THE EFFECT OF INTEGRATION INTO GLOBAL VALUE CHAINS (GVCs) ON INNOVATION PERFORMANCE AND THE CASE OF TÜRKİYE

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ABSTRACT

THE EFFECT OF INTEGRATION INTO GLOBAL VALUE CHAINS (GVCs) ON INNOVATION PERFORMANCE AND THE CASE OF TÜRKİYE

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The thesis investigates the effect of integration into global value chains (GVCs) on innovation performance by analyzing different types of GVC participation, i.e., backward and forward participation. To this end, a cross-country industry-level analysis is conducted using panel data from 41 countries and 19 industries over the period 1995-2018. The thesis puts special emphasis on Türkiye by incorporating both descriptive and econometric analyses. Bridging the fields of GVC and innovation studies, it constructs a comprehensive dataset by transforming and aggregating data from multiple sources, including the OECD Trade in Value-Added (TiVA), Patents, and Analytical Business Enterprise Research and Development databases. The findings indicate that the effects of GVC participation on innovation performance vary according to the type of participation and the technology intensity of industries. The cross-country analysis reveals that backward participation positively affects innovation performance, whereas forward participation does not yield a significant positive effect. When considering technology intensity, importing inputs for exports enhances innovation performance only in medium high-technology industries, while providing inputs for other countries' exports improves innovation performance in

medium low-technology industries. Regarding Türkiye, the results indicate no significant overall effect of either backward or forward participation on innovation performance. However, both backward and forward participation positively affect innovation in medium high-technology industries. Based on these findings, the thesis provides several policy implications, suggesting that the differences in the effects of GVC participation on innovation performance may stem from underlying factors in knowledge economics and innovation studies.

Keywords: Global value chains, innovation performance, backward and forward participation, technology intensity, Türkiye

ÖZ

KÜRESEL DEĞER ZİNCİRLERİNE (KDZ) KATILIMIN YENİLİK PERFORMANSI ÜZERİNDEKİ ETKİSİ VE TÜRKİYE ÖRNEĞİ

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Bu tez, küresel değer zincirlerine (KDZ) eklemlenmenin yenilik performansı üzerindeki etkisini farklı KDZ katılım türlerini (geri katılım ve ileri katılım) analiz ederek incelemektedir. Bu amaçla, 1995-2018 dönemini kapsayan 41 ülke ve 19 sektöre ait panel veri kullanılarak ülkeler arası sektör düzeyinde bir analiz yapılmaktadır. Ayrıca, tez Türkiye'ye özel bir vurgu yaparak hem betimsel hem de ekonometrik analizler içermektedir. KDZ ve yenilik çalışmaları alanlarını birleştiren tez, OECD Ticarette Katma Değer (TiVA), Patent İstatistikleri ve Analitik İşletme Araştırma ve Geliştirme veri tabanları da dahil olmak üzere çeşitli kaynaklardan elde edilen verileri dönüştürüp toplulaştırarak kapsamlı bir veri seti oluşturmuştur. Bulgular, KDZ'ye katılımın yenilik performansı üzerindeki etkisinin, katılımın türüne ve sektörlerin teknoloji yoğunluğuna göre farklılık gösterdiğini ortaya koymaktadır. Ülkeler arası analiz, geri katılımın yenilik performansını olumlu etkilediğini, buna karşın ileri katılımın anlamlı düzeyde olumlu bir etki göstermediğini ortaya koymaktadır. Teknoloji yoğunluğu dikkate alındığında ise, ihracat amacıyla girdi ithalatı, sadece orta-yüksek teknoloji yoğun sektörlerin yenilik performansını artırırken, diğer ülkelerin ihracatına girdi tedarik etme orta-düşük

teknoloji yoğun sektörlerde yenilik performansını iyileştirmektedir. Türkiye'ye ilişkin olarak elde edilen bulgular gerek geri gerekse ileri katılımın genel olarak yenilik performansı üzerinde anlamlı bir etkisinin bulunmadığını ortaya koymaktadır. Ancak hem geri hem de ileri katılım yalnızca orta-yüksek teknoloji yoğun sektörleri olumlu etkilemektedir. Bu bulgulara dayanarak, tez, KDZ'ye katılımın yenilik performansı üzerindeki etkilerindeki farklılıkların bilgi ekonomisi ile yenilik çalışmaları alanlarındaki bazı unsurlardan kaynaklanabileceğini öne süren politika çıkarsamalarında bulunmaktadır.

Anahtar Kelimeler: Küresel değer zincirleri (KDZ), yenilik performansı, geri ve ileri katılım, teknoloji yoğunluğu, Türkiye

To My Family

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LIST OF ABBREVIATIONS

ANBERD	Analytical Business Enterprise Research and Development
EUROSTAT	Statistical Office of the European Union
FDI	Foreign Direct Investment
FE	Fixed Effects
GVC	Global Value Chain
G2SLS	Generalized Two-Stage Least Squares
ICIO	Inter-Country Input-Output Tables
IOT	Input-Output Tables
IPC	International Patent Classification
IPS	Im-Pesaran-Shin
ISIC Rev.4	International Standard Industrial Classification of All Economic Activities Revision 4
KDZ	Küresel Değer Zincirleri
NACE Rev.2	Statistical Classification of Economic Activities in the European Community Revision 2
OECD	Organization for Economic Co-operation and Development
R&D	Research and Development
RE	Random Effects
STAN	Structural Analysis Statistics
TiM	Trade in Employment
TiVA	Trade in Value Added
UNCTAD	United Nations Conference on Trade and Development
WTO	World Trade Organization
2SLS	Two-Stage Least Squares

CHAPTER 1

INTRODUCTION

1.1. Aim of the Thesis

Global value chains (GVCs) are regarded as a distinct feature of the global economy in the twenty-first century, which has implications for all countries at different levels of development, i.e., a wide spectrum of countries ranging from the more advanced to the least developed, and the firms with different sizes and competences operating in different industries. The remarkable effects of GVCs are seen in global trade, investment flows, growth patterns, income generation and employment (Gereffi *et al*., 2001; Baldwin, 2012; OECD, 2013). As the phenomenon has become more evident with its multifaceted reflections, it also becomes an inevitable part of the agenda of the policymakers, who are eager to respond to the changing nature of the global economy. The remarks made by the G20 leaders at the Los Cabos Summit that was held on 18-19 June 2012 explicitly reflected these considerations. The leaders at the summit declared:

> *"We value the discussion held by our Trade Ministers in Puerto Vallarta on the relevance of regional and global value chains to world trade, recognizing their role in fostering economic growth, employment and development and emphasizing the need to enhance the participation of developing countries in such value chains. We encourage a deepening of these discussions in the WTO, UNCTAD and OECD within their respective mandates, and we call on them to accelerate their work on analyzing the functioning of global value chains and their relationship with trade and investment flows, development and jobs…"* (G20, 2012).

GVCs have transformed trade relations through causing changes in "*trade-growth-development links, trade-competitiveness link, and trade-governance options*"

(Taglioni and Winkler, 2016, p.xiii). It is argued that developing countries as well as developed countries can gain economic benefits through participating in GVCs (OECD, 2016; World Bank, 2020, World Bank, 2022, Ziemann and Guérard, 2016). In this vein, OECD (2016) argues that integration into GVCs increases trade by extending and diversifying the export market, enhances investment flows and involves technological, skill and managerial spillovers.

Both the geographical location as well as the governance of economic activity at the international level have been greatly reshaped by the GVCs over the last few decades. For example, for almost any complex product the location of production is no longer a single country, since the various parts of a product are produced in many different countries. In other words, economic activity is now organized around a large network of firms, and a division of labor among these firms, i.e., between the leaders and partners. In essence, GVCs offer various pathways with which countries could develop their local industries such as external demand or enhanced productivity via firm collaboration (World Bank 2022, p. 25-26).

Notwithstanding that, we also have to understand the distributional effects of the gains from globalization in the GVCs. Although positive distributional impacts are often associated with the participation in GVCs, some criticism has also emerged, as GVC participation might not always guarantee upgrading and improved wellbeing for all countries (World Bank, 2022). It is true that, today almost all countries participate in GVCs, but in a variety of ways. As Kowalski *et al.* (2015) argue, the benefits arising from GVCs do not show a uniform fashion and the gains associated with the value chain are not captured in a one size fits all way. Some question the economic benefits arising from the participation of developing countries in GVCs (UNCTAD, 2014). There are considerations about the channels through which the participation into GVCs can yield positive effects and spillovers to the domestic economy. In particular, it is argued that development does not automatically occur through integration into GVCs. Participation in GVCs is risky since it facilitates the transmission of macroeconomic shocks leading to increased volatility and vulnerability. It also necessitates policy coherence among countries amidst the greater sensitivity to the elements of the business environment (OECD, 2013).

Still keeping in mind, the above-mentioned discussion, which intrigues many scholars and policymakers, our purpose is neither to investigate whether the integration into GVCs is a panacea for the development of countries; nor to claim that GVC participation is detrimental for economies. Rather, our primary interest resides in the relationship, if it does exist, between GVC participation and innovation performance of countries, which we consider has significant implications for economic development.

In this vein, the purpose of the thesis is to investigate whether the integration into GVCs has an effect on innovation performance of countries. In particular, the thesis aims to shed light on whether different types of GVC integration (namely, backward participation and forward participation into GVCs) can generate (different) effects on innovation. In addition to cross-country industry analysis, the thesis also aims to put a special emphasis on Türkiye. Last but not least, based on the investigation regarding the aforementioned relationship, the research aims to draw some policy recommendations, which could have implications for science and technology policy as well as foreign trade policy. By focusing on the likely effects of GVC participation on innovation performance, the study can contribute to the emerging literature in this field.

1.2. Statement of the Problem

Despite the fact that GVCs are now an integral part of international trade, their likely effects on innovation performance have not been clearly stated. The main effects of the integration into GVCs are expected to occur mainly through the effects on productivity and value-added. In this vein, it is not so explicit to gain (direct) insights about its effects on innovation performance. Nevertheless, there is still some scope to investigate the relationship between GVC participation and innovation performance.

Regarding the issue, we can utilize some of the main arguments put in the literature on GVCs (see Chapter 2 below). The literature emphasizes the importance of both backward linkages and forward linkages within the GVCs for knowledge acquisition and spillovers. In this vein, one of the key linkages between the two fields, i.e., GVC

and innovation, can be put forward as the role of integration into GVCs in generating as well as diffusing knowledge, and sourcing technology (Morrison *et al*., 2008). Knowledge spillovers from suppliers as well as GVC lead firms and learning through exporting can be regarded as the main mechanisms through which GVC linkages can contribute to skill building, development of human capital, product quality, and process improvement, which in turn leads to the enhancement in innovation performance.

Easier access to a large range of (cheap) intermediate goods (with higher quality) through backward linkages within GVCs could lead to the expansion of product variety and product quality through innovation (Xing *et al*., 2021, p.72). As Halpern *et al*. (2005) also argue, importing new and advanced products is a way to eliminate constraints encountered in the production processes and thereby affects firm productivity positively. The higher the firm productivity, the easier it is to face export sunk costs and produce new goods for foreign customers (Bas and Strauss-Khan, 2011; Kasahara and Lapham, 2013 cited in Lo Turco and Maggioni, 2013). Moreover, increased competition due to imports led by backward linkages in GVCs also might push firms to invest in new technologies, processes and skills. Ziemann and Guérard (2016, p.6) argue that backward participation leads to both reallocation of domestic sources to most competitive firms due to the exposure to import competition, and diffusion of knowledge through learning from suppliers and knowledge spillovers from foreign direct investment.

Regarding forward integration in GVCs, Ziemann and Guérard (2016, p.6) argue that forward participation leads to an increase and diversification of potential export markets and the increased use of factors of production. The increased production for foreign markets necessitates to meet the demand to satisfy international best practices, the convergence of production/product standards. There is pressure to satisfy the international requirements regarding product quality, environmental and labor standards as well as delivery time. All would contribute to feedback loops between "productivity, innovation, human capital endowment" (OECD, 2016).

Even though the likely mechanisms through which integration into GVCs might affect innovation performance can be constructed as above, it is still not so

straightforward to establish the nexus between GVC participation and innovation performance. It is challenging to examine and assess whether these channels smoothly work. And unless these channels smoothly work, it is questionable whether GVC participation can deliver benefits to the countries involved.

In that regard, it is reasonable to investigate the factors which may explain why the channels might not work as proposed and expected above. One of the issues that may hamper the smooth functioning of knowledge acquisition and spillovers can depend on the willingness of GVC lead firms to convey knowledge to (local) suppliers. The lead firm might be willing to transfer knowledge in order to ensure the efficient production within and smooth functioning of GVC (Xing *et al.*, 2021). Nevertheless, the lead firm might also be careful and not have much incentive to disseminate knowledge to the suppliers in core competency areas, which might be different than in the case of complementary areas (Baldwin, 2014).

The effect of GVC integration on innovation activities could also differ according to the absorptive capacity of local producers. The different degrees of absorptive capacity might affect the extent to which producers obtain and utilize knowledge provided within GVC linkages to varying degrees. According to Morrison *et al.* (2008), this is the reason behind different rates of upgrading in firms that are embedded in similar GVCs. By investigating the effect of foreign R&D expenditure available through GVC on innovation, Piermartini and Rubínová (2021) argue that the interactions within GVCs lead to knowledge spillovers. Nevertheless, knowledge-receiving countries can benefit from these spillovers only if they have adequate absorptive capacity The existing technological capabilities and absorptive capacity of producers can be crucial since capable local producers might induce lead firms to transfer knowledge and locate production accordingly e.g., electronics industry GVCs in East Asia (Piermartini and Rubínová, 2021).

The issue can also be associated with the well-known discussion between codified and tacit knowledge (Cowan *et al*., 2000). The degree of knowledge complexity and codificability of technological processes can have an influence on the relationships within the chain (Lara *et al*., 2005). How the interactions within GVCs relate to the

transmission of tacit knowledge is discussed by Piermartini and Rubínová (2021) based on the work of Keller (2004). If at least some part of knowledge is always tacit (or non-codifiable), it could only be transferred with personal (or face-to-face) interactions. It is, in general, assumed that interactions between researchers located in different countries are more difficult, as is the transmission of non-codified knowledge.

Related to the above issue, one might also argue that the detachment of manufacturing and design activities can undermine innovation activities. By enabling interactive learning, geographical proximity can lead to both technical and organizational developments and building trust. Moreover, social embeddedness is key to gain the benefits driven by proximity. In this regard, retaining industrial production for a particular type of industries might be essential for the innovation activities (Buciuni and Finotti, 2016).

All these arguments, in turn, are efforts to bring together the discussion on the GVC with the economics of technology. Grounded on the aforementioned arguments, the effects of GVC participation on innovation performance might become ambiguous under different circumstances. For this reason, whether being a part of GVCs could ensure a progress in innovation performance, especially for developing countries, remains a controversial issue. Whether or not the higher participation rates guarantee to become innovators requires more elaboration.

1.3. Research Questions

Grounded on the statement of the problem in Section 1.2, the main research questions of the thesis are formulated and proposed as follows:
Research Question 1: Is there any significant effect of backward participation into GVCs on innovation performance?
Research Question 2: Is there any significant effect of forward participation into GVCs on innovation performance?

With an aim to explore the research questions above, the thesis will contribute to assessing the arguments discussed in the literature regarding both GVC approach in

international trade and economics of technology. Establishing a clear and automatic link between GVC participation and innovation performance is not always straightforward. The previous studies in the literature set both positive and negative effects, as well as cases of no effect, of integration into GVCs on innovation performance (see Section 1.2. and Chapter 2).

The two research questions are investigated by conducting quantitative analysis, particularly based on econometric estimations. Descriptive data analysis is also implemented to complement the econometric analysis in the special case of Türkiye.

1.4. Contribution of the Thesis

The thesis makes several important contributions to the literature. The main contribution of the thesis stems from its aim to integrate the two separate fields that may be related to each other. Conceptually, the thesis connects the fields of GVCs and innovation. It is challenging to identify a solid and well-established theoretical framework that investigates the effect of GVC integration on innovation. While the thesis is not a theoretical study aimed at developing a new theoretical framework, it nonetheless has an explicit intention to contribute to establishing the nexus between GVC participation and innovation performance.

Our work is among the limited number of studies that directly examines the effect of participation into GVCs on innovation, thereby contributing to and enriching the still-narrow but burgeoning literature. Regarding the literature on GVCs, several studies investigate the main drivers of GVC participation (factor endowments, market size, geography, institutional framework, etc.) as well as the effects of GVC participation on economic development (including its consequences on economic growth, value-added, productivity, income, employment, and macroeconomic implications etc.) (OECD 2013, OECD 2016, World Bank 2020, World Bank 2022). Yet, there are still relatively few studies that explicitly discuss the *common* issues related to both the issue of GVC in international trade and innovation studies, such as (economic and technology) upgrading, productivity enhancement, knowledge acquisition and spillovers, technology dissemination, human capital development,

skill building and the issues related to governance and institutions etc., by moulding the two fields in a single unified manner. (Gereffi 1999, Pietrobelli and Rabelotti 2011, Baldwin 2014, Amador and Cabral, 2016).

Second, the thesis may differ from many existing studies in the literature, and thereby contributing to the lacuna by investigating the effects of different types of participation into GVC (i.e., both backward participation and forward participation) on innovation performance separately. The thesis examines the mutually exclusive effects of GVC participation, rather than focusing on a single type or the joint effects of GVC participation.

In addition to its conceptual contribution, the thesis also makes contributions related to data. The thesis constructs a comprehensive dataset by merging and transforming data accordingly from separate fields (i.e., international trade on the one hand and science, technology and innovation on the other hand). As the data is obtained and compiled from different sources, the classification of the country-industry level data differs among the variables used in the extant empirical modelling. Consequently, the data need to be transformed according to the same classification of economic activities.

To clarify, the contribution regarding the data[1] includes i) merging and transforming the data based on the industry classification in the Trade in Value Added (TiVA) database with the patent data classified according to International Patent Classification (IPC) data by using the concordance scheme "IPC V8 – NACE Rev.2" developed by the Eurostat, ii) aggregating the data of business R&D expenditure by industry that is based on ISIC Rev.4, to the industry classification of the TiVA, iii) transforming GVC participation measures of Türkiye in the TiVA database (2021) into the Eurostat definition of technology intensity of manufacturing industries. The aim of this exercise is to transform and aggregate the data in order to guarantee that

[1] The data sources and the coverage as well as how the data is transformed, aggregated, and harmonized are explained in Chapter 3. Nevertheless, it is convenient to mention the data sources here at the outset as well. The data is obtained from the following sources: OECD TiVA Database, OECD Analytical Business Enterprise Research and Development (ANBERD), OECD Patents by Technology Database, OECD Input-Output Database (IOTs), OECD Trade in Employment (TiM) Database, OECD Demography and Population Statistics Database.

the data from different fields (that is, patent data, R&D expenditure, GVC measures) have the same industry classification, and thus it can all be used compatibly in the analysis.

Based on this comprehensive dataset covering 41 countries and 19 industries from 1995 to 2018, the thesis also differs from existing studies due to its scope and coverage. Compared to previous works, the thesis includes a larger number of countries and industries in the analysis. In addition to cross-country industry-level analysis, the thesis also provides an in-depth examination of Türkiye's innovation performance with respect to GVC participation. With this dual perspective, the thesis is therefore among the limited number of studies that examine Türkiye's innovation performance with respect to GVC participation.

Last but not least, the thesis draws several policy implications based on both the cross-country patterns and the in-depth analysis of the case of Türkiye, which may have implications for foreign trade policy.

1.5. Organization of the Thesis

The rest of the thesis is structured as follows. Chapter 2 presents a brief overview of the literature on the GVC approach in international trade with an attempt to relate it to the theoretical framework on innovation. In this vein, the chapter is divided into two sections. In the first section, the fundamentals of the GVC approach are presented. In the second section, the previous works in the literature on both GVCs and innovation studies are explored with an attempt to compile the arguments regarding the relationship between participation into GVCs and innovation performance.

Chapter 3 investigates the relationship between integration into GVCs and innovation performance, by conducting econometric analysis and using a comprehensive dataset covering 19 industries in 41 countries from 1995 to 2018. The chapter is divided into nine sections. The first section provides information about the dataset that is constructed specifically for the research. In this section, how data from

different fields is collected and transformed is explained. The second section presents a brief descriptive analysis of the trends in the evolution of GVC participation. In the third section, the methods regarding the measurement of integration into GVCs are summarized. As one of these methods, the main Trade in Value Added (TiVA) indicators are explained and elaborated. Section 4 develops empirical strategy and modelling. Section 5 constructs the basic structure of the econometric model. Section 6 takes into account the issue of endogeneity to avoid producing unhealthy estimation results. Section 7 enriches the analysis by investigating the effect of GVC participation by taking into account the technology intensity classification of manufacturing industries. In this vein, the subsections test whether the effect of backward participation and forward participation changes if the econometric analysis is conducted by categorizing the industries according to their technology intensity, namely low-technology, medium low-technology, medium high-technology and high-technology. Lastly, Section 8 and Section 9 present panel unit root tests and adopt a dynamic panel structure, respectively. The model is further extended by incorporating the lagged value of the dependent variable.

Chapter 4 puts special emphasis on the case of Türkiye. The chapter is divided into five sections. The first section briefly presents the earlier works regarding Türkiye's integration into global value chains and its main drivers as well as economic consequences including growth, development, value-added, productivity and innovativeness. The second section presents quantitative analysis. The first subsection presents the main findings of the quantitative analysis. The second subsection presents descriptive analysis and provides insights about Türkiye's GVC participation of manufacturing industries according to the classification of technology definition. In the following subsections of Chapter 4, econometric modelling techniques are applied in order to investigate the effects of Türkiye's GVC participation on her innovation performance.

Finally, Chapter 5 is devoted to present conclusions and policy recommendations. Based on the findings of the investigation in previous chapters, the thesis draws some policy recommendations, which could have implications for science and technology policy as well as foreign trade policy.

CHAPTER 2

LITERATURE REVIEW

The aim of this chapter is to provide an overview of and assess earlier works on the GVC phenomenon in international trade, particularly in relation to innovation studies. The GVC phenomenon can be examined from various disciplinary perspectives, including economic, business and management, and social and public policy analyses. Our work primarily examines GVCs through the lens of economics literature. As stated by Park *et al*. (2013), the economics perspective generally aims to understand GVCs through trade theory, exploring factors that drive specialization and the fragmentation of production, as well as decisions related to production locations. It also addresses measurement challenges, the distributional effects of GVCs, and the role of policy.

At the outset, we need to provide a brief note on the scope of the chapter. First and foremost, this is a chapter that does not do justice to the entire body of work in the international trade economics literature on GVCs. As is well known, there is a burgeoning literature on GVCs that addresses various aspects of the phenomenon. While there are some studies that examine GVCs conceptually (Antràs, 2020), others focus on understanding the drivers and the determinants of GVCs, including factor endowments, trade costs, market size, geography and institutions. (Baldwin, 2016; World Bank, 2020). There are still other studies that discuss the consequences of GVC participation on the issues related to a broader set of economic phenomena, including aggregate income, productivity, income distribution (poverty and inequality), industrialization, and other macroeconomic outcomes such as shock transmission, inflation synchronization and exchange rate sensitivity as well as the issues related to the environment (World Bank, 2020). Some research on GVCs, however, focus on measuring and quantifying GVC participation (Hummels *et al.,*

2001; Johnson and Noguera, 2012; Koopman *et al*., 2012, 2014). As pointed out by Antràs and Chor (2022), for those who are interested in getting an interdisciplinary overview of GVC framework can refer to the work of Gereffi *et al*. (2019). The World Development Report (World Bank, 2020) is also a seminal work that investigates the issue of GVCs from various aspects, including policy perspectives.

Our aim, instead, is to provide a survey that focuses almost exclusively on exploring the interplay between the GVC phenomenon and innovation. By doing so, we gain insights about the mechanisms through which the integration into GVC may have effects on innovation performance. While our aim is to provide an overview of and assess earlier works on the GVC phenomenon in international trade in relation to innovation studies, we still believe that having a foundational understanding of the main aspects of GVCs is essential to examine the GVC-innovation nexus. Therefore, this chapter is structured into two sections. In the first section, we provide a brief overview of the fundamentals of GVC phenomenon and we summarize and present some key aspects of GVCs. In the second section, we discuss earlier studies that in some way, directly or indirectly, relate the GVC participation to innovation and we provide an assessment of the arguments in the relevant literature.

2.1. Some Salient Features and Themes of the GVC Phenomenon

The GVC literature is voluminous and can be approached from various perspectives[2]. However, our study and its objective are narrower and more specific. We are aware that it is not feasible to cover all aspects of the GVC literature in such a study, and that attempting to do so would be ambitious. Undoubtedly, all issues related to GVCs are important and broad enough to deserve being examined in a separate chapter. Nevertheless, a certain foundational knowledge is still necessary to study the GVC-

[2] Morrison *et al*. (2008, p.44) argue that the research on the GVCs could be categorized under two broad approaches, namely the internationalist approach and the industrialist approach. These approaches differ in their focus and methodology as well as policy focus and theoretical background. The internationalist approach includes figures such as Gereffi (and the North Americans school on GVCs) and some scholars from Europe such as Kaplinsky and Gibbon, as well as colleagues at the Danish Institute for International Studies. The industrialist approach includes figures such as Humphrey, Schmitz and colleagues at the Institute of Development Studies, at the University of Sussex. According to Morrison *et al.* (2008), while the internationalist approach is theoretically grounded on international economics, and political economy, the industrialist approach is theoretically grounded on industry and cluster studies.

innovation nexus. Therefore, we believe that highlighting the key aspects of the GVC phenomenon will form the foundation for the main part of our study and will thus be valuable and beneficial.

2.1.1. Putting GVCs into Historical Perspective and Defining GVCs

Before addressing the conceptual definitions and certain features of the GVC phenomenon, it might be more appropriate to start with examining GVCs from a historical perspective. To this end, we can benefit from the historical framework of globalization which is presented by Baldwin in his works. Baldwin (2006, 2013 and 2016) proposes the idea of globalization with distinct phases or unbundlings, which is formed by the three cascading constraints perspective. These constraints are the costs of moving goods, ideas and people that limit the separation of production and consumption. Baldwin (2016) argues that although these costs have fallen and relaxed over time, not all of these costs have decreased simultaneously or by the same amount. While transportation costs have decreased significantly and earlier, the costs of moving ideas and people have not decreased at the same pace.

The first unbundling (circa 1820-1990) is driven by the steam power revolution reducing transportation costs, leading to the separation of consumption and production, industrialization in the North (developed nations) and de-industrialization the South (developing nations), i.e., the Great Divergence. The second unbundling (circa 1990-present) is driven by the information and communication technologies (ICT) revolution lowering the cost of moving ideas, relaxing the coordination constraint, leading to international separation of factories and coordinating complex activities at distance (ICT-enabled offshoring). The second unbundling, resulting in internationalization of production, is also referred to as the rise of global value chains or global value chain revolution[3].

