database for Multinational Enterprises database to get information regarding multinationals in each sector. Among several variables such as number of enterprises, employees, R&D expenditure, output; we prefer to use value-added of multinationals. We calculate the share of value-added of multinationals in each sector. The significance of all GVC measures continue to exist in the manufacturing sample without any significant positive effect of the share of multinational companies in sectors. Therefore, we argue that our results are quite robust. However, we cannot repeat the SGMM analysis for the service sectors because the number of observations in TFP analysis is extremely low (just 81 observations), the number of instruments outweighs the number of cross units, and the estimation has invalid Hansen test statistics. To be more specific, out of 40 countries in our sample, only 22 countries have information regarding multinationals. The year 2009 is also missing in OECD database. In output growth analysis, we find similar results for manufacturing sample. For the services sample, while forward simple GVC participation positively affects the output growth, the share of multinationals also appears to be significantly positive in some specifications. Actually, the number observations of services sample sharply decrease when we include the variable regarding multinationals. Therefore, we cannot make proper discussion because of this data limitation. Furthermore, we also try other variables such as the number of enterprises, but we reach the similar conclusion. Because of these data limitations (especially for the services industries and TFP growth analysis) and overall significant results, we prefer to continue with our benchmark results.

of participation indices and related trade values is the denominators of these ratios. We employ the value-added for the calculation of GVC participation indices and outputs are employed for the calculation of trade volumes as the denominators. For the manufacturing sample, even though the backward linkages lose their significance, forward linkages still promote TFP growth (Table 2.5). For the service sectors, the estimations results are the same (Table 2.6).

Therefore, we strongly argue that producing advanced manufacturing products, climbing up in complex GVCs, that is innovative activities, promotes higher sectoral TFP growth through knowledge spillovers, hyper-specialization, strong competition in international market, and leveraging scale economies. Indeed, qualification and certification of processes for producers can also be considered as another transmission mechanism for the forward linkages. By pursuing activities in GVCs with advanced organizational structures, industries are able to capture efficiency gains and experience process upgrading (see also, Humphrey and Schmitz, 2002b), which is so called TFP growth.

Table 2.3: Total factor productivity growth and integration into GVCs, manufacturing sectors

	GVCs		Simple GVCs		Complex GVCs	
	(1)	(2)	(3)	(4)	(5)	(6)
Lagged TFP growth	0.211***	0.210***	0.205***	0.210***	0.210***	0.211***
	(0.029)	(0.028)	(0.025)	(0.027)	(0.027)	(0.028)
R&D	0.147	0.010	0.016	0.037	0.082	0.038
	(0.092)	(0.086)	(0.094)	(0.098)	(0.100)	(0.077)
Position	0.041	-0.065	0.131	-0.059	0.066	0.002
	(0.208)	(0.179)	(0.252)	(0.193)	(0.212)	(0.190)
Position_sq	-0.030	-0.021	-0.066	-0.023	-0.027	-0.028
	(0.101)	(0.086)	(0.121)	(0.092)	(0.100)	(0.092)
Backward GVC	0.068		-0.185		0.161***	
	(0.063)		(0.145)		(0.043)	
Forward GVC		0.226***		0.338***		0.288***
		(0.046)		(0.107)		(0.056)
# of Obs.	4,057	4,057	4,057	4,057	4,057	4,057
# of country-sector	380	380	380	380	380	380
# of instruments	382	382	382	382	382	382
AR(2)	0.452	0.470	0.431	0.471	0.453	0.465
Hansen (p)	0.336	0.312	0.295	0.292	0.293	0.323

Notes: Robust standard errors in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$. Time dummies are included in all specifications. The Hansen test is a test of overidentification restrictions. Under the null hypothesis, the test statistic is distributed as a chi-squared in the number of overidentifying restrictions, p-values are presented. System GMM results are two-step estimates. The two-step standard errors are computed in accordance to the Windmeijer (2005) finite-sample correction. In the manufacturing and services samples, we employ first six lags endogenous variables as instruments in the TFP growth analysis. We also utilize the collapse command in TFP growth analysis (because of the small number of observations) to get rid of bias that arises when the higher number of instruments are higher than individual unit in our panel data.

Table 2.4: Total factor productivity growth and integration into GVCs, service sectors

	GVCs		Simple GVCs		Complex GVCs	
	(1)	(2)	(3)	(4)	(5)	(6)
Lagged TFP growth	0.127*	0.143**	0.149**	0.141**	0.142**	0.149**
	(0.067)	(0.063)	(0.063)	(0.062)	(0.066)	(0.065)
R&D	-4.746	-2.825	0.698	-2.856	-3.364	-2.668
	(6.223)	(5.549)	(9.100)	(5.394)	(4.707)	(6.589)
Position	-0.207	-0.557	-0.392	-0.492	0.174	-0.648
	(0.519)	(0.488)	(0.393)	(0.503)	(0.643)	(0.604)
Position_sq	0.104	0.270	0.191	0.248	-0.053	0.292
	(0.223)	(0.219)	(0.189)	(0.230)	(0.297)	(0.257)
Backward GVC	-0.574		0.323		-2.412	
	(0.800)		(0.730)		(3.317)	
Forward GVC		0.047		-0.026		0.538
		(0.181)		(0.281)		(0.755)
# of Obs.	495	495	495	495	495	495
# of country-sector	46	46	46	46	46	46
# of instruments	48	48	48	48	48	48
AR(2)	0.696	0.733	0.787	0.730	0.751	0.759
Hansen (p)	0.328	0.410	0.496	0.395	0.411	0.370

Notes: See Notes in Table 2.3.

Table 2.5: Total factor productivity growth and integration into GVCs, manufacturing sectors (robustness)

	GVCs		Simple GVCs		Complex GVCs	
	(1)	(2)	(3)	(4)	(5)	(6)
Lagged TFP growth	0.207***	0.204***	0.211***	0.207***	0.213***	0.203***
	(0.027)	(0.026)	(0.026)	(0.026)	(0.027)	(0.026)
R&D	0.145	0.049	-0.007	0.065	0.070	0.083
	(0.096)	(0.098)	(0.107)	(0.099)	(0.087)	(0.090)
Position	-0.002	0.096	-0.017	0.085	0.087	0.078
	(0.253)	(0.257)	(0.213)	(0.255)	(0.213)	(0.235)
Position_sq	-0.013	-0.083	-0.023	-0.075	-0.040	-0.066
	(0.111)	(0.124)	(0.105)	(0.123)	(0.102)	(0.114)
Y_GVC	0.028		-0.614		0.158	
	(0.188)		(0.436)		(0.130)	
V_GVC		0.505***		0.609***		1.031***
		(0.156)		(0.225)		(0.238)
# of Obs.	4,057	4,057	4,057	4,057	4,057	4,057
# of country-sector	380	380	380	380	380	380
# of instruments	382	382	382	382	382	382
AR(2)	0.429	0.449	0.475	0.452	0.467	0.432
Hansen (p)	0.276	0.308	0.277	0.340	0.309	0.325

Notes: See Notes in Table 2.3.

Table 2.6: Total factor productivity growth and integration into GVCs, service sectors (robustness)

	GVCs		Simple GVCs		Complex GVCs	
	(1)	(2)	(3)	(4)	(5)	(6)
Lagged TFP growth	0.134*	0.148**	0.154**	0.145**	0.132*	0.150**
	(0.067)	(0.059)	(0.064)	(0.061)	(0.066)	(0.063)
R&D	-3.246	-2.390	-1.588	-3.066	-9.074	-0.752
	(4.787)	(6.509)	(4.656)	(6.049)	(10.834)	(7.464)
Position	-0.413	-0.605	-0.102	-0.506	-0.692	-0.695
	(0.365)	(0.543)	(0.407)	(0.605)	(0.585)	(0.675)
Position_sq	0.205	0.270	0.111	0.239	0.305	0.315
	(0.148)	(0.259)	(0.163)	(0.290)	(0.246)	(0.282)
Y_GVC	1.297***		0.852**		1.904***	
	(0.229)		(0.346)		(0.548)	
V_GVC		0.524***		0.700***		1.049**
		(0.177)		(0.232)		(0.457)
# of Obs.	7,873	7,873	7,873	7,873	7,873	7,873
# of country-sector	623	623	623	623	623	623
# of instruments	621	621	621	621	621	621
AR(2)	0.360	0.364	0.360	0.362	0.357	0.364
Hansen (p)	0.277	0.255	0.276	0.265	0.259	0.275

Notes: See Notes in Table 2.3.

2.5.2 Output Growth

For the manufacturing industries, in almost all columns of Table 2.7, significantly negative estimated coefficients on the position index and positively estimated coefficients on the square terms of position index imply that output growth are higher at the two tails of the production line than intermediate stages.

As can be seen from the first two columns of Table 2.7, both backward and forward GVC participation indices have positive impacts on output growth. In next two columns, we repeat the same exercise for simple GVC and find the similar results with the previous columns. In the columns 5 to 6, the impacts of complex GVC are examined. While we fail to find the significant impact of complex backward GVC participation, complex forward GVC participation seems to raise output growth. The significantly positive effect on (simple) backward GVC participation implies that output growth rises in sectors benefitting from imported intermediate inputs in their domestic production, which provides substantial evidence for the learning by importing hypothesis (see Bernard (2007) and Antrás et al. (2017b) for the further

discussion on the importance and complementarities of imported intermediate products). In addition, it seems that knowledge spillovers and finer division of labor play crucial roles in upgrading in output.

The positive but insignificantly estimated coefficient on backward complex GVC participation (at the column 5 of Table 2.7) suggests that imported intermediates used in final products raises output more than imported intermediates used in the production of exported products. Note that one can expect this variable to be significant as well because production is made with foreign inputs and some of this product is sold domestically and some abroad. However, different levels of processed inputs might be used in the production for exporting purposes and domestic consumption. If less processed inputs are imported for the production of domestic consumer products, while more processed, near to be final products are imported for exporting purposes, then the output may be less in this circumstance. This proposition is actually supported by the descriptive statistics because backward length of simple GVC (3.4) is shorter than backward length of complex GVC (4.3), which means that manufacturing sectors are more likely to import more processed inputs for exporting rather than domestic consumption. The significantly positive estimated coefficient on forward complex GVC substantially proves the learning by exporting hypothesis. Manufacturing sectors can benefit from the export-led/GVCs-led industrialization through interactions with the productive sectors. As a consequence of resource allocation across firms in industries, more productive firms survive and less productive firms leave the market (Melitz, 2003), which can be another transmission mechanism of GVCs – output nexus. Another factor stimulating output growth is the higher share of medium skilled worker (base category is low skilled worker) putting the emphasis on broaden skill set in industries. To check the robustness of our results, we also employ the related share of trade volumes in output instead of participation indices in our models. Even though the significances of backward linkages disappear, the significances of forward linkages continue to exist.

Table 2.7: Output growth and integration into GVCs, manufacturing sectors

	GVCs		Simple GVCs		Complex GVCs	
	(1)	(2)	(3)	(4)	(5)	(6)
Lagged VA growth	0.090**	0.090***	0.089**	0.093***	0.092**	0.088***
	(0.038)	(0.035)	(0.035)	(0.035)	(0.036)	(0.034)
Capital	-0.002	-0.003	0.001	-0.002	-0.004	-0.003
	(0.004)	(0.004)	(0.004)	(0.004)	(0.003)	(0.004)
Position	-0.021	-0.208***	-0.218***	-0.163**	-0.012	-0.255***
	(0.105)	(0.078)	(0.073)	(0.066)	(0.114)	(0.080)
Position_sq	0.012	0.033*	0.055***	0.026	0.010	0.049***
	(0.022)	(0.017)	(0.016)	(0.017)	(0.024)	(0.016)
Backward GVC	0.300***		0.104**		0.139	
	(0.070)		(0.047)		(0.088)	
Forward GVC		0.277***		0.399***		0.473***
		(0.066)		(0.126)		(0.107)
High-skilled share	0.045	0.046	-0.031	0.035	-0.014	0.025
	(0.062)	(0.066)	(0.062)	(0.065)	(0.061)	(0.065)
Medium-skilled share	0.065**	0.066**	0.080***	0.073**	0.075**	0.062*
	(0.031)	(0.033)	(0.026)	(0.031)	(0.032)	(0.034)
# of Obs.	5,775	5,775	5,775	5,775	5,775	5,775
# of country-sector	544	544	544	544	544	544
# of instruments	559	559	559	559	559	559
AR(4)	0.491	0.520	0.478	0.522	0.506	0.513
Hansen (p)	0.457	0.401	0.422	0.412	0.415	0.419

Notes: See Notes in Table 2.3. In the manufacturing sample, we employ first eight lags of endogenous variables as instruments in value-added growth analysis. In the manufacturing sample, we include the first three lags of dependent variable in our model to correct autocorrelation. Therefore, we report the estimates for the third lagged dependent variable and AR(4) tests in value-added analysis.

For the service sectors, in both Tables 2.8 and 2.10, all backward and forward GVC participation indices/volumes have significantly positive influences on output growth, which provides strong evidence both for the learning by importing and exporting hypotheses. Deeper involvement in backward GVC participation brings sophisticated intermediates embedded by high level of skills and R&D content. Indeed, imported intermediates allow industries to access to a wide variety of human capital and technologies compared to domestic intermediates (Criscuolo and Timmis, 2017). Similarly, extending forward linkages enables service sectors to reach larger markets and utilize the scale economies and learning by doing. In both panels, almost all education variables are significantly positive, which means that human capital accumulation is one of the stimulators of output growth in service sectors.

Table 2.8: Output growth and integration into GVCs, service sectors

	GVCs		Simple GVCs		Complex GVCs	
	(1)	(2)	(3)	(4)	(5)	(6)
Lagged VA growth	-0.003	-0.006	0.004	-0.005	-0.004	-0.003
	(0.027)	(0.029)	(0.029)	(0.029)	(0.027)	(0.029)
Capital	0.007	0.005	0.008	0.005	0.007	0.007
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
Position	-0.179	-0.275	0.054	-0.254	-0.174	-0.249
	(0.283)	(0.322)	(0.232)	(0.312)	(0.296)	(0.317)
Position_sq	0.065	0.041	-0.020	0.043	0.046	0.043
	(0.108)	(0.107)	(0.091)	(0.106)	(0.109)	(0.108)
Backward GVC	0.543***		0.793**		0.541***	
	(0.153)		(0.331)		(0.167)	
Forward GVC		0.344***		0.450**		0.779**
		(0.131)		(0.181)		(0.309)
High-skilled share	0.146***	0.137***	0.076	0.119***	0.085*	0.106***
	(0.049)	(0.042)	(0.047)	(0.041)	(0.047)	(0.039)
Medium-skilled share	0.169**	0.175**	0.193**	0.190**	0.227**	0.160**
	(0.084)	(0.083)	(0.084)	(0.087)	(0.089)	(0.078)
# of Obs.	7,873	7,873	7,873	7,873	7,873	7,873
# of country-sector	623	623	623	623	623	623
# of instruments	621	621	621	621	621	621
AR(2)	0.356	0.365	0.356	0.363	0.358	0.364
Hansen (p)	0.273	0.271	0.302	0.274	0.256	0.269

Notes: See Notes in Table 2.3. In the services sample, we employ first eight lags of endogenous variables as instruments in value-added growth analysis.

Therefore, we argue that both manufacturing and service sectors ought to participate more to global markets and utilize imported intermediates so that technological advances abroad can be directly or indirectly transmitted into the sectors. In order to provide easier and faster access to foreign intermediate goods and generate strong backward linkages, countries should develop more open sectoral trade policies. Even if strong backward linkages especially complex ones may lead to external shocks more disruptive in supply chains and transmit the shocks into the domestic markets, strengthening the sourcing strategy with diversification of suppliers around the world and improving logistics performances of countries can alleviate these risks along the global value chains.

Table 2.9: Output growth and integration into GVCs, manufacturing sectors (robustness)

	GVCs		Simple GVCs		Complex GVCs	
	(1)	(2)	(3)	(4)	(5)	(6)
Lagged VA growth	0.079**	0.088**	0.084**	0.089**	0.088**	0.089**
	(0.035)	(0.035)	(0.034)	(0.035)	(0.035)	(0.035)
Capital	-0.008**	-0.006*	-0.000	-0.005	-0.005	-0.005
	(0.003)	(0.004)	(0.004)	(0.004)	(0.003)	(0.004)
Position	-0.093	-0.244***	-0.166**	-0.236***	-0.147**	-0.251***
	(0.059)	(0.076)	(0.076)	(0.082)	(0.070)	(0.070)
Position_sq	0.028**	0.019	0.042***	0.015	0.043***	0.042***
	(0.013)	(0.016)	(0.016)	(0.020)	(0.014)	(0.013)
Y_GVC	0.177		-0.124		0.281	
	(0.157)		(0.155)		(0.184)	
V_GVC		0.295**		0.340		0.825***
		(0.142)		(0.250)		(0.223)
High-skilled share	0.045	0.046	-0.031	0.035	-0.014	0.025
	(0.062)	(0.066)	(0.062)	(0.065)	(0.061)	(0.065)
Medium-skilled share	0.065**	0.066**	0.080***	0.073**	0.075**	0.062*
	(0.031)	(0.033)	(0.026)	(0.031)	(0.032)	(0.034)
# of Obs.	5,775	5,775	5,775	5,775	5,775	5,775
# of country-sector	544	544	544	544	544	544
# of instruments	559	559	559	559	559	559
AR(4)	0.541	0.511	0.482	0.517	0.533	0.507
Hansen (p)	0.412	0.392	0.441	0.410	0.425	0.398

Notes: See Notes in Table 2.3. In the manufacturing sample, we employ first eight lags of endogenous variables as instruments in value-added growth analysis. In the manufacturing sample, we include the first three lags of dependent variable in our model to correct autocorrelation. Therefore, we report the estimates for the third lagged dependent variable and AR(4) tests in value-added analysis.

Table 2.10: Output growth and integration into GVCs, service sectors (robustness)

	GVCs		Simple GVCs		Complex GVCs	
	(1)	(2)	(3)	(4)	(5)	(6)
Lagged VA growth	-0.001	-0.001	0.004	0.000	-0.003	-0.000
	(0.027)	(0.028)	(0.027)	(0.028)	(0.027)	(0.028)
Capital	0.008*	0.006	0.011*	0.007	0.008	0.007
	(0.005)	(0.005)	(0.006)	(0.005)	(0.005)	(0.005)
Position	0.499***	-0.089	0.349	-0.108	0.112	-0.017
	(0.176)	(0.288)	(0.252)	(0.275)	(0.226)	(0.240)
Position_sq	-0.155**	-0.043	-0.123	-0.021	-0.038	-0.055
	(0.069)	(0.102)	(0.093)	(0.096)	(0.086)	(0.088)
Y_GVC	1.297***		0.852**		1.904***	
	(0.229)		(0.346)		(0.548)	
V_GVC		0.524***		0.700***		1.049**
		(0.177)		(0.232)		(0.457)
High-skilled share	0.146***	0.137***	0.076	0.119***	0.085*	0.106***
	(0.049)	(0.042)	(0.047)	(0.041)	(0.047)	(0.039)
Medium-skilled share	0.169**	0.175**	0.193**	0.190**	0.227**	0.160**
	(0.084)	(0.083)	(0.084)	(0.087)	(0.089)	(0.078)
# of Obs.	7,873	7,873	7,873	7,873	7,873	7,873
# of country-sector	623	623	623	623	623	623
# of instruments	621	621	621	621	621	621
AR(2)	0.360	0.364	0.360	0.362	0.357	0.364
Hansen (p)	0.277	0.255	0.276	0.265	0.259	0.275

Notes: See Notes in Table 2.3. In the services sample, we employ first eight lags of endogenous variables as instruments in value-added growth analysis.

2.6 Conclusion

The performances of industries cannot be considered apart from the globally integrated production systems. This paper thus aims to evaluate the determinants of TFP and output growth by controlling the position of sectors in a production chain over the period 1996-2009 for manufacturing and services industries in 40 developed and developing economies. In the TFP growth analysis, while we find strong evidence for the positive effect for all three measures of forward GVC participation for the manufacturing industries, we cannot find any evidence for the effect of participation indices on TFP growth of the service sectors. In the output growth analysis, all forward GVC participation indices (both simple and complex) and simple part of the backward GVC have strong positive influences on the output growth of manufacturing industries. All measures of backward and forward

participation raise the output growth of service sectors. We also find some evidence of U-shape relationship with the position index for the manufacturing sample.

Our dynamic panel estimation results imply that even if output growth can be enhanced by increasing participation in almost all measures of backward and forward GVC, the productivity can be only boosted via involving in complex activities. These results lend evidence for the learning by trading hypothesis and lay emphasis on intra-product specialization for higher productivity. In other words, complexity of GVC participation substantially matters for the sectoral productivity growth. Furthermore, our results also imply the importance of human capital development and absorption capacity of industries to support upgrading in sectoral output and productivity.

Overall, our results have important policy recommendations regarding the sectoral performance of developed and developing countries, especially for the sectoral disaggregation as manufacturing and services. Strong evidence for the positive impacts of importing and exporting intermediates, involving in cross-border trade activities, on sectoral performance indicates that successes of industries mostly depend on efficient integration in the global production chains. Given these strong positive effects of integration into world production processes, the adverse effects of possible external shocks and trade conflicts in this chain becomes clearer. Especially, complex GVC participation is more likely to amplify the effects of these shocks. To overcome quick contagious effects of these negative shocks on supply chains and reap the opportunities of open markets, countries ought to take required provisions against possible disruptions in global value chains and enhance their international coordination via investments in digital and sustainable infrastructure.

3 DOES TRADE POLICY MATTER FOR ECONOMIC GROWTH?

3.1 Introduction

Over the past three decades, market access tariffs have fallen, particularly for manufactured goods, with the tremendous improvements in the information, transportation systems and acceleration of trade activities. The General Agreement on Tariffs and Trade (GATT, 1947) and various multilateral/regional trade agreements have helped to minimize trade barriers and liberalized manufacturing products. The Uruguay Round, China's participation in the World Trade Organization (WTO) (established in 1994), and the accession of the Czech Republic, Estonia, Poland, Slovak Republic, Bulgaria, Romania, and Croatia in the European Union (EU) are only three notable successes of increasing liberalization efforts. However, these efforts can still be seen as insufficient because tariff rates are around five percent in developed countries and about eight percent in developing countries (World Development Report, 2020).

The main arguments and the motivation of countries to employ tariffs are protecting some specific industries (infant industries), slowing down the competition in international area, and thereby fostering industrialization and growth. Policy makers also believe that the tariff is an important tool that could prevent the transmission of shocks across borders, as in the recent Covid-19 health crisis. On the other hand, many authors agree that these interventions and barriers impose a direct cost in all producers (Bhagwati and Krueger, 1973) and can impede potential gains from openness (Sachs and Warner, 1995). Still, trade openness-growth relationship has been an interesting and ambiguous subject on which neither theoretical models nor empirical analysis have reached a consensus. Therefore, we believe that finding new evidence from newly released input-output dataset, new calculation methodology, and eventually new measures carry lots of crucial and valuable information for policy makers.

For this purpose, we follow a two-tier estimation strategy. In the first one, the effect of faced and imposed tariffs on sectoral value-added growth is analyzed. In the second step, the extended bilateral trade model is estimated by considering both faced and imposed tariffs. We utilize the most comprehensive input-output (IO) tables provided by the EORA26 to calculate a variety of trade values and weighted tariff rates

for nine manufacturing, mining, agriculture, and fishing sectors of 153 countries through 1990-2015. We also exploit both country and sectoral level heterogeneities of this large sample to assess what extent trade restrictions affect for these sub-groups.

The novelty of this study is investigation of the impact of input and output tariffs on a variety of trade measures based on gross and value-added terms with a large coverage: 153 countries for the period 1990-2015. We also utilize the bilateral gravity model at sectoral framework including both home and partner country specific characteristics into our model. The current literature measures input tariffs as a weighted average of tariffs on the intermediate goods by taking sectoral tariff rates into account (Bas, 2012; Johansson et al., 2014; Cruz and Bussolo, 2015; Liu et al., 2019). However, a sector produces/sells both intermediate and final products, and the faced tariff by the sector includes the tariff on these two product types. Following the tariffs imposed on the products produced by the sector, not the tariffs of the sector, enables the calculation of tariffs on intermediate and final goods, namely input and output tariffs in a more accurate way. Therefore, we prefer to calculate input tariffs as well as output tariffs by utilizing Harmonized System (HS) 6-digit products codes, related HS6-BEC-ISIC Rev. 3 concordance tables, and input-output tables.

Our results suggest that sectoral growth and extended bilateral gravity models are estimated much more precisely by using value-added trade statistics rather than gross trade statistics thanks to the extraction of the actual domestic value-added in trade and elimination of double counting issue. One of the most striking findings is that higher imposed tariffs on final products of low-tech manufacturing sectors of developing countries enhance sectoral growth suggesting supporting evidence for infant industry and import substitution policy arguments. Given the positive impact of protection provided for intermediate and final products on value-added growth of sectors, one can claim that strategic trade policies especially focusing on some prominent manufacturing industries are crucial for their growth. In this way, developing countries can create real and continuous value-added growth through enhanced facilities inside the country (self-sufficiency) and catch the opportunity to build stronger economy. In other words, we can assert that import substitution policy can be best trade strategy to promote growth in developing economies. Moreover, given the strong negative impact of faced tariffs on bilateral forward linkages especially for agriculture, mining, and high-tech sectors and developing countries, the

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benefits of policies and negotiations on regional and multilateral liberalization in global production networks also become clearer.

The chapter is organized as follows. The next section reviews the trade-growth and trade restriction literature. The third section describes data. The fourth section explains IO framework and estimation methodology. The fifth section presents estimation results. The final section concludes the study with policy recommendations.

3.2 Literature Review

In the liberalization literature, the effect of trade liberalization in the form of reduction in tariffs is widely discussed. While some authors reveal that open economies grow faster than the relatively closed counterparts, others prove the benefits of protection on infant industries. The main aim of these restrictive measures is to encourage domestic production and consumption in place of imported products especially for infant industries. Trade protection is believed to efficiently develop the production capacity of industries and to promote industrialization. For many researchers, protection of some specific industries from international competition for a specific period is essential for industries to increase their production at their early production stages and utilization of economies of scale in the consecutive periods (Ahmad, 1978; Bruton, 1989; Persky et al, 1993). Empirical evidence supports these ideas especially for developing countries (Yanikkaya, 2003; DeJong and Ripoll, 2006; Rodrigues, 2010; Adewale, 2017). The other possible channel between protection and growth nexus is enhanced productivity owing to the re-distribution of production factors across sectors (Irwin, 2002a, 2002b). On the other hand, the theoretical literature on openness and growth reveals a variety of channels for the positive impacts of both intermediates and final products liberalization on sectoral performances. These channels are transmission of innovation and technology via imported intermediates, increased managerial effort to cope with the high competition, interactions with sources of technology, utilization of economies of scale via specialization, and reallocation of resources via dropping the least productive firms out of market (Helpman and Krugman, 1985, Romer, 1989; Grossman and Helpman, 1991; Melitz, 2003; Baldwin et al., 2005; Bernard et al., 2006; Fernandes, 2007; Neiman and Gopinath, 2011; Petreski et al., 2017).

In addition to the above-mentioned studies examining the effect of the imposed tariffs at the country level, there are also sector-level studies examining the effect of the imposed tariffs on the intermediate goods. Amiti and Konings (2007) claim that the 10-percentage reduction in input tariffs results in 12 percentage productivity gain for Indonesian firms from 1991 to 2001. Topalova and Khandelwal (2011) and Halpern et al. (2015) find the similar results for Indian and Hungarian firms, respectively. Bas (2012) figures out that Argentina firm's productivity and export participation increase thanks to input tariff reduction. Chevassus-Lozza et al. (2013) claim that reduction in input tariff in agricultural products increases the exports of productive French food manufacturing firms located in downstream part of the production chain. Their empirical analysis provides evidence that the export volumes of these sectors increase at the expense of exit of low productive firms from market. Johansson et al. (2014) assert that an increase in tariff on intermediate and final products reduce the bilateral export level of both OECD and non-OECD economies. Cruz and Bussolo (2015) indicate that imposing lower level of tariffs on intermediate goods leads to higher value-added in export in Morocco by also utilizing foreign trade agreements between Morocco and other countries. Fan et al. (2015) explain this relationship with enhanced quality of export thanks to input liberalization. Feng et al. (2016) use intermediate inputs tariff as an instrumental variable for inputs. They assert that increasing imported input enhances Chinese export during the period of 2007-2013. Tian and Yu (2017) analyze the effects of input trade liberalization on firms' export performance using the same dataset and find a positive relationship. Brandt et al. (2017) and Defever et al. (2019) report the positive effect of input trade liberalization on domestic value-added in gross export of Chinese manufacturing industries. Ing et al. (2018) show that reduction in input tariff increases export performance of Chinese firms. In addition, they find out that reduction in tariffs enhances the South-North and South-South trade volumes.

In the literature, studies investigating the relationship between tariff liberalization and global value chain in inter-country input-output framework is scarce but growing. Rouzet and Miroudot (2013) formalize a measure of the cumulative tariffs including both input and output tariffs along international supply chains. Kowalski et al. (2015) provide substantial evidence of the negative effect of input tariffs on bilateral value-added flows. Muradov (2017) finds that the direct impact of tariffs on imports is more significant than the accumulated tariffs embodied in the cost

of production of the products. Kang and Dagli (2018) assert that high tariff including administrative trade measures has a significant negative indirect impact on export through industrial backward linkages for the United States, the United Kingdom, Korea, China, India, and Japan utilizing partial equilibrium models. Liu et al. (2019) find out that decrease in output tariff of upstream firms decreases vertical integration and decreases in input tariff increases vertical integration of Chinese mergers and acquisitions. However, the literature has the lack of studies analyzing the impacts of trade liberalization on economic growth with new trade concepts in framework of global value chains.

3.3 Data

We utilize inter country input-output tables (GNxGN: G: number of countries (186), N: number of sectors (26)) of the EORA26 database (Lenzen et al., 2012, 2013). This unique database provides the opportunity to reach wide coverage with nine manufacturing, mining, agriculture and fishing sectors of 153 countries (see the Appendix B) for the period of 1990-2015. The manufacturing sectors are food and beverages; textiles and wearing apparel; wood and paper; petroleum, chemical and non-metallic mineral products; metal products; electrical and machinery; transport equipment; other manufacturing; and recycling. We calculate bilateral trade variables by utilizing the calculation methodology of Wang et al. (2017a, b), which enables us to follow each step of a particular industry in global value chains.