[3] There are also other studies that point out how GVCs differ from previous integration cases. For integration, Sturgeon (2013) argues that GVCs differ from earlier integration cases in that the organizational structure within the chain is more complex. Sturgeon (2013) argues that economic globalization includes traditional relationships such as arms-length trade and intra-enterprise trade related to foreign direct investment, but also external international sourcing which is significantly different, especially from the former. What Sturgeon (2013) calls external international sourcing (use of suppliers that are foreign) is akin to intra-enterprise trade in the sense that there is bilateral information sharing and asset specific investments that are not found in arms-length trade.

The literature provides several closely related definitions of GVCs and examines their conceptualization. Kaplinsky and Morris (2001, p.7) state that "*the value chain describes the full range of activities required to bring a product or service from conception through the different phases of production, delivery to final consumers, and final disposal after use*". OECD (2013, p.8) defines a value chain as "*... the full range of activities that firms engage in to bring a product to the market, from its conception to its final use*." These activities include not only stages of production but also design, marketing, logistics as well as after sale customer support. The global character of the value chains comes from the fact that they are spread across countries. In a similar fashion, Degain and Maurer (2016) also note that the term "global value chain" is attributed to the existence of multiple firms across several countries. They define a value chain as "*the sequence of productive activities that firms undertake to create a value, including the various production steps but also all activities belonging to the demand chain/client side such as marketing, sales, or customer service*" (Degain and Maurer, 2016, p.10). Among all these stages, it is generally considered that most value is created in the first and last stages of the chain, i.e., design and final sales respectively (Sturgeon, 2013).

Timmer *et al*. (2014, pp.100-101) provide a definition for a global value chain of a product "*as the value added of all activities that are directly or indirectly needed to produce it*." They prefer to use the term "chain" for all types of international fragmentation. This can be attributed to the presence of studies in the literature that classify the international fragmentation of production. For instance, Baldwin and Venables`s study (2013) classifies the international fragmentation of production into two distinct categories. The types of fragmentation can be characterized as "snakes-like" and "spiders-like". Snake-like type of production involves a linear sequence, whereas a spider-like segmentation involves a center to which different parts arrive from several destinations for an assembly of a final product. According to Timmer *et al*. (2014), these are ideal types and real production activities actually involve a mixture of these two types. Finally, they also emphasize that while a global value chain is typically identified by the country in which the final phase of production takes place, such as Chinese manufacturers of electronics, it is important to recognize that these the ones (countries or firms) who govern a value chain may differ.

Antràs (2020) provides an overview of key conceptualizations associated with the rise of GVCs. In particular, Antràs (2020) differentiates between a broad (or traditional) definition and a narrow (or relational) definition of GVCs. According to the broad perspective of GVCs, GVC is defined as "*a series of stages involved in producing a product or service that is sold to consumers, with each stage adding value, and with at least two stages being produced in different countries*". A firm is considered to participate in GVCs if it "*contributes value in at least one stage*" (Antràs, 2020, p.3). This definition highlights the increased use of foreign value added (embodied in materials, intermediate goods or tasks) in production, particularly for exports. It conceptualizes GVCs as a finer international division of labor, involving trade in parts and components. Antràs (2020) notes that while this broad definition provides many insights, it might overlook certain characteristics of the latest phase of globalization. Therefore, Antràs (2020) also presents the narrow (or relational) perspective of GVCs, which emphasizes the inter-firm and intra-firm transactions, including flows of customized inputs, goods, technology and credit, in environments with limited contractual security and incomplete contract enforcement.

Gereffi and Fernandez-Stark (2016, p.7) state that GVC analysis can be elaborated by considering its six fundamental dimensions: "*input-output structure, geographic scope, governance structure, upgrading, local institutional context, and industry stakeholders*". A value chain by its definition represents an input-output process including all the activities that are necessary to bring up a product or service to its consumers. Therefore, identifying the main activities throughout the process and structure of companies reveals the segments of the chain with different value-added. There can be companies with different characteristics (global/ domestic, private/public, large/SME) in chains. Identification of the companies can contribute to understanding governance structures. Regarding the geographic structure of GVCs, it can be said that although the analysis can be launched at the global level, GVCs function at other geographic scales including regional, national and local levels. Recently, the regionalization of the GVCs can be claimed to have been becoming a trend as the regional trade agreements gain importance and the large emerging economies grow. Regarding the geography of GVCs, Timmer *et al*. (2014) argue that 1990s and 2000s were different in the sense that whereas the former

period witnessed the fragmentation of production at the regional scale, e.g., Asia and Europe, in the latter period the fragmentation of production has become more global in nature.

The changing nature of the boundaries of stages of production in GVCs is another issue that needs to be taken into account (Sturgeon, 2013). Timmer *et al.* (2014, p.106) argue that the international fragmentation of production can be affected by factors such as wages developments, costs of transportation, costs of coordination and risk considerations. For instance, Baldwin and Venables (2013) argue that fragmentation of production is associated with the interplay of two different forces. These forces are unbundling costs comprising costs of coordination, management as well as shipping costs and international cost differences created by different factor intensities in different tasks. Grounded on the work of Baldwin and Venables (2013), Timmer *et al.* (2014) argue that several high-value added stages of production may be clustered in certain spaces due to strong complementarities between factors of production that may cause discontinuities in fragmentation. Furthermore, the direction of relocation and fragmentation may change again due to technological progress that makes mechanized production cheaper, hence decrease the demand for unskilled and low paid labor. Additionally, value chain stages may change due to other technological considerations such as knowledge codification. In the case where knowledge is tacit, design and production stages are likely to take place at the same location, whereas when knowledge is easy to codify different stages of a value chain spread geographically (Sturgeon, 2009). Yet, Sturgeon (2013) warns that the process is not fully technologically determined, where managerial decisions lead the decisions of how to locate and divide different phases of production in a value chain.

2.1.2. Contextualizing GVCs within International Trade Theory

This section aims to briefly explore how the GVC phenomenon, with its interdisciplinary characteristics, can be linked to and integrated into the international trade theory literature. Contextualizing GVCs within international trade theory and understanding how GVCs may fit into key trade models becomes even more relevant when it comes to go beyond mere description to analysis.

As is well known, international trade theory is historically based on and framed by the principle of comparative advantage, the origins of which lie in Ricardo's conceptualization in his book *On the Principles of Political Economy and Taxation* (1817). In this context, the classical trade models, founded on Ricardo's doctrine, and extending from Heckscher-Ohlin to Samuelson, are based on common assumptions, which include the premises that countries only trade final goods in perfectly competitive markets and that the industries consist of homogeneous producers operating at constant returns to scale. However, these basic premises need to be reconsidered when they fail to explain all the stylized facts observed in international trade (Inomata, 2017).

The classical doctrine, with its basic assumptions, does not provide a satisfactory explanation for intra-industry trade between nations with similar endowments and technologies. In this regard, the New Trade Theory, which is a new school of thought pioneered by Helpman and Krugman (1983), has established the theoretical foundations for the prevalence of intra-industry trade by considering production technology. Unlike classical trade theory, The New Trade Theory, takes into account production with increasing returns to scale and trade in imperfectly competitive markets. A further theoretical revision of the classical theory also occurs when one of its basic premises that an industry consists of homogenous producers is reconsidered. A new line of thinking, which is referred to as New-New Theory and pioneered by Melitz (2003), provides an explanation for how heterogeneous firms can prevail within the same industry. By considering the fixed costs of exporting, the New-New Theory suggests that firms' decisions on market entry or exit are endogenous (Inomata, 2017).

Currently, considering whether the rise of GVCs, which is mainly driven by the outstanding advances in ICT since the mid-1990s and has even sliced up more granular production activities and processes, necessitates once again a further reconstruction and extension of classical theory, could also be regarded as relevant. Baldwin (2016) states that, as the second unbundling, i.e., the global value chain revolution, presents more new puzzles in international trade, a new mental model becomes necessary. In this context, Inomata (2017, p.16) also argues that *"a third*

wave of reconstructing classical theory is underway." Inomata (2017, p.16) emphasizes the importance of "*the cross-national transfer of tasks, or the value added generated by these tasks*", rather than the movement of only final goods.

In this regard, a related strand of literature including the economics of globalization also exists, with studies that model fragmentation of production, offshoring, and trade in intermediate goods as well as tasks (Feenstra and Hanson, 1996; Jones, 2000; Deardorff, 2001; Yi, 2003; Antras and Helpman, 2004; Grossman and Rossi-Hansberg, 2008; Baldwin, 2016). Among the studies on fragmentation, Jones (2000) emphasizes the importance of the growing international exchange of inputs and factor mobility alongside the final products, suggesting that the new modifications to traditional international trade theory are required. Therefore, Jones (2000) presents an analytical framework for understanding the nature of fragmentation. Deardorff (2001) examines the effects of the fragmentation of production across different countries on national welfare, trade, and factor prices in both Ricardian and Heckscher-Ohlin models and finds that the fragmentation of production matters, in particular for the value of the country's output.

By integrating some features of both New-New Trade Theory such as within-sectoral heterogeneity with the framework developed by Grossman and Helpman (2002) and Antràs (2003), Antràs and Helpman (2004) develop a theoretical framework for global sourcing strategies of firms. In their model, heterogenous firms choose whether to produce intermediate goods at home or in foreign country. Furthermore, if firms choose outsourcing rather than integrating (vertical integration at home or foreign direct investment in other countries), a decision is also needed to be made among domestic outsourcing and foreign outsourcing (arm's length trade). They examine how productivity variation, industry-specific attributes, wage differentials across countries, and contract relationships affect the choices of firms regarding global sourcing and organizational structures. Therefore, Antràs and Helpman (2004) provide insights for a new theoretical framework about the dynamics of global production and international trade.

Focusing on offshoring and the increased tradability of parts and components, Grossman and Rossi-Hansberg (2008) present a new paradigm framework known as

"trading tasks", which emphasizes the finer international division of labor. By modeling the production as a continuum of tasks, they investigate the effects of a decrease in offshoring costs, which, unlike earlier studies, includes heterogeneity in trade costs for the various tasks, on productivity and factor prices. Grossman and Rossi-Hansberg (2008) find that a decline in the cost of task trade improves the productivity of the factor whose tasks can be more easily offshored.

Lastly, when addressing the need for new thinking in international trade theory, it is important to highlight the outstanding work of Baldwin (2016) within the literature of globalization. Baldwin (2016, p.176) refers to the rise of GVCs as the second unbundling and argues that the second unbundling has massive repercussions on world trade in the sense that this type of trade is "*more multifaceted and the facets are more interconnected"*. What Baldwin (2016) terms it as twenty-first century trade involves complex flows of goods, services, investment and technology. These flows, which used to occur predominantly among the Northern nations, now cross North-South borders. New globalization is different from the old primarily due to the two aspects of the second unbundling, i.e., international fragmentation of production (including fragmentation and offshoring in both manufacturing and services sectors) and transfer of know-how abroad.

Baldwin (2016, p.145) argues that GVCs have "*denationalized"* the principle of comparative advantage. Rather than national boundaries, cross-national production networks have now become the locus of international competition. In this vein, the nature of international competition has changed, and the international boundaries of competitiveness are being redrawn by the second unbundling. Furthermore, GVCs bring about the production stages, rather than sectors, at the core, and the economics of offshoring has come to be characterized by the phenomena of both fractionalization and dispersion, along with their interplay. The fractionalization dimension is associated with "*slicing up the value chain*". A firm's production processes are sliced and aggregated into four levels: from the bottom to the top, these are tasks, occupations (group of tasks), stages (group of occupations) and product. The dispersion dimension concerns the geographic unbundling of production stages (Baldwin, 2016, p.197). The trade-off between gains from specialization and the

associated costs brought by fractionalization plays a crucial role when deciding to offshore. On one hand, offshoring production stages to lower-cost nations decreases production costs. On the other hand, it increases the costs associated with the international fragmentation of production, including "*transportation costs, coordination costs, increased risk and managerial time*". Therefore, the decision to offshore depends on the interplay between the gains from decreasing the costs of production and the costs of international fragmentation (Baldwin, 2016, p.201).

To summarize, the phenomenon of GVCs goes beyond the mere international exchange of final goods and also includes complex flows of trade in parts and components, services, investment, and knowledge spillovers, not only among industrialized countries, as was previously the case, but also between developing and developed nations. Therefore, as indicated by studies in the related strands of literature, there is a need for new thinking in international trade theory. GVCs bring about modifications and adjustments to trade theory, making its conceptualization within this framework increasingly relevant.

2.1.3. Upgrading and Governance Issues

The issue of upgrading is among the most frequently discussed themes in the GVC framework. Despite being widely used in the literature, there is no unique, clear, and broadly accepted definition of upgrading. There are various definitions regarding the exact meaning of this term, and as a result, it suffers from some ambiguity in its definition (Park *et al*., 2013). Nonetheless, we consider that providing some of the key definitions of this concept in the literature is important due to the potential contribution it can make to the other parts of our study.

Gereffi (2005, p. 171) defines economic upgrading as "*firms, countries or regions moving to higher value activities in GVCs in order to increase the benefits (e.g., security, profits, value-added, capabilities) from participating in global production*" (Gereffi, 2005, p. 171). "*Dynamic movement within the value chain by examining how producers shift between different stages of the chain*" is also emphasized by Gereffi and Fernandez-Stark (2011, p.4). Humphrey and Schmitz (2000, 2002)

define upgrading by identifying four types of upgrading within the GVC framework: process upgrading (reorganization of production activities), product upgrading (producing more sophisticated products), functional upgrading (increase skill content of activities) and lastly chain upgrading (moving in the chain into new industries). According to this typology of upgrading, process upgrading enhances value capture by improving production efficiency through process re-engineering or advanced technology, whereas product upgrading boosts value by shifting to product lines with higher unit values. Functional upgrading enhances value capture by either improving the firm's high-value functions (e.g., outsourcing and quality functions) or transitioning activities within the value chain to higher value-added functions. Finally, chain upgrading occurs when the firm applies its knowledge to another chain in a different industry (Park *et al.*, 2013).

Furthermore, Gereffi and Fernandez-Stark (2016) identify several other types of upgrading such as entry in the value chain (participating in GVCs for the first time), backward linkages upgrading (where local firms begin to supply tradable inputs to companies –usually multinational cooperations (MNCs)- that are already located in a separate GVC), and end-market upgrading (moving into more sophisticated markets).

Morrison *et al.* (2008) argue that the concept of upgrading is the most commonly used term in examining how globalization—and its specific manifestation within GVCs—promotes industrial development and innovation in emerging countries, emphasizing that this concept goes beyond the merely improvement of production efficiency. In this context, Morrison *et al.* (2008) in some way relate upgrading to innovation and focuses on the key issues of the technological capabilities (TCs) approach when discussing the upgrading issue. They believe that considering the TCs approach will enrich and clarify the GVC framework. Therefore, Morrison *et al.* (2008) suggest integrating the theory of technological capabilities and GVC approach. They argue that defining the concept of upgrading without considering this approach may remain fuzzy. For instance, they raise questions such as whether upgrading is synonymous with innovation or if upgrading is a result of innovation. Ultimately, Morrison *et al.* (2008, p.45) define upgrading as "*innovation producing*

an increase in the value added" and propose adhering to the definition of upgrading that they have outlined.

The process of upgrading within GVCs is determined by a mixture of policies and strategies that include the public sector, formal institutions, corporations, and workers. To understand this process more comprehensively, the governance structure of the GVCs can be analyzed within a broader institutional framework. Gereffi (1994) argues that local institutional context, including economic and social dynamics, plays a significant role in shaping the participation of countries in GVCs. These institutions, which include legal regulations, subsidies, as well as education and technology policies, can have either a positive or negative effect on industries' performance (Gereffi and Fernandez-Stark, 2016).

Analyzing the governance structure of GVCs is relevant to reveal the power relations between the actors within the chain, which determines the control and coordination mechanism of the chain. Gereffi (1994, p.97) defines governance as "*authority and power relationships that determine how financial, material and human resources are allocated and flow within a chain*." The typology of GVC governance is based on five governance structures, which are market type, modular type, relational type, captive type, and hierarchical type. These structures are measured by three variables: the complexity of the information shared between actors, the codification of information in production, and the level of supplier competence. The five different structures in this GVC configuration also reflect the degree of power asymmetry and the extent of coordination between partners within GVCs. At one end of this configuration is the market type, while at the other end is the hierarchical type. (Gereffi and Frederick, 2009; Gereffi *et al*., 2005; Gereffi and Fernandez-Stark 2016). In the market type of governance, where price is the mediator of the relations and the complexity of transactions is low, ability to codify transactions and the capabilities in the supply base are high. Transactions are relatively simple, information on product specifications can be easily transmitted. Therefore, the degree of power asymmetry and the extent of explicit coordination between partners are low. Exchange requires little cooperation, as the cost of changing partners is low for both parties. On the other hand, in the hierarchical type of governance, the degree

of power asymmetry, the extent of explicit coordination between partners, and the complexity of transactions are high. The capabilities in the supply base and the ability to codify transactions are low.

Regarding this issue, Pietrobelli and Rabelotti (2011) argue that an efficient innovation system, including well-structured institutions responsible for metrology, standards, technical and quality services, could contribute to the establishment of more relational, rather than hierarchical, forms of governance of GVCs and reduce the complexity of transactions. Additionally, the degree of knowledge complexity and of codifiability of technological processes can have an influence on the relationships within the chain (Lara *et al*. 2005).

Gereffi and Fernandez-Stark (2016) point out that governance mechanisms are not stable and they may change as industries evolve. In addition, the characteristics of innovation systems could have an influence on the evolution of the internal governance of GVCs (Pietrobelli and Rabelotti, 2011). Governance mechanisms within an industry may vary among different stages, which means that many GVCs are indeed characterized by multiple governance mechanisms. Multiplicity of governance mechanisms and their changing nature bring also opportunities for upgrading. They also argue that the input-output structure of the value-chain and institutional structure of the country can make differences in upgrading.

Understanding the closely related issues of upgrading and governance can also make the question of who benefits and who loses from GVCs a topic of discussion. Whether GVC integration benefits countries similarly is also one of the issues discussed in the GVC framework. In other words, it is crucial to determine how gains stemming from GVC participation differ between developed and developing countries. Although a comprehensive discussion is beyond the scope of this section, we briefly highlight several key studies referenced at this stage.

World Bank (2020, p.66) reports that the benefits of participating in GVCs are not evenly distributed across or within countries. Inequalities emerge in the allocation of firm markups between countries, in the distribution of capital and labor, including

differences between skilled and unskilled workers, as well as between male and female workers, and also geographically within countries. Gereffi and Fernandez-Stark (2016) argue that whereas developing countries usually provide cheap labor and raw materials, rich nations contribute to the chain with skilled labor, research and development (R&D) and product design. Moreover, the challenge is stated to identify the conditions that lead to climb the value chain from low-value-added basic assembly activities to high value-added activities. They argue that while developed countries usually focus on high value-added activities, developing countries show presence in low value-added activities.

Kummritz (2016) argues that the GVC literature examines the issue by way of a model that depends on two groups of countries, namely the South and the North. As expected, the former provides the low-wage labor input to the technologically advanced latter. Hence, there is an incentive to divide tasks among these two groups of countries which, in turn, creates differential advantages (or disadvantages) to the countries. A dynamic model, in which such a process is at work between low wages and technology, can show, due to learning by doing effects, at the end, the North may experience loss, thereby the overall effect of rising GVC participation on the Northern value added can be negative. (Kummritz, 2016). As Buciuni and Finotto (2016) note, the shift of manufacturing to emerging economies may trigger a process of learning by supplying, that is learning of how to become original equipment manufacturers in emerging economies by being suppliers in global value chains. However, this is just one of the alternatives in the sense that gains could be reversed depending on the assumption of the model. GVCs participation may favor the North (through productivity increase) while disfavor the South due to terms-of-trade losses (Baldwin and Robert-Nicoud, 2014; Grossman and Rossi-Hansberg, 2008). Finally, a third option, as Baldwin and Robert-Nicoud (2014) show, is an increase in benefits to both countries due to technology spillovers from the North to the South.

That being said, the roles of countries and firms are not given in a GVC. In other words, participation into GVCs can be seen as a significant step for firms in the developing countries that try to compete in the global market. In this regard, Gereffi and Fernandez-Stark (2016) claim that the ability to effectively insert into GVCs is a

crucial condition for development in the developing world. What matters is not only to participate in the GVCs but how to gain from such a process. Obviously, the latter requires a capacity not only to access GVCs, but also to compete and to reap benefits in terms of enhancing capabilities and driving economic development. The biggest challenge for such an upgrading in GVCs is to determine the conditions under which the least developed countries and firms could climb the value chain; in other words, how they move from activities that only include unskilled labor to segments that include high value-added activities (Gereffi and Fernandez-Stark, 2016). In essence, a distinction between developed and developing countries and firms should be made and the main challenges faced by the latter group should be identified.

2.1.4. Services and GVCs

Services have increasingly become a prominent feature of the world economy and international trade in recent decades. While services accounted for 53 percent of global GDP in 1970, GDP share of services increased to 67 percent in 2021, thereby contributing more to economy than agriculture and the manufacturing industry (World Bank and WTO, 2023). The share of trade in services in GDP also increased, reaching 13.4 percent in 2022 compared to 7.6 percent in 1990 (OECD, 2024). Notably, commercial services accounted for 22 percent of world trade in the same year. The growth in world exports of commercial services has outpaced to that of goods since 2014. The increasing role of services becomes even clearer when analyzing the value-added terms rather than gross trade statistics. In 2021, services account for 50 percent of global trade in value-added terms (World Bank and WTO, 2023).

Consequently, given the growing importance of services in the global economy and international trade, overlooking the role of services in the international fragmentation of production may result in a limited understanding of the GVC phenomenon. Services may be treated in a similar way to goods in GVCs. Like goods, services can be traded within GVCs as either final goods or intermediate goods in the production of goods and other services (Heuser and Mattoo, 2017).

Services are embedded in goods that are traded within GVCs. Services, including research and development, design, engineering, marketing, after-sales services

contribute to the production and value added of manufacturing goods. Services have been increasingly used in the production of manufacturing goods that are destined for export. In 2018, the share of services value-added in manufacturing exports was 31 percent for OECD countries and 29 percent for non-OECD countries. This reflects the growing reliance of manufacturing on services, which is a phenomenon referred to as the servicification of industrial production (Miroudot and Cadestin, 2017; World Bank and WTO, 2023). Miroudot and Cadestin (2017) also note that the effects of services may still be overlooked if in-house service activities (i.e., servicification within firms) in manufacturing industries operating within GVCs are not taken into account, leading to an underestimation of services value added. By analyzing a sample of countries, mostly OECD members in their study, Miroudot and Cadestin (2017) report that when in-house service activities are included, the share of services value added in manufacturing exports increased to 53 percent from 37 percent, compared to when in-house services activities are not taken into account. Finally, with advancements in technology, making the distinction between goods and services has become more complex. The blurring of the distinction leads to increased complexity in measuring the role of services in GVCs (Miroudot, 2019; WTO, 2019).

Baldwin *et al.* (2015) explain the increasing share of services value added in manufacturing industries by identifying three underlying causes as reclassification of service tasks, task-composition shift, and task-relative price shift. The reclassification of service tasks, which Baldwin *et al.* (2015) refer to as a mechanical explanation, occurs when service tasks are shifted from the manufacturing industry to the service sector as a result of outsourcing, even when there is no change in production processes or relative prices. However, task-composition shifts and task-relative price shifts can provide explanations stemming from changes in products, tasks in production processes or relative prices.

Baldwin *et al.* (2015) argue that, thanks to the technological progress, the nature of final manufactured products may demand more services value added in their production. Automobiles are given as a good case in point. Once viewed primarily as mere mechanical machines, the increasing use of software in their production also

reflects the rising share of services value added in final manufactured products. Secondly, as production becomes more geographically dispersed, it becomes necessary to increase service linkages, including ICT and transportation. Changes in both the nature of final products and tasks within production processes constitute what is referred to as the task-composition shift. Task-relative price shift, however, arises when the share of manufacturing value added decreases due to the offshoring of intermediate goods, a natural tendency driven by the motive of reducing the cost of production. Even if there is no change in task-composition, as it becomes less costly to perform manufacturing tasks through offshoring, the share of services value added in final goods production increases, reflecting changes in the relative price of service tasks (Baldwin *et al.*, 2015; Heuser and Mattoo, 2017).

The increasing share of services in value added can be articulated by the smile curve, which illustrates the shift of value towards services along the value chain. While the original illustration considers the stages of production of individual products at firm-level, the smile curve can be extended to some extent at economy-level by "*identifying the sectorial source of the value added embodied in exported goods*" (Baldwin, 2016). Pre-fabrication activities (such as design, finance, and organizational services), fabrication activities, and post-fabrication activities (such as marketing, post-sales services) constitute the three stages of production along the chain. In short, the smile curve illustrates the value added at each stage of production along the value chain. The observation reflected by the smile curve is that greater share of value added is driven by pre-fabrication and post-fabrication activities, compared to fabrication activities. Thus, the deepening of the smile curve is an articulation of the shift of value added towards services (Baldwin 2013, and 2016).

It is also worth noting that although services can be considered similar to goods, they may differ from goods to some extent. This stems from the fact that the relevance of services within the GVC framework is not limited to their role as the subject of international transactions in the form of final or intermediate goods. Rather, services should be considered for their contribution to both the emergence and development of GVCs. Certain services, such as information and communication technologies,

transportation, and logistics, play a crucial role in enabling the international fragmentation of production, thereby contributing to the emergence, development, proper functioning, and resilience of GVCs (Heuser and Mattoo, 2017; OECD, 2024; World Bank and WTO, 2023). Consequently, services are sometimes referred to as the glue that links the activities of different production stages along the chain, thereby enabling GVCs to function in a fluid manner (Park *et al*., 2013; World Bank and WTO, 2023).

The implications of services in GVCs are mainly discussed in the literature through the effects of services on productivity and comparative advantage. As services have been increasingly involved in the production of both manufacturing goods and other services, the pervasiveness of services in the economy may have important implications for productivity and competitiveness. As a result, services may be considered one of the determinants of these outcomes (Park *et al*., 2013). Baldwin (2016, p.233) argues that with the servicification of manufacturing, the competitiveness of manufacturing exports has become increasingly reliant on the availability of "*a broad range of excellent, reasonably priced services*". Based on several empirical analyses, evidence is also found in relevant studies that easier access to low-cost and high-quality services may enhance productivity of firms in the (downstream) manufacturing industry (Amiti and Wei, 2009; Fernandes and Paunov, 2012; Heuser and Mattoo, 2017; Hoekman and Mattoo, 2008). Fernandes and Paunov (2012) also find that foreign direct investment in services enhances innovation of domestic firms in manufacturing industry. As a consequence, the increasing role of services in both the global economy and international trade has become evident, leading us to consider and discuss GVCs within a broader framework. While services were once mostly regarded as untraded or invisible, they are currently viewed as tradable both in goods and other services, leading to a growing appreciation of blending of goods and services together (OECD, WTO, and World Bank, 2014).

2.2. The Nexus Between GVCs and Innovation

This section presents an overview of and assesses earlier works on the GVC phenomenon in international trade in relation to innovation studies. To this end, it

discusses previous studies that, directly or indirectly, relate the GVC participation to innovation and provide an assessment of the arguments in the relevant literature.

2.2.1. Possible Linkages between GVCs and Innovation: Key Channels

GVCs have emerged as a dominant feature of international trade, forming complex and multi-country networks that have significant implications for productivity and innovation. Many studies have been conducted on GVCs to date, focusing on topics such as the drivers and determinants of GVCs, the consequences of GVC participation on issues related to a broader set of economic phenomena, including aggregate income, productivity, income distribution (poverty and inequality), industrialization, and other macroeconomic outcomes such as shock transmission, inflation synchronization, and exchange rate sensitivity, as well as the measurement and quantification of GVC participation (Antràs, 2020; Baldwin, 2016; Hummels *et al.,* 2001; Johnson and Noguera, 2012; Koopman *et al*., 2012, 2014; World Bank, 2020; WTO, 2013).

Despite extensive research on GVCs, there remains a limited understanding of their direct impact on innovation performance. The influence of GVCs on innovation has largely been overlooked and underexplored. A notable gap exists in the literature regarding the effects of various types of GVC participation, i.e., backward and forward participation, on innovation outcomes. This gap is particularly pronounced in the context of developing countries, such as Türkiye. This section addresses this gap and offers deeper insights and a more nuanced understanding of the underlying mechanisms at play.

An understanding of the effect of GVC participation on innovation performance requires the consideration of key channels. That being said, it is not straightforward to establish the nexus between GVC participation and innovation performance. One of the main arguments in the literature, as Halpern *et al*. (2005) argue, is that importing new and advanced inputs is a way to eliminate constraints encountered in the production processes, thereby positively affecting firm productivity. The higher the firm productivity, the easier it is to face export sunk costs and produce new goods

for foreign markets (Bas and Strauss-Khan, 2011; Kasahara and Lapham, 2013 cited in Lo Turco and Maggioni, 2013). A related argument, which can be linked to this issue, is that easier access to a wide range of (cheap) intermediate goods (with higher quality) may lead to the expansion of product variety and product quality through innovation (Xing *et al*., 2021, p.72).

Another mechanism can be based on increased competition from inputs driven by backward linkages in GVCs. The argument is that increased competition due to imports driven by backward linkages in GVCs pushes firms to invest in new technologies, processes and skills and reallocating domestic sources to the most competitive firms. Increased competition diminishes the market share and profits of low-productivity and import-competing firms, thereby enhancing their incentives to adopt more advanced technologies. The degree of competitive pressure influences the diffusion of existing technologies from leading national firms to the broader economy (OECD, 2016; Ziemann and Guérard, 2016).

An additional channel can be developed through forward participation in GVCs. Forward participation in GVCs, that is providing inputs for other countries' exports, necessitates compliance with international best practices, including production standards, product quality, environmental and labor standards, as well as delivery timelines. These factors contribute to feedback loops between "productivity, innovation, human capital endowment" (OECD, 2016).

Last but not least, the GVC literature emphasizes the role of integration into GVCs in generating and diffusing (foreign) knowledge spillovers, thereby delivering benefits to the countries involved. Firms enhance innovation by importing technology from GVCs (Morrison *et al*., 2008). Learning mechanisms within GVCs, which can work through a variety of mechanisms such as knowledge spillovers from both suppliers and GVC lead firms, as well as learning by exporting[4] are the primary mechanisms

[4] Learning by exporting refers to the idea that firms can increase their productivity as well as innovation capabilities by exporting goods and services. Several factors can contribute this, including knowledge spillovers from operating in foreign markets, increased demand for quality driven by international competition, and economies of scale that enable firms to reduce cost, thereby allocating additional resources to investment (Alvarez and López, 2005).

that contribute to "*skill building, human capital development, product quality, and process improvement*" (Ziemann and Guérard, 2016). This, in turn, may promote innovation for GVC participants.

2.2.2. Challenges in Establishing a Clear and Automatic Link

Access to foreign lower-cost and/or higher-quality intermediate goods, increased competition driven by backward linkages within GVCs, the requirement for compliance with international standards driven by forward linkages within GVCs, and foreign knowledge spillovers seem to be the key channels that may lead to innovation. Nevertheless, these mechanisms may not always operate seamlessly in certain instances. Therefore, establishing a clear and automatic link between GVC participation and innovation is not always straightforward.

Several challenges may stem from the issues related to knowledge transfer, governance of GVCs, and the co-location of production and innovation activities. Understanding the distinction between codified and tacit knowledge becomes important to explore the barriers to knowledge transfer[5]. Piermartini and Rubínová (2021) highlight the importance of tacit knowledge and personal interactions for innovation in their work, where they investigate the effect of foreign R&D expenditure available through GVC on innovation. Based on the work of Keller (2014), Piermartini and Rubínová (2021) discuss how the interactions within GVCs relate to the transmission of tacit knowledge. If at least some part of knowledge is always tacit (or non-codifiable), it could only be transferred with personal (or face-to-face) interactions. In this regard, such interactions between knowledge workers and researchers who are in different regions and countries of the world may be more difficult than expected for the eventual transfer of non-codifiable knowledge (see also Keller 2014). It is, in general, assumed that interactions between researchers located in different countries are more difficult, as is the transmission of non-codified knowledge.

[5] Cowan *et al*. (2000) explore how economists understand and apply the concepts of tacit and codified knowledge. They provide a more precise understanding of these knowledge forms to enhance research directed to public policies for science, technological innovation and economic growth.

Certain barriers to knowledge transfer also stem from issues related to absorptive capacity and learning mechanisms within GVCs. Absorptive capacity of local producers may affect the extent of potential gains that can be obtained from GVCs. Piermartini and Rubínová (2021) find that the interactions within GVCs lead to knowledge spillovers, yet knowledge-receiving countries can benefit from these GVC-driven spillovers only if they have adequate absorptive capacity. For innovation to occur, countries must possess the capacity to absorb, assimilate, and leverage new knowledge effectively.

Morrison *et al.* (2008, p. 43) investigate the ways in which knowledge generation and diffusion takes place, and how they enhance technological capabilities in GVCs. They state that the firms in the developing countries can benefit from participating in GVCs, since they could import technology from GVCs. The rationale behind their argument is that the key role of international linkages lies in "*accessing technological knowledge and enhancing learning and innovation* (p. 40)". However, Morrison *et al.* (2008) also provide a critical assessment, arguing that the firm-level analysis regarding learning and technological efforts has not been explicitly addressed in the GVC literature. They contend that different levels of absorptive capacity cause local firms to exploit knowledge and technology opportunities provided by GVC leaders to a different extent. According to Morrison *et al.* (2008), this explains different rates of upgrading in firms that are embedded in similar GVCs. This argument aligns with the findings of Piermartini and Rubínová (2021).

Related to the issues of knowledge spillovers, including the debate on codifiability of knowledge and absorptive capacity, we can also discuss the role of learning mechanisms in establishing the links between participation into GVCs and innovation activities. In this vein, De Marchi *et al*. (2018) investigate the relationship between the learning channels of developing countries that participate in GVCs, and the extent to which they innovate. They discuss the main learning mechanisms of firms in developing countries that participate in GVCs, through which firms learn and access knowledge to innovate. These learning mechanisms occur either within GVCs or outside GVCs. They list the learning mechanisms within GVCs as "*mutual learning from face-to-face interactions, knowledge transfer from GVC lead firms*

related to a narrow range of tasks, training of local workforce by GVC lead firms, GVC lead firms' pressure to adopt international standards" (De Marchi *et al*., p.393). Based on the degree of innovativeness and type of learning mechanisms, De Marchi *et al*. (2018, p.397-398) classify GVC innovators as "*GVC-led innovators, autonomous innovators, and marginal innovators*". The results of their analysis based on fifty GVCs reveal that most of the GVC innovators are marginal innovators (54 percent of the sample), which use some sources of knowledge within GVCs, and display low innovation performance. On the other hand, GVC-led innovators constitute the smallest group (18 per cent), which use all learning mechanisms within GVCs and show a high level of innovativeness.

Pietrobelli and Rabelotti (2011), in their study proposing the examination of the link between GVCs and innovation systems, argue that the effect of international knowledge and innovation exchange through inter-firm and intra-firm networks, as well as integration into GVC, has not been adequately highlighted in the innovation systems literature. They argue that firms, particularly those in the developing countries, can access knowledge and enhance learning through participating in GVCs. According to them, learning mechanisms may differ depending on the forms of governance within GVCs. The competency of suppliers as well as the institutional structures could affect the relationship between different agents in the chain. In this context, learning can occur either due to the pressure to meet international requirements regarding product quality, environmental and labor standards, and delivery time. Or, if the supplier is less competent, learning can occur as a result of direct involvement of the leader in the chain. Learning can be mutual if suppliers and lead firms in the chain have complementary competences.

The issue of governance in GVCs can also be regarded as one of the factors that may pose a challenge in establishing a clear and automatic link between GVC participation and innovation. This issue can also be addressed, particularly in terms of its impact on knowledge transfer. In governance structures where knowledge is more easily shared (e.g., market-type structures or modular-type structures), innovation may be more conducive than in governance structures where certain instances, including power asymmetry may limit knowledge exchange (e.g.,

hierarchical type). Innovation is more likely to occur when foreign lead firms share technology and know-how with local firms. Countries that are capable of effectively collaborating with lead firms in GVCs are more likely to experience knowledge spillovers.

In this regard, Xing *et al.* (2021) argue that GVC participation can boost domestic innovation capabilities when the foreign outsourcing lead firm is willing to convey the know-how and technology to local suppliers. Foreign outsourcing firms are the customers of the outsourced intermediate goods/inputs; and, in order to ensure the efficient production and GVC smooth functioning, foreign outsourcing firms have incentive to transfer knowledge, i.e., the know-how. On the other hand, the fragmentation of production in GVCs might not always lead to the enhancement of domestic innovative capabilities, for example because the foreign parent company could carefully divide and disseminate knowledge to the suppliers. While the incentive to convey knowledge to local producers can occur in complementary areas, support to innovation activities of local suppliers by foreign outsourcing firms might not occur in the areas that challenge their core competency areas. Therefore, it may require considering the distinction between the concepts of "technology lending" and "technology spillover", as pointed out by Baldwin (2014).

Additionally, the trade-off arising from the co-location of production and innovation activities may hinder the smooth functioning of key channels between GVCs and innovation. When production is offshored and distanced from design, innovation may be constrained due to the disruption of the synergy between production and R&D activities. Geographical proximity and relational proximity may play a crucial role in interactive learning and the building of trust. When production and R&D teams are co-located, they have the opportunity to engage in interactive learning and build trust, which drives technological advancement and fosters innovation.

In this context, Buciuni and Finotto (2016) investigate the co-location of production activities and development/innovation activities in three low-technology Italian manufacturing industries, namely furniture, bicycles and fashion leather goods. They argue that contiguity between local manufacturing activities and not all but a few

research (design) and development activities support innovation. Three key development tasks – prototype development and industrialization are tightly linked to the manufacturing expertise of skilled workers and suppliers specializing in specific phases of the actual industrial production. This finding suggests that although product innovation thrives on global activities, the location of a specific bundle of development activities follows the geography of industrial production. Therefore, Buciuni and Finotto (2016) contend that the co-location of this innovation bundle and more generic production activities is a necessary condition for innovation development in low-technology global industries. In essence, they discuss how the geography of innovation is influenced by the choice of R&D and production locations. Importantly, in low-value added manufacturing activities, local firms function also as hubs of product development activities. This is evident in furniture and fashion leather items industries. The Taiwanese bicycle sector shows how product development shifts to geographies where mass production takes place (Buciuni and Finotto, 2016). The US economy is also given as a case in point, where the detachment of production and design activities can impede innovation. This phenomenon is particularly evident in industries such as semiconductors and solar panels, where innovation activities, previously dominant by the United States, have recently shifted to countries such as South Korea, China and Taiwan (Buciuni and Finotto, 2016, p. 2012). Geographical proximity facilitates interactive learning and trust-building, providing benefits in both technical and organizational developments. Ultimately, it may become important to maintain production activities at the center to sustain innovation activities.

2.2.3. Mixed Results on GVC Participation and Innovation

While the majority of existing studies in the GVC literature has predominantly emphasized productivity, value-added and aggregate income, the impact of GVC participation on innovation has received less attention and been overlooked. Despite the limited number of previous studies, the work in the GVC literature regarding the relationship between participation in GVCs and innovation performance (although some studies mentioned here do not directly examine the relationship between GVCs and innovation, but are somewhat indirectly related to innovation and can, therefore

provide some insight) shows mixed results. Therefore, based on the results, the relationship between GVC integration and innovation performance remains unclear. Moreover, whether participation in GVCs can ensure progress in innovation performance, particularly for developing countries, remains a controversial issue. Whether or not the higher participation rates guarantee to become innovators requires more elaboration.

The effect of backward linkages within GVCs shows mixed results. Table 2.1 summarizes studies on the relationship between backward participation in GVCs and the innovation nexus, along with their results[6]. While some studies report a positive effect of backward linkages on productivity (Bas and Strauss-Kahn, 2011; Halpern *et al*., 2005; Kasahara and Lapham, 2013) and income (Walid, 2022), others find insignificant (Bas and Strauss-Kahn, 2011) or negative effects (Hue and Korwatanasakul, 2023) on productivity.

The effect of backward linkages is also unclear regarding its impact on product innovation (negative effects: Dang and Dang, 2020; Ito *et al*., 2023; insignificant effect: Lo Turco and Maggioni, 2015; Thakur and Sharma, 2025). Furthermore, the relationship between GVC participation and innovation may be dynamic and nonlinear. While early involvement in GVCs may stimulate innovation, as economies mature, there may be a greater reliance on domestic value chains to further promote innovation (Lee, 2019).

Similarly, the effects of forward participation in GVCs exhibit mixed outcomes. Table 2.2 summarizes studies on the relationship between forward participation in GVCs and the innovation nexus, along with their results[7]. Some studies report a positive impact on labor productivity (Hue and Korwatanasakul, 2023), income (Walid, 2022), and innovation (Ito *et al*., 2023). Conversely, other studies suggest an inverted U-shaped relationship between forward GVC participation and innovation, implying that diminishing returns may occur as countries become more deeply integrated (Thakur and Sharma, 2025).

[6] Table 2.1 is presented at the end of this chapter.

[7] Table 2.2 is presented at the end of this chapter.

Although not directly related to GVC participation and innovation nexus, the studies by Lo Turco and Maggioni (2013, 2015) may also be relevant in this context. Lo Turco and Maggioni (2013) argue that importing new inputs may enable firms to extend their production frontiers, thereby positively affecting firm productivity. Furthermore, they find evidence that imports from low-income countries positively and significantly affect the export probability of Italian manufacturing firms, whilst imports from high income countries do not have a significant effect on the export probability. They argue that the cost-saving channel of imports, rather than the technology channel, affects the probability of exporting by Italian manufacturing firms in the period 2000-2004. Consequently, Italian firms appear to have chosen to compete with emerging manufacturing economies by utilizing cheaper inputs from low-income countries rather than upgrading the quality of products. Based on the evidence of both learning by exporting (Serti and Tomasi, 2008; Bratti and Felice, 2012), and positive effects of imports through cost saving on the probability of exports, Lo Turco and Maggioni (2013) argue that Italy could benefit from productivity gains driven by exporting.

Another study conducted by Lo Turco and Maggioni (2015) investigates the causal effect of exports and imports on the firm product scope and the scope of new products in Türkiye. Lo Turco and Maggioni (2015) examine both the mutually exclusive effects of exports and imports and the joint effect of exports and imports on the firm product scope. Their sample consists of Turkish manufacturing firms with at least 20 employees for the period 2005-09. The analysis reveals that although the firm's product scope and the number of new products are positively related to both exports and imports of firms' own produced products, importing has an insignificant effect on "*the probability to increase the product scope and introduce new products*" (Lo Turco and Maggioni, 2015, p.9). The estimation results show that starting to export own produced products increases the probability of expanding the product scope and introducing new products. Although being an importer is not significant, entering both export and import markets at the same time increases the probability of producing new goods and to becoming an innovator (Lo Turco and Maggioni, 2015).

Dang and Dang (2020) support the notion that the effects of GVC participation on innovation are mixed. They find that, although foreign value-added in exports negatively affects the product innovation of firms in Vietnam, it positively contributes to the improvement of existing products. Based on these findings, the study suggests that, in order to meet the increased demands of leading firms in GVCs, local GVC firms focus on improving the existing products rather than introducing new ones.

The work of Walid (2022) also provides valuable insights into the effects of GVC participation. Walid (2022) analyzes the relationship between export sophistication and economic performance using a panel dataset which covers 64 countries and 11 years (the period between 2005 and 2015). The study employs OECD Trade in Value Added (TiVA) indicators to assess GVC participation gains. The findings indicate that, while the backward linkages enhance income, the effects of forward linkages on income are mixed. The forward participation effects vary depending on the end use of the exported domestic value added. In the cases where the domestic value-added is re-imported or while re-exporting the intermediate imports occur, their effects are income enhancing. However, the effect of domestic value-added in exports of final or intermediate products on income is found to be insignificant. Hence, Walid (2022, p.19) argues that gains from GVCs cannot be taken for granted, as diversified and integrated exports and/or imported inputs do not guarantee that countries will "*be able to learn by doing, climb the sophistication ladder or domiciliate more valuable parts of the value chain*". This is evident at the "*sell-side*".

Hue and Korwatanasakul (2023) present contrasting results when examining the implications of the degree of GVC participation in their study, which explores the impact of GVC participation on labor productivity in Vietnam. They find that while backward participation has negative effects, forward participation has positive effects on labor productivity. Based on these findings, Hue and Korwatanasakul (2023) support the notion of learning by exporting and learning by supplying. The negative effect, however, is attributed to the heavy reliance on foreign inputs and the importation of foreign technology, which hampers domestic technology development, and the trap of subordinate role for domestic firms that reflects the international division of labor.

By investigating the relationship between GVC participation centrality and innovation outcome, Ito *et al*. (2023) find that while forward participation has a positive effect on innovation, backward participation leads to negative outcomes. Their findings suggest that knowledge spillovers from downstream linkages are more significant than those from upstream suppliers. Moreover, Ito *et al*. (2023) emphasize the importance of the centrality, that is being a central hub in GVC network, on developing new technologies. They argue that "*embeddedness alone does not seem to clearly translate into more innovation*" (Ito *et al*. 2023, p.14).

Thakur and Sharma (2025), in their exploration of the relationship between GVC embeddedness (encompassing both participation and position) and innovation performance in India, find that only forward participation has a positive effect on innovation performance. Furthermore, forward participation presents an inverted U-shaped effect on innovation performance, suggesting that forward participation initially improves innovation performance, with the impact varies at higher levels of participation. The findings also indicate that backward participation has no significant effect on innovation performance.

Last but not least, Lee (2019) argues that the role of GVC participation in economic development is not linear. While participation in GVCs can foster economic growth, there is no guarantee that it will lead to a transition into high-value-added industries. This is because countries may easily become trapped in low-value-added industries and activities. Although early GVC participation may promote innovation, as economies grow, they must also rely on domestic value chains in order to further foster innovation. This later step is necessary to reduce dependence on foreign-dominated value chains.

In essence, Lee's work (2019) highlights the need to move away from foreign-controlled GVCs in order to enhance local innovation capacity, as demonstrated by the examples of China, South Korea, and Taiwan. Without this shift, there is a danger that countries may stagnate, and remain competitive through reliance on low-wage competition (see Hue and Korwatanasakul, 2023, above for a similar concern).

2.2.4. Assessment of the Discussions in the Literature

As existing studies in the GVC literature suggest, the effects of participation in GVCs on innovation may vary. In this context, there are no clear and automatic channels or mechanisms through which these effects occur. Based on the potential key channels identified in Chapter 2.2.1, the effects of GVC participation on innovation may be expected to be positive. However, research on the GVC-innovation nexus presents mixed results. Therefore, it can be argued that these key channels may not function smoothly, and the expected positive effects of GVC participation on innovation may not always occur. In Chapter 2.2.2, we summarize and discuss the possible challenges that hinder the smooth functioning of these key channels, thus leading to ambiguous effects on innovation.

Based on the arguments and results from studies in the GVC literature, we align with the view that participation in GVCs may not always automatically lead to a positive effect on innovation, and that the effects may vary depending on certain circumstances. Therefore, we contend that whether participation in GVCs may ensure to promote innovation, particularly for developing countries, requires further elaboration. By investigating effects of GVC participation on innovation performance, we aim to contribute to this gap and enrich the literature.

As explained in detail in Chapter 1.4, this thesis makes several important contributions. First, conceptually, it connects the fields of GVCs and innovation, offering an explicit framework that integrates these two areas. Therefore, our work is among the limited number of studies that directly examines the effect of participation into GVCs on innovation, thereby contributing to and enriching the still-narrow but burgeoning literature[8]. Second, it investigates the effects of both backward and forward participation in GVCs on innovation performance separately. Thanks to this perspective, that is, examining the mutually exclusive effects of GVC participation, encompassing both backward and forward participation, rather than focusing on a single type or the joint effects of GVC participation, our work differs from some of

[8] Ito *et al*. (2023) stands out among studies that examine the direct effects.

the existing studies in the literature[9]. Third, in this regard, the thesis differs from existing studies due to its scope and coverage, which include a greater number of countries and industries included in the analysis compared to previous works. In particular, one part of our work involves the cross-country industry-level analysis, based on a comprehensive dataset covering 41 countries and 19 industries from 1995-2018. We construct this dataset by merging and transforming data accordingly from separate fields (i.e., international trade on one hand and science, technology and innovation on the other). Furthermore, our work is not limited to cross-country industry-level analysis; rather, it has dual focus. The thesis also provides an in-depth examination of Türkiye's innovation performance with respect to GVC participation. In this regard, it stands out as one of the few studies focused on Türkiye in this specific field that directly examines the effect of GVC participation on innovation. Finally, based on both the cross-country patterns and the in-depth analysis of the case of Türkiye, the thesis offers several policy recommendations.

Table 2.1. Summary of Studies on the Nexus Between GVC Backward Participation and Innovation

Study	Method	Data	Period	Country	Main Findings
Bas and Strauss-Kahn (2011)	Quantitative	Firm level	1995 - 2005	France	Total factor productivity is positively affected by an increase in imports of intermediate goods. This effect is explained by better complementarity of inputs and technology transfer. However, the positive effect is only significant when developed countries are sources of imports. The effect becomes insignificant when imports sourced from developing countries.
Dang and Dang (2020)	Quantitative	Firm level	2007 - 2015	Vietnam	Foreign value-added in exports negatively affects product innovation. On the other hand, it contributes to the improvement of existing products.

[9] For studies that examine both types of GVC participation, see Hue and Korwatanasakul (2023), Ito *et al*. (2023), Thakur and Sharma (2025), and Walid (2022).

Table 2.1. (continued)

Halpern *et al*. (2005)	Quantitative	Firm level	1992 - 2001	Hungary	Imports of inputs have a significant and positive effect on total factor productivity. Both improved quality of inputs and expansion of variety led by imports have a positive effect on productivity.
Hue and Korwatanasakul (2023)	Quantitative	Firm level	2009 - 2018	Vietnam	The effect of the degree of GVC participation on labor productivity differs according to the type of participation. Grounded on the degree of GVC participation, the study finds that backward participation affects labor productivity negatively. The negative effect can be explained by the subordinate role trap.
Ito *et al*. (2023)	Quantitative	Firm level	1995 - 2011	Japan	GVC participation and centrality are related to innovation outcome. Backward participation has negative effect on innovation outcome.
Kasahara and Lapham (2008)	Quantitative	Firm level	-	Chile	Importing intermediate goods for production becomes important to analyze firm performance. Firms both import intermediates and export are more productive than other firms.
Keller (2004)	Review	-	-	Various	There is some evidence that importation is associated with technology diffusion. However, it is unknown that to what extent is through importation of intermediate goods.
Lee (2019)	Review	-	-	Various	While early GVC participation may foster innovation, as economies grow, they should also rely on domestic value chains to foster innovation.

Table 2.1. (continued)

Lo Turco and Maggioni (2013)	Quantitative	Firm level	2000 - 2004	Italy	Only importing intermediate inputs from low-income countries with cheap labor costs has a positive and significant impact on the export probability of firms. This finding suggests that instead of the technology channel, the cost-saving channel of imports affects the probability of exporting by Italian manufacturing firms. This channel seems to improve firms' competitiveness in global value chains. Italian firms appear to utilize cheaper inputs from low-income countries.
Lo Turco and Maggioni (2015)	Quantitative	Firm level	2007-2009	Türkiye	The study investigates the effects of exports and imports on product scope, the probability to innovate. Within GVCs, being upstream supplier to foreign customers enhances competitiveness of firms. However, importing alone does not turn out to be significant for product innovation.
Thakur and Sharma (2025)	Quantitative	Industry level	2009-2018	India	Backward participation has no significant effect on innovation performance.
Walid (2022)	Quantitative	Industry level	2005 - 2015	Various	The effects of GVC participation on income are mixed. Therefore, the benefits of GVC participation should not be taken for granted. Countries do not necessarily benefit from GVC participation, climb up the value chain and learn by doing.

Table 2.2. Summary of Studies on the Nexus Between GVC Forward Participation and Innovation

Study	Method	Data	Period	Country	Main Findings
Bratti and Felice (2012)	Quantitative	Firm level	1998 - 2003	Italy	Exports status of a firm has a positive effect on the likelihood of product innovations. This finding is interpreted as the effect of learning by exporting. By exporting, firms acquire knowledge and experience.
Hue and Korwatanasakul (2023)	Quantitative	Firm level	2009 - 2018	Vietnam	The effect of the degree of GVC participation on labor productivity differs according to the type of participation. Grounded on the degree of GVC participation, the study finds that forward participation has a positive effect on labor productivity. The study supports the notion of learning by supplying and learning by exporting.
Ito *et al*. (2023)	Quantitative	Firm level	1995 - 2011	Japan	GVC participation and centrality are related to innovation outcome. Forward participation has positive effect on innovation outcome. The study suggests that knowledge spillovers from downstream linkages are more relevant than knowledge spillovers from upstream suppliers.

Table 2.2. (continued)

Keller (2004)	Review	-	-	Various	The literature supports the notion that learning occurs by exporting. Nevertheless, there are also some skeptical empirical studies indicating that these effects are not clear cut.
Lo Turco and Maggioni (2015)	Quantitative	Firm level	2007-2009	Türkiye	The study investigates the effects of exports and imports on product scope, the probability to innovate. The study finds evidence that exporting positively affects the probability to innovate. Within GVCs, being upstream supplier to foreign customers enhances competitiveness of firms.
Thakur and Sharma (2025)	Quantitative	Industry level	2009-2018	India	Forward participation has an inverted U-shaped impact on innovation performance.
Walid (2022)	Quantitative	Industry level	2005 - 2015	Various	Forward linkages seem to have mixed effects. The effects of GVC participation on income are mixed. Therefore, the benefits of GVC participation should not be taken for granted. Countries do not necessarily benefit from GVC participation, climb up the value chain and learn by doing.

CHAPTER 3

CROSS-COUNTRY INDUSTRY-LEVEL ANALYSIS

This chapter investigates the effects of GVC participation on innovation performance using a comprehensive dataset covering 19 industries across 41 countries between 1995 and 2018[10]. The quantitative analysis includes both descriptive statistics and econometric modelling.

3.1. Collection and Transformation of Data

As the research aims to analyze the relationship between GVC participation and innovation performance, we need to combine the data of these two separate areas. That is, the data sources regarding GVC participation on the one hand, and the data sources for innovation performance/activities on the other hand should be harmonized. However, the data sources that include variables related to each area are neither unique nor comprehensive at all. This necessitates detailed examination of various data sources in order to select the indicators as well as the variables which could serve the most for our goal.