Bilateral effectively applied tariff rates are retrieved from the World Integrated Trade Solution (WITS-TRAINS) database. In most country bilateral studies at sectoral level (Bas, 2012; Johansson et al., 2014; Cruz and Bussolo, 2015; Liu et al., 2019), tariff rates on intermediate products are calculated by taking weighted average of sectoral tariff rates utilizing input-output tables. However, tariff rates imposed on intermediate products cannot be the same with tariff rates imposed on final products. To clarify this issue, we extract tariff rates by tracking the tariffs on products with harmonized system (HS) 6-digit product codes so that we are able to differentiate the tariff rates applied on the intermediates and final products. We then take the weighted average of tariff rates imposed on intermediate and final products to reach country-sector specific tariff rates via HS6-ISIC Rev. 3 concordance table.

We mainly calculate two different tariff rates: (i) faced and (ii) imposed for whole commodities produced by sectors (sum of intermediates and finals), intermediates, and finals separately. The faced tariffs directly add cost to producers and ultimately affect the market entry decision of related sectors. The imposed tariffs provide information regarding the protection level of specific sectors. We expect that if countries set higher tariffs on the products of specific industry, it possibly raises the output level of the same industry in domestic market (the infant industry/strategic trade policy arguments) (Krugman, 1987). We actually utilize bilateral country-sectoral trade volumes to accurately calculate the weighted faced and imposed tariff rates. Then, we collapse our country-sectoral bilateral (GNxGN size) dataset to reach the bilateral dataset at sectoral level (GNxG size). By doing this, we consider both conventional trade statistics, which we call gross trade statistics as well as the novel trade in value-added statistics.

The EORA26 dataset include the information of value-added and gross fixed capital formation. We directly employ gross fixed capital formation in our analysis.[6] Following Eaton and Kortum (2002), we control a variety of gravity measures. Gravity measures such as being signatory of free trade agreement and being members of GATT are taken from Institute for Research on the International Economy (Centre d'Etudes Prospectives et d'Informations Internationales - CEPII) (Web 5, 2020). The data on gross domestic product (GDP), population, population density, and regulatory quality are taken from the World Development Indicators - World Bank (WDI-WB). The information on human capital index of countries is taken from Penn World Table (Feenstra et al., 2015). We also utilize historical income classification of countries utilizing the same database. Income classification is based on the country's 1990 income level, that is initial year of our dataset (Web 6, 2020). We also employ the technology classification of OECD based on R&D intensity of sectors (Galindo-Rueda and Verger 2016). We categorize sectors mainly in two groups as high and low technology. High-tech sectors are metal products; electrical and machinery; transport

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[6] As an alternative measure for capital and the purpose of robustness check, we calculate capital stock by utilizing the Perpetual Inventory Method. The initial capital stock values are taken from International Monetary Fund (Web 7, 2020). Country level initial capital stock is split across industries according to the value-added shares of sectors in total economy. Industry specific depreciation ratios are taken from the methodology notes of World Input Output Database (WIOD) (Erumban et al., 2012). Investment values are given as gross fixed capital formation in EORA26 database. We then calculate the sectoral capital stock for each country-sector. The estimations we utilize this definition of capital provide similar result with our benchmark results.

equipment; other manufacturing. The low-tech sectors are food and beverages; textiles and wearing apparel; wood and paper; petroleum, chemical and non-metallic mineral products; and recycling.

Figure 3.1 plots the tariff rates, the shares of export in value-added, and value-added growth, through 1990-2015. While there is a steady decline in faced tariff rates, export shares have considerably increased except for the sharp decline in the 2008 Global Financial Crisis. Contrary to these clear trends, the movement in value-added growth is around 4% on average. At this point, it is important to note that tariff retrieved from WITS are de jure measures, not de facto ones. In other words, tariffs rate we observe from the database may not be enforced by the governments and some of traded products can be exempt from the tariff procedure. Even if we select the effectively applied tariff rates from the WITS database, this can create an issue and lead to over-calculation of tariff values. To address this issue, we take the data on custom/import duties and goods imports in the World Bank so that we can calculate de facto tariff rates. Figure 3.2[7] illustrates the trend of de jure (from WITS) and de facto tariff (from WB) rates through the time. It is noticeable that even if there is nearly 1% difference between these two lines, the trends of these lines are very similar until the 2008 Global Financial Crisis. Therefore, we can argue that our tariff measures are precise enough to catch the true value of tariff rates. Figures 3.3 to 3.4 depict the Figure 3.1 by considering income level of countries. While tariff rates are pretty much similar in two groups of countries, we observe a higher increase in export share in value-added and larger fluctuation in value-added growth through years for developing economies compared to that of developed countries.

The descriptive statistics showing the general trends of variables included in the two different datasets (one is for the growth model with GN size and the other is for gravity model with GNxG size) are provided in Table 3.1 and Table 3.2, respectively. Through the sample period, 3% faced and 9% imposed tariffs are observed in general. When we consider the income level of countries, we notice that while faced and imposed tariffs are closer to each other for developed economies, the imposed input tariffs are higher than faced input tariffs for developing countries, which drives the general picture of total sample. As expectedly, we observe higher level of gross fixed

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[7] The World Bank provides these statistics at country level, not sectoral level. It is crucial to note that we employ all available data for countries, which belongs to approximately 100 countries.

capital formation, population density, regulatory quality, and human capital index for developed economies compared to developing economies.
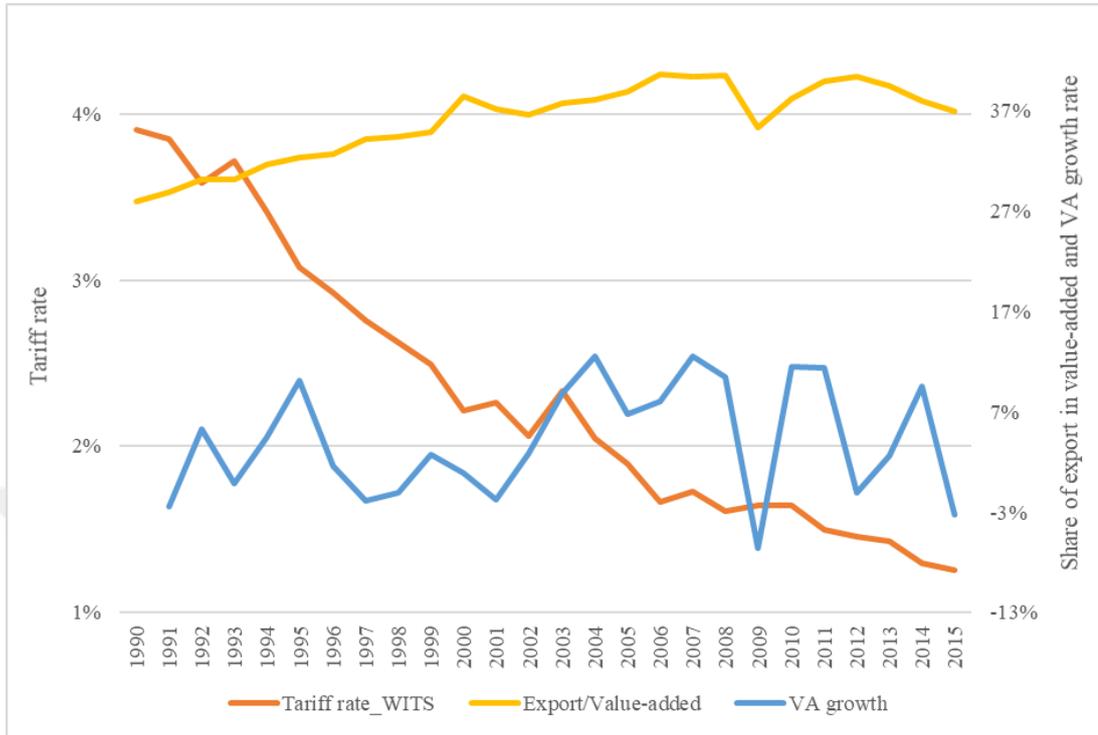
Figure 3.1: Tariff rates and trade
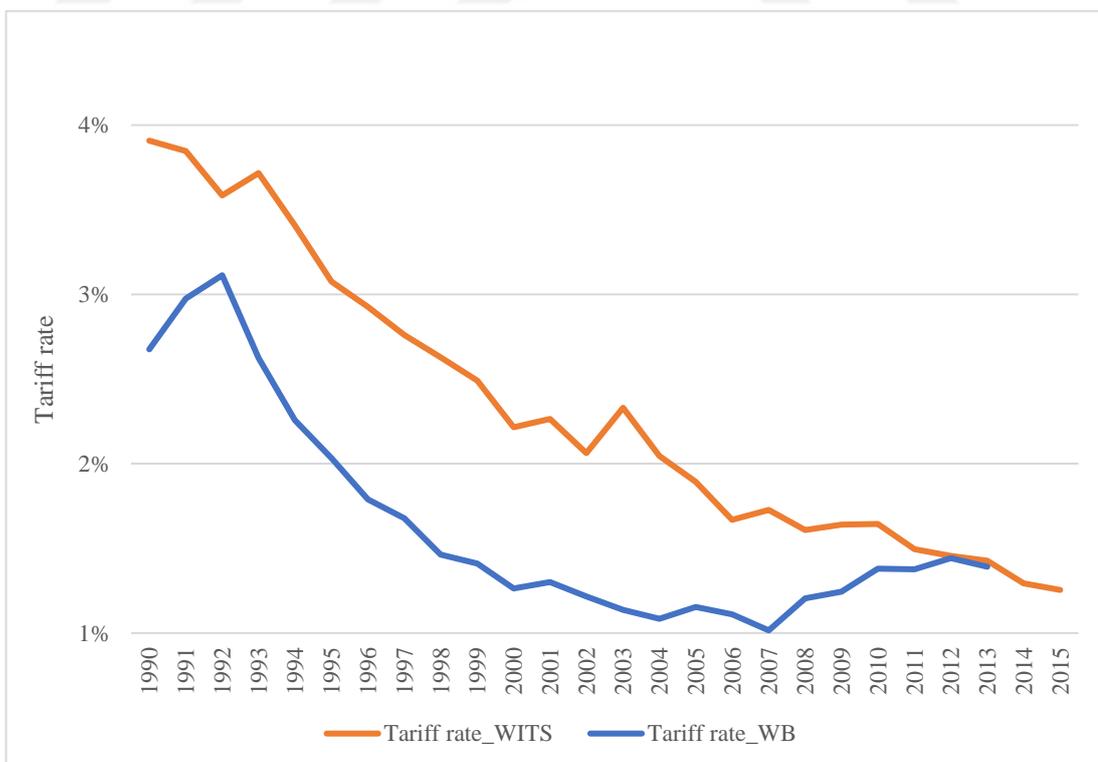
Figure 3.2: Tariff rates (WITS and WB)
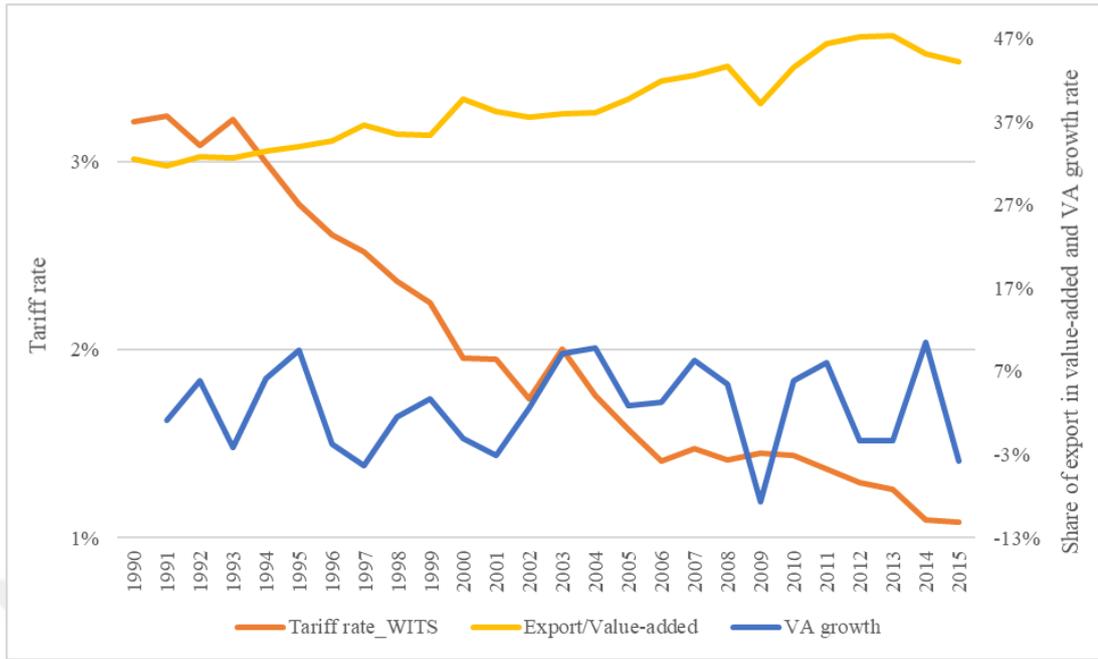
Figure 3.3: Tariff rates and trade, developed countries
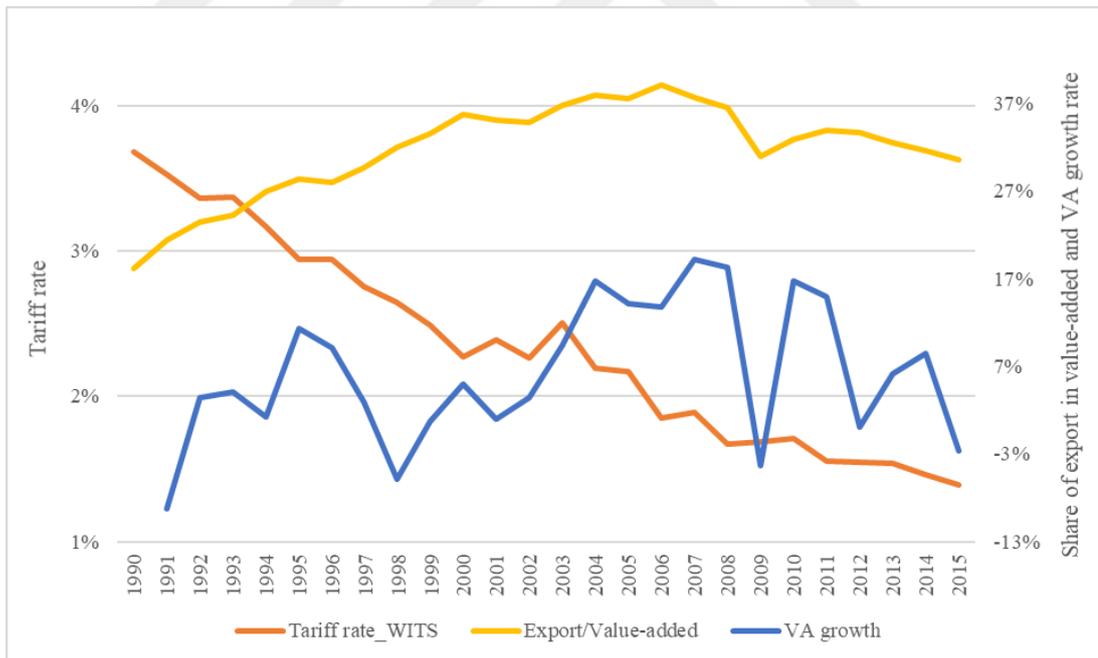
Figure 3.4: Tariff rates and trade, developing countries

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Table 3.1: Summary statistics (GN size unilateral dataset)

Variables	Total Obs.	Total Mean	Total SD	Developed Obs.	Developed Mean	Developed SD	Developing Obs.	Developing Mean	Developing SD
Value-added (billions)	53,549	6.15	30.00	11,447	16.60	48.20	42,102	3.31	21.70
ioTariff_faced (Gross)	53,549	0.02	0.03	11,447	0.02	0.03	42,102	0.02	0.03
ioTariff_faced (VA)	53,549	0.03	0.05	11,447	0.02	0.04	42,102	0.03	0.05
iTariff_faced (Gross)	53,549	0.02	0.02	11,447	0.02	0.02	42,102	0.02	0.02
iTariff_faced (VA)	53,549	0.03	0.05	11,447	0.03	0.05	42,102	0.03	0.05
oTariff_faced	53,549	0.03	0.06	11,447	0.02	0.05	42,102	0.03	0.06
ioTariff_imposed (Gross)	39,560	0.08	0.09	8,797	0.04	0.06	30,763	0.09	0.09
ioTariff_imposed (VA)	39,674	0.09	0.10	8,780	0.04	0.07	30,894	0.10	0.10
iTariff_imposed (Gross)	45,452	0.09	0.10	9,588	0.03	0.06	35,864	0.10	0.11
iTariff_imposed (VA)	45,114	0.20	0.25	9,545	0.08	0.16	35,569	0.23	0.26
oTariff_imposed	41,121	0.05	0.06	9,199	0.03	0.04	31,922	0.05	0.06
GFCF (billions)	53,549	1.63	16.10	11,447	5.09	27.90	42,102	0.69	10.60
Population (millions)	52,878	36.50	133.00	11,104	24.50	52.90	41,774	39.60	147.00
Population density (thousands)	52,801	0.34	1.69	10,996	0.68	2.11	41,805	0.25	1.54
Regulatory quality	34,117	0.04	1.00	6,918	1.36	0.44	27,199	-0.30	0.81
Human capital index	42,593	2.39	0.69	9,183	3.07	0.42	33,410	2.21	0.63

Notes: The summary statistics belong to the unilateral dataset with GN size. "SD" means standard deviation. "VA" and "GFCF" stand for value-added and gross fixed capital formation, respectively.

Table 3.2: Summary statistics (GNxG size bilateral dataset)

Variables	Total			Developed			Developing		
	Obs.	Mean	SD	Obs.	Mean	SD	Obs.	Mean	SD
Gross Export (millions)	2,523,272	73.40	1060.00	860,736	133.00	1430.00	1,662,536	42.80	796.00
VA Export (millions)	2,523,272	51.00	727.00	860,736	91.00	998.00	1,662,536	30.30	534.00
Gross Int. Export (millions)	2,523,272	46.80	676.00	860,736	82.60	910.00	1,662,536	28.20	515.00
VA Int. Export (millions)	2,523,272	24.30	334.00	860,736	41.00	463.00	1,662,536	15.70	242.00
Final Export (millions)	2,523,272	26.70	515.00	860,736	49.90	696.00	1,662,536	14.60	389.00
ioTariff_faced (Gross)	1,519,972	0.05	0.07	599,753	0.05	0.07	920,219	0.04	0.07
ioTariff_faced (VA)	1,577,857	0.06	0.09	624,294	0.07	0.09	953,563	0.06	0.10
iTariff_faced (Gross)	2,276,843	0.03	0.06	776,816	0.04	0.06	1,500,027	0.03	0.06
iTariff_faced (VA)	2,397,108	0.06	0.12	819,690	0.07	0.12	1,577,418	0.06	0.12
oTariff_faced	1,577,857	0.07	0.13	627,158	0.07	0.12	950,699	0.07	0.13
GDP_pop (thousands)	2,400,659	18.02	19.75	802,783	41.70	15.27	1,597,876	6.13	6.75
GDP_pop_partner (thousands)	2,401,558	15.13	18.03	813,625	12.67	17.13	1,587,933	16.39	18.34
GFCF (billions)	2,370,772	0.05	0.23	835,209	0.09	0.34	1,535,563	0.02	0.12
GFCF_partner (billions)	2,523,272	1.30	3.92	860,736	0.91	3.31	1,662,536	1.50	4.18
Common currency	2,474,627	0.01	0.09	846,845	0.01	0.07	1,627,782	0.01	0.09
Free trade agreement	2,474,627	0.14	0.35	846,845	0.15	0.36	1,627,782	0.13	0.34
GATT membership	2,474,627	0.84	0.36	846,845	0.95	0.23	1,627,782	0.79	0.41
GATT membership_partner	2,474,627	0.81	0.39	846,845	0.78	0.41	1,627,782	0.83	0.37

Notes: The summary statistics belong to the bilateral dataset with GNxG size. "SD" means standard deviation. "VA" and "GFCF" stand for value-added and gross fixed capital formation, respectively.

3.4 Input-Output (IO) Model/Framework and Estimation Methodology

3.4.1 IO Model/Framework

Following the hypothetical framework defined in the Inter-Country Input-Output (ICIO) tables and the models in Sundararajan and Thakur (1976), Oosterhaven (1988), we assume the world economy with G countries and N sectors. Given this economic structure where rows represent exporters and columns represent importers in IO tables, we can write forward linkages as follows:

Forward linkages: $$AX + Y = X \tag{3.1}$$

where A is the technical coefficient matrix calculated by dividing the GNxGN intermediate input matrix, Z, by the GNx1 output matrix, X. Y denotes the GNx1 matrix of final products. From producer point of view (supply side - Leontief model), output is sum of sales of domestic intermediates and finals and exports of intermediates and finals.

Backward linkages: $$A'X + V' = X \tag{3.2}$$

where A' is the transpose of the global technical coefficient matrix A. V' denotes the transpose of the 1xGN matrix of value-added of country-sector. From consumer point of view (demand side - Ghoshian model), output can be expressed as a summation of domestic and foreign intermediates and value-added of each country-sector. Writing the backward linkages in this form enables us to equate forward linkages to backward linkages because the size (GNx1) of the matrix X is equal in two equations (demand=supply – market clearing assumption of Computable General Equilibrium Model (CGE)) (West, 1995). Note that the backward linkages can be also expressed like that: $X'A + V = X'$. In that case, however, we would not conduct matrix calculation to observe the association between backward and forward linkages.

Since we can state both forward and backward linkages in terms of output vector, X, the basic accounting balance which is demand for intermediates and finals should be equal to supply of these products suggests the following equation.

$$V' = AX + Y - A'X \tag{3.3}$$

where the value-added of country-sector is summation of sales of intermediate and final goods and services minus consumption of intermediates. To differentiate the products based on their country of origin, we can write the equation (3.3) like that:

$$V' = AX^D + AX^F + Y^D + Y^F - A'X^D - A'X^F \tag{3.4}$$

Equation (3.4) relates the value-added of country-sector to domestic and foreign sales (both intermediates and finals) as well as domestic and foreign buying (only intermediates). Superscripts D and F stand for domestic and foreign transactions, respectively. In this paper, since we mainly interested in the effects of trade policies on sectoral growth, we ignore the domestic portion of this equation.

$$V' = AX^F + Y^F - A'X^F \tag{3.5}$$

We mainly focus on tariffs; therefore, we extend the equation by defining trade values in terms of quantities and prices (like in the CGE model) so that we can also introduce the tariff rates into the model. In the hypothetical world where there are no tariffs, equation (3.5) can be written as equation (3.6). When we introduce tariffs into the system, we end up with the equation (3.7). In the following equations, we assume that the global technical coefficient matrix, A, is constant over time and we treat tariff as an exogenous shock to sectors. All variables in these equations are indexed by country-sector and time, but they are suppressed for the sake of simplicity.

$$\text{ValueAdded} = Q^{IntEx} * P^{IntEx} + Q^{FinalEx} * P^{FinalEx} - Q^{IntIm} * P^{IntIm} \tag{3.6}$$

$$\text{ValueAdded} = Q^{IntEx} * (P^{IntEx} + \text{itariff\_faced}) +$$

$$Q^{FinalEx} * (P^{FinalEx} + \text{otariff\_faced}) - Q^{IntIm} * (P^{IntIm} + \text{itariff\_imposed}) \tag{3.7}$$

In this context, a higher product price due to the higher tariff rates causes to decrease in quantity of exported products. Assuming the price elasticity of product is higher than one, the decrease in quantities results in decreases in export values, thereby decreases in value-added of country-sector through contractions in demand side of the economy. The underlying mechanism of this result can be related to the learning by exporting argument. Deterioration of product prices in the international market may prevent sectors to reap the benefits of GVC and trade in general such as better

knowledge of the market, economies of scale from higher production, exposure of better supply chain management (Humphrey and Schmitz, 2002a; De Marchi et al., 2018). Similarly, an increase in the prices of intermediates through higher imposed tariff rates on these products leads to fall in the quantity of imported intermediates. There are two possibilities regarding the elasticity of imported products. If the price elasticity of imported intermediates is more than one, the value-added of country-sector can increase. This can be possible only if domestic intermediates can be efficient substitutes for these foreign intermediates. In this scenario, the quantity of imported intermediate falls more than the rise in related price so that domestic intermediates enter production process and creates more value-added. In the second case, given the low-price elasticity of intermediates and the necessity of these products in the production process (Obstfeld, 1980), we can claim that the fall in imported values means decreases in value-added of country-sector through supply side contractions. Again, the loss in value-added because of the disruption in backward stages in the global value chains can be explained by the learning by importing argument. Via backward linkages, country-sector benefits from R&D and technology spillover embedded in intermediates (Grossman and Helpman, 1991; Kummritz et al., 2017, Raei et al., 2019), but if there is a restriction in trade through tariffs, these benefits could not be realized.

3.4.2 Estimation Methodology

Given the arguments we explained above, in the first stage, we specify the following empirical model to investigate the association between value-added growth and tariff rates.

$$VAgrowth_{c,s,t} = \beta_0 + \beta_1 Tariff\_faced_{c,s,t} + \beta_2 Tariff\_imposed_{c,s,t} + \beta_3 S_{c,s,t} + \beta_4 C_{c,t} + \beta_5 T_t + \varepsilon_{c,s,t} \tag{3.8}$$

c, s, and t stand for country, sector, and year, respectively. $VAgrowth_{c,s,t}$ signifies the natural logarithm of value-added of country-sector. $Tariff\_faced_{c,s,t}$ stands for faced tariff and $Tariff\_imposed_{c,s,t}$ stands for imposed tariff. These tariffs are calculated by utilizing both gross and value-added trade statistics. The tariff rates are also

differentiated by the product classification of exported products of country-sector as intermediates and finals. $S_{c,s,t}$ represents the capital levels of origin/exporter country. $C_{c,t}$ represents the vector of country level characteristics of origin/exporter country such as population, population density, regularity quality, and human capital index. T_t stands for year dummies.

In the second stage, following the basic framework of Frankel and Romer (1999) and Johansson et al. (2014), we specify the trade equation to estimate the determinants of forward linkages. The bilateral trade equation is estimated as follows:

$$\text{Export}_{p,t} = \beta_0 + \beta_1 \text{Tariff\_faced}_{p,t} + \beta_2 S_{c,s,t} + + \beta_3 C_{c,t}^o + \beta_4 C_{c,t}^d + \beta_5 T_t + \varepsilon_{p,t} \qquad (3.9)$$

p, c, s, and t stand for country-sector-partner country trio, country, sector, and year, respectively. $\text{Export}_{p,t}$ signifies the natural logarithm of exported products of country-sector including both intermediates and finals. $\text{Tariff\_faced}_{p,t}$ stands for faced tariff. Both export values and tariff rates are calculated by employing gross and value-added trade statistics as well as by differentiating according to product classification of exported products of country-sector as intermediates and finals. $S_{c,s,t}$ represents the capital intensity of origin/exporter country. $C_{c,t}^o$ and $C_{c,t}^d$ represent the country level characteristics of origin (home) and destination (partner) country, respectively such as GDP per capita, capital, being signatory of free trade agreement, being members of GATT. T_t is for year dummies.

We take tariffs as an exogenous shock (Estevadeordal and Taylor, 2013).[8] Therefore, these empirical models are estimated by employing the Fixed Effects (FE) estimation technique to get rid of unobservable time-invariants and omitted variable bias.[9]

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[8] We also employ the lagged value of tariff rates because they are predetermined and assumed to be uncorrelated with the current changes in industries' performance. The results are parallel to what we have found from the benchmark model.

[9] We also run our model with the Ordinary Least Squares Estimates (OLS) with country-sector pair and time fixed effects in the growth model and country-sector-partner country and time fixed effects in the gravity model. We get the similar results. To address the possible simultaneity bias between the left- and right-hand side variables, we also employ the first lag of right-hand side variables in the specifications. We obtain the similar results.

3.5 Results

This part presents and interprets the estimation results of both growth and bilateral trade equations in two sub-sections. In our estimations, we also utilize the large coverage of EORA26 dataset by employing sectoral differences and the heterogeneity in country groups based on their incomes.

3.5.1 Results of Value-Added Growth Model

This sub-part represents the results of sectoral value-added growth analysis in Table 3.3. In the columns 1 to 3 (the left panel), faced and imposed tariffs are utilized in their gross terms and in columns 4 to 6 (the right panel), tariffs are employed in their value-added terms. Regarding the difference between columns 2 and 3 in the left panel (gross) and columns 5 and 6 in the right panel (value-added), we conduct our exercises by changing the definition of the tariff imposed on intermediates. For the imposed input tariff rates in columns 2 and 4, we take the weighted average of tariff rates of the specific sector we look at the value-added growth to measure the effects of protection. The imposed input tariff rates in columns 3 and 6, we take all the other sectors to understand the overall effect (tariffs as an input cost and again as a protection).

The results suggest that the effects of tariff rates calculated by utilizing gross and value-added trade statistics seem to be somewhat different. For instance, when we investigate the tariffs by dividing them into input and output components, in the analysis we utilize gross variables (columns 2 and 3), we notice that imposed input tariff negatively and significantly affects value-added growth of sectors only in column 2. In the analysis we employ tariff rates calculated via value-added trade statistics (columns 5 and 6), we observe that both types of imposed input tariffs have negative influence on sectoral growth. One interesting result presented in the right panel we employ value-added trade statistics in the calculation of tariff rates is that even if levying tariffs on imported intermediates negatively effects on sectoral value-added, imposing tariffs on final products (which sector operates) significantly increases sectoral value-added. This observed significant relationship between imposed output tariff and the value-added growth of sectors in columns 5 and 6 suggest that protection

provided for a sector can be seen as a driver for sectoral growth. In addition, all the estimates report insignificant impacts of faced tariffs on sectoral growth.