Before delving into the data sources that can be used for analyzing GVC participation, we first need to emphasize that the phenomenon of GVC itself has put into question the use of traditional trade statistics in order to understand the developments in the global trade, and particularly, the trade-related issues such as bilateral trade balances, revealed comparative advantage, and rules of origin. Xing (2016) argues that the inconvenience of the use of conventional trade statistics in

[10] The list of countries and the list of industries can be found in the Annex (see Tables A2 and A3). The countries include both member states of the OECD (except for Colombia and Costa Rica) but also five other countries (Argentina, China (People's Republic of), Chinese Taipei, Romania, Singapore).

analyzing trade under GVCs has already been put forward in many studies. Instead, it is suggested that in order to understand better the changes stemming from the phenomenon of GVC, tracing the trade in value added becomes crucial. Trade statistics based on *value-added terms* contribute much to gain new insight about the process of value creation and the trade relations between countries (OECD-WTO, 2015).

The measurement of integration into GVCs is a relatively recent issue compared to the concept of GVCs itself. The current progress regarding the quantitative assessment has become recently more prevalent partly because of the development of the inter-country input-output tables. The inter-country input-output tables are grounded on the national input-output tables, national accounts statistics and estimated bilateral trade coefficients; hence, they provide information including data on international trade, investment, and consumption etc. (Xing, 2016).

Nevertheless, some caution still needs to be taken into consideration as Xing (2016) points out that even though international input-output tables are convenient tools for measuring trade in value added, strong assumptions such as homothetic preferences and identical input bundles between domestic sales and exports are made when deriving results from international input-output tables; i.e., "the results of international input-output tables are the estimates derived with strong attached assumptions" (Xing, 2016, p. 7).

One of the prominent inter-country input-output tables are those that are developed by the OECD[11]. The joint OECD-World Trade Organization (WTO) Trade in Value Added (TiVA) initiative, which is the associated database stemming from the OECD-Inter-Country Input-Output (ICIO) tables, considers the flows of goods and services within global value chains that are not measured in conventional gross international trade statistics. It considers the value-added of each country in the production of goods and services that are consumed internationally.

[11] World Input-Output Database (WIOD), UNCTAD EORA GVC Database, Global Trade Analysis Project (GTAP) Database are the other global input-output databases that can be used in GVC analysis (Amador and Cabral, 2016).

The TiVA database (2021)[12] covers 66 economies and 45 unique industries for all years from 1995 to 2018. The industrial classification is based on International Standard Industrial Classification of All Economic Activities (ISIC) Rev.4. The TiVA database includes a set of indicators measuring the value-added content of international trade flows and final demand, and provides information regarding inter-country and inter-industry flows of intermediate goods and services. In addition to determining the source of value added embodied in gross exports, the TiVA database addresses the difference between the share of exported value-added that is directly absorbed by trade partners' domestic demand and the share of exported value-added that is further exported to third countries (OECD, 2021). In our research, we use the TiVA database to provide a detailed portrait of GVC participation since it can provide already-built indicators, which present domestic value-added exports that are used in other countries' exports as a share of gross exports (as an indicator for forward participation) as well as foreign value-added part of exports (as an indicator for backward participation).

The second pillar of the research data are the variables associated with innovation activities and performance at the industry and country levels. The data sources we use for this field are the OECD Patents by Technology Database (under Science, Technology and Industry Database) and the OECD Analytical Business Enterprise Research and Development (ANBERD) Database (under Structural Analysis (STAN) Database)[13].

In our work, we use patent statistics as an indicator for innovation performance for several reasons. As Hong *et al*. (2012) state, patent statistics have been widely used in empirical research on innovation. Despite being an indirect measure of innovation performance, patent statistics still present the capacity of a country to "*exploit knowledge and translate it into potential economic benefits* (p. 1)" (Eurostat, 2017). In addition, patent statistics are available for a comprehensive set of both countries and industries, which is not the case for other direct measures of innovation. One

[12] In our analysis, we use the TiVA database (2021) that was released in November 2021.

[13] The innovation-related data are at the industry level.

might also argue that R&D expenditure statistics are an alternative indicator for innovation. Evidently, in empirical research on innovation, R&D expenditure is used both “as an output indicator” and “as an input indicator”. In our work, we do not use R&D expenditure as output indicator (endogenous variable) but as input indicator (exogenous variable) instead and keep on using patent as endogenous variable. The main underlying reason is that we had difficulty in finding a sufficient number of explanatory variables that are compatible with our country-industry level analysis, i.e., compatibility with the industry classification and the availability of the data for all countries. By using R&D expenditure as an input indicator, we also manage to deal with the limited number of explanatory variables.

In addition to statistics related to GVC measurement and innovation activities, statistics related to some other fields are collected. In this vein, we collect population statistics, gross fixed capital formation statistics and employment statistics. These statistics are used in our empirical framework for forming and/or adjusting endogenous and exogenous variables (other than GVC measurement indicators). Population statistics are used to standardize the statistics for cross-country comparison, which is a common procedure. For instance, the number of yearly patents granted by the USPTO is normalized by the total population.

In our work, population statistics are obtained from OECD Demography and Population Statistics Database. Gross fixed capital formation statistics are obtained from OECD Input-Output Database (IOTs 2021), and employment statistics are obtained from OECD Trade in Employment (TiM 2021) Database.

The up-to-date merged dataset involves the variables regarding patents, GVC participation measures (measures of both backward and forward participation), the business R&D expenditure, gross fixed capital formation and employment by industry and population of 41 countries and 19 industries from 1995 to 2018 (24 years)[14]. The name and short description of the variables as well as the sources where

[14] The time period is considered to be enough to capture the developments and changes regarding both developed and emerging economies within GVCs.

we obtain, calculate and/or transform them are presented in detail in the Annex[15]. The list of countries and industries are also presented in the Annex.

Consequently, one of our contributions in this thesis is to construct a comprehensive dataset and merge and transform the data from separate areas. Since the data are from the sources in different fields, the classification of the country-industry level data differs among variables. Hence, for the empirical study, the data need to be transformed according to the same classification of economic activities. Consequently, the country-industry level data, which are based on ISIC Rev.4, are transformed by using ISIC Rev.4 – TiVA 2021 correspondence table and aggregated according to the industry classification of TiVA database. Table 3.1. provides an example for the transformation and aggregation of the above-mentioned data for three industries (for the concordance for all industries, see Annex Table A.3).

Table 3.1. An Example: Industry List (ISIC Rev.4 – TiVA 2021 Concordance)

N.	Industry Description (TiVA)	ISIC Rev.4 Code	TiVA Code
1	Food products, beverages and tobacco	10, 11, 12	D10T12
2	Textiles, wearing apparel, leather and related products	13, 14, 15	D13T15
3	Wood and of products of wood and cork, except furniture; articles of straw and plaiting materials	16	D16

Source: Guilhoto et al. (2022)

In this vein, one of our contributions in the thesis is to merge the industry classification in the TiVA database (based on ISIC Rev.4) with the classification of patents. We transform the data regarding the number of patents which are originally obtained from technology domains and International Patent Classification (IPC) into ISIC Rev.4. For the transformation process, we use the EUROSTAT's (the Statistical Office of the European Union) correspondence table International Patent

[15] There are some missing values, most of which stem from the data regarding business R&D expenditure by industry.

Classification (IPC) V8 – NACE Rev.2. Table 3.2. provides an example for the transformation and aggregation of the above-mentioned data for three industries (for the concordance for all industries, see Annex Table A.4).

Table 3.2. An Example: Concordance NACE Rev.2 – IPC V8

NACE Rev.2		IPC V8
10	Manufacture of Food Products [10]	A23J A01H A01J A21D A23B A23C A23D A23F A23G A23J A23K A23L 1 A23L 3 A23P C12J C13B C13F C13J C13K
11	Manufacture of Beverages [11]	A23L 2 C12C C12F C12G C12H
12	Manufacture of Tobacco Products [12]	A24B A24D A24F
13	Manufacture of Textiles [13]	D04D D04G D04H D06C D06J D06M D06N D06P D06Q
14	Manufacture of Wearing Apparel [14]	A41B A41C A41D A41F

Source: Van Looy et al. (2015)

Eurostat develops the aforementioned concordance scheme to relate industries to technology. When the industry classification NACE Rev.2 was introduced in 2006, that modification necessitated such a scheme to analyze the relationship between industries and technology. Consequently, the correspondence table was developed to relate industries to IPC, which lists patents according to the technology field they belong to.

Last but not the least, we contribute to the field by aggregating the data of business R&D expenditure by industry that is based on ISIC Rev.4, to the industry classification of the TiVA database, which is also one of the contributions of the study (see Annex Table A.3).

3.2. The Measurement of Integration into GVCs and Trade in Value-Added (TiVA) Indicators

The measurement of integration into GVCs is a relatively recent issue compared to the concept of GVCs itself. The previous empirical research on GVCs can be grouped according to their differing purposes. While there are some studies that aim to investigate the determinants and drivers of GVC integration as well as the consequences of GVCs including the relationship between GVC participation and economic upgrading (Kowalski *et al*., 2015; Taglioni and Winkler, 2016), there also exist some studies that aim to map, measure and quantify GVC participation.

The empirical analysis on GVCs have been done either at the sectoral level or at the firm level, where the latter is a more recent and underdeveloped strand of research. Amador and Cabral (2016) summarize and classify these methodological approaches. Sectoral level analysis can be classified under three groups: "international trade statistics on parts and components; customs statistics on processing trade and international trade data combined with input-output (I-O) tables (Amador and Cabral, 2016, p.284). Moreover, the empirical studies at the firm level are classified under two headings: micro-level studies based on international trade data and firm-level survey data. According to Amador and Cabral (2016), these different methodological approaches are complementary in measuring and mapping GVCs and; in this sense, they reflect different views on quantifying GVCs. Each of them has weaknesses and strengths with respect to the complexity of the data required, the accuracy of the resulting quantification and the (global) coverage of the measure.

To exemplify, the empirical sectoral level analysis based on international trade statistics on parts and components, which can be regarded as the simplest approach with its "high coverage and low complexity of the data and comparability across countries" (Amador and Cabral, 2016, p.285). However, the reliance of this approach on the product classification of trade statistics and the low accuracy of the measure constitute the caveats. However, trade in value-added approach with world input-output tables, which is a more recent approach, provides more accurate measurement and appropriate source of sectoral information for cross-industry and time analysis

while it requires more complex data and still grounds on strong proportionality assumptions (Amador and Cabral, 2016).

As argued in Amador and Cabral (2016, p.288), input-output based measures including classical input-output measures as well as inter-country (global) input-output (ICIO) matrices, could be used to quantify international fragmentation of production by considering "imported input shares of gross output, total inputs or exports". Classical input-output tables provide data for the import content of production and exports. Feenstra and Hanson (1996) developed a measure based on a classical input-output table that focuses on the foreign content of domestic production. Hummels *et al.* (2001), also developed a measure called "vertical specialization", which considers the imported input in exports. In a certain sense, it considers the situations where production takes place in at least two countries and "*goods cross at least twice the international borders*" (Amador and Cabral, 2016, p.288). Furthermore, the recent strand of measures is based on inter-country input-output tables since the concept of "made in the world" instead of "country of origin" becomes crucial in the era of spreading GVCs. The increasing international fragmentation of production in GVCs necessitates the use of both gross trade values and trade statistics in value-added terms.

As shown above, there has already been a massive effort to measure participation rates into GVCs. Nonetheless, in our research we do not aim to construct new formulations to measure integration into GVCs, which is a separate field of research focusing only on GVCs. Rather, we aim to gain insights on the relationship between integration into value chains and innovation performance by using the already-built indicators regarding backward participation and forward participation (of industries). It is more convenient to consider these indicators only as instruments that guide and facilitate our work.

We employ the indicators already built in (the 2021 edition of) the TiVA database, which contains a range of indicators measuring the value-added content of international trade flows and final demand. The indicators were derived from the 2021 release of OECD's Inter-Country Input-Output (ICIO) Database (Guilhoto *et*

al., 2022). The GVC Participation Index, which provides an indication of GVC participation, is the combination of backward and forward linkages (OECD, 2015). Kowalski *et al*. (2005, p.13) state that "*value chain participation is defined in terms of the origin of the value added embodied in exports both looking backward and forward from a reference country.*"

Moreover, Kowalski *et al.*, (2015) argue that the two indicators that constitute the GVC participation index (namely, backward participation and forward participation) measure different forms of engagement. They provide a metric of engagement presenting the demand and supply sides of the value chain. To exemplify, a country that mainly supplies intermediate goods to an assembler country producing and exporting final goods has a high forward participation index, but not necessarily a high backward linkage. In a similar fashion, a country that mostly demands intermediate goods to assemble and export final products has a high backward participation index but does not have high forward linkage.

In that regard, one issue that deserves attention is that even though countries might have similar GVC participation indexes, the decomposition of the integration does not follow similar patterns. To exemplify, Belgium and Norway have similar GVC participation rates, which are measured as 59% for Belgium and 54.7% for Norway. Nevertheless, Norway integrates into GVCs predominantly through providing domestic value-added to other countries' exports. The forward linkage of Norway is higher than that of Belgium.[16]

Therefore, the differentiation between backward and forward linkages becomes important to map out GVC participation of countries. In our work, we use the indicators related to both backward participation and forward participation, which are explicitly defined in the TiVA database. We employ "foreign value-added share of gross exports (EXGR_FVASH)" as a measure of backward participation, and "domestic value-added in exports of intermediate products as a share of total gross

[16] The share of domestic value-added embodied in other countries' exports in Norway's gross exports is 39% in 2018, which is higher than that of Belgium. The same ratio is 22.9% for Belgium (TiVA Database, 2021).

exports (EXGR_INTDVASH)" as a measure of forward participation. Employing these indicators contribute to our study since it draws a general framework for the participation of industries into GVCs. The aforementioned indicators are explained in detail in Guilhoto *et al.* (2022).

Foreign value-added share of gross exports (EXGR_FVASH, percentage) shows "foreign value-added share of gross exports, for domestic industry i in country c. It is "defined as foreign value added embodied in gross exports EXGR_FVA (c,i,p[17]) as a percentage of total gross exports, EXGR (c,i,p)". The indicator is considered as a measure of backward linkages in analyses of GVCs since it is a foreign value-added intensity measure showing import content of exports (Guilhoto *et al.*, 2022, p.27).

$$EXGR_FVASHc,i = \frac{\sum pEXGR_FVAc,p,i}{\sum pEXGRc,p,i} \times 100$$

We draw the figure below in order to provide a better understanding regarding the indicator.

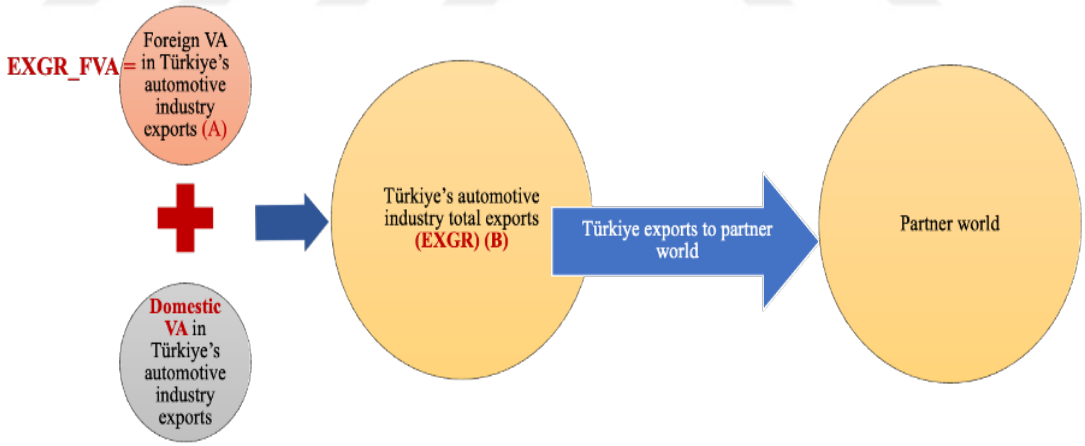


Figure 3.1. Foreign Value-Added Share of Gross Exports ((A/B)*100)

Source: Author's drawing based on the definitions of TiVA indicators

Domestic value added in exports of intermediate products as a share of total gross exports (EXGR_INTDVASH, percentage) is "defined as domestic value added in

[17] "p" denotes partner country.

gross exports of intermediate products, by industry i in country c, as a percentage of total industry exports, EXGR (c,i). It reveals the share of industry exports that consists of domestic value added destined for further production within direct partners' economies - either to meet partners' final demand or to be embodied in exports by direct partners. It can be considered as a measure of forward linkages in GVCs" (Guilhoto *et al.*, 2022, p.32).

$$EXGR_INTDVASHc,i = \frac{\sum pEXGR_INTDVAc,i,p}{\sum pEXGRc,i,p} \times 100$$

We draw the figure below in order to provide a better understanding regarding the indicator.

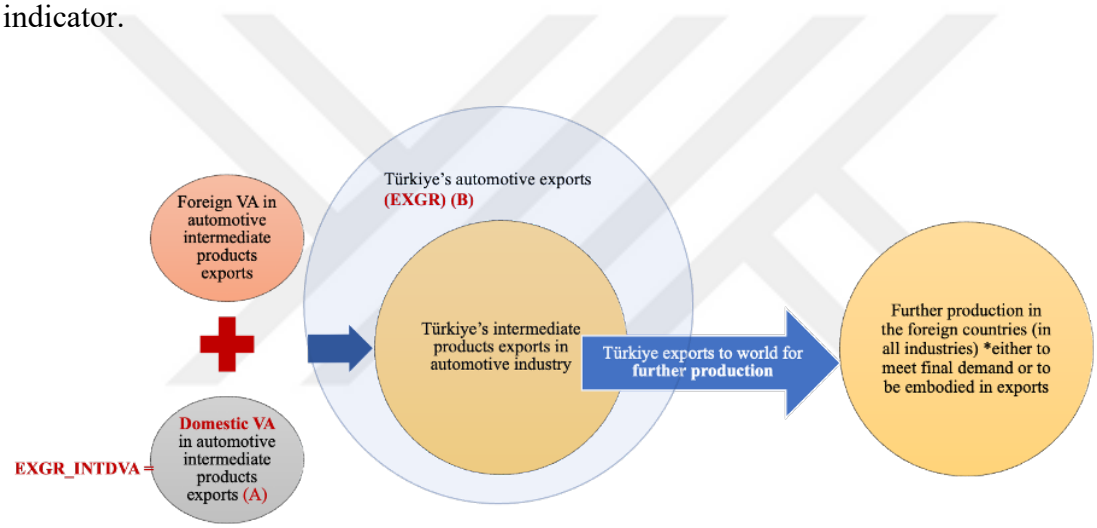


Figure 3.2. Domestic Value Added in Exports of Intermediate Products as a Share of Total Gross Exports ((A/B)*100)

Source: Author's drawing based on the definitions of TiVA indicators

3.3. Trends in GVC Participation: A Descriptive Analysis

This section presents the evolution of GVC participation through a brief descriptive analysis, which precedes a cross-country industry-level analysis that explores the effect of GVC participation on innovation performance.

The rise of GVCs has been a remarkable development in international trade since the mid-1990s (see Chapter 2). As shown in Figure 3.3, the GVC share of global trade

increased between 1995-2015. According to the World Bank (2020), the overall GVC participation increased to its peak level 52% in 2008, from 44% in 1995. The expansion of GVCs was disrupted by the global financial crisis of 2008-2009, and it has been stalled ever since. However, the share of GVCs in global trade remained higher compared to the mid-1990s, with GVC trade accounted for 48% of global trade in 2015, reflecting the significance of the GVC phenomenon. Approximately half of world trade seems to be related to GVCs (World Bank, 2020). The expansionary trend of GVCs largely continued after 2015. Nevertheless, this trajectory was strongly disrupted by the Covid-19 pandemic in 2020, which led to a decline in GVC participation rates. Despite this disruption, GVC-related trade increased in 2021 and 2022 (WTO, 2023).

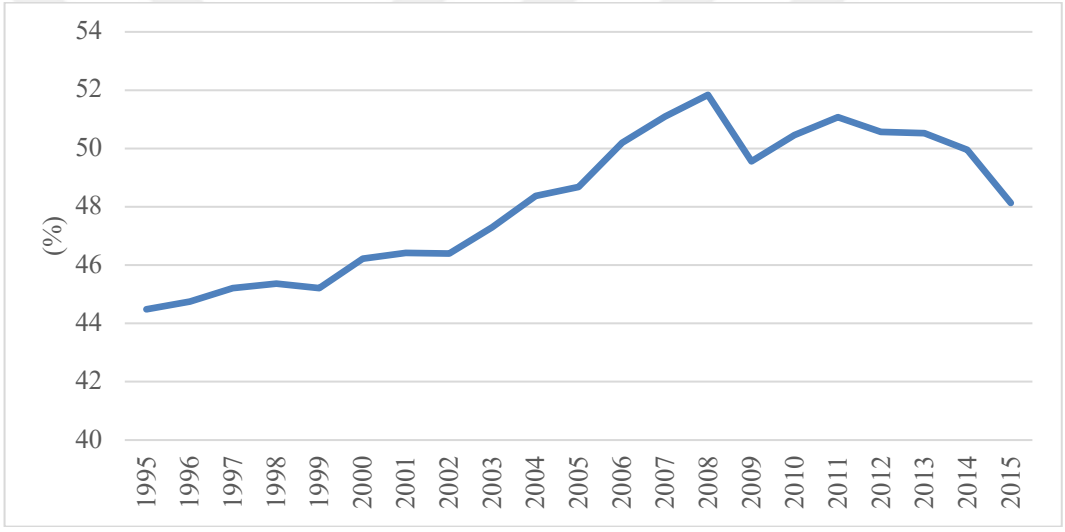


Figure 3.3. GVC Share of Global Trade (%, 1995-2015)

Source: World Bank (2020)

The expansion of activities in GVCs can also be tracked by monitoring international trade statistics on intermediate goods, which is an indicator of the activity in supply chains (WTO, 2024). According to the WTO, the share of intermediate goods was around 40% of non-fuel merchandise trade in 2008 (cited in Lo Turco and Maggioni, 2013). By the last quarter of 2023, the share of intermediate goods in total merchandise trade (excluding fuels) had risen to 52% (WTO, 2024).

Despite the growth in GVC-related trade, recent global developments, which include the pandemic, trade policy shifts toward protectionism, and rising geopolitical

tensions, have revealed potential vulnerabilities that may risk the prevalence, functioning, and further expansion of GVCs. In response to these developments, and considering the likelihood that such disruptions may become more frequent, intensified, and even permanent, new trajectories for international production have begun to emerge. These trajectories regarding international production include reshoring, nearshoring, and friendshoring, which represent alternatives to the prevailing model of unbundling and offshoring in international production. These emerging trajectories, which have increasingly featured on policy agendas, may challenge the international fragmentation of production (UNCTAD, 2022; WTO, 2023).

At present, these developments have not led to deglobalization or the disappearance of GVCs, but rather to a reconfiguration of international production networks (WTO, 2023). According to the OECD (2023), data through the end of 2022 do not yet provide significant evidence of large-scale reshoring or friendshoring. Nevertheless, if disruptions intensify or become permanent, the likelihood of a further shift toward reshoring, nearshoring and friendshoring may increase on policy agendas.

Figure 3.4 presents the GVC participation rates of selected economies between 1995 and 2018. The increase in the GVC participation rates of OECD countries, the EU (28) and the G20 also provides statistical evidence for the growth of GVC trade. While the GVC participation rates of OECD countries, the EU (28), and the G20 were 20.1%, 19.8%, and 22.1% in 1995, respectively, these rates increased to 26.9%, 28.4%, and 27.5% in 2018. However, the decline in GVC participation in 2009 is notable, likely due to the global financial crisis. Although the GVC participation rates of these three groups of economies were higher in 2018 compared to the levels in the mid-1990s, they have not returned to their peak levels observed in 2008. China's growing participation in GVCs has been evident since the early 2000s, with its accession to the WTO likely being a key factor. By 2018, China's GVC participation rate had risen to 36.6%, up from 28.4% in 1995. Türkiye also showed a remarkable increase in its GVC participation, with rates of 21.4% in 1995 and 39.8% in 2018. Türkiye's GVC participation is higher than those of OECD countries, the EU (28) and the G20 (see Chapter 4 for a detailed examination of Türkiye's GVC participation).

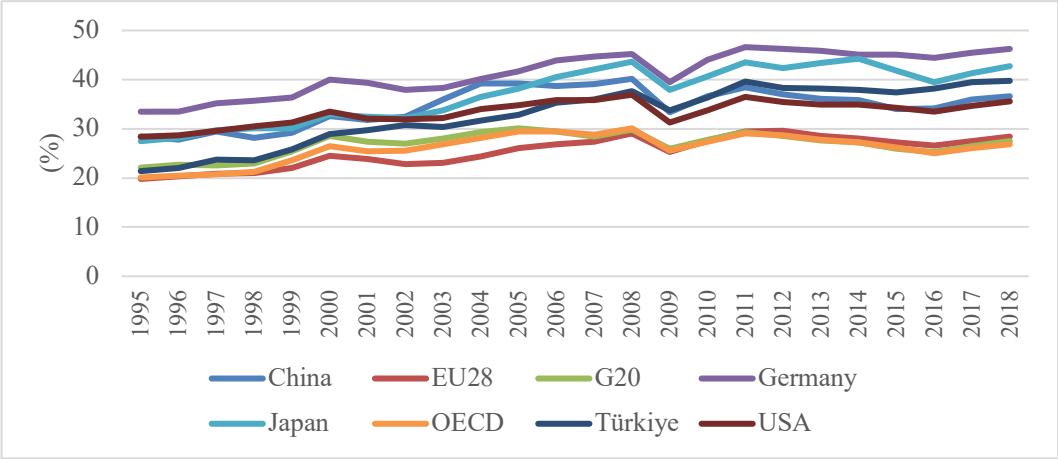


Figure 3.4. GVC Participation of Selected Countries and Country Groups (1995-2018)

Source: TiVA Database

Figure 3.5 presents a comparative view of the GVC participation rates of sixty-six countries and three country groups for the years 1995 and 2018[18]. According to the TiVA statistics, among the sixty-six countries, Luxembourg, Slovak Republic and Brunei Darussalam had the highest GVC participation rates in 2018, all exceeding 65%. Argentina, New Zealand, and Costa Rica, however, had the lowest GVC participation rates in 2018, each below 30%. Malaysia is the only country whose GVC participation rate decreased (by 2.3 percentage points) in 2018 compared to 1995.