To reiterate, these gross statistics depend on aggregate exports including both domestic and foreign value-added, which ultimately distorts the result and questions reliability of results. Conversely, tariff rates calculated by utilizing value-added trade statistics only track domestics value-added of sector and provide more accurate measures. Since conventional trade statistics, gross values, fail to catch the true value of domestic value-added through in global value chains (Koopman et al., 2014) and mostly double counting issues have been raised, we rely now on and interpret the estimates of value-added statistics. Furthermore, the tariff rates provided by the WITS is de jure measures, which also distracts to analyze the actual effect of the tariff rates on sectoral growth. In fact, as many authors emphasize (Radelet, 1999; Brandt and Morrow, 2017; Ing et al., 2018), there is an exemption for processing trade in which these de-jure tariff rates are not actually applied on the traded intermediate goods. Therefore, the results of estimates utilizing the value-added trade statistics should be also carefully interpreted, too. Apart from the main variables of interest, we also observe a positive effect of capital, regulatory quality, and human capital on sectoral growth, which points out the importance of capacity upgrading. Increase in human capital expands knowledge and skills of workforce and regulatory quality ensures the environment where growth is possible. In some specification, we also observe significant negative effect of population and positive effects of population density.

Tables 3.5 and 3.6 repeats the same exercise (the column 5 in Table 3.3) for different country and sector groups so that we can recognize the trade dynamics in more detailed way. Our most crucial finding is that protection of production of final products is successfully implemented in manufacturing industry of developing countries. This kind of protection helps emerging economies gain the necessary industrial experience to engage in competitive exports of manufacturing goods (DeJong and Ripoll, 2006; Schmitz, 2007). We observe the same positive effect of protection on value-added of manufacturing, agriculture, and mining sectors for developed countries when they trade with developed economies. Besides, regarding developed economies, while a rise in faced input tariff rates decreases industry value-added growth regardless of the income level of trading partner, imposed output tariff

of developed countries on agriculture and mining products of developing countries negatively affects sectoral value-added.

Table 3.3: Value-added growth and tariffs

	Gross trade statistics			Value-added trade statistics		
	(1)	(2)	(3)	(4)	(5)	(6)
ioTariff_faced	0.114			-0.073		
	(0.125)			(0.098)		
ioTariff_imposed	-0.111			-0.097		
	(0.087)			(0.082)		
iTariff_faced		0.173	0.162		0.016	-0.046
		(0.188)	(0.171)		(0.085)	(0.090)
iTariff_imposed		-0.195**	-0.148		-0.137***	-0.256***
		(0.093)	(0.108)		(0.048)	(0.050)
oTariff_faced		-0.065	-0.075		0.026	-0.019
		(0.068)	(0.067)		(0.063)	(0.063)
oTariff_imposed		0.216	0.203		0.316**	0.328**
		(0.145)	(0.129)		(0.156)	(0.145)
GFCF	0.394***	0.359***	0.359***	0.401***	0.366***	0.371***
	(0.044)	(0.036)	(0.036)	(0.045)	(0.035)	(0.034)
Population	-0.233	-1.065***	-1.436***	0.047	-1.059***	-1.283***
	(0.462)	(0.310)	(0.230)	(0.511)	(0.303)	(0.227)
Population density	0.425	1.272***	1.615***	0.132	1.257***	1.439***
	(0.447)	(0.300)	(0.219)	(0.496)	(0.294)	(0.223)
Regulatory quality	0.150***	0.159***	0.165***	0.147***	0.150***	0.148***
	(0.021)	(0.021)	(0.022)	(0.022)	(0.021)	(0.020)
Human capital index	0.320***	0.354***	0.388***	0.327***	0.331***	0.327***
	(0.095)	(0.090)	(0.093)	(0.101)	(0.086)	(0.076)
Constant	14.734***	24.996***	29.484***	11.303*	24.915***	27.750***
	(5.559)	(3.759)	(2.760)	(6.171)	(3.693)	(2.752)
# of Obs.	22,786	23,370	23,257	22,847	23,360	23,423
R-squared	0.699	0.701	0.708	0.686	0.705	0.715
# of country-sector	1,511	1,637	1,629	1,511	1,636	1,637

Notes: The dependent variable is natural logarithm of value-added of country-sector. Clustered robust standard errors in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Table 3.4: Value-added growth and tariffs by income groups

Total	Developed-Developed (1)	Developed-Developing (2)	Developing-Developing (3)	Developing-Developed (4)
iTariff_faced	-0.992***	-0.475***	0.047	-1.077***
	(0.373)	(0.163)	(0.058)	(0.390)
iTariff_imposed	0.083	-0.002	0.134***	-0.107
	(0.248)	(0.104)	(0.047)	(0.114)
oTariff_faced	-0.046	0.053	-0.036*	-0.046*
	(0.053)	(0.045)	(0.020)	(0.027)
oTariff_imposed	0.354***	-0.345	0.112*	0.175***
	(0.101)	(0.269)	(0.059)	(0.065)
GFCF	0.173***	0.166***	0.369***	0.378***
	(0.036)	(0.035)	(0.040)	(0.043)
Population	2.456***	2.252***	-0.021	-0.142
	(0.462)	(0.429)	(0.519)	(0.504)
Population density	-1.613***	-1.411***	-0.036	0.119
	(0.462)	(0.433)	(0.496)	(0.482)
Regulatory quality	0.096***	0.098***	0.180***	0.174***
	(0.028)	(0.029)	(0.026)	(0.025)
Human capital index	-0.194**	-0.198**	0.458***	0.479***
	(0.093)	(0.092)	(0.134)	(0.136)
Constant	-13.140**	-10.579**	12.920**	14.168**
	(5.333)	(4.943)	(6.389)	(6.190)
# of Obs.	5,481	5,511	21,242	20,566
R-squared	0.845	0.846	0.639	0.647
# of country-sector	334	336	1,338	1,310

Notes: The fifth model of Table 3.3 is utilized in this table. We use the same control variables in all panels, but they are not reported here. Clustered robust standard errors in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Table 3.5: Value-added growth and tariffs by income groups, manufacturing sectors

	Developed-Developed (1)	Developed-Developing (2)	Developing-Developing (3)	Developing-Developed (4)
iTariff_faced	-0.807**	-0.441**	0.032	-1.247***
	(0.378)	(0.176)	(0.062)	(0.418)
iTariff_imposed	0.046	0.162	0.147***	0.031
	(0.186)	(0.145)	(0.057)	(0.120)
oTariff_faced	-0.000	0.066***	-0.050**	-0.061**
	(0.051)	(0.025)	(0.020)	(0.028)
oTariff_imposed	0.385***	-0.104	0.227***	0.326***
	(0.120)	(0.132)	(0.078)	(0.088)
GFCF	0.177***	0.173***	0.345***	0.353***
	(0.044)	(0.043)	(0.042)	(0.046)
Population	2.493***	2.250***	0.076	-0.052
	(0.534)	(0.489)	(0.568)	(0.555)
Population density	-1.606***	-1.354***	-0.255	-0.102
	(0.531)	(0.487)	-0.542	(0.529)
Regulatory quality	0.113***	0.112***	0.191***	0.181***
	(0.031)	(0.032)	(0.029)	(0.028)
Human capital index	-0.149*	-0.152*	0.540***	0.559***
	(0.089)	(0.089)	(0.151)	(0.153)
Constant	-13.905**	-11.012*	12.217*	13.601**
	(6.179)	(5.650)	(6.971)	(6.782)
# of Obs.	4,138	4,174	16,403	15,893
R-squared	0.874	0.875	0.628	0.639
# of country-sector	250	252	1,012	989

Notes: The fifth model of Table 3.3 is utilized in this table. We use the same control variables in all panels, but they are not reported here. Clustered robust standard errors in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Table 3.6: Value-added growth and tariffs by income groups, agriculture and mining sectors

	Developed-Developed (1)	Developed-Developing (2)	Developing-Developing (3)	Developing-Developed (4)
iTariff_faced	-1.227	-0.104	-0.174	0.036
	(1.141)	(0.283)	(0.129)	(0.282)
iTariff_imposed	0.036	-0.030	0.008	-0.524*
	(0.330)	(0.121)	(0.068)	(0.308)
oTariff_faced	-0.379	0.456	-0.117	-0.207**
	(0.542)	(0.683)	(0.126)	(0.099)
oTariff_imposed	0.217*	-0.934**	-0.084	-0.023
	(0.120)	(0.392)	(0.078)	(0.082)
GFCF	0.176***	0.163***	0.497***	0.500***
	(0.058)	(0.054)	(0.068)	(0.073)
Population	2.215***	2.205**	-0.425	-0.441
	(0.835)	(0.863)	(1.167)	(1.147)
Population density	-1.597**	-1.595*	0.796	0.868
	(0.788)	(0.839)	(1.115)	(1.103)
Regulatory quality	0.043	0.059	0.129***	0.138***
	(0.061)	(0.060)	(0.047)	(0.050)
Human capital index	-0.338	-0.343	0.167	0.236
	(0.259)	(0.255)	(0.286)	(0.286)
Constant	-9.176	-8.742	15.722	15.644
	(9.513)	(9.855)	(14.502)	(14.328)
# of Obs.	1,343	1,337	4,839	4,673
R-squared	0.760	0.768	0.695	0.697
# of country-sector	84	84	326	321

Notes: The fifth model of Table 3.3 is utilized in this table. We use the same control variables in all panels, but they are not reported here. Clustered robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Regarding developing economies, while a rise in faced input and output tariff rates decreases industry value-added growth of developing countries if they trade with developed economies, an increase in the faced output tariff declines manufacturing value-added growth of developing countries trading with developing countries. One noteworthy thing is the positive effect of imposed input tariff on manufacturing value-added of developing countries if they trade with developing countries. We can infer that protection of intermediate manufacturing products is important as protection of final manufacturing products. This can be explained by the infant industry argument and the second-best approach (Nenci, 2011). If there are already failures in the market and a lack of capacity to benefit from economies of scale, selective protection of industries can raise the value-added growth.

At this point, it is important to investigate the product types, that is technology embeddedness of sectors. To achieve this, Tables 3.7 and 3.8 repeat the same exercise (the column 5 in Table 3.3) for different country as well as sector groups according to R&D intensity levels. Results suggest that imposed input tariffs have positive effect on growth of only low-tech sectors traded with developing countries. Similarly, even if the significance of protection on final products of manufacturing, agriculture, and mining sectors of developed countries traded with developing countries persists for both high-tech and low-tech sectors, the protection brings benefits for only low-tech sectors for developing countries. In other words, the main result presented in Table 3.3 is mainly driven from low-tech manufacturing sectors in developing countries. Hence, we can claim that development of manufacturing sectors in developing countries depend on increasing their comparative advantage of low-tech products because their capacity is well-developed to make an improvement in these sectors. On the other hand, improvement in high-tech sectors may take longer period and strong and planned initiatives are required to boost capacity of high-tech sectors at first.

Table 3.7: Value-added growth and tariffs by income groups, high-tech sectors

	Developed-Developed (1)	Developed-Developing (2)	Developing-Developing (3)	Developing-Developed (4)
iTariff_faced	-0.603*	-0.315	0.027	-0.757*
	(0.363)	(0.233)	(0.102)	(0.403)
iTariff_imposed	-0.187	0.291	0.038	-0.414*
	(0.168)	(0.187)	(0.073)	(0.218)
oTariff_faced	0.047	0.043	-0.081**	-0.081
	(0.036)	(0.029)	(0.034)	(0.057)
oTariff_imposed	0.618*	-0.040	-0.096	0.029
	(0.354)	(0.158)	(0.114)	(0.206)
GFCF	0.696***	0.691***	0.419***	0.412***
	(0.070)	(0.067)	(0.088)	(0.089)
Population	1.233***	1.009**	0.195	0.137
	(0.436)	(0.427)	(0.836)	(0.844)
Population density	-1.019***	-0.791**	-0.338	-0.290
	(0.382)	(0.374)	(0.797)	(0.808)
Regulatory quality	-0.006	-0.005	0.149***	0.152***
	(0.024)	(0.024)	(0.040)	(0.041)
Human capital index	-0.125	-0.110	0.560***	0.602***
	(0.112)	(0.105)	(0.213)	(0.221)
Constant	-7.592*	-4.911	8.523	9.319
	(4.482)	(4.415)	(10.274)	(10.340)
# of Obs.	1,876	1,876	7,559	7,478
R-squared	0.944	0.944	0.685	0.684
# of country-sector	112	112	452	452

Notes: The fifth model of Table 3.3 is utilized in this table. We use the same control variables in all panels, but they are not reported here. Clustered robust standard errors in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Table 3.8: Value-added growth and tariffs by income groups, low-tech sectors

	Developed-Developed (1)	Developed-Developing (2)	Developing-Developing (3)	Developing-Developed (4)
iTariff_faced	-0.949**	-0.308*	0.074	-1.309***
	(0.455)	(0.184)	(0.069)	(0.488)
iTariff_imposed	0.019	-0.092	0.165***	-0.050
	(0.258)	(0.105)	(0.058)	(0.137)
oTariff_faced	-0.087	0.040	-0.013	-0.029
	(0.069)	(0.063)	(0.025)	(0.030)
oTariff_imposed	0.266**	-0.467	0.135**	0.162**
	(0.104)	(0.312)	(0.067)	(0.066)
GFCF	0.122***	0.118***	0.347***	0.370***
	(0.031)	(0.030)	(0.036)	(0.038)
Population	2.479***	2.352***	-0.144	-0.304
	(0.593)	(0.572)	(0.654)	(0.621)
Population density	-1.626***	-1.511***	0.140	0.347
	(0.599)	(0.581)	(0.628)	(0.595)
Regulatory quality	0.094***	0.097***	0.193***	0.183***
	(0.035)	(0.036)	(0.034)	(0.032)
Human capital index	-0.214*	-0.216*	0.392**	0.404**
	(0.125)	(0.124)	(0.171)	(0.170)
Constant	-12.515*	-10.858	15.212*	16.794**
	(6.914)	(6.658)	(8.109)	(7.695)
# of Obs.	3,605	3,635	13,683	13,088
R-squared	0.817	0.819	0.619	0.629
# of country-sector	222	224	886	858

Notes: The fifth model of Table 3.3 is utilized in this table. We use the same control variables in all panels, but they are not reported here. Clustered robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

3.5.2 Results of Gravity Model

This sub-section represents the results of bilateral gravity estimation for total (columns 1-2), intermediate (columns 3-4), and final exports (column 5) in Table 3.9. The first column represents the effects of tariff rates on the gross export which are also calculated by utilizing the gross trade values. There is a significantly negative effect of faced tariff on export of country-sector. The same effect of faced tariff is observed in the second column where we employ value-added trade statistics in calculation of both export values and tariff rates. At this point, it is crucial to note that the country-sector bilateral value-added decomposition methodology of Wang et al. (2017a, b) enables us track value-added embedded in global value chains, that is trade of intermediates, not traditional trade. Therefore, the only difference between gross and value-added export comes from the intermediates.

The third and fourth columns indicate the results of intermediates for gross and value-added trade values, respectively. In both specifications, we observe the negative impacts of faced tariffs. This result signifies the threat of disruptions in global supply chains especially for downstream sectors because of their dependency on globally circulated intermediates. The final column of Table 3.9 presents the result for final good export. Similar to negative impact of faced tariff on export of intermediates, faced tariffs on final products have negative impact on export of final products.

Even if the significance levels are the same in gross and value-added statistics, the sizes of coefficients vary significantly. Therefore, we can rely more on the statistics where value-added is considered rather than the conventional trade statistics because these newly defined and calculated values get rid of the issue of double counting and correctly detect the exact value-added in forward linkages in the complex world economy.

Other covariates also carry crucial information for boosting export performance of country-sector. Capital of exporter and importer countries, gross domestic products per capita, having free trade agreements, and being a GATT member improve all types of export performance. Having common currency does not affect export performance of sectors. Considering these results, we can assert that regional and multiregional agreements on trade liberalization build common approach and can deliver improved trade opportunities.

Table 3.9: Bilateral export and trade policies

	ioTariff - Gross Export (1)	ioTariff - VA Export (2)	iTariff - Gross Int. (3)	iTariff - VA Int. (4)	oTariff - Final (5)
Tariff_faced	-0.740***	-0.455***	-0.553***	-0.202***	-0.386***
	(0.016)	(0.011)	(0.013)	(0.006)	(0.009)
GDP_pop	0.228***	0.322***	0.226***	0.350***	0.241***
	(0.011)	(0.010)	(0.009)	(0.009)	(0.012)
GDP_pop_partner	0.573***	0.525***	0.555***	0.375***	0.647***
	(0.009)	(0.008)	(0.007)	(0.007)	(0.010)
GFCF	0.403***	0.365***	0.340***	0.326***	0.421***
	(0.009)	(0.007)	(0.007)	(0.008)	(0.010)
GFCF_partner	0.123***	0.209***	0.089***	0.348***	0.139***
	(0.005)	(0.005)	(0.004)	(0.004)	(0.006)
Common currency	0.088	0.123**	0.017	-0.004	0.080
	(0.060)	(0.059)	(0.048)	(0.040)	(0.074)
Free trade agreement	0.049***	0.038***	0.060***	0.027***	0.051***
	(0.004)	(0.004)	(0.004)	(0.003)	(0.005)
GATT membership	0.074***	0.013*	0.041***	0.020***	0.114***
	(0.007)	(0.007)	(0.005)	(0.005)	(0.008)
GATT membership_partner	0.015***	0.018***	0.028***	0.013***	0.030***
	(0.005)	(0.005)	(0.004)	(0.004)	(0.006)
Constant	-3.491***	-5.089***	-2.468***	-7.626***	-6.450***
	(0.170)	(0.139)	(0.127)	(0.116)	(0.183)
# of Obs.	1,365,937	1,418,334	2,030,652	2,138,692	1,418,499
R-squared	0.674	0.722	0.645	0.696	0.634
# of country-sector-partner	117,881	119,024	173,361	174,599	118,582

Notes: Clustered robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. We also run the columns 3 and 4 for the observations with both input and output tariffs (see the Appendix C).

In Table 3.10, the second specification in Table 3.9 is repeated for different trading partners depending on their income levels. The results suggest that an increase in faced tariffs is attributed to lower levels of export of all countries regardless of their income level. Considering the coefficients of faced tariff rates, we can claim that trade between different income levels (developed-developing and developing-developed trading pairs) is much more deteriorated by an increase in tariff rate. Regarding control variables, we notice that GDP per capita of trading partners, gross fixed capital formation, and GATT membership of both home and partner countries are significant factors stimulating export of home countries in all specifications.

Tables 3.11 and 3.12 repeat the same exercise presented in Table 3.10 for different trading partners depending on their income levels as well as sectors of traded products for manufacturing and agriculture and mining sectors, respectively. For both manufacturing and agriculture & mining samples, an increase in faced tariffs is attributed to lower levels of export of all countries regardless of their income level.

For manufacturing sectors, a rise in tariff rate has a substantially greater impact on transaction between countries from dissimilar income categories such as developed-developing and developing-developed trading pairs (Table 3.11). The findings of the main interest variable as well as control variables are very similar to what we have found in all sample in Table 3.10.

For agriculture and mining sectors, tariff imposed by developed manufacturing trade between countries with countries (columns 1 and 4) has the highest impact on export of both developed and developing countries (Table 3.12). Generally, the trade of agriculture and mining products are more susceptible to a change in trade policy compared to manufacturing products.

Table 3.10: Bilateral export and trade policies by income groups

	Developed-Developed (1)	Developed-Developing (2)	Developing-Developing (3)	Developing-Developed (4)
Tariff_faced	-0.250***	-0.520***	-0.387***	-0.466***
	(0.044)	(0.017)	(0.014)	(0.040)
GDP_pop	0.070***	0.026	0.432***	0.438***
	(0.023)	(0.021)	(0.016)	(0.016)
GDP_pop_partner	0.133***	0.478***	0.485***	0.108***
	(0.020)	(0.012)	(0.012)	(0.023)
GFCF	0.346***	0.335***	0.376***	0.338***
	(0.009)	(0.007)	(0.014)	(0.013)
GFCF_partner	0.485***	0.203***	0.151***	0.484***
	(0.008)	(0.008)	(0.005)	(0.008)
Common currency	0.320***	0.096	0.209	0.500***
	(0.086)	(0.111)	(0.120)	(0.158)
Free trade agreement	0.007	0.047***	0.033***	0.042***
	(0.011)	(0.006)	(0.006)	(0.006)
GATT membership	0.250***	0.241***	0.055***	0.056***
	(0.031)	(0.032)	(0.009)	(0.010)
GATT membership_partner	0.504***	0.016***	0.052***	0.623***
	(0.019)	(0.006)	(0.007)	(0.046)
Constant	-2.875***	-0.406	-4.515***	-7.933***
	(0.384)	(0.269)	(0.218)	(0.338)
# of Obs.	123,699	422,909	561,123	310,603
R-squared	0.768	0.734	0.751	0.712
# of country-sector-partner	7,450	28,331	58,733	24,510

Notes: The second model of Table 3.9 is utilized in this table. Year dummies are included in the model, but they are not reported. Clustered robust standard errors in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Table 3.11: Bilateral export and trade policies by income groups, manufacturing sectors

	Developed-Developed	Developed-Developing	Developing-Developing	Developing-Developed
	(1)	(2)	(3)	(4)
Tariff_faced	-0.178***	-0.532***	-0.372***	-0.401***
	(0.045)	(0.017)	(0.015)	(0.041)
GDP_pop	0.049**	0.012	0.448***	0.477***
	(0.022)	(0.021)	(0.017)	(0.017)
GDP_pop_partner	0.155***	0.472***	0.471***	0.093***
	(0.021)	(0.013)	(0.013)	(0.024)
GFCF	0.369***	0.350***	0.372***	0.296***
	(0.010)	(0.007)	(0.015)	(0.012)
GFCF_partner	0.493***	0.202***	0.149***	0.493***
	(0.008)	(0.008)	(0.006)	(0.009)
Common currency	0.309***	0.100	0.116	0.344***
	(0.088)	(0.111)	(0.120)	(0.061)
Free trade agreement	0.004	0.048***	0.038***	0.050***
	(0.011)	(0.006)	(0.006)	(0.007)
GATT membership	0.260***	0.266***	0.041***	0.035***
	(0.034)	(0.033)	(0.009)	(0.011)
GATT membership_partner	0.509***	0.015**	0.045***	0.630***
	(0.021)	(0.006)	(0.007)	(0.045)
Constant	-4.010***	-0.810***	-4.550***	-7.865***
	(0.394)	(0.280)	(0.233)	(0.361)
# of Obs.	103,405	384,711	497,964	260,408
R-squared	0.781	0.736	0.751	0.715
# of country-sector-partner	6,005	24,771	51,817	20,497

Notes: The second model of Table 3.9 is utilized in this table. Year dummies are included in the model, but they are not reported. Clustered robust standard errors in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Table 3.12: Bilateral export and trade policies by income groups, agriculture and mining sectors

	Developed-Developed (1)	Developed-Developing (2)	Developing-Developing (3)	Developing-Developed (4)
Tariff_faced	-0.709***	-0.297***	-0.560***	-0.958***
	(0.186)	(0.063)	(0.052)	(0.166)
GDP_pop	0.154*	0.247***	0.303***	0.275***
	(0.088)	(0.085)	(0.041)	(0.037)
GDP_pop_partner	0.047	0.563***	0.595***	0.152**
	(0.054)	(0.045)	(0.035)	(0.066)
GFCF	0.251***	0.213***	0.411***	0.553***
	(0.017)	(0.018)	(0.041)	(0.039)
GFCF_partner	0.419***	0.217***	0.165***	0.438***
	(0.026)	(0.031)	(0.016)	(0.021)
Common currency	0.398***	0.119	0.126	0.655***
	(0.009)	(0.121)	(0.103)	(0.021)
Free trade agreement	0.071***	0.045**	0.011	0.013
	(0.026)	(0.019)	(0.017)	(0.015)
GATT membership	0.118**	0.144	0.171***	0.193***
	(0.055)	(0.108)	(0.029)	(0.029)
GATT membership_partner	0.471***	0.033	0.091***	0.751***
	(0.048)	(0.021)	(0.018)	(0.163)
Constant	2.449**	3.627***	-4.377***	-7.883***
	(1.197)	(0.948)	(0.610)	(0.853)
# of Obs.	20,294	38,198	63,159	50,195
R-squared	0.704	0.713	0.754	0.734
# of country-sector-partner	1,445	3,560	6,916	4,013

Notes: The second model of Table 3.9 is utilized in this table. Year dummies are included in the model, but they are not reported. Clustered robust standard errors in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Tables 3.13 and 3.14 repeat the same exercise presented in Table 3.10 for different trading partners depending on their income levels and technology level of sectors. In both tables, we observe the strong negative impact of faced tariff rates on export of traded products. Considering the coefficients of faced tariff rates, we can claim that trade between countries with different income levels (developed-developing and developing-developed trade pairs) is more vulnerable to any change in tariff rates regardless of technology level of sectors. Regarding control variables, we notice that especially the export performance of low-tech sectors highly depends on these instruments. Given the strong evidence regarding the growth enhancing impact of protection of these sectors in value-added growth analysis (Table 3.8), we can certainly claim that sector and country level capacity building policies such as higher capital and being an active part of an international trade organization are important as much as tariff policies.

When we compare the impacts of tariff policy on export of sectors, we observe that trade of high-tech products is affected relatively more than low-tech products. Therefore, we can argue that policy makers should closely monitor global trade restrictiveness of all products but especially agriculture, mining, and high-tech products and take steps forward to prevent any possible fraction in global production chain.

Table 3.13: Bilateral export and trade policies by income groups, high-tech sectors

	Developed-Developed (1)	Developed-Developing (2)	Developing-Developing (3)	Developing-Developed (4)
Tariff_faced	-0.400***	-0.613***	-0.431***	-0.572***
	(0.080)	(0.029)	(0.024)	(0.076)
GDP_pop	0.094***	0.121***	0.408***	0.450***
	(0.026)	(0.031)	(0.031)	(0.032)
GDP_pop_partner	0.162***	0.495***	0.497***	0.090**
	(0.031)	(0.019)	(0.020)	(0.038)
GFCF	0.499***	0.482***	0.451***	0.340***
	(0.017)	(0.012)	(0.026)	(0.022)
GFCF_partner	0.507***	0.198***	0.143***	0.492***
	(0.012)	(0.012)	(0.008)	(0.014)
Common currency	0.438***	0.017	0.035	0.524***
	(0.159)	(0.162)	(0.178)	(0.015)
Free trade agreement	0.020	0.038***	0.034***	0.063***
	(0.017)	(0.009)	(0.010)	(0.011)
GATT membership	0.263***	0.217***	0.054***	0.065***
	(0.054)	(0.050)	(0.015)	(0.019)
GATT membership_partner	0.505***	0.019**	0.041***	0.599***
	(0.035)	(0.009)	(0.011)	(0.076)
Constant	-7.393***	-3.217***	-6.890***	-9.464***
	(0.590)	(0.431)	(0.400)	(0.606)
# of Obs.	50,868	189,993	223,080	113,540
R-squared	0.799	0.731	0.759	0.733
# of country-sector-partner	2,982	12,176	23,752	9,547

Notes: The second model of Table 3.9 is utilized in this table. Year dummies are included in the model, but they are not reported. Clustered robust standard errors in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Table 3.14: Bilateral export and trade policies by income groups, low-tech sectors

	Developed-Developed (1)	Developed-Developing (2)	Developing-Developing (3)	Developing-Developed (4)
Tariff_faced	-0.217***	-0.466***	-0.364***	-0.467***
	(0.052)	(0.021)	(0.017)	(0.045)
GDP_pop	0.049	0.022	0.416***	0.424***
	(0.034)	(0.028)	(0.017)	(0.018)
GDP_pop_partner	0.116***	0.468***	0.483***	0.111***
	(0.025)	(0.016)	(0.015)	(0.029)
GFCF	0.285***	0.268***	0.335***	0.334***
	(0.010)	(0.008)	(0.015)	(0.016)
GFCF_partner	0.468***	0.206***	0.157***	0.475***
	(0.011)	(0.010)	(0.007)	(0.010)
Common currency	0.234***	0.220**	0.240**	0.483**
	(0.079)	(0.089)	(0.080)	(0.227)
Free trade agreement	0.024*	0.054***	0.032***	0.025***
	(0.013)	(0.008)	(0.007)	(0.007)
GATT membership	0.200***	0.217***	0.059***	0.052***
	(0.029)	(0.039)	(0.010)	(0.012)
GATT membership_partner	0.495***	0.015*	0.059***	0.652***
	(0.020)	(0.008)	(0.008)	(0.052)
Constant	-0.976*	0.751**	-3.086***	-6.760***
	(0.505)	(0.353)	(0.247)	(0.398)
# of Obs.	72,831	232,916	338,043	197,063
R-squared	0.754	0.741	0.749	0.704
# of country-sector-partner	4,468	16,155	34,981	14,963

Notes: The second model of Table 3.9 is utilized in this table. Year dummies are included in the model, but they are not reported. Clustered robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

3.6 Conclusion

This chapter analyzes the effects of faced and imposed tariff rates on value-added growth and export performance of industries from 153 countries over the period 1990-2015 by utilizing the gross and value-added trade statistics. Our findings show that the results depend on gross and value-added trade statistics considerably vary because of the lack of ability of gross statistics to detect the true domestic value-added of sectors and double counting issue. For this reason, we rely on value-added trade statistics and interpret the coefficients of these variables. The results of sectoral growth equation suggest that an increase in imposed tariffs on finals result in a rise in value-added growth of sectors which also operate in the same industry. The result is mainly attributed to low-tech manufacturing industries in developing countries. The estimates of bilateral gravity model indicate that tariff faced significantly decreases total, intermediate, and final exports. Given the positive effect of protection of manufacturing products on sectoral value-added, one can claim that import substitution policies preserve their shine even in the highly inter-connected world economics after 1990s. Therefore, we can claim that inward-oriented development strategy in the form of import substitution and infant-industry protection can improve especially manufacturing industries in emerging economies through exploitation of local competition and positive externalities of learning by doing before they enter into tough competition in international markets. The positive effect of protection of manufacturing products reminds the importance and necessity of strategic industry policies for developing countries. Last but not least, a rise in capital, regulatory quality, and human capital boosts the sectoral growth indicating the importance of capacity building of sectors and the institutional environment of countries.