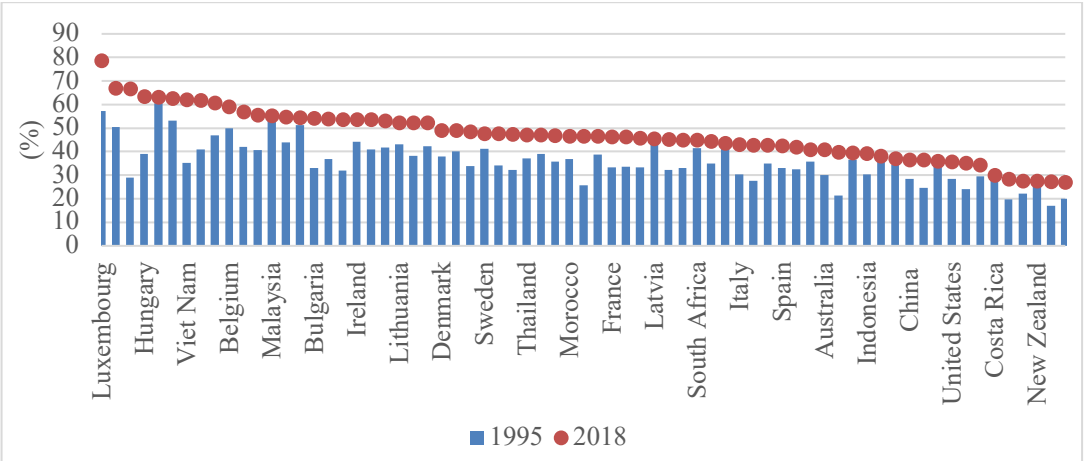


Figure 3.5. GVC Participation (%, 1995 and 2018)

Source: TiVA Database

[18] We calculate the GVC participation index by summing the backward participation and forward participation measures, which we obtain from OECD TiVA database (2021).

For a more comprehensive and nuanced analysis, it is necessary to decompose GVC participation into its two components. Figure 3.6 illustrates backward participation rates of the selected economies from 1995 to 2018. Compared to 1995, backward participation rates showed an increase in 2018 for majority of economies. Specifically, the backward participation rates of OECD countries, the EU (28), and the G20 were 3.2%, 7.2%, and 2.5%, respectively, in 1995. By 2018, these rates increased to 8.1%, 13.6%, and 5%, respectively. However, as observed in overall GVC participation, backward participation rates declined in 2009 due to the global financial crisis.

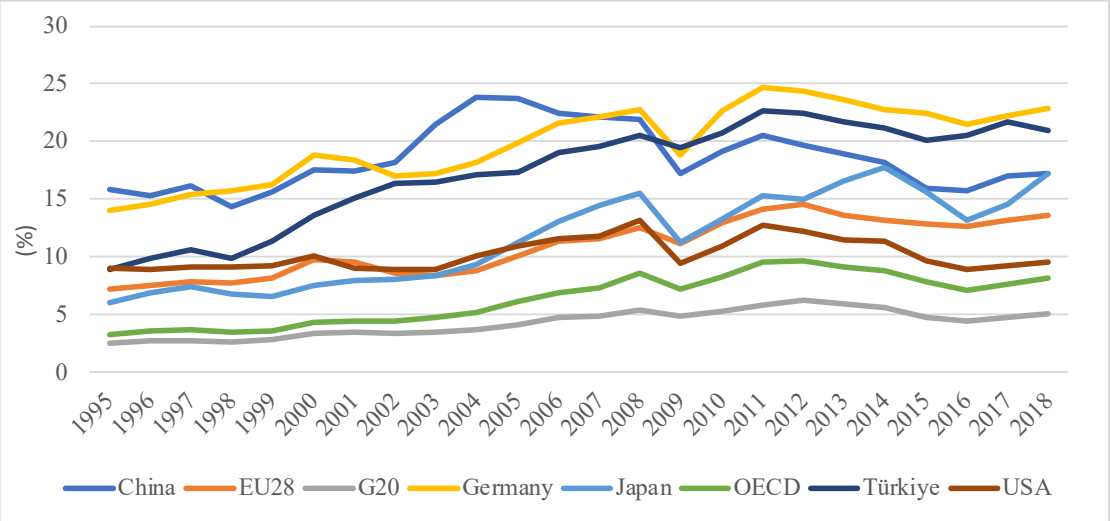


Figure 3.6. Backward Participation of Selected Countries and Country Groups (%, 1995-2018)

Source: TiVA Database

Figure 3.7 provides a comparative view of the backward participation rates of sixty-six countries and three country groups for the years 1995 and 2018. Among the sixty-six countries, Luxembourg, Malta and Viet Nam had the highest backward participation rates in 2018, all exceeding 50%. Saudi Arabia, the Russian Federation, and the US, however, had the lowest backward participation rates in 2018, each below 10%. Compared to 1995, the backward participation rates of Malaysia, Kazakhstan, Hong Kong, Israel, Myanmar, Lao People's Democratic Republic, Costa Rica, Canada, Australia, Norway, New Zealand, the Russian Federation, and Estonia decreased in 2018.

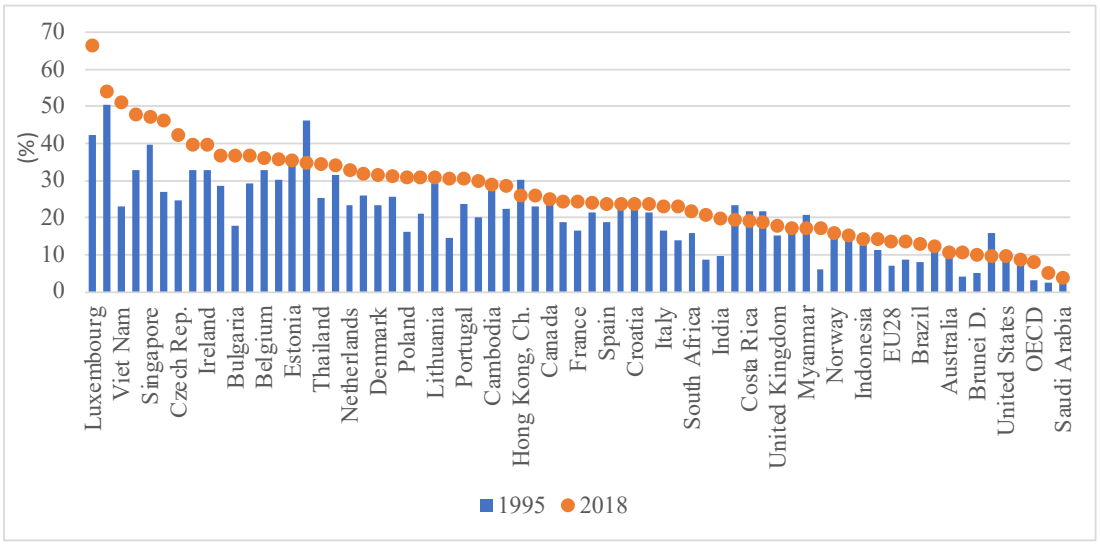


Figure 3.7. Backward Participation (%, 1995 and 2018)

Source: TiVA Database

Regarding forward participation, a similar trend to both overall GVC participation and backward participation was observed between 1995 and 2018. Forward participation rates increased for the majority of economies, with the exception of 2019. Specifically, the forward participation rates of OECD countries, the EU (28), and the G20 were 16.9%, 12.6%, and 19.6% in 1995, respectively, and rose to 18.8%, 14.8%, and 22.5% in 2018 (Figure 3.8).

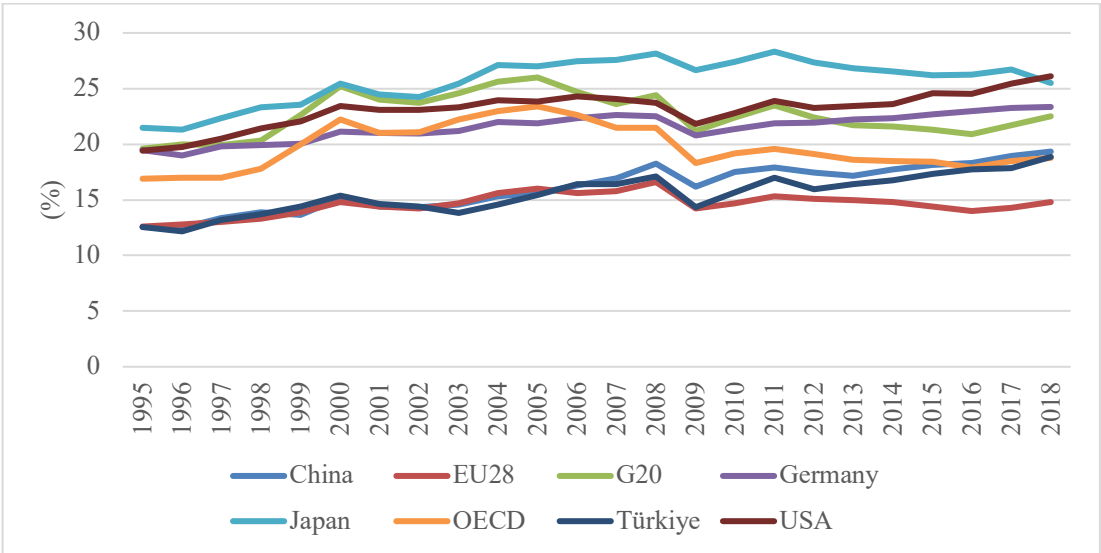


Figure 3.8. Forward Participation of Selected Countries and Country Groups (%, 1995-2018)

Source: TiVA Database

Brunei Darussalam, Kazakhstan, and Saudi Arabia had the highest forward participation rates in 2018, each exceeding 40%. In contrast, Malta, Mexico, and Costa Rica had the lowest forward participation rates in 2018, each below 11%. Compared to 1995, the forward participation rates increased for nearly all countries, except for Luxembourg, South Africa, Viet Nam, Malta, and Latvia, where the rates decreased in 2018 (Figure 3.9).

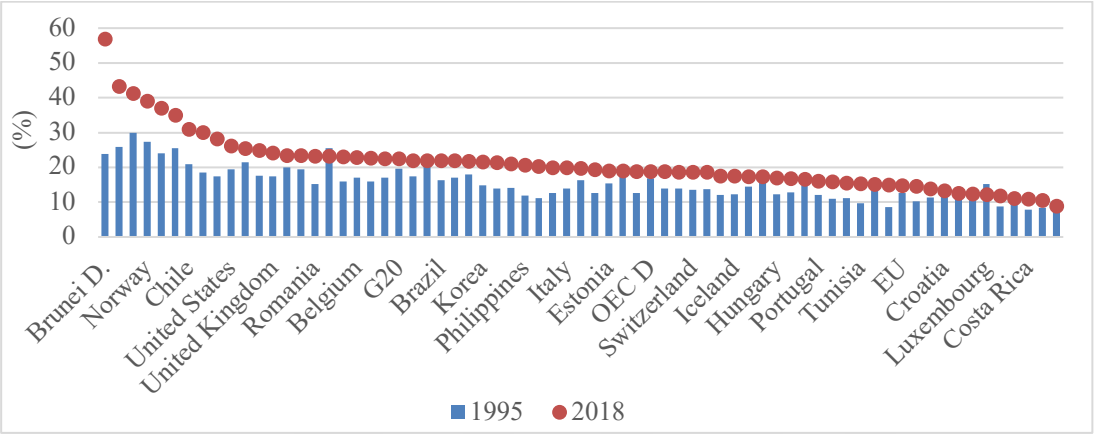


Figure 3.9. Forward Participation (%, 1995 and 2018)

Source: TiVA Database

Turning to the trade linkages of industries, Figure 3.10 presents the GVC participation rates of selected industries for the years 1995 and 2018, whose calculation is based on data of forty-one countries from the OECD TiVA database[19]. Basic metals, other non-metallic mineral products, and wood and products of wood and cork are the industries with the highest GVC participation rates. In contrast, textiles, textile products, footwear, food products, beverages and tobacco, as well as manufacturing not elsewhere classified, repair and installation of machinery and equipment were the industries with the lowest GVC participation rates. By 2018, it was observed that, among the industries examined, GVC participation rates had increased for most industries, with the exceptions of textiles, textile products, footwear, paper products and printing, and wood and products of wood and cork.

[19] The GVC, backward, and forward participation rates of industries are calculated using data covering forty-one countries. The list of these countries is provided in Annex, and their data are also employed in cross-country industry-level analysis (see Section 3.4 below).

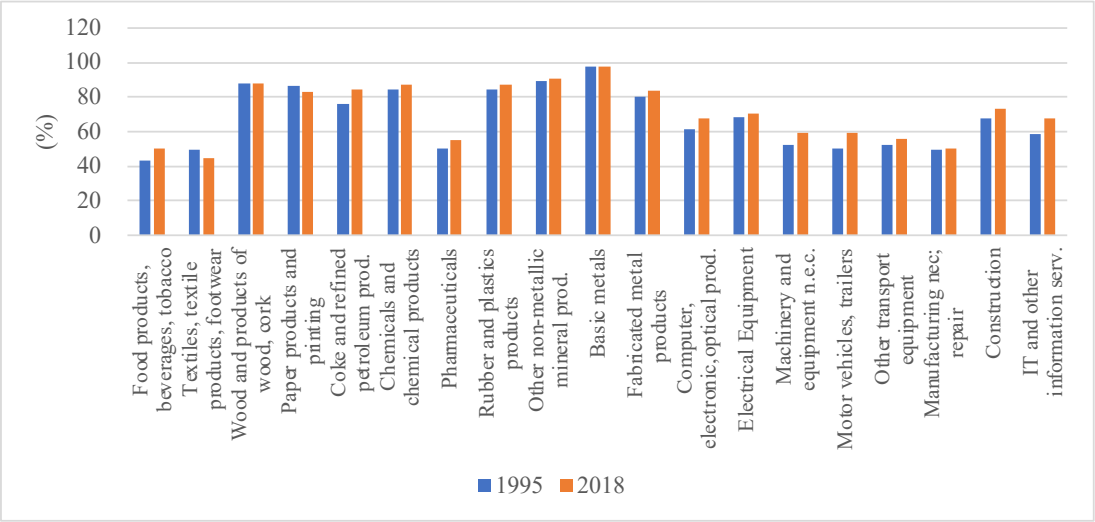


Figure 3.10. GVC Participation by Selected Industries (%, 1995 and 2018)

Source: TiVA Database

The foreign value-added content of exports by these industries, expressed as a percentage of total exports, also increased for the majority of industries, with the exception of textiles, textile products, footwear. In 2018, coke and refined petroleum products, motor vehicles, trailers and semi-trailers, and basic metals had the highest foreign value-added content of exports, each with the backward participation rates exceeding 33%. Conversely, among the selected industries, textiles, textile products, footwear, construction and other non-metallic mineral products, were the industries with the lowest backward participation rates, each falling below 22% (Figure 3.11).

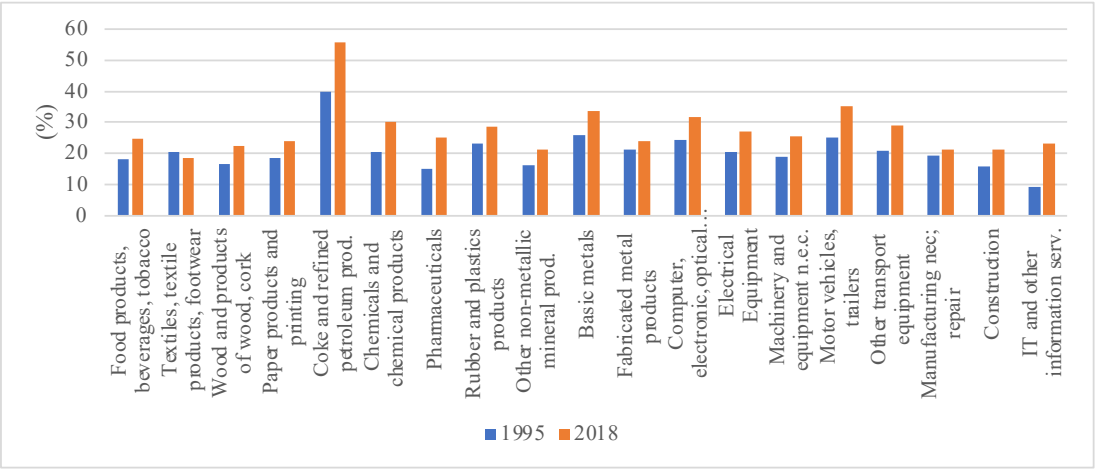


Figure 3.11. Backward Participation by Selected Industries (%, 1995 and 2018)

Source: TiVA Database

However, the forward participation rates of the industries, expressed as domestic value-added in exports of intermediate products as a share of total gross exports, exhibited a different pattern from backward participation. Specifically, by 2018, most industries had lower forward participation rates compared to 1995, with the exceptions of fabricated metal products excluding weapons, machinery and equipment not elsewhere classified, and food, beverages, and tobacco. Similar to overall GVC participation, other non-metallic mineral products, wood and products of wood and cork, and basic metals were the industries with the highest forward participation rates, each exceeding 60%. In contrast, motor vehicles, trailers, and semi-trailers, food products, beverages and tobacco had the lowest forward participation rates, all below 26% (Figure 3.12).

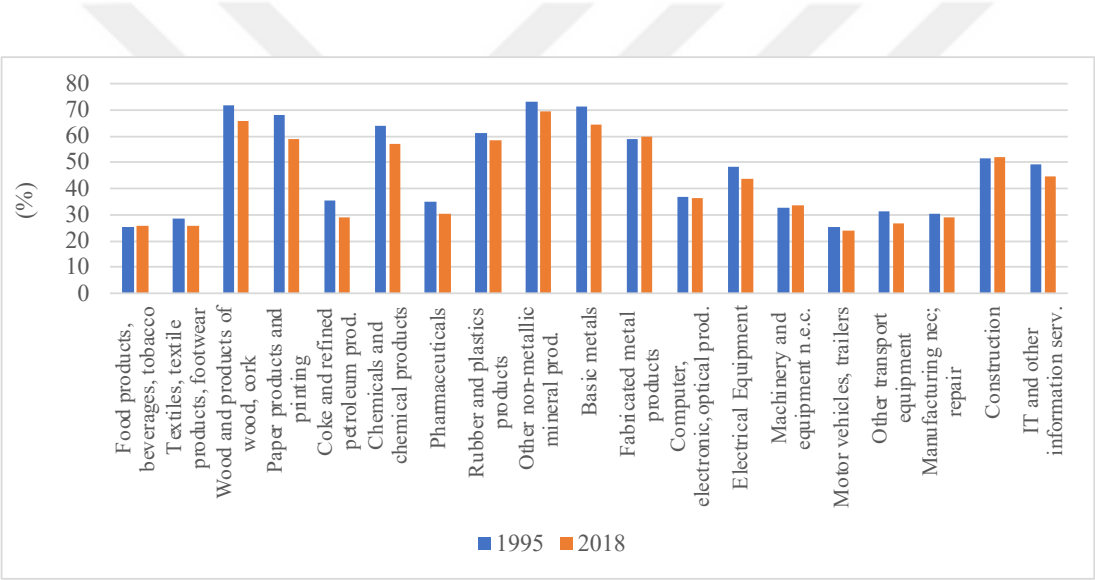


Figure 3.12. Forward Participation by Selected Industries (%, 1995 and 2018)

Source: TiVA Database

Furthermore, as our interest lies in exploring the effect of GVC participation on innovation performance, we calculate and present the overall GVC participation rates, as well as the backward and forward participation rates of manufacturing industries, categorized by technology intensity, using data from OECD-TiVA database. In this regard, we first merge the industry classification in the TiVA database with the technology intensity classification of manufacturing industries provided by the EUROSTAT. The technological intensity is defined as the ratio of R&D expenditure to value added (Eurostat, 2022). Twenty-four manufacturing

industries are categorized into four groups, i.e., low technology, medium-low technology, medium-high technology, and high technology. As illustrated in Figure 3.13, the medium-low technology group exhibited the highest GVC participation rate, followed by the medium-high technology group, while the low technology group had the lowest rate. Moreover, with the exception of the low technology group, the GVC participation of all groups increased by 2018 compared to 1995. This increase in GVC participation rates is primarily attributed to the rise in backward participation rather than forward participation. Specifically, while backward participation increased across all technology groups, forward participation declined.

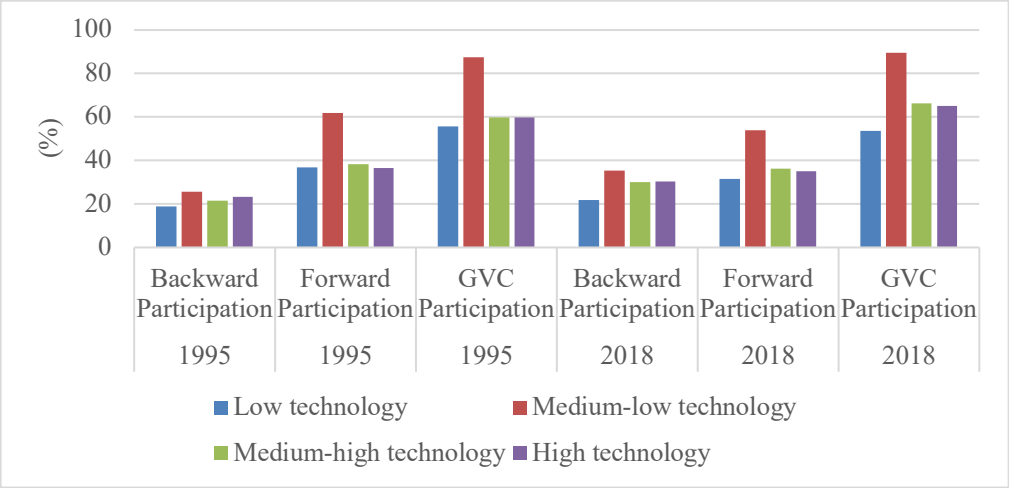


Figure 3.13. GVC, Backward, and Forward Participation by Manufacturing Industries According to Technology Intensity (%, 1995 and 2018)

Source: Author`s own calculations based on merged data obtained from OECD TiVA database and Eurostat Technology Classification of Manufacturing Industries

3.4. Empirical Strategy and Modelling

The purpose of our empirical study is to estimate the effect of GVC participation on innovation performance. In order to investigate the relationship between innovation performance and integration into GVCs, an econometric investigation is conducted by means of a series of cross-country industry panel regression analyses based on our merged dataset covering 19 industries in 41 countries from 1995 to 2018.[20]

[20] The number of countries and industries is smaller than the original TiVA dataset since the patent statistics and R&D statistics are available for 41 countries and 19 industries. Even so, there is still some missing data, most of which stem from missing R&D expenditure by industry.

For our model specification, we first begin with the specification of the dependent variable, i.e., the variable that is used as an indicator for innovation performance. Hong *et al.* (2012) review the research on empirical innovation studies and summarize the variables that are used as measures of innovation performance as well as determinants and sources of innovation. Regarding the measures of innovation, they classify the variables into two groups, namely indirect and direct measures of innovation (Table 3.3). While the indirect measures include R&D and patent-based indicators, the direct measures include both objective measures such as innovation counts and the subjective measures based on innovation-related data collected via firm-based surveys.

Table 3.3. Summary of Dependent Variables in the Empirical Research on Innovation

Dependent Variables	Indirect measures	Number of patents, R&D expenditure, research intensity, patent portfolio information, utility model counts, patent propensity
	Direct measures	Product innovation, process innovation, percentage of turnover due to the sales of new products and services, innovative product sales, innovative sales productivity (i.e., innovative product sales per employee), labour productivity (turnover /employee), rework/scrap rate, production lead time

Source: Author's presentation based on Hong *et al*. (2012).

Despite having drawbacks regarding the scope of innovation activities, and hence not being a perfect measure; patent statistics have been widely used in order to evaluate the innovative performance of a country as they are considered to show the capacity of a country to "*exploit knowledge and translate it into potential economic benefits* (p. 1)" (Eurostat, 2017). The data for direct measures are not available at the country-industry classification for all industries and countries in the dataset. The most comprehensive data for country-industry level is available for patent data. Therefore, we use patent data as the measure for the innovation performance.

In our study, the economy-wide innovation outcomes are measured at the country-industry level by using the yearly number of patents granted by the United States Patent and Trademark Office (USPTO)[21]. Patents granted by the USPTO are considered to be a convenient measure of innovation performance for several reasons:

1- USPTO has been one of the three leading offices for world patent applications and grants. It was the leading office for world fillings from 1883 to 1963. (WIPO, 2017). Even though Japan surpassed the US in 1968 and maintained the top position until 2005, the USPTO was the leading office in patent grants in the periods 1998- 2006 and 2013-2014 (WIPO, 2021).

2- The usage of the data provided by the same and unique authority, in our study i.e., the USPTO, decreases the possible challenges due to different-country-specific procedures, thereby enabling comparability between countries.

3- It is difficult to obtain patent data according to the classification of economic activities. The patent data are foremost provided according to the International Patent Classification (IPC) and the field of technology. Data in the USPTO and European Patent Office (EPO) are available according to the IPC. The data provided by (the websites of) Japan Patent Office and State Intellectual Property Office (SIPO) of China are not based on the classification of economic activities. We obtain patent data from the OECD Patent database that develops patent data by deriving data from European Patent Office's Worldwide Patent Statistical database (PATSTAT). The OECD Patent database provides patent data by technology according to IPC. The data is not classified according to ISIC Rev. 4. The GVC indicators, however, are calculated by using OECD – TiVA industry classification, which in turn is based on ISIC Rev.4. In order to match the relevant data through making a reasonable correspondence between different datasets, in our study, it is necessary to obtain patent data by industry classification. Consequently, we transform the patent data by IPC into patent data by NACE Rev.2 by using EUROSTAT'S correspondence table IPC – NACE Rev.2. This data transformation is one of our contributions in the thesis.

[21] The data on patents granted by the USPTO are obtained from the OECD Patents by Technology database.

4- The USPTO data gives information on the patents that are granted as well as patent applications. As Piermartini and Rubínová (2021) state, the number of patents granted is a good indicator since it represents the patent applications that have already successfully satisfied the innovation requirements.
5- Used as a measure of innovation outcomes at a country-industry level, the yearly number of patents granted by the USPTO are available for a large sample of countries and industries (We denote this variable as *usptog*).

We adjust and normalize the number of yearly patents granted by the USPTO by the total population (*usptogp*). Belloc (2018) uses the standardized per-capita number of yearly manufacturing business patent applications filed at the European Patent Office (EPO) measured at a country-sector-year level and states that in cross-country innovation comparison, it is common to use the procedure of adjusting the number of patents by population. Finally, assuming the relationship between the innovation performance and the GVC participation to be linear is obviously a constraint of the model. As a way of formulating and estimating nonlinear relationships, we estimate a log-log model. Consequently, we use logs and the dependent variable appears in a transformed way, i.e., in the logarithmic form. In this context, the dependent variable is the per-capita number of patents granted by the USPTO expressed in natural logarithm (*lusptogp*).

As for the explanatory variables, we construct a strategy of including the variables that are of our interest. As for the core independent variables, we include backward participation measure, and forward participation measure. As for an indicator of backward participation into GVCs, we use foreign value-added share of gross exports for domestic industry i in country c (*lfvash*). Likewise, as for an indicator of forward participation into GVCs, we use domestic value added in gross exports of intermediate products by industry i in country c, as a percentage of total industry exports (*lintdvash*). As for the control variable, we include the business enterprise R&D expenditure by industry[22], which is normalized by population (*lrdpdcop*), and the capital intensity of industries.

[22] Data on business enterprise R&D expenditure by industry are obtained from the OECD Analytical Business Enterprise Research and Development database.

In an econometric work regarding the drivers of GVC participation, the modelling results suggest that industries using capital more intensively present stronger GVC participation and gross exports in countries relatively more endowed with capital (World Bank, 2020). If there is also any possible linkage between the capital intensity of industries and the innovation activities; this point should be considered. For instance, if capital-intensive industries are somehow more innovative, then a positive relationship between the GVC participation and innovation seems to exist, even if integration into GVCs itself does not have any significant influence on innovation performance.

There are several studies that highlight a potential relationship between capital intensity and innovation (Bao *et al.*, 2023; Belloc, 2018; Eissa E. and C. Zaki, 2023; Guan J. C. and L. Pang, 2017; Seenaiah, K., and B. N. Rath, 2018). Empirical studies show that the effect of capital intensity on innovation is mixed, implying that the relationship between the two is multifaceted and complex. While some studies report a positive effect of capital intensity on innovation, others indicate a negative relationship between the two.

Guan and Pang (2017), for example, argue that capital intensive industries are more likely to innovate because these industries are considered to possess adequate financial resources and technologies, which can enhance innovation capabilities: more financial and technological resources can be allocated to increase R&D investment. Moreover, it is also argued that firms in capital intensive industries are well positioned to acquire and apply knowledge as well as facilitate the transfer of knowledge to other firms. On the other hand, Bao *et al.,* (2023) find a negative effect of capital intensity on innovation. They argue that the higher the capital intensity, the less proportion of investment in R&D. This in turn makes it more difficult for firms to achieve technological transformation and upgrading.

Consequently, it is necessary to account for capital intensity to examine whether it drives the econometric findings of our model. Capital intensity can be measured using the capital-labor ratio, the capital-output ratio, or the capital-value added ratio. Although capital stock is preferred for calculating these measures of capital intensity,

its estimation is challenging due to difficulties in estimating prices, accounting for depreciation, and determining asset lifespans (OECD, 2009). In certain circumstances, direct capital stock data may not be readily available over time or across countries, particularly at higher levels of industry disaggregation and when considering a wide range of countries for cross country comparisons. In such cases, alternative proxies may be used to approximate capital intensity. For instance, Belloc (2018, p. 13) in his cross-country industry-level analysis of the effects of institutional complementarities between employee representation laws and dismissal restrictions on innovation outcomes, uses "*the ratio of gross fixed capital formation to the number of employees*" as a measure of capital intensity. Following the work of Belloc (2018), we extract gross fixed capital formation and employment statistics at industry-country-year level from the OECD's Input-Output Database and Trade in Employment Database, respectively. Due to the unavailability of readily accessible capital stock data, we calculate the ratio of gross fixed capital formation to employment at the industry level (*lklco*). We acknowledge that capital stock is more relevant for assessing capital intensity; while gross fixed capital formation represents investment flows, and therefore, is not a direct proxy for capital intensity. Nevertheless, as the gross fixed capital formation to employment ratio represents the average capital investment per worker over a given period, it may still provide valuable insights into capital deepening trends across industries and over time.

We implement the following econometric estimation methods: ordinary least squares regression (OLS), fixed-effects model (FE), random-effects model (RE), instrumental variables (IV) estimation for panel data (fixed effects two-stage least squares (2SLS) instrumental variables estimation and random effects generalized two-stage least squares (G2SLS) instrumental variables estimation), and dynamic autoregressive panel data model. We use the Stata for our estimations. We apply the aforementioned panel data models because the panel data allows us to deal with more issues than cross-sectional data and time-series data alone do (Kennedy, 2008 cited in Park, 2011). As Baltagi (2005, p.5) states, "*Panel data give more informative data, more variability, less collinearity among the variables, more degrees of freedom and more efficiency*". As also Park (2011,) puts it, panel data models become more attractive since they can deal with "heterogeneity and examine fixed and/or random

effects in the longitudinal data (p.1)." Moreover, we are interested in modelling our panel data structure by applying instrumental variable estimation to deal with the endogeneity issue stemming from an unobservable variable that affect both the GVC participation and innovation performance so that we can alleviate bias stemming from endogenous regressors.

The following sections regarding the econometric model are mainly developed by considering separations between static panel data models and dynamic autoregressive panel data model. In each separation, we also construct our models dealing with endogeneity issue. In this vein, we group our estimation methods as i) static models with/without dealing with endogeneity and (ii) dynamic models with/without dealing with endogeneity.

3.5. Basic Structure of the Econometric Model

As a first step, we construct OLS, fixed effects model and random effects model by using our merged dataset. As the diagnostic tests show, our country-industry level panel data (i.e., the panel identification is country-industry pairwise) presents heteroscedasticity and serial correlation[23]. For this reason, in addition to classical (non-robust) standard errors, robust standard errors corrected for clustering at country-industry level are reported. We control for possible further over time error correlation bias by clustering standard errors by country-industry. By dividing the number of patents and business enterprise R&D expenditure by population, and taking natural logarithms we derive the following equations to be estimated:

$$lusptogp_{cit} = \alpha_{ci} + \beta_1\, lrdpdcop_{cit} + \beta_2\, lklco_{cit} + \beta_3\, lfvash_{cit} + \varepsilon_{cit} \quad (1)$$

$$lusptogp_{cit} = \alpha_{ci} + \beta_1\, lrdpdcop_{cit} + \beta_2\, lklco_{cit} + \beta_3\, lintdvash_{cit} + \varepsilon_{cit} \quad (2)$$

where the subscript ***c*** stands for country; the subscript ***i*** denotes industry; ***lusptogp_cit*** is the number of patents granted by the USPTO divided by population

[23] For heteroscedasticity, the commands "*estat hettest*" and *"xttest3"* and for serial correlation, the commands *"actest robust"* and *"xtserial"* are implemented in Stata.

and expressed in natural logarithm; our control variables, ***lrdpdcop_cit***, is the business enterprise R&D data by industry, which follows ISIC Rev. 4, divided by population and are expressed in US dollars at PPP at constant prices and in natural logarithm; ***lklco_cit***, is a proxy for capital intensity[24], which is measured as the ratio of gross fixed capital formation in US dollars at constant prices to employment, expressed in natural logarithm; ***lfvash_cit*** is a measure of backward participation and it is the foreign value added in gross exports for domestic industry i in country c, as a percentage of total industry exports, expressed in natural logarithm, ***lintdvash_cit*** is a measure of forward participation and it is the domestic value added in gross exports of intermediate products by industry i in country c, as a percentage of total industry exports, expressed in natural logarithm. The latter two represent our key variables of investigation, which are explained in detail and expressed in mathematical formulas in Section 3.2. We investigate the role of GVC participation at country-industry level on innovation performance. ε_{cit} is the error component.

As discussed in detail in Chapter 2, the literature identifies various linkages between GVCs and innovation. However, several challenges exist in establishing a clear link, which results in mixed outcomes regarding the effects of GVC participation on innovation. Similarly, as indicated by empirical studies, the effect of capital intensity on innovation remains unclear. Therefore, we do not expect a clearly defined positive or negative sign of the variables *lfvash_cit*, *lintdvash_cit* and *lklco_cit*. Unlike the previous variables, R&D expenditure is widely considered as one of the key determinants of innovation; therefore, we expect a positive sign for the variable *lrdpdcop_cit*.Table 3.4 presents the outcomes of our baseline estimates for the role of backward participation. In this basic set of estimation, the postestimation test reveals that the fixed effect estimation is preferred to random effect estimation[25]. The preliminary estimation results have revealed that when we run estimations with robust standard errors, the effect of backward participation into GVCs turns out to be statistically insignificant.

[24] See Section 3.4 above for a discussion on the measurement of capital intensity.

[25] The test is implemented by using the xtoverid command. "This test statistic is asymptotically equivalent to the usual Hausman fixed-vs-random effects test…. Unlike the Hausman version, the test reported by xtoverid extends straightforwardly to heteroskedastic- and cluster-robust versions, and is guaranteed always to generate a nonnegative test statistic". (Stata 14, Help)

Table 3.5 shows the outcomes of our baseline estimates for the role of forward participation. In this basic set of estimation, the postestimation test reveals that the fixed effect estimation is preferred to random effect estimation.

By using xtoverid command in Stata, we get Sargan-Hansen statistics, p-value of which is 0. As we prefer the fixed effect estimation over random effect estimation, we interpret the estimation results of the fixed effect estimation. In this regard, the estimation results of the fixed effects model have revealed that the effect of forward participation into GVCs is negative and statistically significant.

Nevertheless, we should be cautious when interpreting the estimation results of the aforementioned regressions. Even though we use panel data and panel data models accordingly to control for both observable and unobservable determinants, these models are unlikely to produce healthy estimation. In other words, we might not get unbiased results unless we take into consideration the likely endogeneity issues. Consequently, it becomes important to adopt the appropriate econometric estimation methods according to the concerns regarding endogeneity issues.

In order to deal with the endogeneity issues, we prefer to apply the instrumental variable approach, which includes more complex models. These models include fixed effects two-stage least squares instrumental variable estimation and generalized two-stage least squares random effects instrumental variable estimation. These models might be used to tackle the issues stemming from the cases including reverse causality and omitted variables.

As a consequence, the following section (Section 3.6) is specifically dedicated to addressing the aforementioned endogeneity issues. In the next section, we aim to account for the endogeneity issues that might arise from unobservable heterogeneity (random effects) correlated with the regressors, as well as from simultaneity bias.
By analyzing the effect of participation in global value chains on innovation performance while considering the issues driven by endogeneity, we may obtain more reliable and robust results.

Table 3.4. The Effect of Backward Participation into GVCs on Innovation Performance (Basic Structure)

VARIABLES	(1) Model1 OLS	(2) Model2 OLS (Robust)	(3) Model3 Fixed Effect	(4) Model4 Fixed Effect (Robust)	(5) Model5 Random Effect	(6) Model6 Random Effect (Robust)
lfvash	-0.367***	-0.367***	0.096*	0.096	-0.051	-0.051
	(0.036)	(0.133)	(0.055)	(0.115)	(0.051)	(0.103)
lrdpdcop	0.796***	0.796***	0.138***	0.138***	0.237***	0.237***
	(0.011)	(0.033)	(0.015)	(0.026)	(0.014)	(0.026)
lklco	0.291***	0.291***	0.096***	0.096**	0.200***	0.200***
	(0.009)	(0.030)	(0.020)	(0.041)	(0.017)	(0.033)
Constant	-15.149***	-15.149***	-15.006***	-15.006***	-15.240***	-15.240***
	(0.121)	(0.445)	(0.175)	(0.380)	(0.177)	(0.357)
Observations	8,246	8,246	8,246	8,246	8,246	8,246
R-squared	0.539	0.539	0.554	0.02	0.497	0.497
F-Stat	3209	295.1	51.60	11.92		
Prob > F	0	0	0	0.000	0	0
Degree of Freedom	8242	614	7628	614	3	3
Number of panelid			615	615	615	615
Wald					556.4	143

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.10

Notes: In Model2, Model4, and Model6 robust standard errors corrected for clustering at country–industry level are reported in parentheses. The dependent variable is the number of patents granted by the United States Patent and Trademark Office (USPTO)" (lusptogp)" by priority date, industry i, country c, and year t, which is transformed by the author from technology domains & IPC classification into ISIC Rev.4 and it is expressed in natural logarithm. Regressions cover the period 1995–2018. The postestimation test reveals that the fixed effect estimation is preferred to random effect estimation.

Table 3.5. The Effect of Forward Participation into GVCs on Innovation Performance (Basic Structure)

VARIABLES	(1) Model1 OLS	(2) Model2 OLS Robust	(3) Model3 Fixed Effect	(4) Model4 Fixed Effect Robust	(5) Model5 Random Effect	(6) Model6 Random Effect Robust
lrdpdcop	0.812***	0.812***	0.136***	0.136***	0.233***	0.233***
	(0.011)	(0.033)	(0.015)	(0.026)	(0.014)	(0.026)
lintdvash	0.160***	0.160	-0.380***	-0.380*	-0.251***	-0.251*
	(0.042)	(0.147)	(0.096)	(0.203)	(0.082)	(0.149)
lklco	0.286***	0.286***	0.091***	0.091**	0.189***	0.189***
	(0.009)	(0.030)	(0.020)	(0.041)	(0.017)	(0.033)
Constant	-16.945***	-16.945***	-13.301***	-13.301***	-14.471***	-14.471***
	(0.159)	(0.562)	(0.363)	(0.749)	(0.313)	(0.555)
Observations	8,246	8,246	8,246	8,246	8,246	8,246
R-squared	0.534	0.534	0.021	0.021	0.472	0.472
F-Stat	3145	295.5	55.87	12.07		
Prob > F	0	0	0	0.000	0	0
Degree of Freedom	8242	614	7628	614	3	3
Number of panelid			615	615	615	615
Wald					564.3	138

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.10

Notes: In Model2, Model4, and Model6, robust standard errors corrected for clustering at country–industry level are reported in parentheses. The dependent variable is the number of patents granted by the United States Patent and Trademark Office (USPTO)" (lusptogp)" by priority date, industry i, country c, and year t, which is transformed by the author from technology domains & IPC classification into ISIC Rev.4 and it is expressed in natural logarithm. Regressions cover the period 1995–2018. The postestimation test reveals that the fixed effect estimation is preferred to random effect estimation.

3.6. Endogeneity Issue

The possible sources of endogeneity include omitted variable bias, misspecification of the model, reverse causality and measurement errors. We keep in mind that the opposite direction of causality may also hold, i.e., innovation performance affects the type and the extent of integration into GVCs. High levels of innovation performance might drive higher levels of GVC participation. That is, stronger GVC links can be established by more innovative industries in a country. Alternatively, the unobserved common factors that drive GVC participation can also affect innovation activities. An unobserved variable might jointly determine the level of GVC participation and the performance of innovation activities. Innovation performance and GVC participation can be simultaneously determined, thereby resulting in endogeneity.

We consider instrumental variables (IV) estimation for panel data and apply fixed effects two-stage least squares instrumental variable estimation technique and generalized two-stage least squares random effects IV regression. Therefore, we address the sources of endogeneity issues (i.e., reverse causality and omitted variables) that lead to biased coefficients of GVC participation measures.

Our instrumenting strategy is grounded on the works of Baldwin and Lopez-Gonzales' (2014); Constantinescu *et al*., (2019), Montalbano and Nenci (2020). Baldwin and Lopez-Gonzales (2014) argue that the second bundling of globalization brings not only more goods crossing borders but also "international mobility of managerial and manufacturing know-how". In this North-South production sharing framework, the North, not relying on local (i.e., the South) know-how, brings technology, management and other know-how needed. It is argued that the hub/headquarter economies (the US, Germany and Japan) lead the international production network and there is technological asymmetry between headquarter and factory economies. Consequently, the nations located near the US, Germany and Japan could industrialize by participating into the GVCs led by those hub countries rather than building their own (Baldwin and Lopez-Gonzales, 2014).

Based on Baldwin and Lopez-Gonzales' (2014) work, which highlights the distinction between hub and factory economies by analyzing backward

specialization, Constantinescu *et al*. (2019), compute the instrument for each country c, industry s, and year t, as the average value-added from the United States, Japan and Germany embodied in exports of industry s of three countries in the sample that are closest in income to country c. Building on a similar grounding, Montalbano and Nenci (2020) instrument "*their measure of GVC participation for each country in the dataset with the GVC participation of its respective regional hub country"* (p.27)".

Consequently, similar to that of Montalbano and Nenci (2020)'s work, we instrument the measures of GVC participation measures with the GVC participation of hub countries, which are supposed to drive the regional expansion of GVCs in all the aforementioned works. In our basic model, we instrument the measure of backward participation (*lfvash*) for each country in the dataset with the measure of backward participation of its respective regional hub country (the US for America, Germany for Europe and Japan for Asia). In a similar vein, we instrument the measure of forward participation (lintdvash) for each country in the dataset with the measure of forward participation of its respective regional hub country (the US for America, Germany for Europe and Japan for Asia). In order to classify the respective geographical regions of country, we use the country grouping in UNIDO statistics (Upadhyaya, 2013).

In order to evaluate whether the instruments are relevant and sufficiently correlated with the endogenous variable, we use the Stock-Yogo test. Stock-Yogo (2005) provide critical values for the F-statistics to be used for evaluating whether the given instruments are weak. If the F-statistics exceed the critical values, it indicates that the instruments are not weak. As weak instruments yield biased and inconsistent estimation results, by using the Stock-Yogo test, we ensure that endogeneity issues can be dealt with our instruments. Alongside the Stock-Yogo test, we also use other diagnostic tests including Kleibergen-Paap rk identification LM statistic and endogeneity Chi-square test to evaluate the validity of the instrument and to test for endogeneity and whether the endogenous variable is correlated with the error term. Low p values of Chi-square indicates that endogeneity is present. In that case, OLS estimates are biased and instrumental variable approach is preferred to OLS estimation.

Table 3.6 and Table 3.7 present the estimation results of 2SLS IV and G2SLS IV regressions. Regarding the effect of backward participation shown in Table 3.6, in both models, F-statistics exceed the Stock-Yogo (2005) critical values. The instrument is not weakly identified. The endogeneity test of 2SLS IV reveals that the p-value of Chi-square statistics is 0, implying the regressor *lfvash* is endogenous and hence it is necessary to use an instrument.

Consequently, we prefer 2SLS IV panel regression to a simple fixed effects model. In the G2SLS IV model, the regressor *lfvash* does not turn out to be endogenous. As the endogeneity is detected by the 2SLS IV model, we interpret the estimation results of the 2SLS IV model. Therefore, in order to evaluate the effect of backward participation on innovation performance, 2SLS IV model (Model 7) is preferred. According to the estimation results of the 2SLS IV model, the effect of backward participation on innovation performance is positive and statistically significant.

Table 3.7 summarizes the estimation results of 2SLS and G2SLS IV regression estimations of forward participation on innovation performance. In both models, F-statistics exceed the Stock-Yogo (2005) critical values. The instrument is not weakly identified. The endogeneity tests reveal that we do not reject the null hypothesis that the regressor *lintdvash* is exogenous. As we use panel data for the analysis, issues are likely to arise regarding the structure of the error term of the model such as heteroscedasticity and autocorrelation. IV models can help by providing benefits when there are problems with the error term. G2SLS IV model remains consistent even when there is heteroscedasticity and autocorrelation in the error term (Wooldridge, 2010). G2SLS is more efficient than 2SLS when there is heteroscedasticity and autocorrelation in the error term (Hsiao, 2014). Additionally, using G2SLS model may still be beneficial when the instruments are not weak, even if endogeneity tests do not provide evidence for endogeneity. While the endogeneity tests are valuable, one should acknowledge their limitations. Statistical tests might not always detect endogeneity (Green, 2011; Wooldridge, 2010).

While the estimation results of the fixed effect model, random effect model and FE 2SLS IV model reveal that the effect of forward participation is negative, the

estimation results of the G2SLS model turned out to be insignificant. The estimation results of the models are not clear cut but, in any case, they do not indicate a positive effect of forward participation on innovation performance.

The estimation results regarding backward participation suggest that the expected mechanisms proposed in the relevant literature work.[26] In particular, several arguments in the literature seem to hold. Specifically, easier access to cheap, high-quality intermediate goods may reduce production costs and constraints, leading to higher productivity and innovation (Halpern *et al*., 2005; Xing *et al*., 2021).

Backward linkages may also promote knowledge acquisition and spillovers, technology sourcing from suppliers, and improvements in product quality and human capital (Morrison *et al*., 2008). Import competition may force firms to invest in new technologies and skills (Ziemann and Guérard, 2016).

Turning to the effects of forward participation on innovation performance, the outcome is different from that of backward participation. The absence of a positive effect of forward participation on innovation performance supports several arguments proposed in the literature, which suggest that, due to possible challenges, being a supplier for other countries' exports may not always improve innovation performance.

As discussed thoroughly in Chapter 2, several underlying factors can explain this outcome. Specifically, knowledge spillovers from outsourcing firms may not occur (Xing *et al*., 2021). The inadequacy of local firms' absorptive capacity and technological capabilities as well as distance (both geographical and relational) affect knowledge transfer and the benefits from GVC participation (Baldwin, 2014; Foray, 2004; Morrison *et al*., 2008).

Furthermore, hierarchical governance structures, where knowledge is less codified and power asymmetry is high, may limit innovation outcomes (Gereffi *et al*., 2005).

[26] See Chapter 2 above for a detailed discussion of the nexus between GVCs and innovation.

Table 3.6. The Effect of Backward Participation on Innovation Performance: Endogeneity and IV Estimation

	(7)	(8)
	Model 7	Model 8
VARIABLES	Fixed Effect 2SLS IV Robust	Random Effect G2SLS IV Robust
lfvash	0.630***	-0.035
	(0.181)	(0.141)
lrdpdcop	0.115***	0.249***
	(0.026)	(0.026)
lklco	0.063	0.208***
	(0.043)	(0.033)
Constant		-15.328***
		(0.467)
Observations	8,212	8,246
R-squared	0.008	0.4965
F-Stat	15.18	51.61
Prob > F	0.000	0
Degree of Freedom	580	3
Number of panelid	581	615
Wald	3940.427	4526.608

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.10

Notes: The dependent variable is the number of patents granted by the United States Patent and Trademark Office (USPTO)" (lusptogp)" by priority date, industry i, country c, and year t, which is transformed by the author from technology domains & IPC classification into ISIC Rev.4 and it is expressed in natural logarithm. Regressions cover the period 1995–2018. The instrumenting strategy is grounded on the works of Baldwin and Lopez-Gonzales' (2019); Constantinescu et al., (2019), Montalbano, P. and Nenci, S. (2020). The instrument for Ifvash is for each country in the dataset the lfvash of its respective regional hub country (the US for America, Germany for Europe and Japan for Asia). The preferred model is fixed effect 2SLS IV (Model 7).

Table 3.7. The Effect of Forward Participation into GVCs on Innovation Performance: Endogeneity and IV Estimation

VARIABLES	(7) Model7 Fixed Effect 2SLS IV	(8) Model8 Random Effect G2SLS IV
lrdpdcop	0.128***	0.243***
	(0.027)	(0.026)
lintdvash	-0.917**	-0.296
	(0.400)	(0.210)
lklco	0.075*	0.196***
	(0.043)	(0.034)
Constant		-14.336***
		(0.798)
Observations	8,212	8,246
R-squared	0.0175	0.4687
F-Stat	14.67	54.29
Prob > F	0.000	0.000
Degree of Freedom	580	3
Number of panelid	581	615
Wald	1522.063	3805.70

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.10

Notes: The dependent variable is the number of patents granted by the United States Patent and Trademark Office (USPTO)" (lusptogp)" by priority date, industry i, country c, and year t, which is transformed by the author from technology domains & IPC classification into ISIC Rev.4 and it is expressed in natural logarithm. Regressions cover the period 1995–2018. The instrumenting strategy is grounded on the works of Baldwin and Lopez-Gonzales' (2019); Constantinescu et al., (2019), Montalbano, P. and Nenci, S. (2020). The instrument for lintdvash is for each country in the dataset the lintdvash of its respective regional hub country (the US for America, Germany for Europe and Japan for Asia). The preferred model is the G2SLS IV (Model 8).

3.7. GVCs and Technology Intensity Classification

In this section, we can delve into more by investigating the effect of GVC participation according to the technology classification of industries. Since the classification of technology intensity is only available for manufacturing industries, the analysis is confined to manufacturing industries and does not include services. In particular, we test whether the effects of backward participation and forward participation vary if we run the estimations by technology intensity classification of industries[27]. In this vein, we also classify the industries in our dataset into four technology groups, namely, low-technology, medium low-technology, medium high-technology and high-technology.

One of our contributions, hence, is to merge industry classification of the TiVA database with the technology intensity classification. In order to do this, we use the Eurostat's technology intensity classification of manufacturing industries[28], which aggregates the manufacturing industries based on NACE Rev.2 at 2-digit level by considering technology intensity. Eurostat, in its sectoral approach, defines technology intensity as R&D expenditure/value added (Eurostat, 2022). Twenty-four manufacturing industries are classified into four technology intensity categories: high-technology, medium high-technology, medium low-technology and low-technology.

The classification of these two different fields, one is the TiVA database and the other is the Eurostat's technology intensity definition, are based on the classification of manufacturing industries, ISIC Rev.4 and NACE Rev.2, respectively. The two classifications are the same at the 2-digit level and consequently we can compile aggregates accordingly. Table 3.8 presents the correspondence between TiVA definition of industries and Eurostat's technology intensity definition of manufacturing industries, which we use in our analysis.

[27] Table 3.17 summarizes the findings.

[28] Eurostat's technology intensity definition of manufacturing industries can be found in the Annex.

Table 3.8. Correspondence between TiVA Industry Codes and Eurostat's Technology Intensity Definition of Manufacturing Industries

TiVA Code	Industry Description	ISIC Rev.4 Code	Eurostat Technology Intensity Classification
D10T12	Food products, beverages and tobacco	10-12	Low
D13T15	Textiles, wearing apparel, leather and related products	13-15	Low
D16	Wood and of products of wood and cork, except furniture; articles of straw and plaiting materials	16	Low
D17T18	Paper products and printing	17-18	Low
D19	Coke and refined petroleum products	19	Medium low
D20	Chemicals and chemical products	20	Medium high
D21	Pharmaceuticals, medicinal chemical and botanical products	21	High
D22	Rubber and plastic products	22	Medium low
D23	Other non-metallic mineral products	23	Medium low
D24	Basic metals	24	Medium low
D25	Fabricated metal products, except machinery and equipment	25	Medium low
D26	Computer, electronic and optical products	26	High
D27	Electrical equipment	27	Medium high
D28	Machinery and equipment n.e.c.	28	Medium high
D29	Motor vehicles, trailers and semi-trailers	29	Medium high
D30	Other transport equipment	30	Medium high
D31T33	Furniture, other manufacturing and repair and installation of machinery and equipment	31-33	Low

Source: TiVA Database (2021) and Eurostat

3.7.1. The Effect of Backward Participation According to Technology Intensity Classification

Table 3.9 presents the estimation results of backward participation on innovation performance according to low-technology classification. Our preferred model is the

G2SLS IV model (Model 5). For standard FE and RE panel estimations, the postestimation test reveals that the fixed effect estimation is preferred to random effect estimation. For the panel IV regressions, in both 2SLS IV and G2SLS IV models, F-statistics exceed the Stock-Yogo (2005) critical values. The instrument is not weakly identified. In the 2SLS IV model, the test statistic of the endogeneity test shows that the instrumented variable, i.e., the backward participation measure does not turn out to be endogenous at 5% significance level. However, in the G2SLS model, we reject the null hypothesis and conclude that endogeneity is present in the model. Consequently, we prefer to interpret the estimation results of G2SLS IV model. Regarding the low-technology classification, the effect of backward participation on innovation performance is negative and statistically significant.

Table 3.10 presents the estimation results of backward participation on innovation performance according to medium low-technology classification. Our preferred model is the G2SLS IV model (Model 5)[29]. Regarding the medium low-technology classification, the effect of backward participation on innovation performance is statistically negative significant.

Table 3.11 presents the estimation results of backward participation on innovation performance according to medium high-technology classification. Grounded on the IV models, regarding the medium high-technology classification, the effect of backward participation on innovation performance is positive and statistically significant in medium-high technology industries.