All in all, there is no clear-cut and unidirectional relationship between trade liberalization and growth especially given the strong heterogeneities in terms of sectors and income levels of countries. This situation obliges governments to take careful and dynamic decisions regarding the sector which need to be supported and to sustain imported intermediates in general through policies and negotiations on regional and multilateral liberalization in global production networks. Most importantly, improvements in regulatory quality appear as initial conditions for benefitting from trade and specializing high learning/value-added production and thereby trade activities.

4 DO LOWER TARIFF RATES PROMOTE GLOBAL VALUE CHAIN PARTICIPATION?

4.1 Introduction

Since 1980s, production process of countries is enormously fragmented across borders/locations in a way that countries are able to specialize a specific part of production chain according to their comparative advantages. Nowadays, increasing share of world trade is mostly attributable to trade of intermediates used in production in the importer country (World Development Report, 2020). For this reason, trade policies in the form of tariff and non-tariff barriers draw more attention even if successive autonomous and multinational liberalization efforts are especially realized over the decades.

In this highly interconnected world economies, tariffs on intermediates which can cross borders more than once also generate indirect costs to both producers and customers apart from their simple direct effect. This idea of amplification of tariff rates, that is the cumulative effect of tariff, is first systemically analyzed by using input-output (IO) tables by Rouzet and Miroudot (2013). They mainly suggest that reduction in tariff rates with also many things such as improvements in transportation and communication technologies is more likely to increase fragmentation in the global value chains (GVCs). However, this inevitably raises the cumulative effect of tariff, that is indirect portion coming from crossing more borders. Given this argument, they also expect higher impact in vertical specialization pattern of trade, that is transaction of inputs to be used in country's exported products. At this point, it is crucial to note that even if the study of Rouzet and Miroudot (2013) and many other studies employ effectively applied tariff rates provided by the World Integrated Trade Solution (WITS), one caveat is that governments may render the tariffs unbinding for many products for the purpose of encouraging export performance of sectors depending on these intermediates, which is called as the inward processing trade regime (Wang and Yu, 2012; Yu, 2015). In other words, the inward processing regime can be defined as an export incentive system providing effective customs exemption for raw materials or inputs used by exporting sectors to produce exported products. Therefore, first, it is important to measure the cumulative tariff rates until recent years with a large number of countries as much as possible and understand the extend of which indirect tariff

rates can affect sectoral global value chain participation levels. Secondly, it is noteworthy to investigate global GVC participation by dividing it into two main parts as simple and complex. Since a simple part measures trade activities with only one cross bordering and a complex part considers multiple cross bordering trade, analyzing these two measures enables us to understand the extend of inward processing regime and the effect of cumulative tariff rates in general.

For these purposes, we first calculate input tariff rates as well as GVC participations (simple and complex) in terms of value-added terms by employing decomposition methodology of Wang et al. (2017a, b) because calculating tariffs gross terms also leads to some indirect effects arising from double counting issues in gross trade statistics. We then calculate cumulative tariff rates by employing the calculation strategy of Rouzet and Miroudot (2013). Lastly, we provide more complete picture of the effects of tariff policy by calculating tariff rates by using value-added trade statistics and tracking cumulative tariff rates along with the value chain via employing sectoral and technological heterogeneities in EORA26 sample from the year 1990 to the year 2015 (Lenzen et al., 2012, 2013).

The main novelty of this chapter is the calculation of input tariff rates utilizing value-added trade statistics from product level tariff rates as well as benefitting the concept of cumulative tariff rates along a value chain. Furthermore, apart from the calculation of these variables, this chapter also provides empirical evidence regarding the effects of these variety of tariff policy measures on the global value chain participation indices.

Our graphical analysis suggests that while simple tariff is approximately 6% in the world, the cumulative tariff is 7%, which means there is almost 12% indirect tariffs accumulated along with global value chains. The empirical analysis finds out that both simple and cumulative tariffs have negative effect on total, forward, and backward GVC participations. Given the cascading impacts of these trade barriers, the importance and necessity of autonomous, regional, and global liberalization efforts is clearly evident. As important as the trade liberalization, capacity building of country/sector is quite important to reap the benefits of GVCs. Specifically, given the significant U-shaped pattern of position index, accruing new functions like adding more productive processes into a production activity can be seen good instrument to move along production chain, that is a functional upgrading. Increasing capital intensity, attracting more FDI, and incentivizing higher education level in general are

other factors significantly stimulating GVC participation. Even if the general results are robust, there are also some distinctions in the effects of tariff rates depending on country and sector level heterogeneities.

The chapter is organized as follows. The next section reviews the trade restriction literature with special focus on (cumulative) tariff rates and the determinants of global value chain participation. The third section describes data we employ in our analysis. The fourth section explains the empirical methodology. The fifth section presents estimation results, and the final section completes the chapter with some policy recommendations.

4.2 Literature Review

The concept of cumulative tariffs along with global value chain is not new but calculating cumulative tariff and analyzing the impact of it are quite new research avenues thanks to the newly released inter-country input-output tables by the World Input-Output Database (WIOD), the Organisation for Economic Co-operation and Development (OECD), and the EORA. In one of the earliest studies, Yi (2003, 2010) offers a theoretical model investigating a magnified effect of tariff reductions on trade using a multistage production function, that is multiple cross bordering. Ferrantino (2012) illustrates that total trade cost rises exponentially when the number of production stage increases. Baldwin and Venables (2013) characterize production chains as snake and spider types. In their theoretical framework, shipping and any other coordination costs are also included as trade costs through global production chains.

Apart from these conceptual foundations in theoretical models, there are some studies calculating the cumulative cost of trade (Koopman et al., 2010; Fally, 2012; Rouzet and Miroudot, 2013; Muradov, 2017). Koopman et al. (2010) consider gross trade statistics and multistage production as two reasons for the amplification of trade cost. Their findings regarding both transportation and tariff costs reveal that Asian countries have the highest magnification ratios because of their involvement in longer production chains. It is important to note that following their idea, we track sector's value-added in global value chain and calculate both tariffs and cumulative tariffs by using value-added trade statistics. Fally (2012) employ transportation costs and define cumulative tariff rates, but he does not give any detailed discussion of the concept.

Rouzet and Miroudot (2013) elaborate the concept in bilateral framework with providing the detailed calculation methodology. Their simulation results suggest that if tariffs on Chinese product decreases by 30%, cumulative imposed tariffs of the European Union (EU) and Japan on Chinese product reduce by 5%. Muradov (2017) proposes two measures as cumulative tariff rates and number of border crossings by employing data from 2001, 2005, and 2010. He finds out that while the average number of border crossings increases, faced cumulative tariff increases. Recently, some studies have employed the methodology addressed in these theoretical models and calculate the cumulative tariff burden. However, these studies (Mao and Görg, 2020; Wu et al., 2021) focus only on trade war between the US and China and present some descriptive results. Therefore, this chapter significantly contributes the scarce empirical literature related to cumulative tariffs.

Regarding the determinants of global value chain participation, the literature is quite rich and consists of many studies at firm (Lanz and Miroudot, 2011; Cieślik et al., 2019; Urata and Baek, 2020), sector, and country level. In sector and country level studies, tariff rates, capital intensity, foreign direct investment, and skilled labor are the most frequently utilized determinants or drivers of GVC participation. On the tariff rates, Kowalski et al. (2005) indicate that both faced and imposed tariffs have negative impact on participation. Similarly, Nordas (2006) emphasizes the importance of open trade policies in participation of electronics and textile sectors in global value chains. Regarding capital intensity, some studies (van der Marel, 2015) reveal that capital endowment has a positive effect on forward linkages whereas others (Landesmann et al., 2015) find no significant evidence. The studies employing foreign direct investment inflows in their analysis (Kowalski et al., 2015; Stehrer and Stöllinger, 2015; Buelens and Tirpák, 2017; Banerjee and Zeman, 2020) suggest that there is a significantly positive association between FDI inflow and GVC participation. FDI can develop capital and then boosts participation of domestic sectors into global production networks. In fact, FDI can be seen as a major instrument of multinational enterprises to involve in GVCs (Amador and Cabral, 2016). Related to skilled labor, some studies (Chen et al., 2015; Taglioni and Winkler, 2016; Farole et al., 2018; Ignatenko et al., 2019) find out positive relationship between skill labor and GVC participation. They explain this with the ability of skilled labors to conduct complex organizations and operations needed to participate in global value chain.

4.3 Data

We employ mainly four different databases. The first one is the EORA26 database (Lenzen et al., 2012, 2013). We use inter country input-output tables covering 186 countries and 26 sectors for the period of 1990-2015. Since tariff rate is mainly relevant with only nine manufacturing, mining, agriculture, and fishing sectors, we continue with these sectors. The manufacturing sectors are food and beverages; textiles and wearing apparel; wood and paper; petroleum, chemical and non-metallic mineral products; metal products; electrical and machinery; transport equipment; other manufacturing; and recycling. We calculate both forward and backward GVC participation (simple and complex) indices as well as both forward and backward lengths from this database by employing the value-added decomposition methodology of Wang et al. (2017a, b). Forward GVC participation consists of domestic value-added in exported products. If these exported products cross border only once and consumed in the partner country, they are classified as a simple GVC participation. If the exported products cross border more than once and consumed in another (third) country other than the trade partners, they are classified as a complex GVC participation. Backward GVC participation consists of foreign value-added in imported products. If these imported products cross border only once and consumed in the importer country, they are classified as a simple GVC participation. If the imported products cross border more than once and consumed in another (third) country other than the trade partners, they are classified as a complex GVC participation.

Production lengths of these trade volumes count how many times these intermediates are utilized in production process until they are consumed as final products. In other words, a length counts the number of production stages in a value chain both from user and producer sides. It also shows the fragmentation and complexity level of trade. Following Wang et al. (2017a, b), we take the ratio of forward length to backward length, called as the position index to reach more consistent estimate regarding a relative production length. We also use data on gross fixed capital formation and labor compensation of sectors provided by the IO tables of EORA26. We divide gross fixed capital formation by labor compensation to reach the capital intensity of sectors.

The second database is the World Integrated Trade Solution (WITS-TRAINS) database. We obtain bilateral effectively applied tariff rates at the product level (HS 6-digit codes) from this database. We can thus differentiate tariffs on intermediates from tariffs on final products by utilizing their broad economic category (BEC) codes. We then aggregate this product level data to reach sector level variables (via HS6-ISIC Rev. 3 concordance table provided by the OECD). We calculate both faced and imposed input tariff rates. Following the calculation steps indicated in Rouzet and Miroudot (2013), we also calculate cumulative tariff rates of each measure.

Let consider the global economy with G number of countries and N number of sectors. In this environment, Rouzet and Miroudot (2013) provide the calculation of cumulative tariff rates as follows:

$$CT_{JxJ} = T_{JxJ} + \left[e_{1xJ} \times B_{JxJ} \times A_{JxJ}^n \right]' \times e_{1xJ} \tag{4.1}$$

where

$$e_{1xJ} = [1\ 1\ 1\ 1\ 1 \ldots \ldots \ldots .1]_{1xJ}$$

$$B_{JxJ} = A_{JxJ} \times T_{JxJ} \text{ (element to element multiplication)}$$

J=GNxGN

A_{JxJ}= Leontief matrix

T_{JxJ}= Input tariff at the first stage

n= Number of cross bordering, that is production stage (distance or forward length measure) Since the average number of total production length is 7, we take n as 7.

The third database is the FDI database on flows and stock of the United Nations Conference on Trade and Development (UNCTAD) (Web 8, 2021). We take foreign direct investment (FDI) stock of countries as a share of their GDP's. As the last database, we utilize the Our World in Data which combines three published datasets: Lee-Lee (2016); Barro-Lee (2018) and the Human Development Report (Web 9, 2021) of the United Nations Development Program. We utilize average years of schooling of adult population of countries. After merging the variables coming from these four different databases, we end up with 12 sectors and 168 countries as an operational sample (see the Appendix D). Since EORA26 country and sectoral coverage are relatively wide, we aim to separate analysis for subgroups. To achieve this, we benefit from the historical income classification provided by the World Bank and R&D

intensity (technology) classification of the Organization for Economic Co-operation and Development (Galindo-Rueda and Verger, 2016). We categorize sectors mainly in two groups as high and low technology. High-tech sectors are metal products; electrical and machinery; transport equipment; other manufacturing. The low-tech sectors are food and beverages; textiles and wearing apparel; wood and paper; petroleum, chemical and non-metallic mineral products; and recycling.

Table 4.1 presents the descriptive statistics of variables we employ in the empirical analysis. We observe higher mean values of backward GVC participation compared to those for forward GVC participation for both country groups, which is mainly driven by the manufacturing sectors. In addition, both imposed and faced tariff rates are approximately 6% for the full sample. Note that in contrast to developed countries, developing countries have relatively higher imposed tariffs. Both faced and imposed cumulative tariffs are 1 percentage point higher than the simple tariffs, which makes approximately 12% indirect tariff. There is no noticeable difference in a position index for developed and developing economies, that is the relative forward length. We observe higher capital intensity and FDI stock share in developing countries, whereas the mean years of completed years of schooling for developed countries is much higher that of developing ones. It is important to reiterate that capital intensity is calculated by dividing gross fixed capital formation by labor compensation. We thus defend the lower level of capital intensity of developed countries by higher level of labor compensation in these countries.

Tables 4.2 and 4.3 represent the descriptive statistics for manufacturing and service sectors, respectively. For manufacturing industries, the share of complex parts reaches the share of simple GVC participation. This observation is driven by the characteristics of developed countries. In fact, the complex backward GVC participation is higher than the simple backward GVC participation in developed economies. While we observe 8% faced and 2% imposed tariffs in developed economies, the faced and imposed tariffs in developing countries are 6% and 8%, respectively. For agriculture and mining sectors, the backward GVC participation is much lower than the forward GVC participation. The 2% faced and 3% imposed tariffs are noticed in developed countries whereas developing countries also protect these sectors with 8% tariff rates on average like in the manufacturing industries. Considering other sector level variables, we notice that manufacturing industries are located in the middle part of the production chain whereas agriculture and mining

sectors are slightly located in relatively upper part of the supply chain. Again, there is no notable difference in position index between developed and developing countries.

Tables 4.4 and 4.5 represent the descriptive statistics for high-tech and low-tech sectors, respectively. For high-tech industries, we observe higher backward GVC participation compared to forward GVC participation. In fact, the difference between the shares of simple and complex part of backward participation is quite low for these sectors. While we observe 8% faced and 2% imposed tariffs in developed economies, the faced and imposed tariffs in developing countries are 6% and 8%, respectively. For low-tech sectors, the nearly similar pattern is observed. The 7% faced and 2% imposed tariffs are noticed in developed countries whereas 5% faced and 8% imposed tariffs are noticed in developing countries. Considering other sector level variables, we notice that high tech industries in developed countries are in initial stages of the production chain, whereas high-tech sectors in developing countries are slightly located in the middle the supply chain. For low-tech sectors, there is no remarkable difference in position index between developed and developing countries.

Figure 4.1 depicts the faced simple and cumulative tariff rates as well as shares of simple and complex parts in global value chain index through 1990-2015. The first notable thing is that these tariff rates are highly correlated to each other and follow the similar path. The cumulative tariff rate is 1 percentage point higher than the tariff rate. The second thing is decreasing share of simple part of global value chain participation and increasing complex part of global value chain except for the 2008 Global Financial Crisis. Since the complex part of GVC represents the trade volumes that cross border more than once, this points out the importance of the cumulative tariff along with supply chains and reveals the threat of amplified effect of input tariff clearly.

Table 4.1: Summary statistics, total sample

Variables	Total			Developed Countries			Developing Countries		
	Obs.	Mean	SD	Obs.	Mean	SD	Obs.	Mean	SD
GVC/VA (%)	2,177,626	0.88	8.00	745,589	0.58	4.28	1,432,037	1.04	9.36
Simple GVC/VA (%)	2,177,626	0.50	5.36	745,589	0.30	2.85	1,432,037	0.60	6.28
Complex GVC/VA (%)	2,177,626	0.38	4.97	745,589	0.27	2.03	1,432,037	0.44	5.95
Forward GVC/VA (%)	2,522,693	0.29	3.48	860,717	0.22	1.16	1,661,976	0.34	4.20
Forward simple GVC/VA (%)	2,522,693	0.19	3.00	860,717	0.13	0.92	1,661,976	0.22	3.64
Forward complex GVC/VA (%)	2,522,693	0.10	0.59	860,717	0.08	0.35	1,661,976	0.11	0.69
Backward GVC/VA (%)	2,177,626	0.57	6.98	745,589	0.35	3.96	1,432,037	0.68	8.12
Backward simple GVC/VA (%)	2,177,626	0.29	4.24	745,589	0.17	2.61	1,432,037	0.36	4.87
Backward complex GVC/VA (%)	2,177,626	0.27	4.86	745,589	0.19	1.94	1,432,037	0.32	5.83
iTariff_faced	2,397,108	0.06	0.12	819,690	0.07	0.12	1,577,418	0.06	0.12
iTariff_imposes	2,069,235	0.06	0.09	739,989	0.02	0.05	1,329,246	0.08	0.11
icuTariff_faced	2,397,108	0.07	0.12	819,753	0.08	0.12	1,577,355	0.06	0.12
icuTariff_imposes	2,069,235	0.07	0.10	740,047	0.02	0.05	1,329,188	0.09	0.11
Position	2,485,346	0.97	0.22	849,164	0.94	0.20	1,636,182	0.98	0.22
GFCF_LC	2,523,272	342.53	13662.16	860,736	11.68	290.37	1,662,536	513.83	16,827.38
FDI/GDP	2,435,016	0.78	12.19	840,454	0.62	1.55	1,594,562	0.86	15.02
Schooling	2,384,684	8.51	2.95	808,423	10.80	1.73	1,576,261	7.33	2.74

Notes: Income classification is based on the country's 1990 income level, that is initial year of our dataset (the World Development Indicators (WDI)-World Bank, 2020). "SD" stands for standard deviation. "GVC" means summation of forward and backward GVC linkages. "VA" represents sectoral value-added and all trade measures are expressed as their shares in sectoral value-added. "i" and "icu" mean input and cumulative input tariffs, respectively. GFCF_LC is calculated by dividing gross fixed capital formation by labor compensation.

Table 4.2: Summary statistics, manufacturing sectors

Variables	Obs.	Total Mean	SD	Obs.	Developed Countries Mean	SD	Obs.	Developing Countries Mean	SD
GVC/VA (%)	1,793,815	0.93	8.72	617,224	0.60	4.58	1,176,591	1.10	10.23
Simple GVC/VA (%)	1,793,815	0.52	5.81	617,224	0.31	3.03	1,176,591	0.63	6.83
Complex GVC/VA (%)	1,793,815	0.42	5.46	617,224	0.29	2.20	1,176,591	0.48	6.55
Forward GVC/VA (%)	2,093,826	0.25	3.64	718,444	0.19	0.98	1,375,382	0.27	4.44
Forward simple GVC/VA (%)	2,093,826	0.16	3.14	718,444	0.11	0.75	1,375,382	0.18	3.84
Forward complex GVC/VA (%)	2,093,826	0.09	0.60	718,444	0.08	0.31	1,375,382	0.09	0.70
Backward GVC/VA (%)	1,793,815	0.66	7.68	617,224	0.40	4.32	1,176,591	0.80	8.94
Backward simple GVC/VA (%)	1,793,815	0.35	4.66	617,224	0.19	2.85	1,176,591	0.43	5.37
Backward complex GVC/VA (%)	1,793,815	0.32	5.35	617,224	0.21	2.12	1,176,591	0.38	6.42
iTariff_faced	1,979,364	0.07	0.12	680,368	0.08	0.13	1,298,996	0.06	0.12
iTariff_imposes	1,704,307	0.06	0.09	612,519	0.02	0.05	1,091,788	0.08	0.10
icuTariff_faced	1,979,499	0.08	0.12	680,460	0.09	0.13	1,299,039	0.07	0.12
icuTariff_imposes	1,704,335	0.07	0.10	612,571	0.03	0.05	1,091,764	0.09	0.11
Position	2,063,984	0.96	0.21	708,392	0.93	0.19	1,355,592	0.98	0.22
GFCF_LC	2,094,281	40.97	1499.42	718,461	0.64	1.15	1,375,820	62.03	1,849.61
FDI/GDP	2,019,485	0.84	13.03	700,091	0.64	1.61	1,319,394	0.95	16.08
Schooling	1,975,853	8.54	2.93	673,431	10.78	1.73	1,302,422	7.39	2.74

Notes: See Notes in Table 4.1.

Table 4.3: Summary statistics, agriculture and mining sectors

Variables	Total			Developed Countries			Developing Countries		
	Obs.	Mean	SD	Obs.	Mean	SD	Obs.	Mean	SD
GVC/VA (%)	383,811	0.66	2.77	128,365	0.47	2.27	255,446	0.76	2.99
Simple GVC/VA (%)	383,811	0.43	2.28	128,365	0.29	1.77	255,446	0.50	2.50
Complex GVC/VA (%)	383,811	0.23	0.81	128,365	0.19	0.79	255,446	0.25	0.82
Forward GVC/VA (%)	428,867	0.53	2.53	142,273	0.34	1.81	286,594	0.63	2.82
Forward simple GVC/VA (%)	428,867	0.36	2.18	142,273	0.22	1.52	286,594	0.43	2.44
Forward complex GVC/VA (%)	428,867	0.17	0.57	142,273	0.12	0.48	286,594	0.20	0.61
Backward GVC/VA (%)	383,811	0.10	0.93	128,365	0.13	1.17	255,446	0.09	0.78
Backward simple GVC/VA (%)	383,811	0.05	0.59	128,365	0.06	0.77	255,446	0.05	0.48
Backward complex GVC/VA (%)	383,811	0.05	0.53	128,365	0.07	0.59	255,446	0.04	0.50
iTariff_faced	417,744	0.03	0.08	139,322	0.03	0.08	278,422	0.03	0.08
iTariff_imposes	364,928	0.06	0.09	127,470	0.02	0.04	237,458	0.08	0.11
icuTariff_faced	417,609	0.04	0.08	139,293	0.03	0.08	278,316	0.04	0.09
icuTariff_imposes	364,900	0.07	0.10	127,476	0.02	0.05	237,424	0.09	0.11
Position	421,362	1.01	0.23	140,772	1.02	0.23	280,590	1.01	0.23
GFCF_LC	428,991	1.46	41.47	142,275	3.83	71.31	286,716	0.29	6.72
FDI/GDP	415,531	0.47	6.71	140,363	0.54	1.20	275,168	0.44	8.20
Schooling	408,831	8.33	3.04	134,992	10.90	1.70	273,839	7.06	2.73

Notes: See Notes in Table 4.1.

Table 4.4: Summary statistics, high-tech sectors

Variables	Total			Developed Countries			Developing Countries		
	Obs.	Mean	SD	Obs.	Mean	SD	Obs.	Mean	SD
GVC/VA (%)	870,539	1.02	8.47	305,010	0.66	5.67	565,529	1.22	9.64
Simple GVC/VA (%)	870,539	0.55	4.78	305,010	0.33	3.85	565,529	0.67	5.21
Complex GVC/VA (%)	870,539	0.47	6.20	305,010	0.33	2.63	565,529	0.55	7.45
Forward GVC/VA (%)	1,019,653	0.22	1.14	356,634	0.18	0.90	663,019	0.25	1.25
Forward simple GVC/VA (%)	1,019,653	0.14	0.90	356,634	0.10	0.65	663,019	0.15	1.00
Forward complex GVC/VA (%)	1,019,653	0.09	0.35	356,634	0.08	0.32	663,019	0.09	0.37
Backward GVC/VA (%)	870,539	0.79	8.28	305,010	0.47	5.46	565,529	0.95	9.46
Backward simple GVC/VA (%)	870,539	0.41	4.63	305,010	0.22	3.73	565,529	0.51	5.04
Backward complex GVC/VA (%)	870,539	0.38	6.16	305,010	0.25	2.56	565,529	0.45	7.41
iTariff_faced	971,031	0.06	0.12	340,079	0.08	0.12	630,952	0.06	0.12
iTariff_imposes	829,205	0.06	0.09	302,650	0.02	0.05	526,555	0.08	0.10
icuTariff_faced	971,111	0.07	0.12	340,150	0.09	0.12	630,961	0.07	0.12
icuTariff_imposes	829,281	0.07	0.10	302,683	0.03	0.05	526,598	0.09	0.11
Position	1,003,454	0.95	0.22	350,913	0.89	0.18	652,541	0.98	0.23
GFCF_LC	1,019,778	3.41	62.85	356,634	1.19	1.09	663,144	4.61	77.91
FDI/GDP	982,560	0.94	14.25	347,123	0.65	1.68	635,437	1.09	17.67
Schooling	959,570	8.61	2.91	333,261	10.77	1.73	626,309	7.46	2.76

Notes: See Notes in Table 4.1.

Table 4.5: Summary statistics, low-tech sectors

Variables		Total			Developed Countries			Developing Countries	
	Obs.	Mean	SD	Obs.	Mean	SD	Obs.	Mean	SD
GVC/VA (%)	1,307,087	0.79	7.67	440,579	0.52	2.94	866,508	0.92	9.17
Simple GVC/VA (%)	1,307,087	0.47	5.72	440,579	0.28	1.87	866,508	0.56	6.89
Complex GVC/VA (%)	1,307,087	0.32	3.94	440,579	0.23	1.46	866,508	0.37	4.72
Forward GVC/VA (%)	1,503,040	0.34	4.41	504,083	0.24	1.31	998,957	0.39	5.32
Forward simple GVC/VA (%)	1,503,040	0.23	3.82	504,083	0.15	1.07	998,957	0.27	4.62
Forward complex GVC/VA (%)	1,503,040	0.11	0.71	504,083	0.09	0.36	998,957	0.12	0.83
Backward GVC/VA (%)	1,307,087	0.42	5.95	440,579	0.27	2.42	866,508	0.49	7.10
Backward simple GVC/VA (%)	1,307,087	0.22	3.96	440,579	0.12	1.39	866,508	0.27	4.76
Backward complex GVC/VA (%)	1,307,087	0.20	3.75	440,579	0.14	1.36	866,508	0.23	4.50
iTariff_faced	1,426,077	0.06	0.12	479,611	0.07	0.12	946,466	0.05	0.12
iTariff_imposes	1,240,030	0.06	0.09	437,339	0.02	0.05	802,691	0.08	0.11
icuTariff_faced	1,425,997	0.07	0.12	479,603	0.07	0.12	946,394	0.06	0.12
icuTariff_imposes	1,239,954	0.07	0.10	437,364	0.02	0.05	802,590	0.09	0.11
Position	1,481,892	0.99	0.22	498,251	0.98	0.21	983,641	0.99	0.22
GFCF_LC	1,503,494	55.17	1768.85	504,102	1.15	37.93	999,392	82.42	2,168.89
FDI/GDP	1,452,456	0.68	10.57	493,331	0.60	1.45	959,125	0.71	12.96
Schooling	1,425,114	8.43	2.97	475,162	10.82	1.73	949,952	7.24	2.73

Notes: See Notes in Table 4.1.
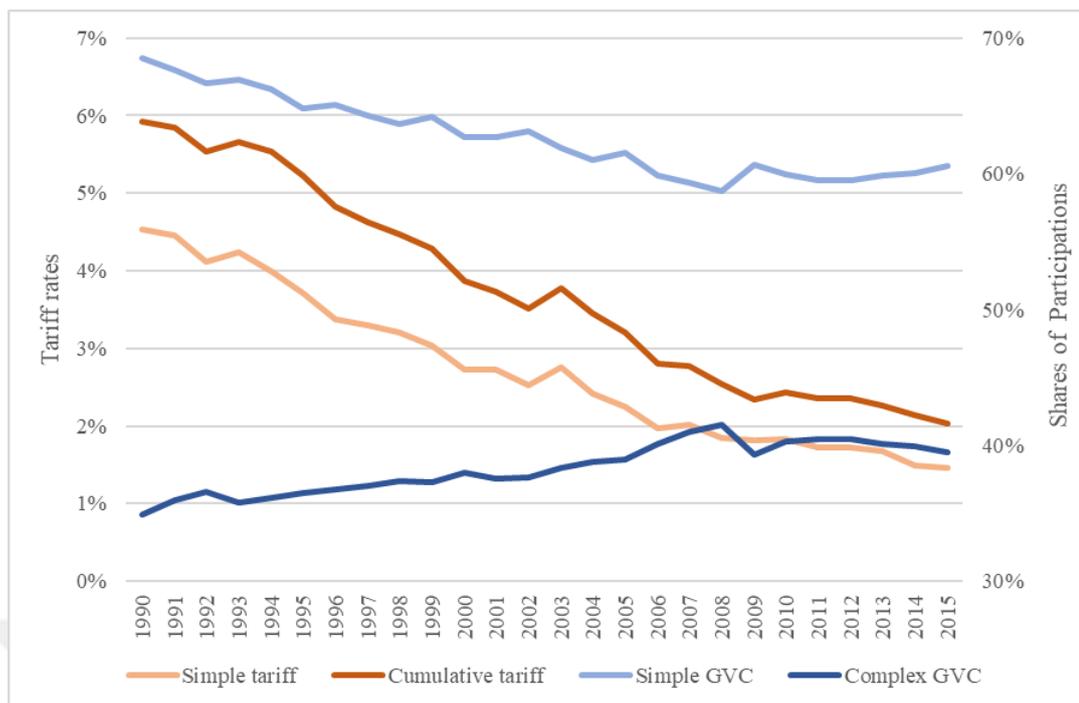
Figure 4.1: Tariff rates and GVC participation

Figures 4.2 to 4.5 illustrate the same variables by differentiating them according to income level of trading pairs. The first thing we observe is that the trend of variables persists in these sub-groups. The cumulative tariffs are higher than the simple tariffs and both tariff rates have declined through time. While the share of simple GVC follows a decreasing trend, the trend of share of complex GVC is upward sloping until the year 2009. In fact, the trend continues even after the year 2009 for some trading partners such as developed-developed and developing-developed countries. This means that developed economies continue to be active players in vertical specialization even after the global downturn. The second thing we want to emphasize that developing countries impose higher tariffs on intermediates regardless of the income level of trading partners compared to developed countries. The developing countries decrease their tariff rates from nearly 10% to 2% through the period with multidimensional liberalization efforts.
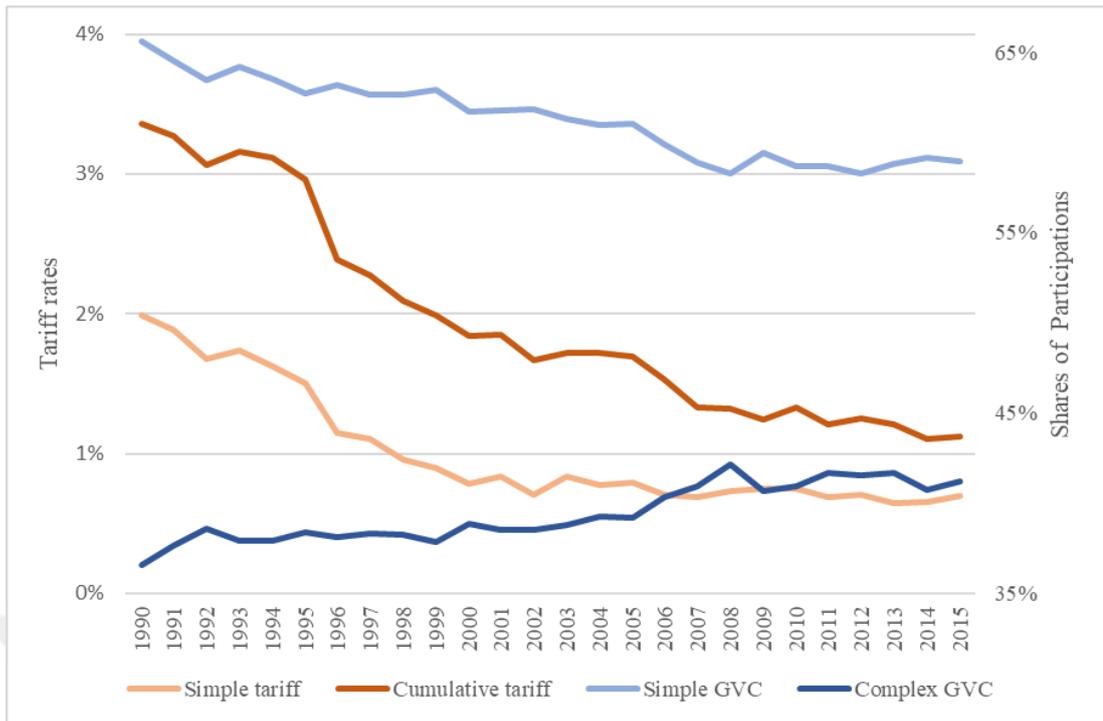
Figure 4.2: Tariff rates and GVC participation, developed - developed countries
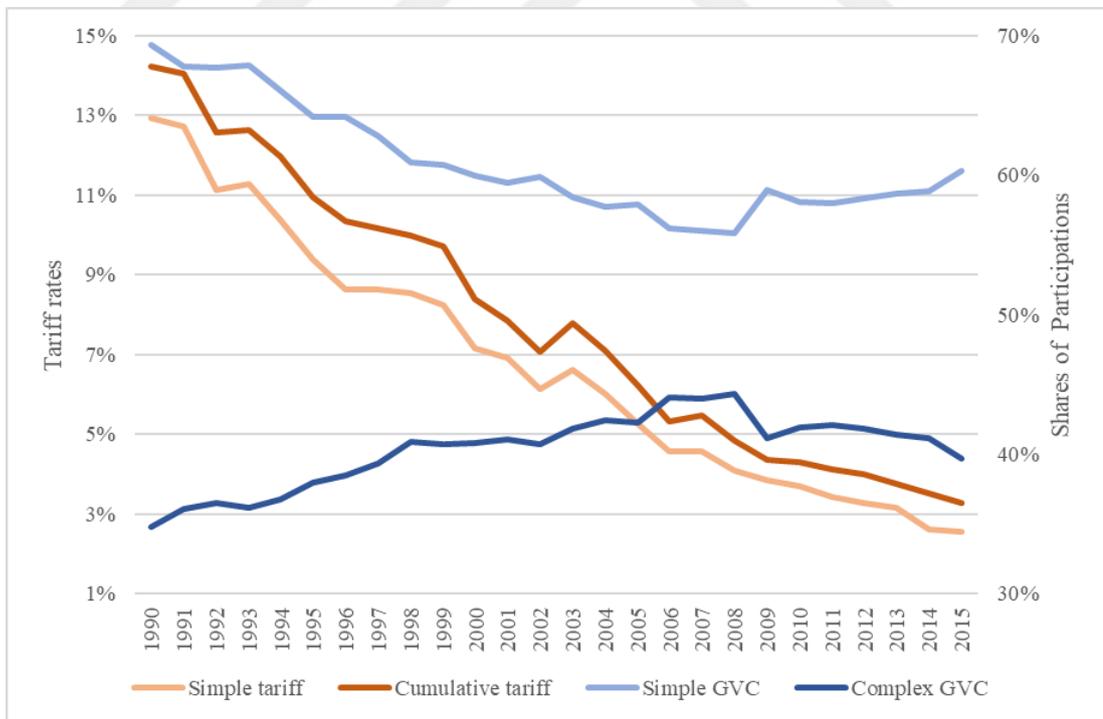
Figure 4.3: Tariff rates and GVC participation, developed – developing countries

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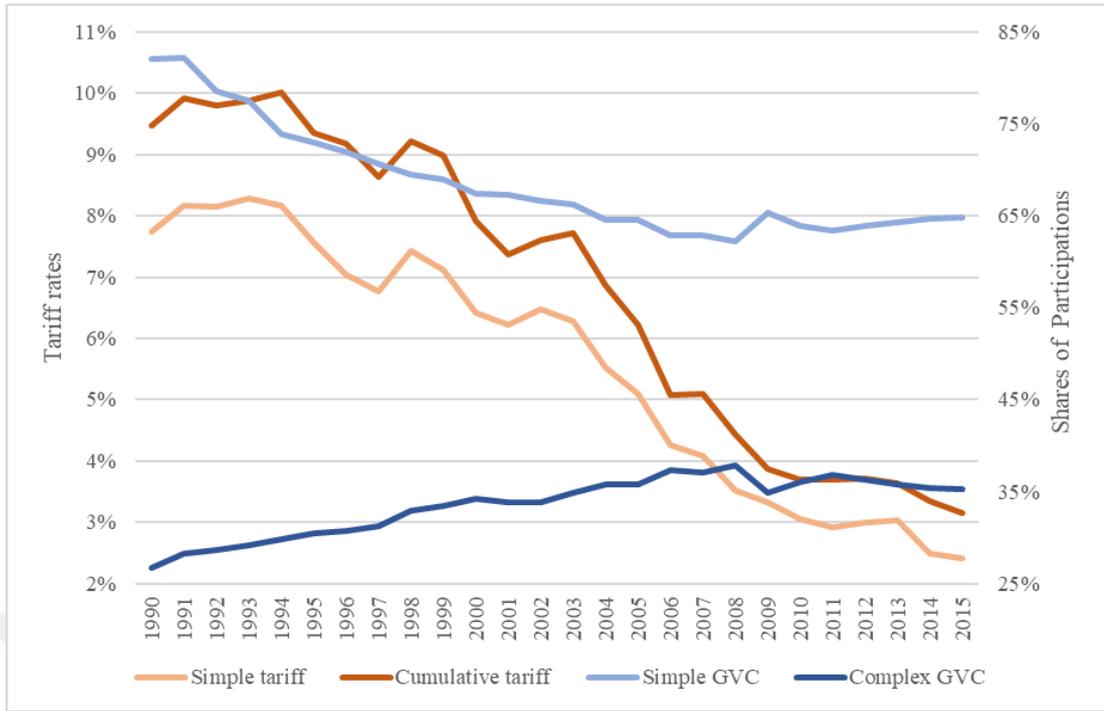
Figure 4.4: Tariff rates and GVC participation, developing – developing countries
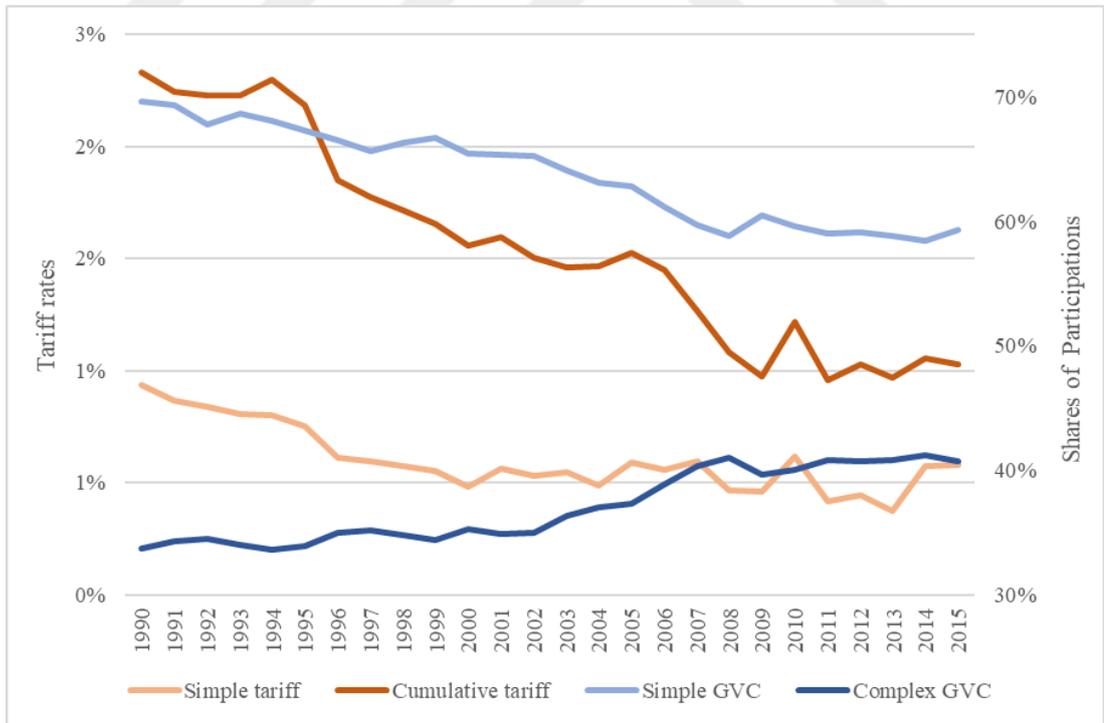
Figure 4.5: Tariff rate and GVC participation, developing – developed countries

Figures 4.6 to 4.10 display the relationship between faced tariffs and global value chain participation for manufacturing sectors. Compared to the general trends represented in Figure 4.1, we observe slightly higher tariff rates for manufacturing industries. When we consider the case by considering different trading pairs, we notice the same tendency of all variables because of the higher share of manufacturing sectors in our sample. Another important point we want to attract attention is that the difference between simple and cumulative tariff rates have decreased for developed-developed and developing-developed country pairs after the 2008 Global Financial crisis. This may be explained by the shortened and narrowed global value chains in the global downturn. In other words, with this crisis, the global production system faced with the threat of disruption in global value chains for the first time. The current World Bank report (2020) also states that after the crisis, intermediate goods trade decreased and there were modest growth periods at interval. The report points out the changes in trade reforms as the most important reason for this situation. Considering our graphical representation, we attribute this policy change to mainly developed economies.
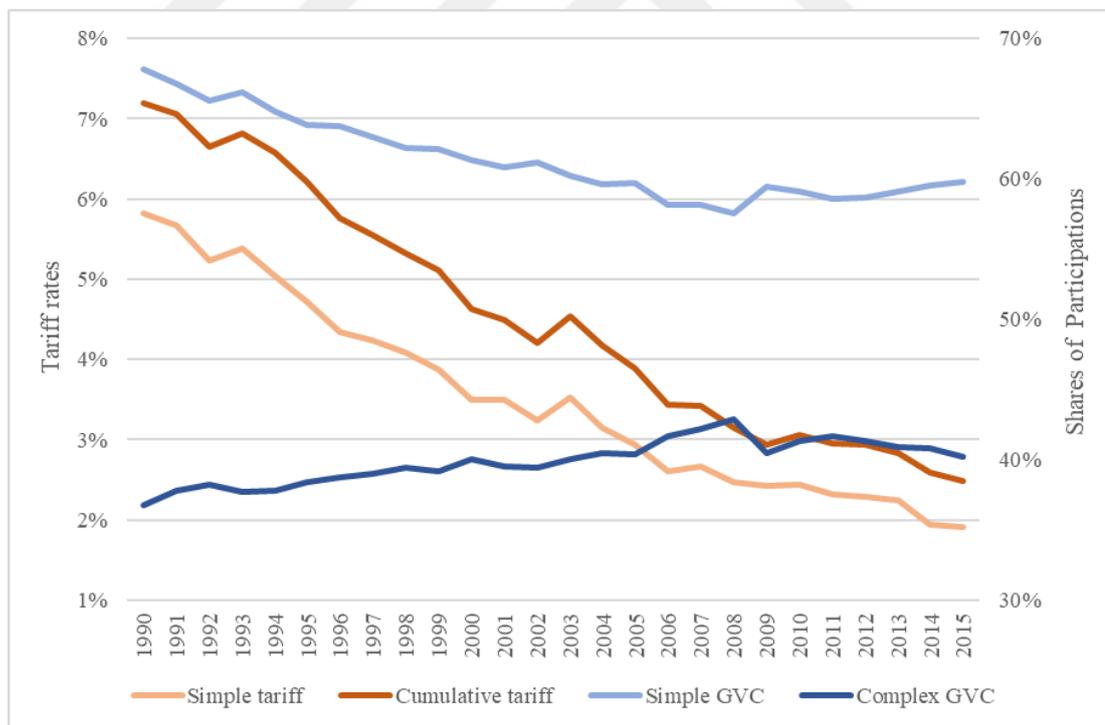
Figure 4.6: Tariff rate and GVC participation, manufacturing

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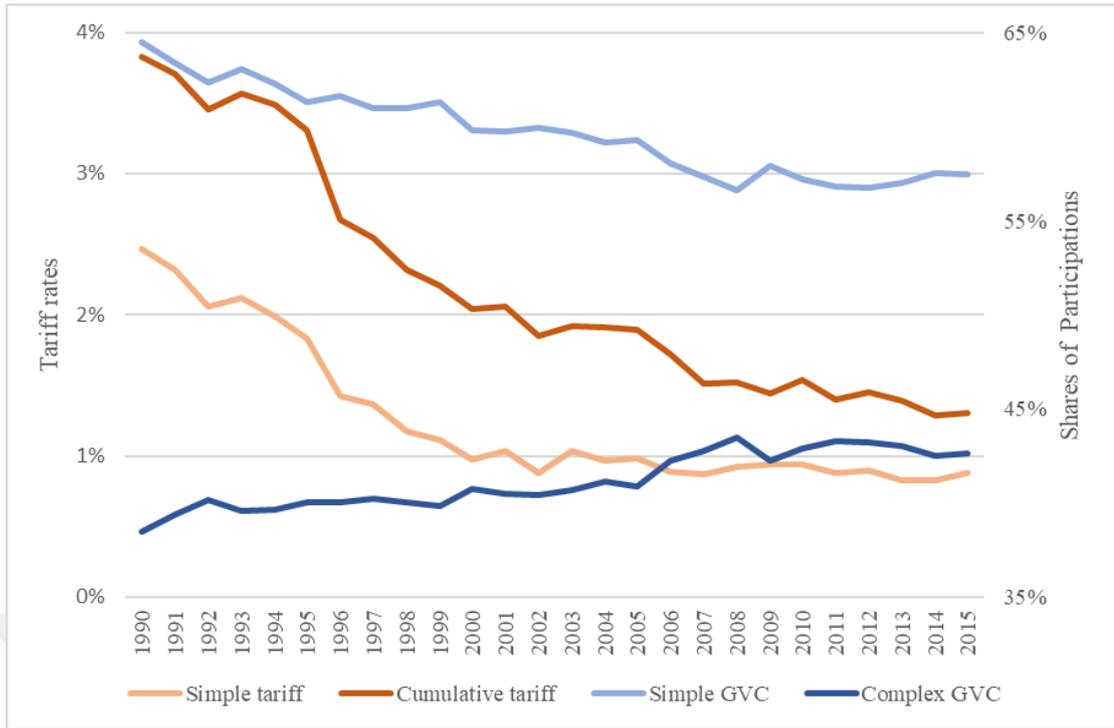
Figure 4.7: Tariff rates and GVC participation, manufacturing, developed - developed countries
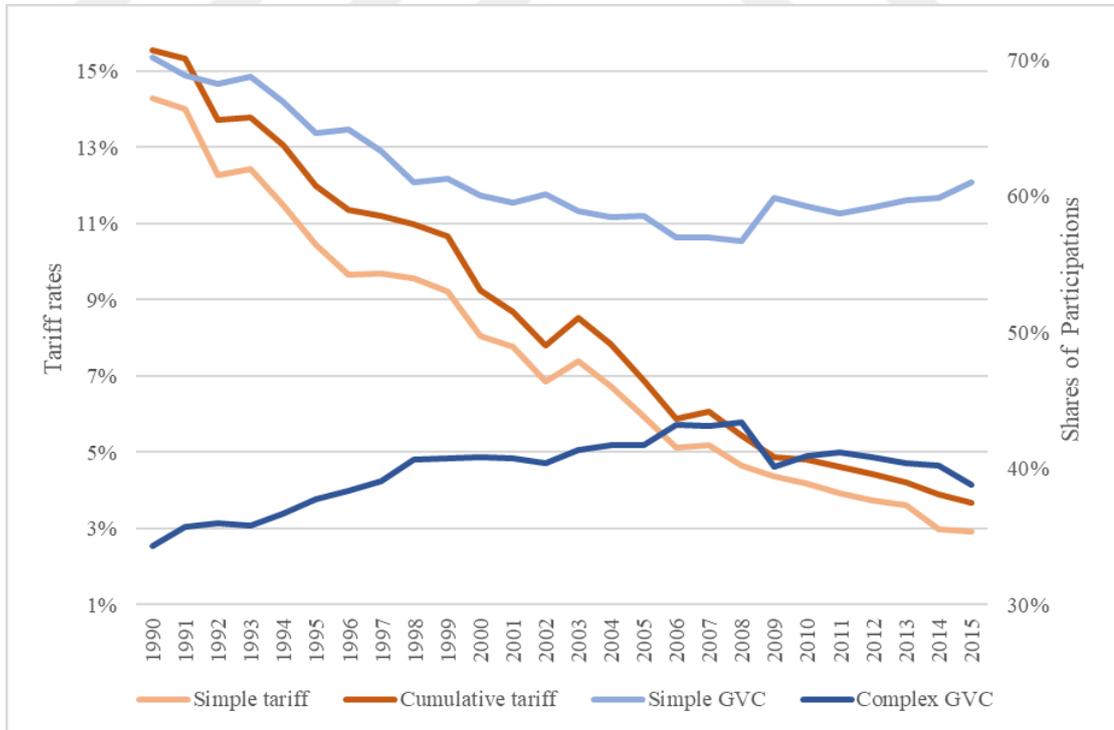
Figure 4.8: Tariff rates and GVC participation, manufacturing, developed - developing countries
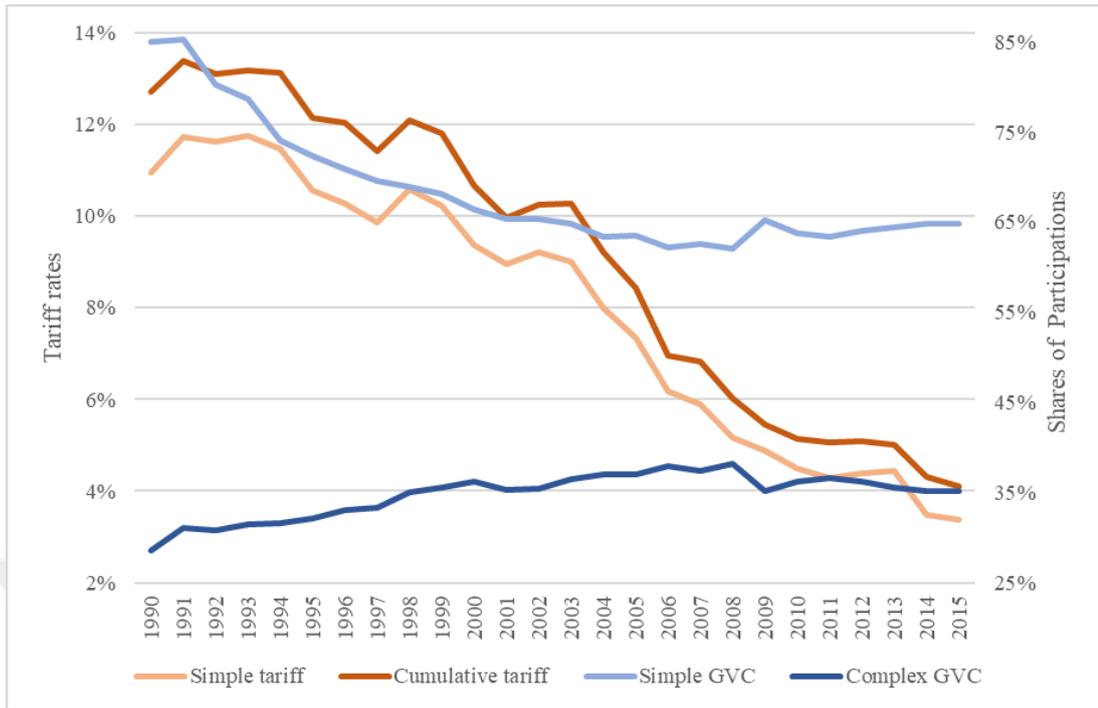
Figure 4.9: Tariff rates and GVC participation, manufacturing, developing - developing countries
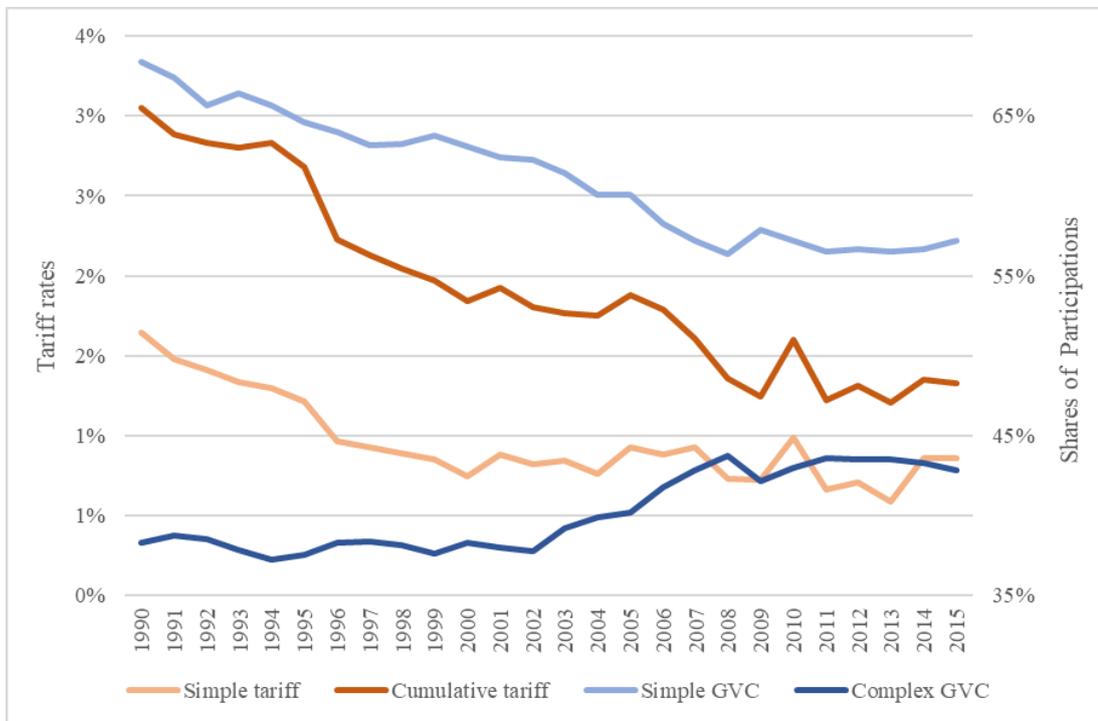
Figure 4.10: Tariff rates and GVC participation, manufacturing, developing - developed countries