Table 3.12 presents the estimation results of backward participation on innovation performance according to high-technology classification. Our preferred model is the G2SLS IV model (Model 5). Regarding the high-technology classification, the effect of backward participation on innovation performance is statistically insignificant.

All in all, the effect of backward participation on innovation performance differs according to technology classification of industries. Without considering the

[29] We conduct postestimation tests to choose between FE and RE models. For the instrumental variable models, we assess the identification and check for weak instruments using the Stock-Yogo F statistics. We perform the same tests for all technology groups to determine the appropriate model (throughout Chapter 3 and Chapter 4).

technology classification, the overall effect of backward participation turns out to be positively significant[30]. However, the effect differs according to the technology classification of industries. While the effect is found to be negative in both the low-technology group and medium low-technology group, it is statistically insignificant in high-technology group. Moreover, the effect becomes positive in the medium-high-technology group of industries, which is similar to the overall pattern.

The results provide further insight to conclude that the effect of backward participation on innovation performance is not uniform across all industries. Our interpretation of the results is that while providing intermediate goods from other countries for export negatively affects the innovation performance of low-technology and medium low-technology group of industries, it positively affects that of medium-high technology group of industries.

The estimation result that backward participation has a positive effect on innovation only in medium-high technology industries also suggests that arguments supporting the positive channels that enhance innovation do not hold for the remaining technology intensity groups.

As discussed in Chapter 2, Bucini and Finotti (2016) suggest that the separation of the production activities from certain development activities, particularly in low-technology industries, may hinder innovation.

By investigating the effect of backward participation of the firms in Vietnam, Dang and Dang (2020) also find a negative effect on product innovation. Consequently, they argue that domestic firms tend to focus on improving existing products rather than developing new ones.

Finally, Lee's (2019) argument provides an explanation for the differing outcomes regarding innovation across industries, suggesting that only after local capabilities are established can the benefits from GVCs prevail.

[30] See Chapter 3.6 above.

Table 3.9. The Effect of Backward Participation into GVCs on Innovation Performance According to Low-Technology Classification

VARIABLES	(1) Model1 Low-tech OLS	(2) Model2 Low-tech Fixed Effect	(3) Model3 Low-tech Random Effect	(4) Model4 Low-tech Fixed Effect 2SLS IV	(5) Model5 Low-tech Random Effect G2SLS IV
lfvash	-0.306	-0.439**	-0.590***	-0.325	-1.066***
	(0.255)	(0.183)	(0.154)	(0.324)	(0.324)
lrdpdcop	0.837***	0.121**	0.238***	0.117**	0.243***
	(0.079)	(0.051)	(0.047)	(0.052)	(0.049)
lklco	0.546***	0.085	0.272***	0.077	0.291***
	(0.065)	(0.094)	(0.072)	(0.096)	(0.074)
Constant	-15.427***	-13.849***	-13.915***		-12.421***
	(0.814)	(0.552)	(0.496)		(1.010)
Observations	1,964	1,964	1,964	1,949	1,964
R-squared	0.5787	0.0139	0.5251	0.014	0.4538
F-Stat	87	3.289		1.850	16.02
Prob > F	0	0.0224	0	0.141	0.000
Degree of Freedom	152	152	3	137	3
Number of panelid		153	153	138	153
Wald			60.30	1011.751	968.999

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.10

Notes: Postestimation test reveals that the fixed effect estimation is preferred to random effect estimation. In IV models (Model 4 and Model 5), F-statistics exceed the Stock-Yogo (2005) critical values. We interpret the estimation results of the Model 5.

Table 3.10. The Effect of Backward Participation into GVCs on Innovation Performance According to Medium Low-Technology Classification

VARIABLES	(1) Model1 Medlow-tech OLS	(2) Model2 Medlow-tech Fixed Effect	(3) Model3 Medlow-tech Random Effect	(4) Model4 Medlow-tech Fixed Effect 2SLS IV	(5) Model5 Medlow-tech Random Effect G2SLS IV
lfvash	-1.225***	0.191	-0.134	0.307	-0.455**
	(0.165)	(0.153)	(0.156)	(0.230)	(0.199)
lrdpdcop	0.732***	0.090*	0.203***	0.086*	0.232***
	(0.060)	(0.047)	(0.046)	(0.048)	(0.047)
lklco	0.345***	0.072	0.163**	0.067	0.191***
	(0.069)	(0.070)	(0.064)	(0.069)	(0.063)
Constant	-12.286***	-15.870***	-15.313***		-14.272***
	(0.574)	(0.496)	(0.538)		(0.682)
Observations	2,048	2,048	2,048	2,040	2,048
R-squared	0.5326	0.0114	0.4659	0.0107	0.5160
F-Stat	140.7	2.678		2.683	14.28
Prob > F	0	0.0490	0.000	0.0489	0.000
Degree of Freedom	156	156	3	148	3
Number of panelid		157	157	149	157
Wald			31.66	1681.368	1710.625

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.10

Notes: In IV models (Model 4 and Model 5), F-statistics exceed the Stock-Yogo (2005) critical values. We interpret the regression results of the Model 5.

Table 3.11. The Effect of Backward Participation into GVCs on Innovation Performance According to Medium High-Technology Classification

VARIABLES	(1) Model1 Medhigh-tech OLS	(2) Model2 Medhigh-tech Fixed Effect	(3) Model3 Medhigh-tech Random Effect	(4) Model4 Medhigh-tech Fixed Effect 2SLS IV	(5) Model5 Medhigh-tech Random Effect G2SLS IV
lfvash	-1.251***	0.226	0.055	1.440***	0.964**
	(0.287)	(0.160)	(0.150)	(0.473)	(0.408)
lrdpdcop	0.751***	0.159***	0.237***	0.108**	0.209***
	(0.066)	(0.057)	(0.055)	(0.054)	(0.054)
lklco	0.240***	0.264***	0.268***	0.176**	0.217***
	(0.058)	(0.068)	(0.057)	(0.084)	(0.064)
Constant	-11.843***	-15.678***	-15.446***		-18.357***
	(1.037)	(0.556)	(0.572)		(1.386)
Observations	2,433	2,433	2,433	2,429	2,433
R-squared	0.475	0.055	0.3340	-0.00	0.0991
F-Stat	81.80	9.749		11.08	16.08
Prob > F	0	0.000	0.000	0.000	0.000
Degree of Freedom	168	168	3	164	3
Number of panelid		169	169	165	169
Wald			40.90	1151.493	1241.430

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.10

Notes: In IV models (Model 4 and Model 5), F-statistics exceed the Stock-Yogo (2005) critical values. The endogenous tests reveal that the instrumented variable (lfvash) turns out to be endogenous at 5% significance level. In this vein, we interpret the results of these IV models.

Table 3.12. The Effect of Backward Participation into GVCs on Innovation Performance According to High-Technology Classification

VARIABLES	(1) Model1 High-tech OLS	(2) Model2 High-tech Fixed Effect	(3) Model3 High-tech Random Effect	(4) Model4 High-tech Fixed Effect 2SLS IV	(5) Model5 High-tech Random Effect G2SLS IV
lfvash	-0.135	0.171	-0.057	0.926	0.112
	(0.188)	(0.379)	(0.306)	(0.685)	(0.492)
lrdpdcop	0.933***	0.298**	0.550***	0.225*	0.538***
	(0.069)	(0.122)	(0.100)	(0.131)	(0.106)
lklco	0.273***	-0.007	0.114	-0.061	0.099
	(0.060)	(0.090)	(0.086)	(0.101)	(0.092)
Constant	-15.704***	-13.808***	-14.287***		-14.750***
	(0.672)	(1.290)	(1.082)		(1.461)
Observations	1,113	1,113	1,113	1,113	1,113
R-squared	0.725	0.043	0.7216	0.008	0.7163
F-Stat	148.2	2.229		2.736	11.68
Prob > F	0	0.0921	0.000	0.0498	0.000
Degree of Freedom	72	72	3	72	3
Number of panelid		73	73	73	73
Wald			39.14	277.597	321.08

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.10

Notes: In IV models (Model 4 and Model 5), F-statistics exceed the Stock-Yogo (2005) critical values. We interpret the estimation results of the Model 5.

3.7.2. The Effect of Forward Participation According to Technology Intensity Classification

Table 3.13 presents the estimation results of forward participation on innovation performance according to low-technology classification. While the effect is insignificant in the FE 2SLS IV model, it turns out to be negative and statistically significant in the RE G2SLS IV model. None of these models indicate any positive impact of forward participation on innovation performance in low-technology group of industries. Table 3.14 presents the estimation results of forward participation on innovation performance according to medium low-technology classification. The preferred model is RE G2SLS IV model. Regarding the medium low-technology classification, the effect of forward participation is positively significant. Table 3.15 presents the estimation results of forward participation on innovation performance according to medium high-technology classification. As the endogeneity is detected by the FE 2SLS IV model, the preferred model is the FE 2SLS IV model. Regarding the medium high-technology classification, the effect of forward participation turns out to be significant and negative. Regarding the high-technology classification, the effect of forward participation is presented in Table 3.16. According to the estimation results of both IV models, for the high-technology industries, the effect of forward participation on innovation performance is negatively significant. To sum up, the effect of forward participation on innovation performance differs according to the technology classification of industries. As shown in Section 3.6, without considering the technology intensity classification, the overall effect of forward participation does not turn out to be positive. The effect is statistically significant and negative for medium-high technology group and high-technology group. For the medium low-technology group, the effect becomes positively significant. The differing outcomes across technology intensity groups of industries suggest, as in the overall pattern discussed in Chapter 3.6 above, being a supplier for other countries' exports may not always enhance innovation performance of all technology intensity groups. Differences in local firms' technological capabilities and absorptive capacity, as well as varying hierarchical governance structures across industries may provide plausible explanations for this outcome (Gereffi *et al*., 2005; Morrison *et al*., 2008).

Table 3.13. The Effect of Forward Participation into GVCs on Innovation Performance According to Low-Technology Classification

VARIABLES	(1) Model1 Low-tech OLS	(2) Model2 Low-tech Fixed Effect	(3) Model3 Low-tech Random Effect	(4) Model4 Low-tech Fixed Effect 2SLS IV	(5) Model5 Low-tech Random Effect G2SLS IV
lintdvash	-0.668**	0.516*	-0.110	-1.243	-0.920**
	(0.257)	(0.268)	(0.230)	(1.016)	(0.398)
lrdpdcop	0.819***	0.113**	0.228***	0.084	0.221***
	(0.070)	(0.050)	(0.046)	(0.053)	(0.048)
lklco	0.552***	0.070	0.247***	0.010	0.254***
	(0.058)	(0.095)	(0.071)	(0.103)	(0.069)
Constant	-14.042***	-16.991***	-15.374***		-12.545***
	(0.934)	(0.965)	(0.808)		(1.394)
Observations	1,964	1,964	1,964	1,949	1,964
R-squared	0.593	0.011	0.5666	-0.022	0.4901
F-Stat	110.7	2.793		1.802	16.99
Prob > F	0	0.0424	0.00	0.150	0.000
Degree of Freedom	152	152	3	137	3
Number of panelid		153	153	138	153
Wald			43.10	291.669	1149.655

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.10

Notes: In IV models (Model 4 and Model 5), F-statistics exceed the Stock-Yogo (2005) critical values. The endogenous tests reveal that the instrumented variable (lintdvash) turns out to be endogenous at 5% significance level.

Table 3.14. The Effect of Forward Participation into GVCs on Innovation Performance According to Medium Low-Technology Classification

VARIABLES	(1) Model1 Medlow-tech OLS	(2) Model2 Medlow-tech Fixed Effect	(3) Model3 Medlow-tech Random Effect	(4) Model4 Medlow-tech Fixed Effect 2SLS IV	(5) Model5 Medlow-tech Random Effect G2SLS IV
lintdvash	1.438***	-0.215	0.431**	-0.009	1.045***
	(0.251)	(0.271)	(0.188)	(0.469)	(0.299)
lrdpdcop	0.706***	0.094**	0.200***	0.097**	0.216***
	(0.065)	(0.047)	(0.046)	(0.049)	(0.046)
lklco	0.375***	0.073	0.172***	0.079	0.208***
	(0.068)	(0.070)	(0.063)	(0.072)	(0.064)
Constant	-22.142***	-14.381***	-17.473***		-19.947***
	(0.993)	(1.107)	(0.751)		(1.180)
Observations	2,048	2,048	2,048	2,040	2,048
R-squared	0.504	0.010	0.4884	0.010	0.4696
F-Stat	115.9	2.285		2.062	14.93
Prob > F	0	0.0810	5.84e-08	0.108	0.000
Degree of Freedom	156	156	3	148	3
Number of panelid		157	157	149	157
Wald			36.51	1172.388	2000.583

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.10

Notes: Postestimation test reveals that the fixed effect estimation is preferred to random effect estimation. In IV models (Model 4 and Model 5), F-statistics exceed the Stock-Yogo (2005) critical values. The endogenous tests reveal that the instrumented variable (lintdvash) turns out to be endogenous at 5% significance level in the RE G2SLS model. In this vein, we interpret the results of the Model 5.

Table 3.15. The Effect of Forward Participation into GVCs on Innovation Performance According to Medium High-Technology Classification

VARIABLES	(1) Model1 Medhigh-tech OLS	(2) Model2 Medhigh-tech Fixed Effect	(3) Model3 Medhigh-tech Random Effect	(4) Model4 Medhigh-tech Fixed Effect 2SLS IV	(5) Model5 Medhigh-tech Random Effect G2SLS IV
lintdvash	3.010***	-0.699**	-0.108	-1.909***	0.001
	(0.330)	(0.339)	(0.293)	(0.607)	(0.461)
lrdpdcop	0.711***	0.156***	0.255***	0.134**	0.263***
	(0.063)	(0.055)	(0.054)	(0.055)	(0.055)
lklco	0.656***	0.246***	0.262***	0.187***	0.270***
	(0.076)	(0.067)	(0.060)	(0.069)	(0.067)
Constant	-28.071***	-12.390***	-14.895***		-15.313***
	(1.319)	(1.255)	(1.125)		(1.758)
Observations	2,433	2,433	2,433	2,429	2,433
R-squared	0.564	0.061	0.3283	0.037	0.3586
F-Stat	113.5	9.965		11.69	15.51
Prob > F	0	0.000	9.68e-10	0.000	0.000
Degree of Freedom	168	168	3	164	3
Number of panelid		169	169	165	169
Wald			44.91	501.707	818.08

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.10

Notes: In IV models (Model 4 and Model 5), F-statistics exceed the Stock-Yogo (2005) critical values. The endogenous tests reveal that the instrumented variable (lintdvash) turns out to be endogenous at 5% significance level in the FE 2SLS IV model.

Table 3.16. The Effect of Forward Participation into GVCs on Innovation Performance According to High-Technology Classification

VARIABLES	(1) Model1 High-tech OLS	(2) Model2 High-tech Fixed Effect	(3) Model3 High-tech Random Effect	(4) Model4 High-tech Fixed Effect 2SLS IV	(5) Model5 High-tech Random Effect G2SLS IV
lintdvash	0.373	-1.018	-0.275	-5.595**	-4.091*
	(0.378)	(0.735)	(0.578)	(2.621)	(2.391)
lrdpdcop	0.919***	0.275**	0.544***	0.093	0.273
	(0.072)	(0.119)	(0.101)	(0.206)	(0.172)
lklco	0.262***	-0.004	0.107	-0.043	0.007
	(0.055)	(0.098)	(0.087)	(0.129)	(0.115)
Constant	-17.322***	-9.753***	-13.503***		0.440
	(1.206)	(2.439)	(1.816)		(8.432)
Observations	1,113	1,113	1,113	1,113	1,113
R-squared	0.725	0.058	0.7138	-0.276	0.0003
F-Stat	149.2	2.226		6.575	9.831
Prob > F	0	0.0924	6.26e-09	0.000544	0.0000
Degree of Freedom	72	72	3	72	3
Number of panelid		73	73	73	73
Wald			41.09	38.386	41.571

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.10

Notes: Postestimation test reveals that the fixed effect estimation is preferred to random effect estimation. In IV models (Model 4 and Model 5), F-statistics exceed the Stock-Yogo (2005) critical values.

Table 3.17. Summary of the Findings (Cross-Country Industry-Level Analysis)

GVC Participation Type	Industry	Estimated Effects on Innovation	Preferred Model and Explanation
Backward Participation	Overall	Significantly positive	FE 2SLS IV model estimation
	Low-technology	Significantly negative	RE G2SLS IV model estimation
	Medium low-technology	Significantly negative	RE G2SLS IV model estimation
	Medium high-technology	Significantly positive	Both IV models (FE 2SLS IV model estimation and RE G2SLS IV model estimation) provide evidence that the effect of backward participation on innovation performance is significantly positive.
	High-technology	insignificant	RE G2SLS IV model estimation
Forward Participation	Overall	Insignificant/ significantly negative	While the effect is negative in the FE, RE, and FE 2SLS IV models, it turns out to be statistically insignificant in the RE G2SLS IV model. Nevertheless, none of these models indicate any positive impact of forward participation on innovation performance.
	Low-technology	Insignificant/ significantly negative	While the effect is insignificant in the FE 2SLS IV model, it turns out to be negative and statistically significant in the RE G2SLS IV model. In any case, none of these models indicate a positive effect of forward participation on innovation performance.
	Medium low-technology	Significantly positive	RE G2SLS IV model estimation
	Medium high-technology	Significantly negative	FE 2SLS IV model estimation
	High-technology	Significantly negative	Both IV models (FE 2SLS IV model estimation and RE G2SLS IV model estimation) provide evidence that the effect of forward participation on innovation performance is significantly negative.

3.8. Panel Unit Root Tests

In empirical research, panel unit root tests have gained prominence due to the unique structure of panel data. The shift from studying micro panels, characterized by a large N and a small T, to macro panels with large N and large T has highlighted the importance of dealing with regression heterogeneity.

The relevant literature raises concerns on the reliability of standard pooled estimators for dynamic panel data estimation (Baltagi, 2005). Baltagi (2005) points out that pooled estimators, such as FE "*are subject to large potential bias when the parameters are heterogeneous across countries and the regressors are serially correlated* (p.237)".

In this context, panel unit root tests have been used in various areas of economics, including international R&D spillovers, growth, saving, and investment dynamics, among others (Hurlin and Mignon, 2007). This shows, indeed, a burgeoning field within panel data econometrics.

There are various panel data unit root tests, such as Im-Pesaran-Shin (IPS) test and Fisher-type test, most of which operate under the null hypothesis that all panels contain a unit root.

In our work, we also examine the prevalence of unit roots in our panel dataset to evaluate their potential implications for our thesis when using dynamic panel data modelling.

While our data structure has a panels structure with limited T and a relatively large N, it does not conform to the structure of large N and large T that is used in macro models.

We apply both first-generation and second-generation unit root tests using Stata commands (see Table 3.18 and Table 3.19). For the first-generation tests, we use the Im-Pesaran-Shin (IPS) test and Fisher-type tests, since they accommodate

unbalanced panels. Yet, some tests are not computed for the certain panels of the variables lusptogp and rdpdcop.

Other first-generation tests, such as Levin-Lin-Chin test, are not implemented due to their assumption of a balanced panel structure and their sensitivity to missing data in Stata.

In addition, these tests are not well suited for datasets with a large number of panels and relatively few time periods. In order to address contemporaneous correlation, we employ the Stata commands xtunitroot ips, and xtunitroot dfuller with the "demean" option.

Nevertheless, first-generation unit root tests assume the cross-sectional independence (Hurlin and Mignon, 2007). Hence, we proceed to test for cross-sectional dependency in our data.

Using Stata's xtcdf command, the cross-sectional dependency test indicates rejection of the null hypothesis of cross-sectional independence (Table 3.20).

Consequently, we apply second-generation unit root tests. We use Pesaran's CADF test, which "runs t t-test for unit roots in heterogeneous panels with cross-section dependence and … it allows to avoid size distortions, especially in the case of models with residual serial correlations and linear trends" (Stata14, Help).

Therefore, interpreting the results of the second unit root generation tests (Table 3.19), we find that for the variables lusptogp, lfvash and lintdvash, we reject the null hypothesis that all series are non-stationary.

These results allow us to apply, more confidently, estimation techniques and modelling the data. On the other hand, the test for rdpdcop could not be conducted in Stata due to issues with missing values and insufficient observations for this variable.

Table 3.18. Panel Data Unit Root Tests (1st generation) – Summary

	IPS Tests				Fisher type Tests			
	No trend (p-value)		With Trend (p-value)		No trend (p-value)		With Trend (p-value)	
	Lags(0)	Lags(1)	Lags(0)	Lags(1)	Lags(0)	Lags(1)	Lags(0)	Lags(1)
usptogp	-2.7941 (0.026)	-6.7602 (0.000)	59.1689 (1.000)	31.0929 (1.000)	1810.48 (0.000)	1704.71 (0.0052)	964.522 (1.0000)	1045.821 1(.0000)
lusptogp	-	-	-	-	4404.6622 (0.0000)	2150.1511 (0.0000)	3929.233 (0.0000)	1697.8194 (0.0000)
rdpdcop	-	-	-	-	2448.7996 (0.0000)	-	2029.8799 0.0000	-
lrdpdcop	-	-	-	-	-	-	-	-
fvash	-9.7627 (0.000)	-8.5537 (0.000)	-2.6415 (0.0041)	-3.3292 (0.0004)	2263.6453 (0.0000)	2217.3979 (0.0000)	1887.1683 0.0000	2018.7537 0.0000
lfvash	-12.8765 (0.000)	-10.7823 (0.000)	-.61123 (0.000)	-	2545.4787 0.0000	2400.1200 (0.0000)	2186.4511 0.0000	2279.9691 0.0000
intdvash	-9.9781 (0.000)	-7.8360 (0.000)	-6.6847 (0.000)	-4.2812 (0.000)	2348.5270 (0.0000)	2130.6566 (0.0000)	2254.9840 0.0000	1998.4757 0.0000
lintdvash	-10.0505 (0.000)	-8.5557 (0.000)	-5.7026 (0.000)	-	2301.7252 (0.0000)	2163.1161 (0.0000)	2165.2143 (0.0000)	1962.8940 (0.0000)
klco	-11.3876 (0.000)	-1.3800 (0.0838)	-7.1555 (0.0000)	-	2051.1611 (0.0000)	1347.5555 (0.9974)	1939.7571 (0.0000)	1028.6609 (1.0000)
lklco	-9.7409 (0.000)	-8.2326 (0.0000)	-6.1836 (0.0000)	-	2226.6177 (0.0000)	2141.1957 (0.0000)	1971.5247 (0.0000)	2016.9386 (0.0000)

Notes: The Im-Pesaran-Shin (IPS) test and Fisher-type tests are implemented since they allow for unbalanced panels. The tests are not computed for some of the panels of the variables lusptogp and rdpdcop. The remaining 1st generation unit tests are not implemented because they assume that one has a balanced panel data set and they are very sensitive to missing data in Stata. In addition, the other 1st generation tests are not well suited to datasets with a large number of panels and relatively few time periods (e.g., the Levin-Lin-Chin Test). The Stata commands xtunitroot ips, and xtunitroot dfuller are implemented with the option "demean" in order to help control for contemporaneous correlation. Nevertheless, the 1st generation unit root tests assume the cross-sectional independency (Hurlin and Mignon, 2007).

Table 3.19. Panel Data Unit Root Tests (2nd generation) – Summary

	Pesaran CADF Test			
	No trend (p-value)		With Trend (p-value)	
	Lags(0)	Lags(1)	Lags(0)	Lags(1)
usptogp	-40.193 (0.000)	-18.288 (0.000)	-29.275 (0.000)	-7.980 (0.000)
lusptogp	-	-	-	-
rdpdcop	-	-	-	-
lrdpdcop	-	-	-	-
fvash	-2.110 (0.000)	-2.033 (0.000)	-2.418 (0.002)	-2.345 (0.224)
lfvash	-13.920 (0.000)	-11.577 (0.000)	-7.672 (0.000)	-5.881 (0.000)
intdvash	-2.295 (0.000)	-2.299 (0.000)	-2.585 (0.000)	-2.537 (0.000)
lintdvash	-16.570 (0.000)	-16.276 (0.000)	-10.233 (0.000)	-8.658 (0.000)
klco	-7.244 (0.000)	-10.450 (0.000)	-0.248 (0.402)	-6.873 (0.000)
lklco	-15.920 (0.000)	-14.486 (0.000)	-8.461 (0.000)	-6.624 (0.000)

Notes: We implement Pesaran's CADF test, which "runs t t-test for unit roots in heterogeneous panels with cross-section dependence. It allows to avoid size distortions, especially in the case of models with residual serial correlations and linear trends" (Stata14, Help).

Table 3.20. Cross Section Dependence Test

Variable	CD-Test	p-value	Average joint T
usptogp	340.943	0.000	22.63
lusptogp	326.345	0.000	16.33
rdpdcop	163.259	0.000	12.61
lrdpdcop	176.04	0.000	12.49
fvash	836.678	0.000	24.00
lfvash	861.515	0.000	23.84
intdvash	311.019	0.000	24.00
lintdvash	313.453	0.000	23.84
klco	829.801	0.000	23.64
lklco	904.493	0.000	23.64

Notes: Under the null hypothesis of cross-section independence, CD ~ N(0,1). P-values close to zero indicate data are correlated across panel groups. We apply Stata's xtcdf test.

3.9. Dynamic Panel Structure

In this section, we further extend the model by incorporating the lagged value of the dependent variable. Belloc (2018) argues that industries might be characterized by different time-variant innovation patterns that can be brought by industry-specific technological shocks. In order to deal with this issue and capture time-variant sectoral innovation patterns, Belloc (2018) employs a first-order autoregressive component, which considers lagged sectoral innovation activity. Moreover, a dynamic panel structure also allows for considering the persistence of innovation, which suggests that past innovation performance of firms may have an effect on current innovation behavior (Peters, 2009). In light of these considerations and following the approach of Belloc (2018), we include the lagged value of the number of patents granted by the USPTO, normalized by population.[31]

Thereby, the equations to be estimated are formulated as follows:

$$lusptogp_{cit} = \alpha_{ci} + \beta_1 lusptogp_{cit-1} + \beta_2\, lrdpdcop_{cit} + \beta_3\, lfvash_{cit} + \beta_4\, lklco_{cit} + \varepsilon_{cit} \quad (3)$$

$$lusptogp_{cit} = \delta_{ci} + \beta_5 lusptogp_{cit-1} + \beta_6\, lrdpdcop_{cit} + \beta_7\, lintdvash_{cit} + \beta_8\, lklco_{cit} + \nu_{cit} \quad (4)$$

where

- The subscript ***c*** stands for country, and the subscript ***i*** denotes for industry;
- ***lusptogp_cit*** is the number of patents granted by the USPTO divided by population and expressed in natural logarithm;
- ***lusptog_cit-1*** is the lagged value of lusptogp_cit with a lag of one period;
- ***lrdpdcop_cit*** is the business enterprise R&D data by industry (main activity orientation), which follows ISIC Rev. 4, divided by population and are expressed in US dollars at PPP at constant prices and in natural logarithm;

[31] This version of the dynamic model may be regarded as preliminary; however, it can still provide certain insights. For further research, the dynamic model can be improved by extending it to include the lagged values of the explanatory variables.