Figures 4.11 to 4.15 display the relationship between faced tariffs and global value chain participation for agriculture and mining sectors. Compared to the general trends represented in Figure 4.1, we observe much lower tariff rates for agriculture and mining sectors. Moreover, we notice lower variation in simple tariff compared to cumulative tariffs for the products of agriculture and mining sector. We can infer that even though tariff imposed on these products follows a stable path through years, the figure can be misleading regardless of consideration the interaction of these sectors with other sectors in the global value chains. When we consider the case by considering different trading pairs, we notice that the general tendency is mainly driven from the transactions between the developed-developed and developing-developed country pairs. This means that we observe much more transaction cost with different patterns for products finally consumed in developed economies.
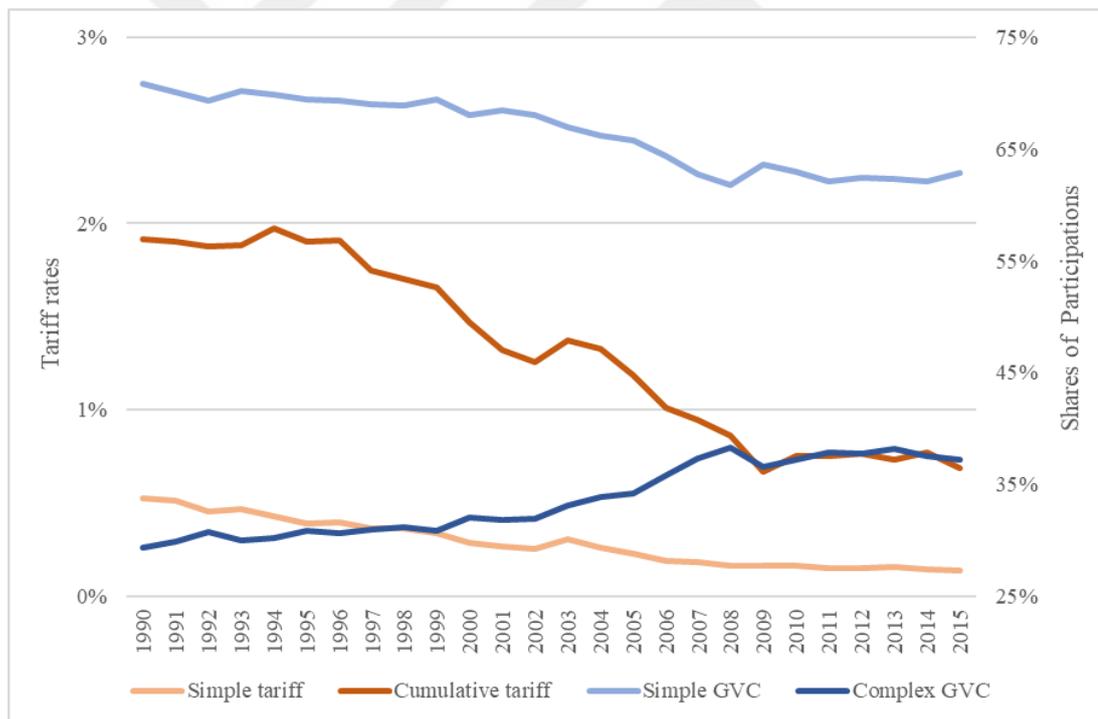
Figure 4.11: Tariff rates and GVC participation, agriculture and mining
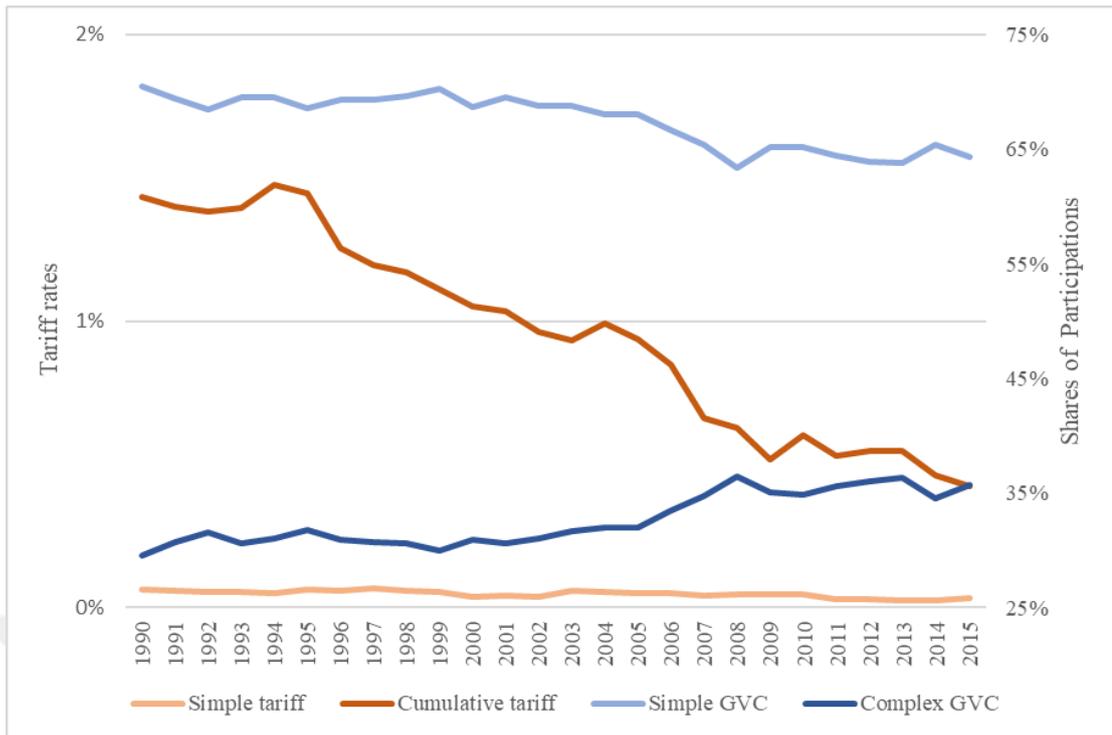
Figure 4.12: Tariff rates and GVC participation, agriculture and mining, developed - developed countries
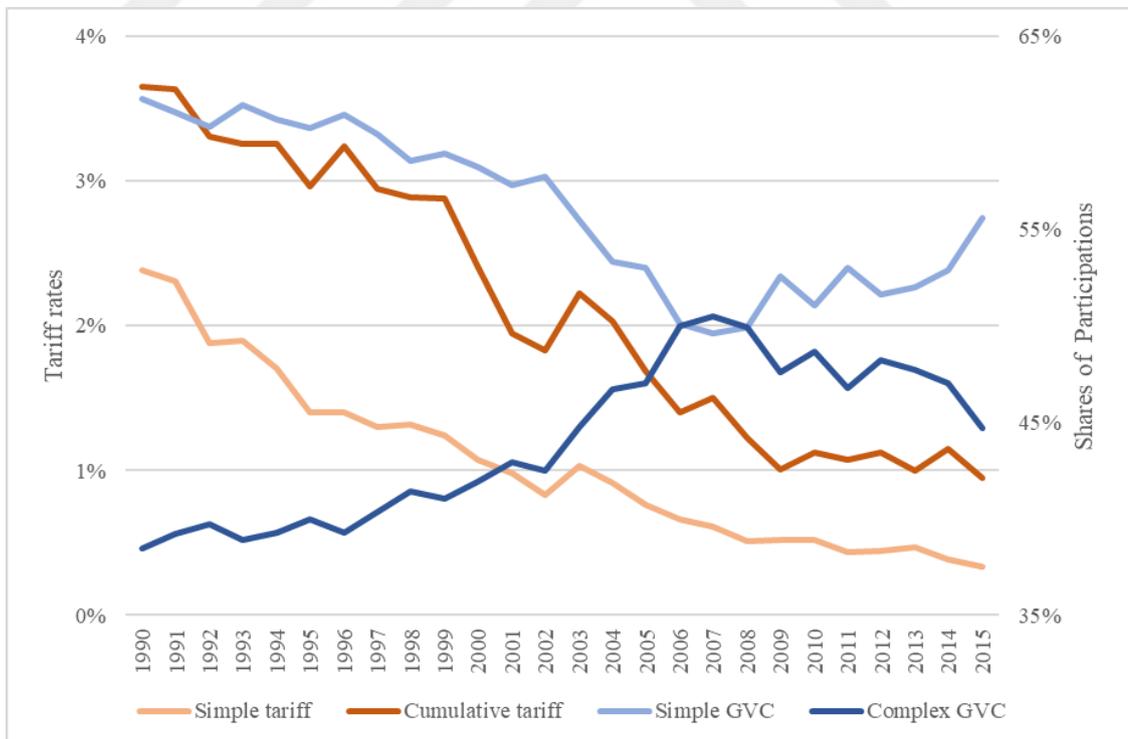
Figure 4.13: Tariff rates and GVC participation, agriculture and mining, developed - developing countries
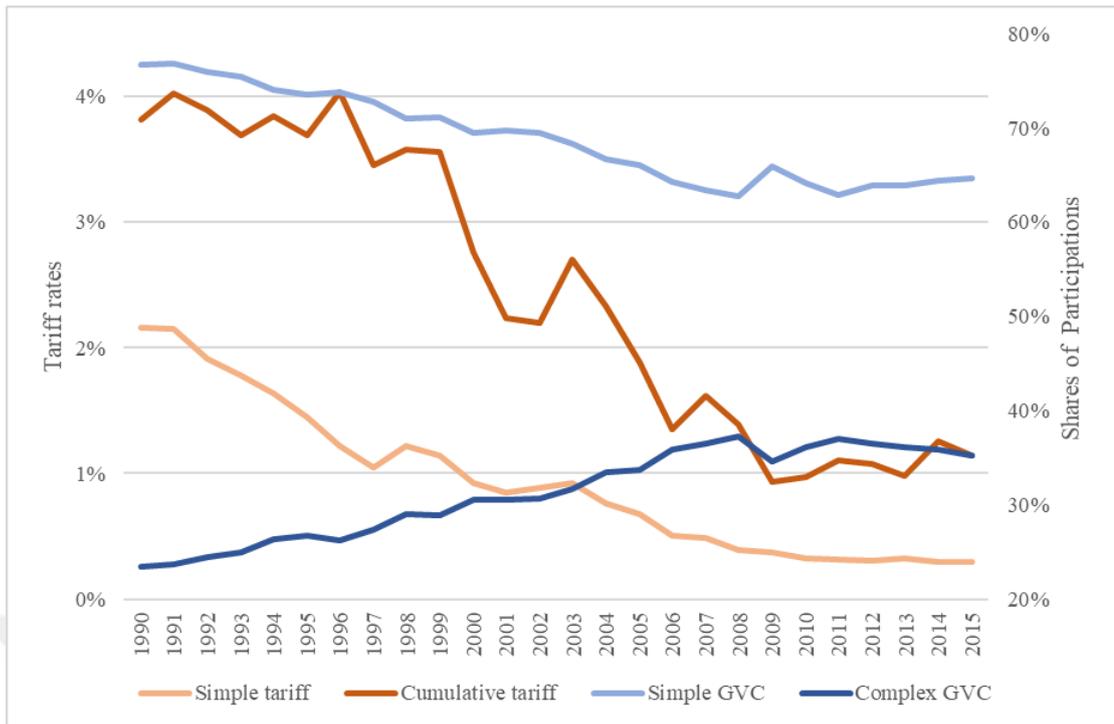
Figure 4.14: Tariff rates and GVC participation, agriculture and mining, developing - developing countries
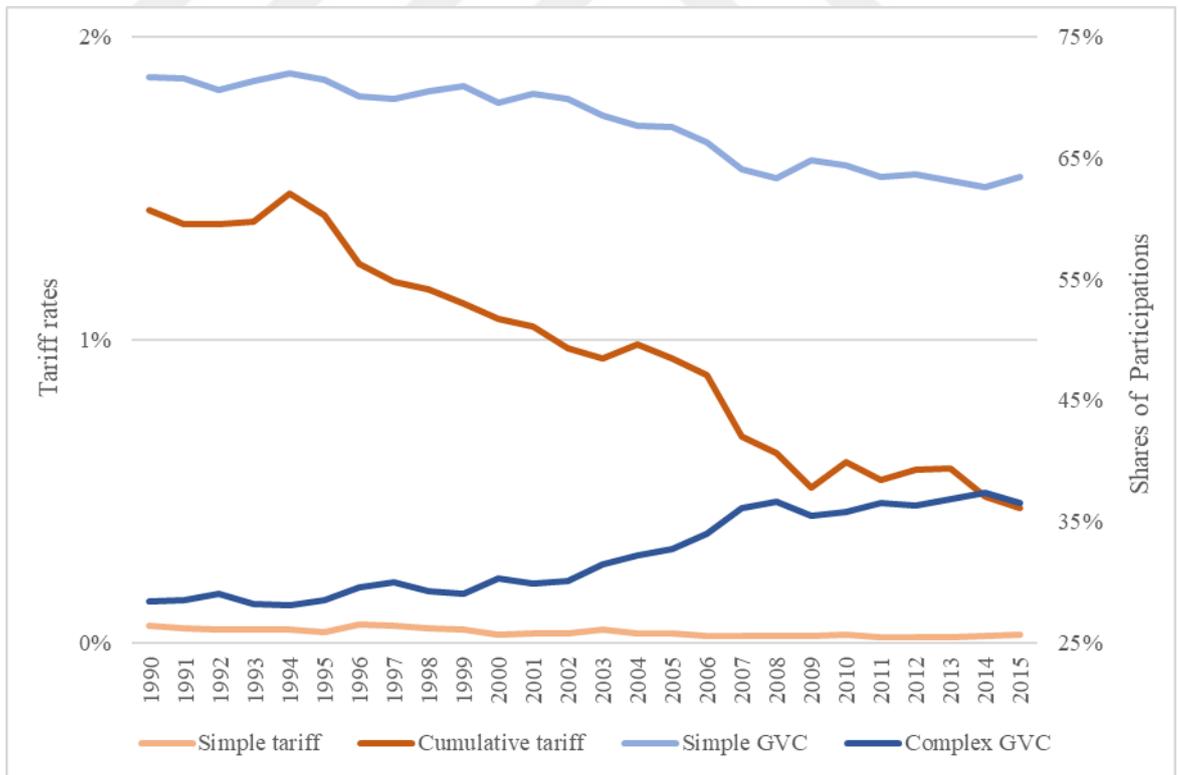
Figure 4.15: Tariff rates and GVC participation, agriculture and mining, developing - developed countries

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Table 4.6 presents the position index of sectors (weighted averages of countries by trade) through time by considering income levels of countries. To reiterate, the position index is defined as ratio of forward linkages over backward linkages, that is the division of distance of particular production stage to ending stage by the distance from starting stage. If a sector thus has fewer backward production stages relative to forward. Since we employ the forward production length by deciding optimal level of cross bordering (see the discussion in the Appendix D), we want to analyze the trends in a position index, that is relative forward length in this visual illustration. The darker blue in cells means a higher position index, and vice versa. Table 4.6 illustrates the trend for all economies as well as developed and developing countries. Even if there is no trend in position through years except for recycling sector especially after the year 2007, there is obvious sectoral heterogeneity in this measure. Recycling; petroleum, chemical and non-metallic mineral products; mining; and metal products sectors are in relatively upstream part of a production chain.

While the patters of developed and developing countries do not significantly differ from each other by the initial eye-inspection, the sectors electrical and machinery and transport equipment sectors in developed economies are in upper segment of production chain compared to their counterparts in developing economies.

Table 4.6: Production lengths of sectors through time by income level of countries

Sector\Year - All Countries	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Fishing	0.77	0.76	0.79	0.83	0.79	0.76	0.80	0.79	0.77	0.76	0.74	0.74	0.75	0.78	0.80	0.80	0.80	0.86	0.88	0.83	0.88	0.85	0.84	0.83	0.84	0.83
Agriculture	0.86	0.90	0.88	0.88	0.90	0.88	0.86	0.88	0.88	0.88	0.87	0.88	0.88	0.89	0.89	0.88	0.88	0.89	0.90	0.88	0.88	0.87	0.88	0.88	0.91	0.88
Other Man.	0.87	0.85	0.87	0.86	0.86	0.85	0.86	0.85	0.85	0.84	0.84	0.85	0.83	0.84	0.83	0.85	0.82	0.81	0.82	0.83	0.82	0.84	0.81	0.83	0.82	0.83
Recycling	1.00	1.02	1.01	0.99	0.99	1.02	1.02	1.02	1.05	1.05	1.03	1.03	1.04	1.05	1.04	1.07	1.09	1.17	1.20	1.24	1.20	1.20	1.20	1.21	1.20	1.19
Mining	1.04	1.22	1.04	1.10	1.07	1.18	1.06	1.08	1.05	1.05	1.06	1.23	1.05	1.23	1.13	1.04	1.05	1.05	1.00	1.05	1.00	1.06	1.03	1.02	1.02	1.00
Food & Beverages	0.81	0.83	0.81	0.80	0.81	0.80	0.81	0.82	0.81	0.81	0.82	0.81	0.82	0.82	0.83	0.82	0.82	0.83	0.84	0.84	0.86	0.84	0.86	0.85	0.85	0.84
Textiles	0.85	0.85	0.84	0.82	0.84	0.83	0.83	0.82	0.81	0.81	0.80	0.81	0.82	0.81	0.79	0.80	0.81	0.82	0.82	0.83	0.83	0.84	0.81	0.83	0.83	0.85
Wood and Paper	1.00	1.00	1.02	1.01	1.00	1.02	1.02	1.02	0.99	0.99	1.01	1.01	1.04	1.01	1.07	1.02	1.02	1.00	0.99	1.04	1.02	1.02	1.01	1.02	1.03	1.01
Petroleum	1.15	1.04	1.17	1.10	1.09	1.08	1.18	1.08	1.17	1.18	1.19	1.20	1.24	1.09	1.12	1.13	1.11	1.14	1.11	1.11	1.17	1.10	1.14	1.14	1.12	1.13
Metal Products	1.05	1.12	1.00	1.04	1.03	1.03	1.02	1.03	1.02	1.02	1.02	1.02	1.02	1.02	0.99	1.01	1.00	0.99	0.99	1.00	0.99	1.00	0.96	1.00	0.97	0.97
Electrical	0.87	0.88	0.85	0.86	0.87	0.87	0.85	0.86	0.87	0.87	0.86	0.86	0.85	0.85	0.87	0.86	0.84	0.84	0.84	0.83	0.84	0.85	0.84	0.83	0.85	0.85
Transport Equip.	0.80	0.81	0.81	0.81	0.83	0.80	0.81	0.81	0.80	0.80	0.84	0.83	0.82	0.81	0.82	0.82	0.80	0.81	0.82	0.84	0.83	0.82	0.81	0.82	0.86	0.81
Developed	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
Fishing	1.25	1.23	1.19	1.20	1.21	1.25	1.20	1.22	1.25	1.25	1.25	1.27	1.26	1.24	1.22	1.24	1.20	1.21	1.22	1.26	1.19	1.20	1.16	1.23	1.17	1.17
Agriculture	1.12	1.14	1.12	1.13	1.13	1.13	1.13	1.13	1.14	1.14	1.14	1.13	1.13	1.11	1.11	1.12	1.10	1.12	1.12	1.12	1.10	1.11	1.10	1.09	1.10	1.11
Other Man.	1.16	1.15	1.13	1.16	1.16	1.16	1.16	1.17	1.17	1.17	1.18	1.14	1.16	1.17	1.17	1.14	1.16	1.21	1.17	1.16	1.15	1.13	1.17	1.14	1.17	1.16
Recycling	1.00	1.01	0.99	1.04	1.02	1.00	1.01	1.02	1.03	1.03	1.02	1.04	1.02	1.01	1.00	1.02	1.01	1.02	1.02	1.03	0.99	1.01	0.99	0.99	1.03	1.00
Mining	0.87	0.71	0.84	0.78	0.85	0.69	0.85	0.84	0.86	0.85	0.87	0.76	0.87	0.71	0.79	0.85	0.86	0.86	0.86	0.79	0.90	0.76	0.84	0.84	0.85	0.83
Food & Beverages	1.22	1.20	1.22	1.26	1.22	1.24	1.24	1.21	1.23	1.24	1.23	1.25	1.24	1.21	1.21	1.23	1.20	1.23	1.23	1.20	1.17	1.21	1.18	1.19	1.18	1.21
Textiles	1.16	1.13	1.19	1.20	1.16	1.20	1.21	1.23	1.24	1.24	1.25	1.25	1.22	1.25	1.23	1.23	1.22	1.21	1.20	1.19	1.18	1.18	1.18	1.19	1.19	1.17
Wood and Paper	1.00	1.00	0.99	0.98	1.00	0.97	0.98	1.00	1.01	1.01	1.00	0.99	0.96	0.99	0.92	0.97	0.98	1.00	1.01	0.95	0.98	0.96	0.98	0.98	0.97	0.98
Petroleum	0.86	0.95	0.85	0.91	0.92	0.93	0.84	0.95	0.85	0.84	0.83	0.83	0.81	0.92	0.90	0.89	0.91	0.89	0.89	0.91	0.84	0.90	0.86	0.87	0.89	0.88
Metal Products	0.96	0.93	1.03	0.97	0.98	0.97	0.99	0.99	0.99	0.99	0.99	0.99	0.98	0.99	1.00	0.99	0.99	1.01	0.99	0.99	0.98	1.01	1.01	1.00	1.02	1.01
Electrical	1.18	1.16	1.19	1.19	1.17	1.15	1.19	1.17	1.17	1.16	1.18	1.17	1.20	1.18	1.15	1.16	1.20	1.16	1.20	1.18	1.15	1.14	1.14	1.20	1.17	1.20
Transport Equip.	1.28	1.25	1.24	1.26	1.23	1.28	1.29	1.27	1.29	1.29	1.22	1.24	1.29	1.27	1.25	1.29	1.31	1.30	1.28	1.24	1.27	1.26	1.30	1.29	1.18	1.31
Developing	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
Fishing	1.33	1.36	1.30	1.19	1.27	1.34	1.28	1.23	1.30	1.32	1.33	1.34	1.30	1.24	1.22	1.21	1.21	1.10	1.05	1.12	1.04	1.10	1.14	1.14	1.13	1.15
Agriculture	1.22	1.09	1.16	1.14	1.10	1.13	1.16	1.14	1.14	1.13	1.14	1.14	1.13	1.11	1.13	1.13	1.15	1.13	1.11	1.13	1.13	1.13	1.13	1.13	1.08	1.13
Other Man.	1.11	1.25	1.21	1.18	1.17	1.19	1.19	1.20	1.20	1.22	1.23	1.24	1.26	1.24	1.25	1.25	1.31	1.27	1.27	1.26	1.28	1.24	1.29	1.26	1.27	1.25
Recycling	1.01	0.90	1.01	0.95	1.00	0.95	0.93	0.92	0.85	0.85	0.90	0.91	0.90	0.90	0.93	0.88	0.87	0.79	0.76	0.70	0.80	0.79	0.79	0.78	0.77	0.81
Mining	1.07	1.05	1.08	1.06	1.03	1.08	1.04	1.06	1.06	1.06	1.05	1.07	1.07	1.08	1.05	1.08	1.05	1.08	1.08	1.11	1.11	1.10	1.08	1.10	1.10	1.11
Food & Beverages	1.29	1.22	1.24	1.25	1.24	1.25	1.23	1.23	1.23	1.23	1.22	1.23	1.22	1.24	1.22	1.22	1.24	1.20	1.16	1.18	1.16	1.18	1.16	1.17	1.18	1.18
Textiles	1.22	1.24	1.20	1.23	1.24	1.22	1.22	1.23	1.23	1.23	1.26	1.22	1.22	1.22	1.28	1.26	1.25	1.25	1.25	1.24	1.23	1.20	1.26	1.26	1.22	1.19
Wood and Paper	0.98	1.03	0.97	1.01	1.01	1.01	0.98	0.95	0.99	0.99	0.96	0.98	0.98	1.00	0.99	0.99	0.98	1.00	1.00	0.97	0.98	1.01	0.99	0.99	0.97	0.99
Petroleum	0.93	1.00	0.91	0.92	0.90	0.94	0.92	0.89	0.91	0.91	0.90	0.92	0.92	0.92	0.89	0.91	0.93	0.88	0.95	0.92	0.91	0.94	0.92	0.90	0.91	0.90
Metal Products	0.93	0.78	0.93	0.94	0.94	0.96	0.93	0.94	0.96	0.96	0.97	0.96	0.97	0.97	1.00	0.99	0.99	0.99	1.02	0.99	1.02	0.99	1.05	0.99	1.04	1.04
Electrical	1.05	1.09	1.12	1.09	1.09	1.09	1.11	1.10	1.09	1.10	1.12	1.10	1.11	1.13	1.13	1.13	1.15	1.19	1.16	1.19	1.18	1.17	1.19	1.17	1.17	1.13
Transport Equip.	1.07	1.13	1.15	1.13	1.13	1.12	1.08	1.15	1.15	1.15	1.13	1.15	1.08	1.13	1.14	1.09	1.12	1.12	1.12	1.12	1.08	1.13	1.14	1.11	1.16	1.12

4.4 Estimation Methodology

Following the models discussed in the literature (Fernandes et al., 2020; Banerjee and Zeman, 2020), we specify the following empirical model to investigate the association between tariff rates and global value chain participations.

$$\text{GVC\_Participation}_{p,t} = \beta_0 + \beta_1 \text{Tariff\_faced}_{p,t} + \beta_2 \text{Tariff\_imposed}_{p,t} + \beta_3 P_{p,t} +$$
$$\beta_4 P_{p,t}^2 + \beta_5 S_{c,s,t} + \beta_6 C_{c,t} + \beta_7 T_t + \varepsilon_{p,t} \tag{4.2}$$

p, c, s, and t stand for country-sector-partner country trio, country, sector, and year, respectively. $\text{GVC\_Participation}_{p,t}$ signifies the vector of total, forward, and backward GVC participations (simple and complex parts as well). $\text{Tariff\_faced}_{p,t}$ stands for faced tariff and $\text{Tariff\_imposed}_{p,t}$ stands for imposed tariff. These tariffs are calculated by utilizing both value-added trade statistics and a cumulative tariff procedure. In the analysis we employ total GVC as the left-hand side variable, we then examine the impacts of both faced and imposed tariff rates on participation. Similarly, we consider the impact of faced (imposed) tariffs on the (backward) forward GVC participation. We expect that while a faced tariff (can be considered as a market access tariff) inevitably leads to rise in the price of products which import duties are levied on and the competitiveness of sectors in an international market may deteriorate, imposed tariff is more likely to rise production cost of sectors considering the higher dependence of sectors in the sample on intermediates (see the descriptive statistics in Table 4.1). We also assess the total effect of these tariffs along with global value chain by employing cumulative tariff rates.

$P_{p,t}$ represents the relative production length, which is the position index of related trade flows. We also include the square term of position index to catch the U-shape relationship between GVC participation and production stages (if any). Shih (1996) and Mudambi (2008) develop the concept of smile curve and claim that the sectors located at the first and end stages of the production chains create higher value-added relative to sectors located in the middle stages (fabrication stages). Therefore, we expect a negative coefficient on the position and a positive coefficient on the square term of position index. $S_{c,s,t}$ represents the capital intensity of sectors. $C_{c,t}$ represents the vector of country level characteristics of country such as share of foreign direct investment stock in GDP and the mean years of schooling. T_t stands for year dummies. Given the positive impact that literature finds out, we expect that FDI stock and

schooling also appear as the significant drivers for GVC participation of sectors. Attracting foreign direct investment enables industries to meet new technology, production process, and better managerial practices (Martínez-Galán and Fontoura, 2019). Better educated workers are well-equipped to succeed complex and knowledge intensive activities required to participate in the global value chain (De Vries et al., 2016).

The empirical models are estimated by employing the Fixed Effects (FE) estimation technique to get rid of the unobservable time-invariants and the omitted variable bias.[10]

4.5 Results

This part presents and interprets the estimation results in three sub-sections as the benchmark results (Tables 4.7 to 4.8), results with country heterogeneity (Tables 4.9 to 4.11), results with sectoral heterogeneity (Tables 4.12 to 4.17), and results with technological heterogeneity (Tables 4.18 to 4.23).

4.5.1 Benchmark Results

This sub-part represents the benchmark results of determinants of global value chain participation. In the columns 1 to 3 of Tables 4.7 and 4.8, we employ total GVC participation ratios by summing up backward and forward linkages. In columns 4 to 6 and 7 to 9, we estimate the determinants of forward and backward GVC participations, respectively. In Table 4.7, the results of tariff rates are presented. Regarding the tariff variables, the findings at the first three columns suggest that both faced and imposed tariffs have negative effect on total, simple, and complex GVC participations with the higher impact of imposed tariffs. When we investigate each linkage separately, we notice that the significant effects of trade barriers continue to exist. The results suggest that not only a market access tariff impedes the realization of benefits coming from participation into forward GVC but also a tariff which countries impose on imported intermediates deteriorates the flow of imported inputs. Therefore, lower tariffs and

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[10] We also employ the lagged value of tariff rates because they are predetermined and assumed to be uncorrelated with the current changes in industries' performance. We also run our model with the Ordinary Least Squares Estimates (OLS) with country-sector-partner country and time fixed effects. We get very similar results.

thus deepening cooperation among economies can be seen the drivers of higher participation into the global production system. Regarding the sectoral control variables, we observe a U-shaped pattern between relative production stages, that is the position in GVC, and almost all types of GVC participations. Given this significant result, we can argue that moving from the fabrication stages to pre- or post-fabrication stages improves GVC participation. To catch this benefit, sectors can adopt new function in their production process (Humphrey, 2004). Capital intensity displaying the sectoral endowments has a positive influence on GVC participation regardless of forward and backward linkages. Regarding the country level control variables, FDI stock and years of schooling are the other significant determinants to boost GVC participation. The presence of FDI stock can reshape economic structure in a way that higher productivity and production are realized (Buelens and Tirpák, 2017).

Table 4.8 repeats the same exercise by using cumulative tariff rates instead of simple tariffs. The results are very similar and the conclusion we get is exactly same with that of we can infer from Table 4.7. The market accession and input tariffs negatively affect GVC participation level of sectors regardless of simple and complex parts. However, it is important to note that the effects of these tariffs on GVC participation are relatively higher in a simple part compared to a complex part. This may suggest that initial impact of any policy changes mostly harms the simple part of GVC, that is intermediates cross border only once and consumed in the partner country. Another explanation can be related to the existence of inward processing regime. Under this regime which many countries utilize, there is already an exemption of tariffs imposed on intermediates used in exporting purposes, which thus mitigates the impact of tariffs utilized in complex parts of GVC participations. Without considering country and sector level heterogeneities, the results driven from the aggregate sample significantly prove the detrimental impact of any protective measures on accession and integration into global value chains. Even if countries aim to liberalize their economies, the results show that there is a significant variation in tariff rates across nations and borders and tariffs still matter. To achieve trade liberalization and benefit from GVCs, countries should globally negotiate with each other and set the tariff rates at optimal levels. Furthermore, to efficiently catch the benefits from GVC, countries/sectors should develop their capacity by building up new functions along with the global value chain, investing in capital stock, foreign investment, and encouraging labor to obtain better skills.

Table 4.7: Simple tariffs and GVC participations

	GVCs (1)	Simple GVC (2)	Complex GVC (3)	Forward GVCs (4)	Forward Simple GVC (5)	Forward Complex GVC (6)	Backward GVCs (7)	Backward Simple GVC (8)	Backward Complex GVC (9)
Tariff_faced	-0.304***	-0.206***	-0.103**	-0.129***	-0.102***	-0.027***			
	(0.061)	(0.033)	(0.045)	(0.023)	(0.020)	(0.004)			
Tariff_imposed	-0.695***	-0.436***	-0.267***				-0.629***	-0.388***	-0.248***
	(0.090)	(0.064)	(0.053)				(0.072)	(0.045)	(0.049)
Pos	-0.496***	-0.180**	-0.323**	-0.405***	-0.322***	-0.082***	-0.015	0.198***	-0.219*
	(0.158)	(0.077)	(0.130)	(0.057)	(0.048)	(0.011)	(0.133)	(0.048)	(0.121)
Pos_sq	0.011***	0.004**	0.007**	0.009***	0.007***	0.002***	0.000	-0.004***	0.005*
	(0.003)	(0.002)	(0.003)	(0.001)	(0.001)	(0.000)	(0.003)	(0.001)	(0.003)
Capital intensity	0.646***	0.241***	0.409***	0.061***	0.040***	0.020***	0.571***	0.188***	0.386***
	(0.092)	(0.031)	(0.080)	(0.016)	(0.014)	(0.003)	(0.086)	(0.025)	(0.077)
FDI stock	0.017**	0.007**	0.009**	0.003	0.002	0.002*	0.012**	0.005	0.008**
	(0.007)	(0.004)	(0.004)	(0.002)	(0.002)	(0.001)	(0.006)	(0.003)	(0.004)
Schooling	0.029**	0.007	0.023**	-0.000	-0.000	0.000	0.033***	0.008*	0.026***
	(0.013)	(0.008)	(0.010)	(0.006)	(0.005)	(0.001)	(0.011)	(0.004)	(0.010)
Constant	2.759***	1.280***	1.495***	0.820***	0.616***	0.203***	1.735***	0.525***	1.225***
	(0.273)	(0.139)	(0.213)	(0.091)	(0.080)	(0.015)	(0.228)	(0.078)	(0.200)
# of Obs.	1,850,892	1,850,892	1,850,892	2,182,737	2,182,737	2,182,737	1,930,221	1,930,221	1,930,221
R-squared	0.477	0.441	0.517	0.356	0.345	0.526	0.519	0.505	0.533

Notes: Year dummies are included in the model, but they are not reported. Clustered robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 4.8: Cumulative tariffs and GVC participations

	GVCs (1)	Simple GVC (2)	Complex GVC (3)	Forward GVCs (4)	Forward Simple GVC (5)	Forward Complex GVC (6)	Backward GVCs (7)	Backward Simple GVC (8)	Backward Complex GVC (9)
Tariff_faced	-0.289***	-0.197***	-0.098**	-0.122***	-0.096***	-0.026***			
	(0.060)	(0.033)	(0.044)	(0.024)	(0.021)	(0.004)			
Tariff_imposed	-0.681***	-0.429***	-0.260***				-0.622***	-0.383***	-0.247***
	(0.091)	(0.064)	(0.052)				(0.071)	(0.043)	(0.048)
Pos	-0.495***	-0.181**	-0.320**	-0.404***	-0.321***	-0.082***	-0.016	0.196***	-0.218*
	(0.158)	(0.077)	(0.130)	(0.056)	(0.048)	(0.011)	(0.133)	(0.048)	(0.121)
Pos_sq	0.011***	0.004**	0.007**	0.009***	0.007***	0.002***	0.000	-0.004***	0.005*
	(0.003)	(0.002)	(0.003)	(0.001)	(0.001)	(0.000)	(0.003)	(0.001)	(0.003)
Capital intensity	0.655***	0.241***	0.418***	0.060***	0.040***	0.020***	0.580***	0.188***	0.395***
	(0.093)	(0.031)	(0.081)	(0.016)	(0.014)	(0.003)	(0.087)	(0.025)	(0.077)
FDI stock	0.017**	0.007**	0.009**	0.003	0.002	0.002*	0.012*	0.005	0.008**
	(0.007)	(0.004)	(0.004)	(0.003)	(0.002)	(0.001)	(0.006)	(0.003)	(0.004)
Schooling	0.029**	0.007	0.023**	-0.000	-0.000	0.000	0.033***	0.008*	0.026***
	(0.013)	(0.008)	(0.010)	(0.006)	(0.005)	(0.001)	(0.011)	(0.004)	(0.010)
Constant	2.787***	1.288***	1.516***	0.819***	0.616***	0.203***	1.768***	0.533***	1.250***
	(0.274)	(0.140)	(0.214)	(0.092)	(0.080)	(0.015)	(0.230)	(0.077)	(0.202)
# of Obs.	1,850,510	1,850,510	1,850,510	2,182,701	2,182,701	2,182,701	1,930,069	1,930,069	1,930,069
R-squared	0.477	0.441	0.516	0.356	0.345	0.526	0.519	0.505	0.532

Notes: Year dummies are included in the model, but they are not reported. Clustered robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

4.5.2 Results with Country Heterogeneity

This subsection represents the results for trade pairs depending on their income levels. Tables 4.9, 4.10, and 4.11 represent the result of total, forward, and backward GVC participations, respectively. In Table 4.9, while faced and imposed tariff rates negatively affect GVC participation between developing-developing pairs, faced tariff is only significant for developed-developing pairs and imposed tariff is significant for developed-developed and developing-developed country pairs. Regarding the control variables, capital intensity is the only variable that boosts the GVC participation of countries regardless of the income level of trading partners. The strong inverted U-shaped relationship between position index and GVC participation among countries with the same income category figures out the importance of functional upgrading in global value chain participation. The positive impacts of foreign direct investment and schooling do not significantly persist in all specifications but vary depending on the income pairs.

Table 4.10 presents the results of forward GVC participation. As it can be noticeable, the results are quite parallel with results provided in Table 4.9 with minor distinctions. Now, the impact of faced tariff rates on forward GVC participation of developing countries when they trade with developed economies is significantly negative. Even though the capital intensity loses its significance in most specifications, the significance of other sector level control variable, that is position index, continues to persist. The more steps through forward linkages until to be consumed as final product, that is the more it is used in industries as intermediates, the more the industry's participation in GVC will be. Table 4.11 presents the results of backward GVC participation. As it can be noticeable, the results are quite parallel with results provided in Table 4.9. Capital intensity appears as significant driver for higher backward participation into GVC. Note that similar to Table 4.9, given the much higher estimated coefficients, imposed tariffs have more influential effects on participation. Hence, we can conclude that for all sectors, higher tariffs significantly impede deeper involvement in GVC with varying degree depending on level of income. We can further claim that sectoral instruments such as movement to higher segments in production chain for forward and higher capital intensity for backward participation are much more effective tools to manage successful participation into GVCs rather than improvements in country level statistics.

Table 4.9: Tariffs and GVC participations by trading partners

	Tariff				**Cumulative Tariff**			
	Developed-Developed	**Developed-Developing**	**Developing-Developing**	**Developing-Developed**	**Developed-Developed**	**Developed-Developing**	**Developing-Developing**	**Developing-Developed**
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Tariff_faced	0.125	-0.255***	-0.245***	0.358	0.060	-0.240***	-0.235***	0.430
	(0.243)	(0.054)	(0.079)	(0.755)	(0.221)	(0.051)	(0.079)	(0.755)
Tariff_imposed	-2.763**	-0.007	-0.494***	-1.580***	-2.326*	0.007	-0.475***	-1.571***
	(1.309)	(0.043)	(0.126)	(0.266)	(1.224)	(0.060)	(0.128)	(0.260)
Pos	-3.888**	0.010	-0.604***	-3.970*	-3.882**	0.015	-0.609***	-3.927*
	(1.829)	(0.090)	(0.185)	(2.254)	(1.828)	(0.090)	(0.185)	(2.230)
Pos_sq	1.532*	-0.001	0.012***	1.298	1.544*	-0.001	0.012***	1.281
	(0.907)	(0.003)	(0.004)	(1.171)	(0.907)	(0.003)	(0.004)	(1.159)
Capital intensity	0.118***	0.107***	0.735***	0.967***	0.126***	0.108***	0.734***	0.998***
	(0.045)	(0.030)	(0.173)	(0.160)	(0.045)	(0.030)	(0.173)	(0.162)
FDI stock	-0.018	0.037***	0.022**	0.016	-0.019	0.037***	0.022**	0.016
	(0.013)	(0.012)	(0.009)	(0.018)	(0.013)	(0.012)	(0.009)	(0.018)
Schooling	-0.002	0.033***	0.021	-0.026	-0.008	0.033***	0.021	-0.025
	(0.027)	(0.010)	(0.026)	(0.049)	(0.028)	(0.010)	(0.026)	(0.049)
Constant	4.265***	0.110	2.900***	7.160***	4.336***	0.105	2.903***	7.213***
	(0.988)	(0.124)	(0.516)	(1.263)	(0.994)	(0.124)	(0.515)	(1.255)
# of Obs.	148,492	513,505	787,098	401,797	148,508	513,586	786,464	401,952
R-squared	0.519	0.594	0.374	0.555	0.520	0.594	0.374	0.555

Notes: Year dummies are included in the model, but they are not reported. Clustered robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 4.10: Tariffs and forward GVC participations by trading partners

| | Tariff | | | | Cumulative Tariff | | | |
| | **Developed-Developed** | **Developed-Developing** | **Developing-Developing** | **Developing-Developed** | **Developed-Developed** | **Developed-Developing** | **Developing-Developing** | **Developing-Developed** |
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Tariff_faced	0.008	-0.089***	-0.128***	-0.117***	-0.014	-0.085***	-0.118**	-0.132***
	(0.022)	(0.013)	(0.047)	(0.038)	(0.021)	(0.013)	(0.047)	(0.038)
Pos	-1.390*	-0.091***	-0.474***	-4.977***	-1.389*	-0.090***	-0.472***	-4.974***
	(0.726)	(0.013)	(0.114)	(0.527)	(0.726)	(0.013)	(0.113)	(0.527)
Pos_sq	0.445	0.003***	0.010***	1.881***	0.445	0.003***	0.010***	1.880***
	(0.292)	(0.001)	(0.002)	(0.212)	(0.292)	(0.001)	(0.002)	(0.212)
Capital intensity	-0.045	0.012	0.075**	0.088***	-0.045	0.012	0.075**	0.088***
	(0.029)	(0.008)	(0.032)	(0.013)	(0.029)	(0.008)	(0.032)	(0.013)
FDI stock	-0.005**	0.000	0.007*	0.001	-0.005**	0.000	0.007*	0.001
	(0.002)	(0.002)	(0.004)	(0.011)	(0.002)	(0.002)	(0.004)	(0.011)
Schooling	0.001	0.003	-0.004	-0.005	0.001	0.003	-0.004	-0.005
	(0.006)	(0.003)	(0.016)	(0.007)	(0.006)	(0.003)	(0.016)	(0.007)
Constant	1.327***	0.164***	0.904***	3.778***	1.329***	0.163***	0.902***	3.779***
	(0.383)	(0.037)	(0.215)	(0.321)	(0.383)	(0.037)	(0.215)	(0.321)
# of Obs.	162,871	586,221	978,876	454,769	162,882	586,281	978,740	454,798
R-squared	0.953	0.822	0.288	0.885	0.953	0.820	0.288	0.885

Notes: Year dummies are included in the model, but they are not reported. Clustered robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 4.11: Tariffs and backward GVC participations by trading partners

	Tariff				Cumulative Tariff			
	Developed-Developed (1)	Developed-Developing (2)	Developing-Developing (3)	Developing-Developed (4)	Developed-Developed (5)	Developed-Developing (6)	Developing-Developing (7)	Developing-Developed (8)
Tariff_imposed	-2.570**	0.044	-0.411***	-1.486***	-2.197*	0.034	-0.401***	-1.478***
	(1.292)	(0.040)	(0.054)	(0.261)	(1.205)	(0.058)	(0.053)	(0.255)
Pos	-2.613*	0.175*	0.009	0.664	-2.608*	0.175*	0.001	0.673
	(1.507)	(0.092)	(0.090)	(2.272)	(1.508)	(0.092)	(0.090)	(2.251)
Pos_sq	1.206	-0.007**	-0.000	-0.467	1.217	-0.007**	0.000	-0.469
	(0.792)	(0.003)	(0.002)	(1.164)	(0.793)	(0.003)	(0.002)	(1.153)
Capital intensity	0.165***	0.088***	0.610***	0.912***	0.171***	0.088***	0.609***	0.945***
	(0.031)	(0.028)	(0.155)	(0.161)	(0.031)	(0.028)	(0.155)	(0.164)
FDI stock	-0.012	0.040***	0.012**	-0.004	-0.014	0.040***	0.012**	-0.003
	(0.013)	(0.011)	(0.006)	(0.016)	(0.012)	(0.011)	(0.006)	(0.016)
Schooling	-0.009	0.033***	0.023	-0.007	-0.015	0.033***	0.023	-0.007
	(0.025)	(0.008)	(0.015)	(0.050)	(0.026)	(0.008)	(0.015)	(0.050)
Constant	2.953***	-0.201*	1.652***	3.599***	3.018***	-0.202*	1.656***	3.691***
	(0.819)	(0.121)	(0.339)	(1.271)	(0.828)	(0.121)	(0.337)	(1.271)
# of Obs.	149,970	542,093	833,473	404,685	149,976	542,134	833,135	404,824
R-squared	0.405	0.515	0.478	0.541	0.406	0.515	0.478	0.540

Notes: Year dummies are included in the model, but they are not reported. Clustered robust standard errors in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

4.5.3 Results with Country and Sectoral Heterogeneity

This subsection represents the results for trade pairs depending on their income levels as well as sectors. Tables 4.12, 4.13, and 4.14 represent the results of manufacturing and Tables 4.15, 4.16, and 4.17 present the results of agriculture and mining sectors.

In Table 4.12, for manufacturing sectors, we observe very similar relationship between tariff rates and GVC participations. The results suggest that even if there are some differences in the effect of tariffs for country pairs, it is important to note that developed countries should decrease tariff polices on products coming from developed countries. The same is valid for developing countries regardless of the income level of trade partners.

Tables 4.13 to 4.14 present the results of forward and backward GVC participations, respectively. As it can be noticeable, the results are quite parallel with results provided in Table 4.12 with minor distinctions. There is negative impact of faced tariff rates on forward GVC participation of developing countries when they trade with developed economies. In fact, this finding is exactly same with the result we have found in all sectors. The similarity between the results of whole and manufacturing sample is quite expected since the majority of sectors in our sample are classified as manufacturing industries. This is also valid for backward GVC participation.

Given the results related to backward GVC participation (Table 4.14), we can claim that for manufacturing industries, higher imposed tariffs significantly impede backward GVC participation of developed (especially if they trade with developed countries) and developing countries. Similar to the general results, movement towards higher segments in production chain and higher capital intensity are significant drivers of GVC participation.

When we compare the results of simple and cumulative tariffs, we notice that the results are mainly parallel in total and manufacturing samples. The results are also quite expected given the highly parallel trends of simple and cumulative tariff rates through the sample period.

Table 4.12: Tariffs and GVC participations by trading partners, manufacturing sectors

	Tariff				Cumulative Tariff			
	Developed-Developed	Developed-Developing	Developing-Developing	Developing-Developed	Developed-Developed	Developed-Developing	Developing-Developing	Developing-Developed
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Tariff_faced	0.027	-0.266***	-0.262***	0.283	-0.034	-0.251***	-0.255***	0.363
	(0.258)	(0.057)	(0.091)	(0.800)	(0.236)	(0.055)	(0.090)	(0.799)
Tariff_imposed	-3.480**	-0.015	-0.596***	-1.906***	-2.991**	-0.028	-0.572***	-1.898***
	(1.552)	(0.047)	(0.150)	(0.326)	(1.450)	(0.066)	(0.153)	(0.319)
Pos	-3.491	-0.215	-0.675**	-3.339	-3.511*	-0.214	-0.685**	-3.319
	(2.128)	(0.162)	(0.296)	(2.785)	(2.130)	(0.162)	(0.296)	(2.750)
Pos_sq	1.435	0.071	0.050**	0.941	1.460	0.074	0.051**	0.934
	(1.142)	(0.060)	(0.022)	(1.438)	(1.143)	(0.060)	(0.022)	(1.419)
Capital intensity	0.156***	0.095***	0.864***	1.187***	0.164***	0.096***	0.863***	1.225***
	(0.044)	(0.037)	(0.212)	(0.203)	(0.045)	(0.037)	(0.212)	(0.206)
FDI stock	-0.027*	0.032***	0.022**	0.014	-0.028*	0.033***	0.022**	0.015
	(0.015)	(0.012)	(0.009)	(0.019)	(0.015)	(0.012)	(0.009)	(0.019)
Schooling	-0.019	0.035***	0.032	-0.021	-0.026	0.035***	0.033	-0.019
	(0.033)	(0.011)	(0.031)	(0.059)	(0.034)	(0.011)	(0.032)	(0.059)
Constant	4.363***	0.196	3.064***	7.337***	4.464***	0.193	3.072***	7.414***
	(1.128)	(0.138)	(0.645)	(1.597)	(1.139)	(0.138)	(0.644)	(1.586)
# of Obs.	117,157	427,173	649,747	323,146	117,174	427,277	649,325	323,274
R-squared	0.489	0.592	0.366	0.546	0.490	0.593	0.366	0.545

Notes: Year dummies are included in the model, but they are not reported. Clustered robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 4.13: Tariffs and forward GVC participations by trading partners, manufacturing sectors

| | **Tariff** | | | | **Cumulative Tariff** | | | |
| | Developed-Developed | Developed-Developing | Developing-Developing | Developing-Developed | Developed-Developed | Developed-Developing | Developing-Developing | Developing-Developed |
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Tariff_faced	0.011	-0.094***	-0.139**	-0.124***	-0.008	-0.090***	-0.131**	-0.136***
	(0.022)	(0.014)	(0.055)	(0.040)	(0.021)	(0.014)	(0.055)	(0.040)
Pos	0.215	-0.283***	-0.436***	-4.188***	0.214	-0.284***	-0.433***	-4.185***
	(0.296)	(0.038)	(0.153)	(0.581)	(0.295)	(0.038)	(0.153)	(0.581)
Pos_sq	-0.171	0.096***	0.011***	1.578***	-0.170	0.097***	0.011***	1.577***
	(0.147)	(0.014)	(0.004)	(0.230)	(0.147)	(0.014)	(0.004)	(0.230)
Capital intensity	-0.024	0.002	0.077**	0.075***	-0.024	0.002	0.077**	0.075***
	(0.016)	(0.007)	(0.038)	(0.012)	(0.016)	(0.007)	(0.038)	(0.012)
FDI stock	-0.004**	0.001	0.007*	0.003	-0.004**	0.001	0.007*	0.003
	(0.002)	(0.002)	(0.004)	(0.010)	(0.002)	(0.002)	(0.004)	(0.010)
Schooling	-0.004	0.005**	0.002	0.003	-0.004	0.005**	0.002	0.003
	(0.006)	(0.003)	(0.019)	(0.007)	(0.006)	(0.003)	(0.019)	(0.007)
Constant	0.422**	0.206***	0.831***	3.125***	0.423**	0.206***	0.829***	3.125***
	(0.166)	(0.035)	(0.269)	(0.361)	(0.166)	(0.035)	(0.269)	(0.361)
# of Obs.	129,329	490,254	813,291	366,756	129,340	490,342	813,261	366,785
R-squared	0.964	0.843	0.271	0.815	0.964	0.841	0.271	0.815

Notes: Year dummies are included in the model, but they are not reported. Clustered robust standard errors in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Table 4.14: Tariffs and backward GVC participations by trading partners, manufacturing sectors

	Tariff				**Cumulative Tariff**			
	Developed-Developed	**Developed-Developing**	**Developing-Developing**	**Developing-Developed**	**Developed-Developed**	**Developed-Developing**	**Developing-Developing**	**Developing-Developed**
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Tariff_imposed	-3.144**	0.029	-0.474***	-1.786***	-2.730*	0.008	-0.462***	-1.784***
	(1.534)	(0.045)	(0.065)	(0.320)	(1.433)	(0.064)	(0.063)	(0.313)
Pos	-4.216**	0.105	0.034	0.050	-4.238**	0.106	0.021	0.027
	(2.024)	(0.130)	(0.131)	(2.861)	(2.026)	(0.130)	(0.131)	(2.831)
Pos_sq	1.912*	-0.012	-0.003	-0.342	1.936*	-0.012	-0.002	-0.331
	(1.090)	(0.048)	(0.009)	(1.442)	(1.091)	(0.048)	(0.009)	(1.425)
Capital intensity	0.183***	0.089**	0.730***	1.144***	0.188***	0.089**	0.730***	1.186***
	(0.039)	(0.035)	(0.190)	(0.203)	(0.039)	(0.035)	(0.190)	(0.207)
FDI stock	-0.022	0.035***	0.010	-0.002	-0.023	0.035***	0.010*	-0.001
	(0.015)	(0.012)	(0.006)	(0.018)	(0.014)	(0.012)	(0.006)	(0.018)
Schooling	-0.022	0.032***	0.028	-0.005	-0.029	0.032***	0.029	-0.004
	(0.032)	(0.009)	(0.019)	(0.060)	(0.033)	(0.009)	(0.019)	(0.060)
Constant	4.150***	-0.126	1.774***	4.667***	4.241***	-0.126	1.782***	4.792***
	(1.069)	(0.131)	(0.384)	(1.641)	(1.081)	(0.131)	(0.382)	(1.640)
# of Obs.	118,604	453,542	691,842	325,890	118,611	453,577	691,589	326,000
R-squared	0.402	0.517	0.477	0.540	0.403	0.517	0.477	0.539

Notes: Year dummies are included in the model, but they are not reported. Clustered robust standard errors in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

In Table 4.15, for agriculture and mining sectors, faced tariffs of developed countries when they trade with developing economies and faced tariffs of developing countries when they trade with developing countries have negative impacts on total GVC participation. In other words, protective measures applied by developing countries can be seen as detrimental barriers in the front of GVC participation of all countries. The results are similar in analysis we employ cumulative tariff rates.

When we conduct separate analysis for forward and backward GVC participations, we notice that the significance of faced tariff rates continues to exist only in developing-developing trading pairs (Table 4.16). Regarding backward linkages, while the tariffs which developing countries impose negatively affect their GVC participation, the effect is opposite for developed economies (Table 4.17). In other words, developed countries benefit from protectionism on agriculture and mining products, which is consistent with the identified effects of the US agricultural policy and the EU common agricultural policy (OECD, 2011).

We observe similar effect sectoral control variables with the analysis of manufacturing sample. Incorporating higher capital-intensive production process and acquiring new function which moves the agricultural and mining products into multiple production stages enhance backward and forward GVC participations, respectively.

When we compare the results of simple and cumulative tariffs, we notice that there is some distinction for agriculture and mining sectors. In some specifications, while simple tariffs are significant, cumulative tariffs are not significant.

Table 4.15: Tariffs and GVC participations by trading partners, agriculture and mining sectors

	Tariff				Cumulative Tariff			
	Developed-Developed	Developed-Developing	Developing-Developing	Developing-Developed	Developed-Developed	Developed-Developing	Developing-Developing	Developing-Developed
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Tariff_faced	0.339*	-0.114**	-0.094**	0.081	0.228	-0.093**	-0.044	0.022
	(0.193)	(0.052)	(0.047)	(0.182)	(0.194)	(0.047)	(0.045)	(0.183)
Tariff_imposed	0.814	0.064	0.038	-0.082	0.978	0.230	0.038	-0.085
	(0.710)	(0.092)	(0.095)	(0.109)	(0.785)	(0.142)	(0.092)	(0.110)
Pos	-6.567	0.275	-1.078***	-9.166***	-6.528	0.277	-1.078***	-9.176***
	(4.265)	(0.351)	(0.172)	(1.483)	(4.270)	(0.351)	(0.172)	(1.490)
Pos_sq	2.483	-0.010	0.021***	3.574***	2.474	-0.010	0.021***	3.578***
	(1.706)	(0.013)	(0.003)	(0.612)	(1.709)	(0.013)	(0.003)	(0.615)
Capital intensity	0.010	0.156***	0.164***	0.131***	0.011	0.156***	0.162***	0.132***
	(0.108)	(0.049)	(0.055)	(0.045)	(0.108)	(0.049)	(0.055)	(0.045)
FDI stock	0.031	0.071*	0.016	0.053*	0.032*	0.072*	0.014	0.053*
	(0.019)	(0.037)	(0.046)	(0.030)	(0.019)	(0.038)	(0.047)	(0.030)
Schooling	0.049*	0.020	-0.015	-0.036	0.049*	0.020	-0.016	-0.036
	(0.027)	(0.020)	(0.027)	(0.027)	(0.028)	(0.020)	(0.027)	(0.027)
Constant	4.507**	0.203	1.932***	7.074***	4.459**	0.201	1.922***	7.083***
	(2.278)	(0.398)	(0.286)	(0.865)	(2.270)	(0.399)	(0.286)	(0.870)
# of Obs.	31,335	86,332	137,351	78,651	31,334	86,309	137,139	78,678
R-squared	0.893	0.615	0.856	0.950	0.893	0.615	0.858	0.950

Notes: Year dummies are included in the model, but they are not reported. Clustered robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 4.16: Tariffs and forward GVC participations by trading partners, agriculture and mining sectors

	Tariff				**Cumulative Tariff**			
	Developed-Developed	**Developed-Developing**	**Developing-Developing**	**Developing-Developed**	**Developed-Developed**	**Developed-Developing**	**Developing-Developing**	**Developing-Developed**
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Tariff_faced	0.094	-0.051	-0.090**	0.068	0.018	-0.039	-0.052	-0.001
	(0.090)	(0.034)	(0.039)	(0.169)	(0.095)	(0.032)	(0.038)	(0.169)
Pos	-8.217**	-0.175***	-0.897***	-7.328***	-8.210**	-0.174***	-0.896***	-7.325***
	(3.563)	(0.042)	(0.132)	(1.258)	(3.564)	(0.042)	(0.132)	(1.258)
Pos_sq	3.106**	0.006***	0.018***	2.838***	3.103**	0.006***	0.018***	2.837***
	(1.418)	(0.002)	(0.003)	(0.525)	(1.418)	(0.002)	(0.003)	(0.525)
Capital intensity	-0.104	0.034	0.071	0.117***	-0.104	0.034	0.071	0.117***
	(0.095)	(0.021)	(0.057)	(0.041)	(0.095)	(0.021)	(0.057)	(0.041)
FDI stock	-0.002	0.001	0.061	-0.038	-0.002	0.000	0.061	-0.038
	(0.009)	(0.013)	(0.060)	(0.095)	(0.009)	(0.013)	(0.061)	(0.095)
Schooling	0.021	-0.009	-0.028	-0.039	0.021	-0.009	-0.028	-0.039
	(0.023)	(0.013)	(0.023)	(0.025)	(0.023)	(0.013)	(0.023)	(0.025)
Constant	5.149***	0.470***	1.472***	5.860***	5.144***	0.470***	1.468***	5.860***
	(1.858)	(0.152)	(0.222)	(0.726)	(1.858)	(0.152)	(0.222)	(0.727)
# of Obs.	33,542	95,967	165,585	88,013	33,542	95,939	165,479	88,013
R-squared	0.942	0.769	0.877	0.953	0.942	0.769	0.877	0.953

Notes: Year dummies are included in the model, but they are not reported. Clustered robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

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Table 4.17: Tariffs and backward GVC participations by trading partners, agriculture and mining sectors

	Tariff				**Cumulative Tariff**			
	Developed-Developed	**Developed-Developing**	**Developing-Developing**	**Developing-Developed**	**Developed-Developed**	**Developed-Developing**	**Developing-Developing**	**Developing-Developed**
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Tariff_imposed	0.299**	0.150*	-0.054***	-0.086***	0.436**	0.204	-0.052***	-0.070***
	(0.133)	(0.078)	(0.012)	(0.019)	(0.194)	(0.129)	(0.012)	(0.018)
Pos	1.802*	0.509	-0.020	-0.902**	1.870*	0.510	-0.020	-0.913**
	(1.018)	(0.391)	(0.035)	(0.379)	(1.028)	(0.391)	(0.035)	(0.378)
Pos_sq	-0.644*	-0.019	0.000	0.345**	-0.665*	-0.019	0.000	0.349**
	(0.390)	(0.014)	(0.001)	(0.156)	(0.394)	(0.014)	(0.001)	(0.155)
Capital intensity	0.102**	0.106**	0.057***	0.045***	0.103***	0.106**	0.057***	0.045***
	(0.040)	(0.041)	(0.014)	(0.012)	(0.040)	(0.042)	(0.014)	(0.012)
FDI stock	0.033*	0.079**	0.011*	-0.005	0.033*	0.079**	0.010*	-0.005
	(0.017)	(0.039)	(0.006)	(0.006)	(0.017)	(0.039)	(0.005)	(0.006)
Schooling	0.033**	0.034***	0.006	0.001	0.032**	0.034***	0.006	0.001
	(0.015)	(0.013)	(0.008)	(0.005)	(0.015)	(0.013)	(0.008)	(0.005)
Constant	-0.836	-0.441	0.226***	0.810***	-0.882	-0.445	0.226***	0.813***
	(0.588)	(0.408)	(0.070)	(0.211)	(0.595)	(0.410)	(0.070)	(0.209)
# of Obs.	31,366	88,551	141,631	78,795	31,365	88,557	141,546	78,824
R-squared	0.496	0.476	0.595	0.559	0.495	0.476	0.595	0.558

Notes: Year dummies are included in the model, but they are not reported. Clustered robust standard errors in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

4.5.4 Results with Country and Technological Heterogeneity

This subsection represents the results for trade pairs depending on their income levels as well as technology level of sectors. Tables 4.18, 4.19, and 4.20 present the results of high-tech sectors and Tables 4.21, 4.22, and 4.23 present the results of low-tech sectors.

While higher faced tariff rates have negative impacts on GVC participation between developed-developing pairs, imposed tariffs have the significantly negative impacts on developed-developed trade partners and developing economies for high-tech sectors as shown in Table 4.18. Capital intensity appears as a significant determinant for GVC participation for all trading partners whereas country level control variables do not significantly affect GVC participation.

The results presented in Tables 4.19 and 4.20 are parallel with results provided in Table 4.18 with minor distinctions. For high-tech sectors, while higher faced tariff rate is related with lower level of forward GVC participation between developed-developing and developing-developing trade pairs (Table 4.19), the effect of imposed tariff is negative only for developing countries (Table 4.20). While upgrading in GVC through higher relative position index enhances the forward GVC participation, capital intensity also remains to be significant for the backward linkages.

When we compare the results of simple and cumulative tariffs, we notice that the results are mainly parallel for both high-tech and low-tech sectors as opposed to the difference between manufacturing and non-manufacturing sectors.

Table 4.18: Tariffs and GVC participations by trading partners, high-tech sectors

	Tariff				**Cumulative Tariff**			
	Developed-Developed	**Developed-Developing**	**Developing-Developing**	**Developing-Developed**	**Developed-Developed**	**Developed-Developing**	**Developing-Developing**	**Developing-Developed**
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Tariff_faced	-0.478	-0.256***	-0.138	0.917	-0.432	-0.238***	-0.124	0.963
	(0.328)	(0.080)	(0.086)	(1.737)	(0.313)	(0.076)	(0.083)	(1.738)
Tariff_imposed	-5.346*	-0.035	-0.392***	-2.399***	-4.587	-0.107	-0.367***	-2.357***
	(3.180)	(0.047)	(0.089)	(0.584)	(2.976)	(0.068)	(0.085)	(0.566)
Pos	-4.323	-0.408***	0.161	-0.307	-4.394	-0.411***	0.080	-0.358
	(4.265)	(0.156)	(0.974)	(6.217)	(4.272)	(0.156)	(0.973)	(6.040)
Pos_sq	1.956	0.167**	-0.380	-0.268	2.018	0.170***	-0.352	-0.246
	(2.364)	(0.066)	(0.503)	(3.276)	(2.369)	(0.066)	(0.503)	(3.186)
Capital intensity	0.856***	0.223**	0.731***	1.523***	0.863***	0.223**	0.730***	1.533***
	(0.230)	(0.109)	(0.141)	(0.475)	(0.231)	(0.109)	(0.140)	(0.477)
FDI stock	-0.037	0.022**	0.024*	0.022	-0.039	0.022**	0.025*	0.023
	(0.026)	(0.011)	(0.013)	(0.034)	(0.026)	(0.011)	(0.013)	(0.034)
Schooling	-0.043	0.036**	0.009	-0.060	-0.055	0.037**	0.009	-0.060
	(0.064)	(0.016)	(0.021)	(0.104)	(0.066)	(0.016)	(0.021)	(0.104)
Constant	5.165**	0.091	0.525	3.561	5.309**	0.092	0.575	3.606
	(2.091)	(0.149)	(0.488)	(3.062)	(2.114)	(0.148)	(0.488)	(2.977)
# of Obs.	56,731	213,048	315,472	156,043	56,739	213,130	315,330	156,116
R-squared	0.442	0.547	0.514	0.571	0.444	0.547	0.515	0.571

Notes: Year dummies are included in the model, but they are not reported. Clustered robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 4.19: Tariffs and forward GVC participations by trading partners, high-tech sectors

	Tariff				Cumulative Tariff			
	Developed-Developed (1)	Developed-Developing (2)	Developing-Developing (3)	Developing-Developed (4)	Developed-Developed (5)	Developed-Developing (6)	Developing-Developing (7)	Developing-Developed (8)
Tariff_faced	0.009	-0.088***	-0.090***	-0.105	-0.011	-0.081***	-0.080***	-0.120*
	(0.021)	(0.019)	(0.015)	(0.072)	(0.020)	(0.017)	(0.014)	(0.071)
Pos	0.506	-0.323***	-0.383***	-5.041***	0.507	-0.325***	-0.380***	-5.033***
	(0.463)	(0.047)	(0.084)	(1.029)	(0.463)	(0.047)	(0.084)	(1.028)
Pos_sq	-0.258	0.118***	0.009***	1.972***	-0.259	0.120***	0.009***	1.969***
	(0.242)	(0.017)	(0.002)	(0.418)	(0.242)	(0.017)	(0.002)	(0.418)
Capital intensity	-0.156***	0.004	0.038***	0.050**	-0.155***	0.004	0.038***	0.051**
	(0.045)	(0.015)	(0.011)	(0.022)	(0.045)	(0.015)	(0.011)	(0.022)
FDI stock	-0.001	0.001	0.008	0.002	-0.001	0.001	0.008	0.002
	(0.003)	(0.003)	(0.006)	(0.018)	(0.003)	(0.003)	(0.006)	(0.018)
Schooling	-0.003	0.006	-0.018***	-0.014	-0.003	0.006	-0.018**	-0.014
	(0.007)	(0.004)	(0.007)	(0.010)	(0.007)	(0.004)	(0.007)	(0.010)
Constant	0.207	0.203***	0.566***	3.429***	0.208	0.203***	0.563***	3.426***
	(0.230)	(0.036)	(0.102)	(0.625)	(0.230)	(0.036)	(0.102)	(0.624)
# of Obs.	62,875	245,130	394,420	176,375	62,881	245,200	394,388	176,389
R-squared	0.966	0.797	0.879	0.915	0.966	0.797	0.879	0.915

Notes: Year dummies are included in the model, but they are not reported. Clustered robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 4.20: Tariffs and backward GVC participations by trading partners, high-tech sectors

	Tariff				Cumulative Tariff			
	Developed-Developed	Developed-Developing	Developing-Developing	Developing-Developed	Developed-Developed	Developed-Developing	Developing-Developing	Developing-Developed
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Tariff_imposed	-5.031	-0.001	-0.409***	-2.287***	-4.363	-0.062	-0.399***	-2.253***
	(3.145)	(0.050)	(0.074)	(0.575)	(2.940)	(0.063)	(0.072)	(0.557)
Pos	-5.563	-0.010	1.891**	2.379	-5.631	-0.010	1.792**	2.243
	(4.073)	(0.117)	(0.908)	(6.421)	(4.078)	(0.117)	(0.906)	(6.256)
Pos_sq	2.609	0.035	-1.000**	-1.375	2.670	0.035	-0.961**	-1.318
	(2.263)	(0.052)	(0.483)	(3.291)	(2.267)	(0.051)	(0.481)	(3.206)
Capital intensity	1.014***	0.238*	0.672***	1.576***	1.019***	0.238*	0.670***	1.596***
	(0.220)	(0.130)	(0.130)	(0.483)	(0.222)	(0.130)	(0.130)	(0.488)
FDI stock	-0.034	0.024**	0.012	-0.002	-0.036	0.024**	0.012	-0.000
	(0.026)	(0.009)	(0.008)	(0.031)	(0.025)	(0.009)	(0.008)	(0.031)
Schooling	-0.046	0.029**	0.031	-0.008	-0.056	0.029**	0.031	-0.010
	(0.061)	(0.013)	(0.019)	(0.108)	(0.063)	(0.013)	(0.019)	(0.109)
Constant	5.234***	-0.189	-0.739*	1.473	5.372***	-0.188	-0.678	1.591
	(2.000)	(0.128)	(0.441)	(3.204)	(2.022)	(0.128)	(0.439)	(3.137)
# of Obs.	57,447	224,079	332,877	157,383	57,450	224,099	332,806	157,447
R-squared	0.378	0.471	0.477	0.569	0.380	0.471	0.478	0.569

Notes: Year dummies are included in the model, but they are not reported. Clustered robust standard errors in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Tables 4.21, 4.22, and 4.23 present the results of low-tech sectors for total, forward, and backward GVC participations, respectively. One of the important results suggests that both tariff rates reduce GVC participation between developing-developing pairs, which simply implies that in order to improve integration among developing countries, further reduction in tariff rates among them is clearly needed.

The results presented in Tables 4.22 and 4.23 are parallel with results provided in Table 4.21 with minor distinctions. While faced tariff rates negatively affects GVC participation between developed-developing trade partners and developing countries (Table 4.22), imposed tariff negatively affects GVC participation of developing countries regardless of income levels of trading partners (Table 4.23).

When we compare the results of simple and cumulative tariffs, we notice that the results are mainly parallel for both high-tech and low-tech sectors. Overall, the protection mostly harms the trade flows of low-tech sectors among developing countries considering both backward and forward linkages. Given the higher fraction of sectors that produces low-tech products, easy substitutability, and thereby relatively more elastic world demand of this type of products, more responsiveness of low-tech sectors to any change in tariff rates regarding different trade pairs compared to high-tech sectors becomes more apparent. While changing the origin of low-tech input is easier, changing the origin of high-tech input is rather difficult because the complexity/uniqueness of high-tech products and the incompatible of production process to new inputs.

Table 4.21: Tariffs and GVC participations by trading partners, low-tech sectors

	Tariff				Cumulative Tariff			
	Developed-Developed	Developed-Developing	Developing-Developing	Developing-Developed	Developed-Developed	Developed-Developing	Developing-Developing	Developing-Developed
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Tariff_faced	0.574	-0.257***	-0.330***	-0.015	0.422	-0.244***	-0.322***	0.075
	(0.356)	(0.073)	(0.121)	(0.262)	(0.316)	(0.069)	(0.121)	(0.275)
Tariff_imposed	-0.890**	0.013	-0.561***	-1.045***	-0.690*	0.091	-0.544***	-1.064***
	(0.395)	(0.066)	(0.200)	(0.218)	(0.407)	(0.092)	(0.203)	(0.221)
Pos	-4.071**	0.059	-0.477**	-6.198***	-4.057**	0.064	-0.474**	-6.132***
	(1.775)	(0.136)	(0.227)	(1.065)	(1.771)	(0.136)	(0.227)	(1.058)
Pos_sq	1.495**	-0.003	0.010**	2.162***	1.492**	-0.003	0.009**	2.141***
	(0.718)	(0.005)	(0.004)	(0.384)	(0.716)	(0.005)	(0.004)	(0.384)
Capital intensity	0.057	0.093***	0.755***	0.740***	0.061	0.093***	0.754***	0.782***
	(0.041)	(0.031)	(0.241)	(0.116)	(0.041)	(0.031)	(0.241)	(0.123)
FDI stock	-0.011	0.047**	0.016	0.013	-0.011	0.047**	0.017	0.013
	(0.010)	(0.019)	(0.012)	(0.011)	(0.010)	(0.019)	(0.012)	(0.011)
Schooling	0.017	0.031**	0.026	0.003	0.015	0.031**	0.026	0.006
	(0.020)	(0.012)	(0.038)	(0.035)	(0.020)	(0.012)	(0.038)	(0.035)
Constant	3.835***	0.203	4.210***	8.485***	3.863***	0.198	4.207***	8.607***
	(1.024)	(0.175)	(1.043)	(0.832)	(1.021)	(0.175)	(1.041)	(0.850)
# of Obs.	91,761	300,457	471,626	245,754	91,769	300,456	471,134	245,836
R-squared	0.722	0.622	0.352	0.538	0.722	0.622	0.352	0.537

Notes: Year dummies are included in the model, but they are not reported. Clustered robust standard errors in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Table 4.22: Tariffs and forward GVC participations by trading partners, low-tech sectors

	Tariff				Cumulative Tariff			
	Developed-Developed	Developed-Developing	Developing-Developing	Developing-Developed	Developed-Developed	Developed-Developing	Developing-Developing	Developing-Developed
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Tariff_faced	0.003	-0.089***	-0.153**	-0.133***	-0.020	-0.086***	-0.143*	-0.148***
	(0.036)	(0.018)	(0.078)	(0.041)	(0.035)	(0.019)	(0.078)	(0.041)
Pos	-2.748**	-0.105***	-0.522***	-4.860***	-2.748**	-0.105***	-0.521***	-4.860***
	(1.197)	(0.019)	(0.151)	(0.591)	(1.196)	(0.019)	(0.150)	(0.591)
Pos_sq	0.946**	0.004***	0.010***	1.806***	0.946**	0.004***	0.010***	1.806***
	(0.472)	(0.001)	(0.003)	(0.236)	(0.472)	(0.001)	(0.003)	(0.236)
Capital intensity	-0.033	0.012	0.088**	0.109***	-0.033	0.012	0.088**	0.109***
	(0.032)	(0.008)	(0.044)	(0.015)	(0.032)	(0.008)	(0.044)	(0.015)
FDI stock	-0.005*	0.000	0.006	-0.001	-0.005*	0.001	0.006	-0.001
	(0.003)	(0.003)	(0.004)	(0.014)	(0.003)	(0.003)	(0.004)	(0.014)
Schooling	0.004	0.001	0.004	0.001	0.004	0.001	0.004	0.001
	(0.009)	(0.004)	(0.024)	(0.010)	(0.009)	(0.004)	(0.024)	(0.010)
Constant	2.176***	0.227***	1.177***	4.021***	2.177***	0.226***	1.176***	4.023***
	(0.636)	(0.059)	(0.372)	(0.363)	(0.636)	(0.059)	(0.372)	(0.364)
# of Obs.	99,996	341,091	584,456	278,394	100,001	341,081	584,352	278,409
R-squared	0.949	0.832	0.278	0.878	0.949	0.830	0.278	0.878

Notes: Year dummies are included in the model, but they are not reported. Clustered robust standard errors in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Table 4.23: Tariffs and backward GVC participations by trading partners, low-tech sectors

	Tariff				**Cumulative Tariff**			
	Developed-Developed	**Developed-Developing**	**Developing-Developing**	**Developing-Developed**	**Developed-Developed**	**Developed-Developing**	**Developing-Developing**	**Developing-Developed**
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Tariff_imposed	-0.744**	0.075	-0.413***	-0.952***	-0.595*	0.100	-0.403***	-0.967***
	(0.315)	(0.060)	(0.075)	(0.209)	(0.320)	(0.090)	(0.074)	(0.211)
Pos	-1.231	0.248*	0.183*	-0.760	-1.194	0.248*	0.181*	-0.690
	(0.829)	(0.142)	(0.102)	(0.801)	(0.828)	(0.142)	(0.102)	(0.793)
Pos_sq	0.583*	-0.009*	-0.004*	0.137	0.568*	-0.009*	-0.004*	0.115
	(0.340)	(0.005)	(0.002)	(0.266)	(0.340)	(0.005)	(0.002)	(0.265)
Capital intensity	0.097***	0.071***	0.605***	0.636***	0.099***	0.071***	0.604***	0.678***
	(0.022)	(0.027)	(0.216)	(0.113)	(0.022)	(0.027)	(0.216)	(0.120)
FDI stock	-0.006	0.050***	0.010	-0.001	-0.007	0.050***	0.010	-0.001
	(0.010)	(0.019)	(0.009)	(0.009)	(0.010)	(0.019)	(0.009)	(0.009)
Schooling	0.008	0.036***	0.016	0.002	0.006	0.036***	0.017	0.004
	(0.017)	(0.010)	(0.020)	(0.033)	(0.017)	(0.010)	(0.020)	(0.033)
Constant	1.605***	-0.229	2.493***	4.094***	1.611***	-0.232	2.489***	4.219***
	(0.577)	(0.177)	(0.778)	(0.701)	(0.579)	(0.178)	(0.776)	(0.724)
# of Obs.	92,523	318,014	500,596	247,302	92,526	318,035	500,329	247,377
R-squared	0.515	0.542	0.478	0.501	0.513	0.542	0.478	0.500

Notes: Year dummies are included in the model, but they are not reported. Clustered robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

4.6 Conclusion

This chapter investigates the effects of tariffs on global value chain participation utilizing value-added trade statistics and the concept of cumulative tariff rates for 12 sectors from 168 countries through the period 1990-2015. The main finding is that tariff rates significantly deteriorate global value chain participation of sectors in these highly fragmented production networks. Moreover, simple tariffs can then turn into even higher tariff rates (nearly 12% of indirect cost) via knock-on effect along with supply chains which means important cost for producers in the value chain. Furthermore, our estimates take the inward processing regime into account and provide separate estimates by employing simple and complex parts of GVC participation.

Our visual graphs show that while the simple tariff in the world is around 6%, the cumulative tariff is 7%, implying that there are approximately 12% indirect tariffs along with the global value chains. According to the empirical findings, both simple and cumulative tariffs have detrimental impacts on total, forward, and backward GVC participations. To realize the benefits of GVCs, country/sector capacity building is just as crucial as trade liberalization. Given the strong U-shaped pattern of position index, adding new functions, such as adding more productive processes to manufacturing, can be considered as a good tool for moving along the production chain, or functional upgrading. Other factors encouraging GVC participation include increasing capital intensity, attracting more FDI stock, and rewarding higher education levels in general. Even while the overall findings are consistent, there are some differences in the effects of tariff rates based on income level of countries and sector heterogeneities. In general, manufacturing industries, low-tech sectors, developing countries, and trade between developed-developed countries are seen as more vulnerable groups to any trade barriers. Removal of any barriers that sub-groups can encounter in their backward and forward linkages can boost their GVC participations.

Overall, while the global value chains get larger and longer, a particular interest is drawn into tariff policies. Trade barriers especially in the form of tariff rates are still a significant concern because of its cumulative effect along with global value chains. Given the significant results in this chapter, we can claim that policy makers ought to track the domestic value-added of sectors along with the value chain and focus on the indirect effect of tariff rates by taking length of trade flows into account. Accordingly, the findings driven from the precise assessment of these new measures should be

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discussed and taken place in national polices and international negotiations. Specifically, even if there are successive rounds to liberalize the trade of intermediates, the inward processing regime, and specific tariff exemption on some sectors, tariffs on intermediates still matter for sectoral performance with also considering country and sector level heterogeneities. Therefore, autonomous and global liberalization efforts are quite crucial for all sectors to benefit from global production system considering cascading effects of these liberalization efforts.

5 CONCLUSION AND DISCUSSION

5.1 Conclusion

With the improvements in information, communication, and transportation technologies and the expansion of global trade especially in the fragmented production system in the last three decades, the growth impacts of participating into these activities, the main determinants of both participation levels and sectoral output and productivity growth, and the potential drivers and threats for these measures appear to be important research questions. Specifically, the relationship between trade openness and economic growth attracts attention again on which neither theoretical models nor empirical analysis has reached a consensus. Therefore, this dissertation aims to understand the effects of sectoral trade policies on sectoral performances by using mainly two sets of trade openness measures: (i) trade volumes based on gross and value-added trade statistics and (ii) simple and cumulative input and output tariff rates. In the first chapter, we briefly review the literature on trade theories as well as trade policies. In our second chapter, we investigate output and productivity growth consequences of participation into global value chains by focusing on the degree of participation level. In the third chapter, we analyze the same relationship with also including a variety of tariff rates as policy determinants in a two-phase model: Growth and gravity models. In the fourth chapter, we mainly examine the impacts of tariff rates on GVC participations by employing both simple and cumulative tariff rates.

The first chapter provides the systematic review of trade theories including absolute advantage (Smith, 1776), comparative advantage (Ricardo, 1817), Heckscher-Ohlin theories (Heckscher, 1919; Ohlin, 1933), and a brief history of trade policies in the form of tariffs, non-tariff-measures, preferential trading agreements, regional/multilateral agreements, free trade association, custom union, common market, economic union, and the membership of international organizations. In this introduction part, we also explain the main motivation of the thesis, the contributions to literature, and the scope of the dissertation. Milestone trade theories illustrate us the trade dynamics in a simple framework, but they also present the benefits of participation into trade activities. While the classical international trade focuses on the trade of final products among countries, the current pattern of trade is quite different from what was observed before. Nowadays, countries benefit not only differences in

factor endowments among countries, but also gain from knowledge and technology embedded in trade as well as acquire advanced organization and management practices in the global market. This shows us the importance of sectoral developments in order to both participate in today's trade and obtain the desired/promised benefits from trade activities.

The second chapter investigates the determinants of total factor productivity and value-added growth by taking both the position of the industry in the global value chain and the complexity of participation into account for the period of 1996-2009 for 40 developed and developing countries. Our estimation results clearly show that while all measures of forward GVC participations raise the total factor productivity growth of manufacturing industries, there is no significant effect of participation into GVCs on the productivity of service sectors. Almost all measures of backward and forward GVC participations substantially promote the output growth of manufacturing and services industries regardless of the complexity of participations. These significant results provide strong evidence for the learning by trading hypothesis and indicate the importance of deeper involvement into GVCs for higher sectoral productivity. The findings are quite parallel to those found in the literature (Kummritz, 2016; Taglioni and Winkler, 2016; Formai and Vergara Caffarelli, 2016; Constantinescu et al., 2019; Jona-Lasinio and Meliciani, 2019; Yanikkaya and Altun, 2019, 2020). Substantial evidence for the positive impact of importing and exporting intermediates, that is participating in GVCs, on sectoral performance imply that the successes of industries depend highly on their efficient integration in the global production process. As a result, we consider that manufacturing industries should participate more in the forward GVC and especially in the complex part of it to support higher sectoral TFP growth through knowledge spillovers, hyper-specialization, strong international rivalry, scale economies, and better qualification and certification of processes. Both the manufacturing and service sectors can also reach higher sectoral output thanks to the higher participation in global markets. In order to achieve this, initiating new international cooperation and deepening the existing ones with the advanced rules and commitments can be seen as the most effective tools. Even though strong backward linkages, particularly the complex ones, can render external shocks more disruptive in supply chains and transmit the shocks to domestic markets directly, strengthening sourcing strategies with global diversification of suppliers and improving country logistics performance can mitigate these risks along the global value chains. Given the

strong U-shape relationship between value-added growth and the relative position index and the positive impact of high skilled labor on sectoral growth, we can recommend that sectors should integrate more functions in their production process which moves them pre- or post-manufacturing stages in the global production chain and enhances their capacities.

Given the substantial impact of participating into GVCs, especially the sectoral productivity and growth impacts of complex part of GVC participation in the second chapter, the main aim of *the third chapter* is to integrate one of the important policy measures, that is tariff rates into our analysis. This chapter provides new evidence on the issue by employing a variety of different tariff measures for both intermediates and final products called input and output tariff rates, respectively. We utilize the EORA26 input-output tables to calculate trade statistics. After merging tariff rates and country specific information (such as gravity measures) with EORA26, we have 11 sectors (nine manufacturing, mining, agriculture and fishing) from 153 countries over the periods 1990-2015 as an operational sample. Our main contribution to the current empirical literature is the calculation of input and output tariff rates separately by utilizing tariff rates on harmonized system 6-digit product codes and aggregating them into reach sectoral tariff rates. To this end, we undertake estimations in two phases: sectoral growth and extended sectoral gravity models. Our results show that imposed output tariffs significantly raise the value-added growth of low-tech manufacturing sectors of developing countries, which provides substantial evidence for the import substitution policies and infant industry argument. This specific result is parallel to what the literature finds out (Yanikkaya, 2003; DeJong and Ripoll, 2006; Rodrigues, 2010; Adewale, 2017). The literature also asserts that for industries to increase their production at their early stages of production and use economies of scale in subsequent periods, some specific industries must be protected from international competition for a specific period. Therefore, we claim that strategic trade policies especially focusing on specific manufacturing industries can actually have growth enhancing effects for the developing economies. Our results also reveal that developed economies also benefit from protection applied on their final products regardless of sectoral categories. The analysis of sectoral growth model provides substantial evidence for the positive impacts of capital, regulatory quality, and human capital on sectoral growth, which points out the importance of capacity upgrading. The extended sectoral gravity analysis reveals the strong negative impacts of any distraction in transaction of

products as similar to the related literature (Johansson et al., 2014; Tian and Yu, 2017; Ing et al., 2018). Given the significantly negative impacts of faced tariffs on bilateral forward linkages especially for agriculture, mining, and high-tech sectors and developing countries, we can argue that governments should consider sector specific trade policies and strengthen their capacities to reap the benefits of international trade and to achieve economic growth.

The third chapter proves that even if there is a strong growth effect of protection of low-tech manufacturing sectors of developing countries, in almost all of the specifications, there exists no benefit from the protection provided for intermediates. Therefore, in *the fourth chapter*, we analyze the transaction of intermediates, that is global value chain participation in a more detailed way. The trade of intermediates consists of ever-growing share of global trade. In this highly fragmented global production system, any change in a tariff rate may generate higher impact than that of simple direct tariff can do. To assess the impacts of tariffs on global value chain participation, the fourth chapter uses value-added trade statistics and the idea of cumulative tariff rates for 12 sectors from 168 countries over the years 1990 to 2015. From a simple eye inspection, the simple tariffs result in higher tariff rates (almost 12% of cumulative tariff rates as an indirect cost) due to a knock-on impact along the supply chains. The main empirical finding is that both market access and input tariff rates significantly reduce sectoral forward and backward global value chain participation, respectively. Moreover, the effect is persistent in the analysis when we employ cumulative tariff rates. The related literature also reaches the similar conclusion regarding the detrimental impact of higher tariff rates (Kowalski et al., 2005; Nordas, 2006). Given this finding, we can suggest that governments should reduce tariffs and remove any other trade barriers to expand sources of inputs as well as sources of supply. Apart from these trade policy variables, endowments at the sector and country levels such as higher relative length, capital intensity, FDI stock, and education level appear to be the major drivers of higher total, forward, and backward GVC participation. Well-defined laws, favorable business environment, and government promotions can be seen effective instruments to attract foreign direct investment as well as to reach higher segment of global value chains. Even if the general results are robust, there are also some distinctions in the effects of tariff rates depending on country and sector level heterogeneities. In general, the negative impacts of tariffs on the global value chain participations of some specific sub-groups such as

manufacturing industries, low-tech sectors, developing countries, and trade between developed-developed countries are considerably higher compared to the effects on any other sub-groups. As a policy-related debate, given the cascading impacts of these liberalization initiatives; autonomous, regional, and global liberalization efforts are critical for all sectors to reap the benefits from the global production system.

5.2 Policy Discussion

The global trade is enormously transformed in the several decades. This enables many sectors from different locations of the world to specialize in a specific segment of production chain in which they have competitive advantage as well as to experience enhanced operational practices in international markets. In general, the conclusion we reach is that sectors can benefit from participation into GVC activities through achieving higher output and productivity growth. Therefore, the negative and escalating effect of any distraction in the global production system is more relevant. In a similar vein, any liberalization efforts in both goods and services as well as production factors expand access to markets and reap the benefits of global value chains. In this respect, the first important thing is ensuring, at least selective, trade liberalization by autonomous decreases in tariffs, regional trade agreements, and multilateral negotiations among countries. The second policy suggestion is investing in supporting services such as transporting, financing, and accounting which lowers transaction costs and enhances the connectivity of countries with each other. By ensuring the improvement in these areas, countries also prepare themselves for a demand or supply shock that may occur in any country or simultaneously in many countries in the global world like we have observed in the 1929 Great Depression, the 2008 Global Financial Crisis, and the recent Covid-19 pandemic. In other words, the advances in these sectors also play crucial role not only in efficient integration into GVCs but also in alleviating the risk related to higher level of integration among countries. Furthermore, the improvements in legal and regulatory framework ensuring fast and smooth transaction of products through global production system are important as the auxiliary supporting services. These facilities also help to attract more investors into countries and enhance the relationship of the domestic sectors with the

global economy so that the countries are able to deepen their trade relationship with other countries from all over the world.

Even if the general inference is in that way, further and detailed analysis also reveals that the positive growth impact of trade openness varies depending on income level of countries/trading partners, sectors, technology classification of sectors, and types of products as inputs and outputs. Specifically, the protection provided especially on low-tech manufacturing final products boosts growth of these sectors in developing countries as we pointed out in the third chapter. Even if this is the case, the important point is that protectionism ought to be temporary. In other words, countries protect their manufacturing industries to accumulate sufficient experience, momentum, and benefit from economies of scale for a certain time. After the industries have adequately matured, they ought to open up the competition from international trade. Therefore, even a country that heavily follows protectionist policies will eventually try to sell its products in the international market and gain from the benefits of the global value chains, after a certain period of time, through policies that promote liberalization of trade and especially exports.

At this point, it is important to note that sectoral performances measured with total factor productivity growth, value-added growth, and higher GVC participation levels critically depend on capacity of sectors and endowments of countries. In other words, investing in research and development, hiring better educated workers/high skilled labors, ensuring governmental quality, and thereby adding more functions in production process through positioning sectors more upstream can be seen as main requirements to stimulate sectoral performances. Since factor endowments matter, countries should strengthen the capacity of research and development and the ability of their workforce by matching the needs of sectors with education system provides. Since the good governance also matters, countries should improve their legal and regulatory framework, enforcement of contracts, and intellectual property rights so that stability and predictability of goods and services flows can be sustained.

Therefore, policy makers should simultaneously focus on both inward policies such as any stimulating actions in capital, technology, and governance and outward policies such as trade liberalization efforts in any types and at various levels to develop the sectors and to effectively integrate them into global value chains. In this way, sustainable economic growth and development can be achieved through policies for upgrading as well as policies facilitating global value chain participation.

5.3 Limitations

This dissertation has also some limitations. The first one is related to coverage of the current input-output tables provided by the World Input Output Database (WIOD) (Timmer et al., 2015), Organization for Economic Co-operation and Development (OECD), and EORA (Lenzen et al., 2012, 2013). Even though they are quite beneficial to detect the true domestic value-added of sectors and to calculate the related trade measures, each one of them has also some specific deficiencies. The WIOD does not consider the period of 1995-2014 as a one sequence because of the changing international standard industrial classification of all the economic activities in 2008. While the input-output tables provided by the OECD observe these years without any distractions in period, it has also some limitations. Their country coverage is very limited to get inference about countries with different level of incomes in the world. Although the sectoral coverage of EORA is also limited compared to the input-output tables provided by the WIOD and OECD, the highest number of countries and years are observed through this database. One may argue that with the improved input-output tables, researchers can have more sector disaggregation or the firm level data to obtain more refined estimates. Moreover, we believe in that the future input-output tables will be improved with more disaggregation of sectors and can be even compiled at the firm level.

The second limitation is related to the current input-output methodology. Even though the value-added accounting and decomposition methodology of Wang et al. (2017a, b) enables us to detect the true domestic value-added of each sector embedded in intermediates, it cannot detect the domestic value-added embedded in final products in bilateral at country-sector datasets. Therefore, we can only employ the value-added trade statistics of only transaction of intermediates, that is global value chain activities in the third chapter.

The third constraint is a lack of detailed sectoral level data on physical capital, human capital, and research and development intensity. Even though the WIOD contains information on labor compensation and workhour with respect to skill level of labors and the OECD provides R&D expenditure of sectors, the coverages of them are quite limited, which makes impossible to introduce these variables in our empirical models.

The fourth one is that we can reach some country level statistics such as transportation costs, ease of doing business, and the activities of multinationals for only some certain countries and period. Since including these variables dramatically decreases the number of observations in our sample and produces a biased sample, we continue with our basic models and ignore the effects of them in our analysis.

The last limitation is that even if we select the effectively applied tariff rates from the World Integrated Trade Solution (WITS) database, these tariffs may not actually be levied by all governments for some specific export promotion purposes and some of traded products can be exempted from the tariff procedure. Even if the country level comparison reveals that de facto and de jure measures of tariffs are not very different from each other in the third chapter, observing the true tariff rates would be important to precisely measure the impacts of tariff policies on sectoral growth.

5.4 Future Research Directions

Given the different impacts of simple and complex global value chain participation on sectoral growth in the second chapter, different impacts of gross and value-added trade statistics on sectoral growth and bilateral export in the third chapter, and the varying results of simple and cumulative tariff rates on global value chain participations in the fourth chapter, this dissertation reveals the importance of accuracy in measurement of sectoral trade related variables to find real and true impact of any trade policies on sectoral performances. We may not precisely be able to assess the effect of policies we cannot properly measure. To achieve this, newly released input-output tables are quite beneficial, but their coverage is rather limited as indicated in the previous sub-section. Therefore, enriching the coverage of these databases and publicly opening them will be quite beneficial for future researchers as well as policy makers.

The current calculation methodologies related to advanced trade measures and more specifically input-output methodology is already well-developed, but further improvements will take place in near soon. For instance, the calculation methodology of Wang et al. (2017a, b) can be further developed to detect the domestic value-added embedded in final products for bilateral at country-sector datasets.

Given the strong heterogeneities in our sample, the future research should be devoted to specific sector ("spider" or "snake" types) analysis to precisely understand the impacts of sectoral trade policies in a detailed and comprehensive manner. By doing this, employing sector level data play crucial information. Even if these variables are limited in general, analyzing specific country may enrich the sector level variables in empirical models.

One of the important outward trade policy measures, that is tariff rates are crucial determinants which needs to be further consideration. Custom officers and statisticians in international institutions and organizations ought to measure and calculate the de facto measures rather than the de jure measures. Obtaining de facto measures of tariff rates by considering inward processing regime, exemptions, and specific government intervention would significantly contribute to the literature. In addition, even if we do not consider the impact of non-tariff barriers in the dissertation, we will focus on these measures in our future research.

Given the importance of supporting services such as transporting, financing, and accounting in connectivity of countries, new studies should investigate the impacts of service sectors on global value chain participation and growth of non-service sectors. Moreover, although direct simple tariffs are not applied to products in the service sector, we can detect the indirect tariffs applied to products in the service by tracking the simple tariff along with the global value chains, that is calculating cumulative tariff rates.

The spread of global value chains (GVCs) causes factors of production to be more sensitive to any changes in the international market. In order to understand the dependence of factors of production on international demand, the statistics of capital and employment in trade can be effective tools in recognizing the impact of external demand on factors of production and thus production in globally interdependent world economies. According to the OEDC report (Horvát et al., 2020), around 30% of total employment depends on foreign final demand and this trend shows an increasing tendency from 2005 to 2015. However, this ratio and trend represent only the average. Since developed countries participate in more complex and developing countries involve in simple global value chains (World Bank Report, 2020), tracking the factors of production embedded in trade provides important insights for the researchers to test the classical trade theories as well as to conduct detailed empirical analysis. Furthermore, the impacts of specific trade shocks such as accession of Turkey to

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Custom Union in 1995, Chinese accession to WTO in 2001, and the trade war between the United States and China in 2018 on sectoral capital and employment in trade can be evaluated. Using the value-added accounting and decomposition methodology of Wang et al. (2017a, b), not only capital or labor embedded in different segments of trade can be measured, but also research and development level, technology, foreign direct investment, skilled labor as well as greenhouse gas emissions embedded in different segments of trade can be calculated.

With the improvements in input-output tables, the calculation methodologies, strategies in empirical analysis, and data collection methodology, we hope that the future theoretical, empirical, and descriptive studies as well as reports of international institutions will be well-developed and more available to precisely catch the true effect of any sectoral trade policies.

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BIOGRAPGHY

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