- ***lfvash_cit*** is a measure of backward participation and it is the foreign value added in gross exports for domestic industry i in country c, as a percentage of total industry exports expressed in natural logarithm;
- ***lintdvash_cit*** is a measure of forward participation and it is the domestic value added in gross exports of intermediate products by industry i in country c, as a percentage of total industry exports expressed in natural logarithm;
- α_{ci} and γ_i are country-industry effects. ε_{cit} and ν_{cit} are the error components.

The estimation results of the dynamic model are presented in Table 3.21 and Table 3.22. Table 3.21 presents the estimation results of backward participation. For standard FE and RE panel estimations, postestimation test reveals that the fixed effect estimation is preferred to random effect estimation. For the panel IV regressions, in both 2SLS IV and G2SLS IV models, F-statistics exceed the Stock-Yogo (2005) critical values. The instrument is not weakly identified. This means that the instrument is highly correlated with the endogenous variable. Grounded on the outcome of the endogeneity tests we reject the null hypothesis that the regressor *lfvash* is exogenous at 5% significance level. We interpret the estimation results of the FE 2SLS IV model and RE G2SLS IV models. While the effect of backward participation is insignificant in the FE 2SLS IV model, it turns out to be negative and statistically significant in the RE G2SLS IV model. All in all, none of these models indicate any positive impact of backward participation on innovation performance. Table 3.22 presents the estimation results of forward participation in the model with a lagged dependent variable. While the effect is negatively significant in the FE 2SLS IV model, it turns out to be insignificant in the RE G2SLS IV model. However, none of these models indicate any positive impact of forward participation on innovation performance, which is consistent with the result we obtain from the static models. Similar to the estimation results we obtain from the static models above, the effect of GVC participation on innovation shows mixed results. The absence of any positive effect of forward participation on innovation observed in overall pattern when technology intensity differences are not taken into account suggests, in both static and dynamic models, that arguments asserting that being a supplier of other countries' exports may not guarantee improvements in innovation outcomes due to possible challenges remain valid.

Table 3.21. The Effect of Backward Participation into GVCs on Innovation Performance: Dynamic Panel Structure

VARIABLES	(1) Model1 OLS	(2) Model2 Fixed Effect	(3) Model3 Random Effect	(4) Model4 Fixed Effect 2SLS IV	(5) Model5 Random Effect 2GLS IV
lusptogplag1	0.895***	0.387***	0.770***	0.384***	0.886***
	(0.009)	(0.026)	(0.015)	(0.026)	(0.009)
lrdpdcop	0.076***	0.069***	0.135***	0.059***	0.076***
	(0.009)	(0.020)	(0.014)	(0.021)	(0.009)
lfvash	-0.050***	-0.042	-0.094***	0.170	-0.204***
	(0.017)	(0.076)	(0.032)	(0.114)	(0.032)
lklco	0.033***	0.064**	0.073***	0.052	0.040***
	(0.005)	(0.032)	(0.009)	(0.033)	(0.006)
Constant	-1.582***	-8.794***	-3.435***		-1.220***
	(0.138)	(0.451)	(0.241)		(0.152)
Observations	7,611	7,611	7,611	7,585	7,611
R-squared	0.900	0.142	0.8973	0.140	0.8991
F-Stat	13163	65.90		67.49	10693
Prob > F	0	0	0	0	0
Degree of Freedom	572	572	4	546	4
Number of panelid		573	573	547	573
Wald			12004	3547.278	4096.71

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.10

Notes: The dependent variable is the number of patents granted by the United States Patent and Trademark Office (USPTO)" (lusptogp)" by priority date, industry s, country c, and year t, which is transformed by the author from technology domains & IPC classification into ISIC Rev.4 and it is expressed in natural logarithm. Regressions cover the period 1995–2018.

Table 3.22. The Effect of Forward Participation into GVCs on Innovation Performance: Dynamic Model Structure

VARIABLES	(1) Model1 OLS Robust	(2) Model2 Fixed Effect Robust	(3) Model3 Random Effect Robust	(4) Model4 Fixed Effect 2SLS IV Robust	(5) Model5 Random Effect 2GLS IV Robust
lusptogplag1	0.896***	0.384***	0.771***	0.379***	0.893***
	(0.008)	(0.026)	(0.015)	(0.026)	(0.009)
lrdpdcop	0.077***	0.062***	0.136***	0.049**	0.079***
	(0.009)	(0.020)	(0.014)	(0.021)	(0.009)
lintdvash	0.004	-0.299**	-0.003	-0.977***	0.029
	(0.019)	(0.134)	(0.035)	(0.324)	(0.022)
lkl co	0.031***	0.054*	0.070***	0.035	0.033***
	(0.005)	(0.032)	(0.009)	(0.034)	(0.005)
Constant	-1.733***	-7.845***	-3.710***		-1.886***
	(0.167)	(0.643)	(0.287)		(0.176)
Observations	7,611	7,611	7,611	7,585	7,611
R-squared	0.900	0.143	0.8972	0.136	0.9001
F-Stat	13158	67.03		72.21	12418
Prob > F	0	0	0	0	0
Degree of Freedom	572	572	4	546	4
Number of panelid		573	573	547	573
Wald			11966	1399.93	1659.273

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.10

Notes: The dependent variable is the number of patents granted by the United States Patent and Trademark Office (USPTO)" (lusptogp)" by priority date, industry s, country c, and year t, which is transformed by the author from technology domains & IPC classification into ISIC Rev.4 and it is expressed in natural logarithm. Regressions cover the period 1995–2018.

CHAPTER 4

THE CASE OF TÜRKİYE

Complementing the cross-country industry-level analysis presented in Chapter 3, this chapter provides an in-depth analysis of the effects of Türkiye's participation in GVCs on its innovation performance. A pertinent question that may arise is why Türkiye merits special consideration in a discussion of the GVC-innovation nexus. The rationale for focusing on Türkiye as a particular case can be attributed to several factors. These include Türkiye's increasing integration into GVCs, its position in global and regional production networks, and its status as a developing country with a notable trade and economic volume.

However, Türkiye's growing participation in GVCs alone may not be sufficient to fully justify its separate examination. What further enhances Türkiye's relevance is the fact that its increased integration into GVCs during the new phase of globalization since the mid-1990s coincided with the establishment of the Customs Union with the European Union in 1995. This alignment may also be interpreted, to some extent, within the framework of Baldwin's taxonomy regarding the international fragmentation of production, i.e., positioning the EU as a regional hub and Türkiye as a factory economy, which provides further support to consider Türkiye as a distinct and illustrative case. The Customs Union between Türkiye and the EU has contributed significantly to Türkiye's integration into GVCs, particularly within European production networks, and may have reinforced its effects on trade and innovation outcomes.

Furthermore, as outlined in its Twelfth Development Plan, Türkiye has established a clear goal of increasing higher value-added exports and improving access to technology and knowledge transfer by further enhancing participation in GVCs. This

strategic commitment highlights Türkiye's aspiration to improve its international competitiveness and technological capabilities through strengthening its position within GVCs. Despite its growing participation in GVCs, Türkiye's position within international production chains has not considerably improved. In particular, the sophistication of its export products and innovation outcomes has remained limited compared to its peers. Türkiye has primarily specialized in products with standardized, rather than advanced, technologies in international production chains (Taymaz *et al*. 2011; World Bank, 2022). This situation warrants a thorough investigation into the effects of Türkiye's GVC participation on its innovation performance.The aforementioned features underscore the rationale for treating Türkiye as a relevant and illustrative case for further analysis aimed at understanding the nuanced relationship between GVC participation and innovation performance. Such an analysis may provide valuable insights into whether and in what ways countries can leverage GVC participation to enhance innovation.

4.1. Literature Review: Türkiye's GVC Participation and Innovation Performance

This section briefly discusses the earlier works regarding Türkiye's integration into global value chains and its main drivers as well as economic consequences of this integration such as growth, development, productivity and innovativeness. One of the seminal works analyzing the developments and the transformation in international production chains and the position of Türkiye in those chains is by Taymaz *et al.* (2011). The work examines Türkiye's position during the period of 2002-2008 in five global production chains (motor vehicles, textiles and wearing apparel, television, food and machinery), which are also among the key sectors in Türkiye's trade, and broadly speaking economy. In order to analyze different production stages within a chain, Taymaz *et al.* (2011) use four product groups, namely raw materials, standard inputs, main inputs and final goods. Moreover, the machinery and equipment used in production is also included in the grouping.[32]

[32] Those product groups include products at six digit-level in 1992 Harmonized System, for whose classification the Benchmark Input-Output Accounts of the United States is used. The study is based on analyzing foreign trade statistics, which are obtained from UN Comtrade data source. For further details see Taymaz *et al*. (2011).

According to the findings of Taymaz *et al.* (2011), the products/industries in which Türkiye specializes in the international production chains are those with generally low growth rates. Moreover, Türkiye is competitive in the products/industries with relatively low unit prices. On the other hand, Türkiye has increased its exports due to Türkiye's export markets having grown faster than the other markets. In this vein, Türkiye has used market advantages and geographical location well. Nevertheless, Türkiye does not strengthen its position in international production chains since it has not been competitive in fast growing and technologically advanced products (Taymaz *et al*. 2011, p. 89).

Taymaz *et al.* (2011) argue that Türkiye's position in international production chains does not improve even though its export structure has been transformed. The reason behind is that Türkiye has specialized and it has been competitive in the products, whose technology is standardized for the period in question. For these products, production costs are relatively low. Machinery and motor vehicles are a good case in point. While textiles and wearing apparel, which is labor-intensive, was the most important industry with its rising share in Türkiye's exports from 1980s to the mid-1990s, the share of motor vehicles and machinery began to increase from the mid-1990s. The increased share of motor vehicles and machinery, whose technology can be regarded as medium-technology, at the expense of decreasing shares of textiles and wearing apparel could be interpreted as the transformation of Türkiye's exports. In spite of that transformation, Türkiye has not improved its position but, in other words, kept its stance in international production chains.

Taymaz *et al.* (2011) put forward two propositions underlying this situation. Firstly, the specialized products in foreign trade might not have high value-added. Countries like Türkiye that are specialized in products with standardized technology and low cost might not improve their position in international production chains even though there is structural transformation in their exports. Secondly, due to the fragmentation of production into different countries in international production chains, the specialization in production stages rather than specialization in individual products becomes more important. For instance, even though an automobile is a product with high value-added, its production consists of various stages with different value-

added. At a first glance, the increased share of motor vehicles exports can be regarded as an affirmative development at industry/product level; however, if the specialization occurs at low value-added stages of production and/or at the production stages that use more standardized technology, this does not lead to an improvement in the country's relative position in international production chains despite the structural transformation of foreign trade. In a nutshell, structural transformation of exports does not always guarantee the improvement in the position of a country in international production chains.

Türkiye's integration into GVCs is also analyzed in OECD's Economic Survey of Türkiye (2016). Grounded on the argument that participation in GVCs increases productivity, OECD (2016) states that participation of Türkiye in GVCs is important for its economic development. Moreover, it argues that despite its progress in GVC integration, Türkiye still lags behind particularly in terms of exported value-added. Türkiye's backward participation (i.e., the use of foreign inputs in order to produce intermediate and final goods to be exported) has been increasing. Ziemann and Guérard (2016, p.6) argue that backward participation leads to both reallocation of domestic sources to most competitive firms due to the exposure to import competition, and diffusion of knowledge through learning from suppliers and knowledge spillovers from foreign direct investment.

On the other hand, OECD (2016) states that Türkiye's forward participation (i.e., the provision of inputs/intermediate goods to other countries' exports) has remained limited and below its potential compared to other countries. OECD (2016) and Ziemann and Guérard (2016, p.3) discuss the underlying reasons, which include the institutional characteristics preventing efficient allocation of resources, underdeveloped human capital, and inadequate investment in knowledge-based capital, R&D and innovation. Regarding forward integration, Ziemann and Guérard (2016, p.6) argue that forward participation leads to increase and diversification of potential export markets and the use of Türkiye's factors of production. The increased production for foreign markets necessitates to meet the demand to satisfy international best practices, the convergence of production/product standards. All would contribute to feedback loops between "productivity, innovation, human capital endowment" and in turn to rebalancing the Turkish economy.

Gündoğdu and Saraçoğlu (2016) also investigate Türkiye's backward participation in global value chains by using the World Input Output Database (WIOD) for the period of 1995-2011. For backward participation, they use the formula of vertical specialization, introduced and defined by Hummels *et al.* (2001). Similar to the study of OECD (2016), the authors find that Türkiye's vertical specialization increased during the period in question. In addition, the study examines the vertical specialization in manufacturing industries according to different levels of technology.

The results of Gündoğdu and Saraçoğlu (2016) reveal that compared to those of low-technology industries and medium low-technology industries, the vertical specialization of medium-high technology industries and high-technology industries increased more. Authors argue that similar to the effect of foreign direct investment (FDI) on inducing technology transfer, vertical specialization might also be a way of improvement of technologies. In this vein, higher vertical specialization in high technology industries "could lead to a higher level of technology transfers from abroad and subsequent spillover effect" (p.38). Having pointed to this probable positive knowledge transfer-related positive effect of increased backward participation, the authors point out that this would not be taken for granted as a case of technology transfer, if it is not going beyond assembling activities.

In addition, by integrating the source partner countries in the analysis it is found that China contributed most to Türkiye's vertical specialization in 2010 even though Germany played the most significant role in vertical specialization of Türkiye's exports up until then. Moreover, the study shows that China's contribution to vertical specialization mainly stems from low-technology industries such as textiles. Gündoğdu and Saraçoğlu (2016) argue that vertical specialization in technology intensive industries driven by developed countries might contribute better to Türkiye's position in global value chains. They state that China contributes most to Türkiye's vertical specialization. However, this contribution occurs mostly in low-technology industries such as textiles. Hence, based on these findings, they also conclude that increased backward participation might not necessarily conduce to upgrading Türkiye's position in global value chains.

Ozer *et al*. (2016) also examine Türkiye's position in GVCs by reviewing three industries, namely automotive sector, textiles and apparel sector, and agri-food sector. By analyzing the structure of these value chains and Türkiye's position within them, the study reveals that Türkiye's participation is mainly concentrated in assembly and low value-added segments of the chain, whereas it exhibits successful upgrading in the textiles and apparel sector. Moreover, Ozer *et al*. (2016) investigate the factors influencing spillovers from foreign direct investment and their effects on the productivity of domestic firms. Their findings indicate that high R&D expenditure and supplying foreign-owned firms enhance productivity.

A growing recent strand of the literature also discusses value chain integration by relating it to the issues of productivity and value-addition. In this vein, Kılıçaslan *et al.* (2021) investigate the effects of value chain integration (both domestic and global value chains) on productivity for Turkish manufacturing firms. By using firm-level data covering the period of 2003-2015 and applying fixed effects model, they examine the effect of firms' positioning (supplier, final firm) in the chains. They find that being a supplier in domestic value chains has a negative effect on productivity. The negative coefficient of being a supplier turns out to be positive but insignificant when a firm takes position as a supplier in GVCs. Another finding of the study based on the productivity estimation results of the full sample is that importing intermediate goods improves productivity, especially for small and medium-sized enterprises. Finally, having both supplier and purchaser positions do not turn out to be a statistically significant determinant of productivity.

In a similar fashion, Yanıkkaya *et al.* (2022) investigate the impact of openness (measured by several measures including GVC measures) on value-added and total factor productivity (TFP) growth, and exports of Turkish sectors for the time period of 1995-2014. By using datasets of World Input-Output Database (WIOD) and World Integrated Trade Solution (WITS) and applying generalized method of moments, they find that domestic value added in exports enhance sectoral value-added; however, domestic value added in exports does not have significant effect on TFP. Moreover, they state that even if backward linkages appear to be important for TFP in manufacturing industries, they do not have significant effects on sectoral value added.

The work done by Erdil and Göksidan (2016) provides another perspective on the issue. With an aim to investigate whether GVC structure increases knowledge transfer and innovation in Türkiye, Erdil and Göksidan (2016) seek to relate the knowledge spillovers and learning mechanisms in regional networks to global linkages in GVCs. They approach the issue by integrating two main perspectives. The first perspective is the regional network theory in which the local supplier-buyer linkages are embedded. The second one is the knowledge theory in which the issues of knowledge spillovers, types of knowledge and learning are discussed within an institutional and organizational framework. With a reasoning stating that GVCs might not always ensure an automatic climbing up the capabilities ladder, Erdil and Göksidan (2016) propose that the process must begin initially with the regional networks, which can be followed by acquiring capabilities from developed countries through global linkages. In this vein, integrating into GVCs is important as long as it is not limited to a single one and simultaneous expansion of capabilities and opportunities are utilized.

A recent report published by the World Bank (2022) is another attempt to understand GVCs in Türkiye. According to the report, Türkiye participates actively in several GVCs. A significant portion of Türkiye's international trade is related with GVCs, whereby backward and forward linkages constitute more than one third of total exports. With respect to the World Bank GVC taxonomy (World Bank, 2020), Türkiye is classified as an "advanced manufacturing and services" country, as backward participation and the focus on manufacturing activities continue to increase, which in turn enhances it from "basic manufacturing country" (World Bank, 2020). In addition, Türkiye's GVC participation occurs in multiple GVCs, which shows geographical diversification. The two outstanding regional value chains that Türkiye participates in are the European Union, through the Customs Union, and the Middle East and North Africa region.

The firm-level analysis, which constitutes one part of the World Bank report (2022), also gives some insights about Türkiye's participation in GVCs. The study conducted by the World Bank (2022) defines a firm as a "GVC exporter" if it "*imports at least*

10 percent of its intermediates and exports at least 10 percent of its output"[33] (World Bank, 2020, p.87) and as a "*domestically linked GVC firm/GVC domestic suppliers*" if its sales to a GVC exporter "*constitute at least 10 percent of its turnover*" (World Bank, 2020, p.88). By using this definition, the study reveals some findings about the GVC firms.

The findings of the analysis done by the World Bank (2020) reveal that GVC exporters outperform domestically oriented firms even though the GVC exporters constitute a small group of all companies in Türkiye. In this vein, the average value-added produced by GVC exporters, productivity levels, export values (per firm), employment size and innovation outputs (expressed in number of patents and designs per firm) of GVC firms are larger compared to other firms. GVC exporters are mainly concentrated in manufacturing sectors, particularly in manufacturing of textiles, rubber and plastics, machinery, apparel and fabricated metal products. Other striking characteristics of GVC firms is their intensive use of intermediate inputs and reliance on internationally sourced inputs for the sake of being competitive through accession to higher-quality inputs (World Bank, 2020).

Notwithstanding the increased participation of Türkiye into several GVCs with more advanced manufacturing activities and associated domestic value-added exports, World Bank (2022) argues that there is still scope for Türkiye to enhance its participation and upgrade. The main reasons behind this argument can be seen when Türkiye is compared to those of selected peer countries (Czech Republic, Poland, Slovak Republic, Republic of Korea, etc.) with respect to some indicators. Firstly, it is stated that the share of final goods in Türkiye's total goods and services exports is higher compared to the peer countries, which raises the questions that whether Türkiye is concentrated on downstream part (of the GVCs) and whether GVC participation of Türkiye is optimal with respect to the gains from integration. Yet, the report still indicates that Türkiye's focus on final goods is not merely limited to simple assembly, but an improvement through complex activities of final goods has been witnessed. Second, considering particularly forward linkages, Türkiye's GVC

[33] The definition provided by the World Bank is open to criticism because it might be considered overly simplistic and lacking sophistication.

participation focuses on the EU, which questions the (sub)optimal integration into GVCs with some other regions. Additionally, with regard to the grouping of countries according to the World Bank GVC taxonomy (2020); even though Türkiye is classified under the advanced manufacturing and services group, it is still remains outside the innovative group (World Bank, 2022). Consequently, the World Bank (2022) proposes enhancing innovation activities, decreasing barriers in services trade, and improving merchandise trade with more trade partners (via deepening trade with the EU and signing bilateral agreements) to reap the benefits of the potential trade stemming from the participation into GVCs.

Finally, Erkök (2020) also studies Türkiye's integration into GVCs and examines Türkiye's position and domestic and foreign value-added in exports throughout the period of 1995-2009 by using OECD TiVA database. Erkök (2020) states that Türkiye has positioned competitively in GVCs thanks to its logistics advantages stemming from geographical location and its relatively low production cost brought by relatively cheap labor. Moreover, she depicts that Türkiye's integration into GVCs was higher in 2009 compared to 1995; in which Türkiye's backward participation was higher than its forward participation and backward participation showed an increasing trend throughout that period. The study argues that the high participation does not necessarily mean that neither the trade deficit is decreasing nor the level of economic development and the level of employment are equally high. It is difficult to compete only with cheap labor and geopolitical location advantages. In this vein, Erkök (2020) underlines that it is necessary to produce and export high value-added products and qualified brands.

4.2. Quantitative Analysis

This section investigates the effects of Türkiye's GVC participation on innovation performance by conducting a quantitative analysis. Two different types of quantitative analyses are implemented in this chapter, namely, a descriptive analysis and an econometric analysis. The first subsection briefly presents and summarizes the basic findings of both types of quantitative analyses. The second subsection presents the descriptive analysis in detail and provides insights about Türkiye's GVC

participation of its manufacturing industries according to the classification of technology definition. In the following subsections of this chapter, the econometric analysis, i.e., the second part of the quantitative analysis is presented and econometric modelling techniques are applied.

4.2.1. Basic Findings of the Quantitative Analysis

Compared to 1995, Türkiye's GVC participation (both backward participation and forward participation) increased in 2018. Moreover, the increase in backward participation rate is higher than that of forward participation rate. These findings reveal that Türkiye's integration into global trade has increased. Nonetheless, Türkiye's increased integration is mostly explained by importing intermediate goods for its exports rather than by providing inputs to other countries' exports. In this regard, classification of manufacturing industries according to technology intensity provides additional insights. Throughout 1995-2018, while the backward participation rates increased in all technology groups, the forward participation rates decreased except for the low-technology group. This means that the low-technology group is the only group where both backward participation and forward participation increased. In this vein, when drawing policy conclusions regarding the innovation performance of various industries, we should keep in mind that for different technology groups the nature of integration into GVCs is different.

The effect of backward participation on Türkiye's innovation performance is found to be insignificant except for the medium-high technology group. The effect is positive for the medium-high technology group, which means that importing intermediate goods for exports improves the innovation performance of the medium high-technology group, which include the industries of chemicals and chemical products, electrical equipment, machinery and equipment n.e.c., motor vehicles, trailers and semi-trailers, and other transport equipment. As stated in detail in above Chapters; this can be attributed to increase in knowledge spillovers from suppliers, importing intermediate goods with higher quality, eliminating constraints in the production process and increase in productivity. Nevertheless, unlike the medium-high technology group, why the innovation performance of the other technology

groups were not affected in Türkiye by the increase in importing intermediate goods needs to be explained in detail (see Chapter 5 for policy discussion).

Moreover, the findings regarding Türkiye's backward participation can be compared to the results of the above cross-country analysis. Overall, the effect is positive for other countries, which is different from the result for Türkiye. However, similar to the case of Türkiye, for the other countries the effect becomes ambiguous and differs according to different technology intensity groups. For instance, similar to Türkiye, while the effect of importing intermediate goods for exports is positive for medium high-technology groups, it is insignificant for medium low-technology groups.

In this vein, we can argue that importing imports for exports later to be used in other countries' exports does not always improve the innovation performance in all industries. While the effect is positive when considering all industries for all countries at the same time, disaggregated data for specific technology intensive industries and/or specific countries (as in the case of Türkiye) do not yield the same uniform results.

In addition, the effect of providing inputs for the other countries' exports is found to be negative for Türkiye, which is consistent with the result of the cross-country analysis. However, similar to the findings of the cross-country analysis, the effects differ according to different technology groups of manufacturing industries. For instance, exporting inputs for other countries' exports do not improve the innovation performance of the medium low-technology group. On the other hand, for the other technology groups, we do not reach decisive conclusions since the results are mixed.

Consequently, first and foremost the quantitative analysis warns us that both different technology intensity groups and each country need to be investigated separately. It is thereby reasonable to propose industry-tailored and/or country-specific policy recommendations without reaching generally valid conclusions regarding the role of GVC participation on innovation performance (see concluding remarks and policy discussion in Chapter 5).

4.2.2. Descriptive Analysis: Türkiye's GVC Participation According to Technology Intensity Classification of Manufacturing Industries

Our contribution in this section is to provide some insights about Türkiye's GVC participation for manufacturing industries according to the classification of technology intensity. As discussed in Chapter 3, the classification of technology intensity is only available for manufacturing industries. Therefore, the analysis is confined to manufacturing industries and does not include services.

This section investigates the effects of Türkiye's GVC participation on innovation performance by conducting quantitative analysis. The first subsection presents descriptive analysis and provides insights about Türkiye's GVC participation of manufacturing industries according to the classification of technology definition. In the second subsection, econometric modelling techniques are applied.

We obtain data regarding GVC participation measures from TiVA database (2021) and use EUROSTAT's technology classification of manufacturing industries, which is based on NACE Rev.2 at 2-digit level. Table 4.1 shows EUROSTAT's intensity technology definition of manufacturing industries.

Table 4.1. Eurostat Technology Intensity Definition of Manufacturing Industries

Classification	Industry Description	NACE Rev.2 Codes
High-technology Industries	Manufacture of basic pharmaceutical products and pharmaceutical preparations	21
	Manufacture of computer, electronic and optical products	26
Medium high-technology industries	Manufacture of chemicals and chemical products	20
	Manufacture of electrical equipment; Manufacture of machinery and equipment n.e.c.; Manufacture of motor vehicles, trailers and semi-trailers; Manufacture of other transport equipment	27 to 30

Table 4.1. (continued)

Medium low-technology industries	Manufacture of coke and refined petroleum products	19
	Manufacture of rubber and plastic products; Manufacture of other non-metallic mineral products; Manufacture of basic metals; Manufacture of fabricated metals products, excepts machinery and equipment	22-25
	Repair and installation of machinery and equipment	33
Low-technology industries	Manufacture of food products, beverages, tobacco products, textile, wearing apparel, leather and related products, wood and of products of wood, paper and paper products, printing and reproduction of recorded media	10 to 18
	Manufacture of furniture; Other manufacturing	31 to 32

Source: Eurostat

As explained in detail in Chapter 3, while the backward participation can be expressed as "*foreign value added embodied in exports as percentage share of total gross exports of the exporting country*", forward participation can be defined as "*domestic value added embodied in foreign exports as a share (%) of total gross exports of the value-added source country*" (Guilhoto *et al.,* 2022). The GVC participation is defined as the sum of backward and forward participation.

Based on the OECD-TiVA database, it is shown that Türkiye's integration into GVCs has increased in the last three decades. Figure 4.1 below illustrates the backward participation, forward participation and the GVC participation of Türkiye for the period 1995-2018. While GVC participation of Türkiye was 21.4% in 1995, it increased to 39.8% in 2018. The foreign value-added share in Türkiye's gross exports (i.e., backward participation) has increased considerably from 8.8% in 1995 to 20.9% in 2018. This corresponds to a 12.1 percentage point increase in backward participation rate. Nevertheless, the share of domestic value-added in Türkiye's exports that are embodied in foreign countries' exports, i.e., forward participation has increased from 12.6% in 1995 to 18.9% in 2018. This corresponds to a 6.3 percentage point increase in forward participation rate.

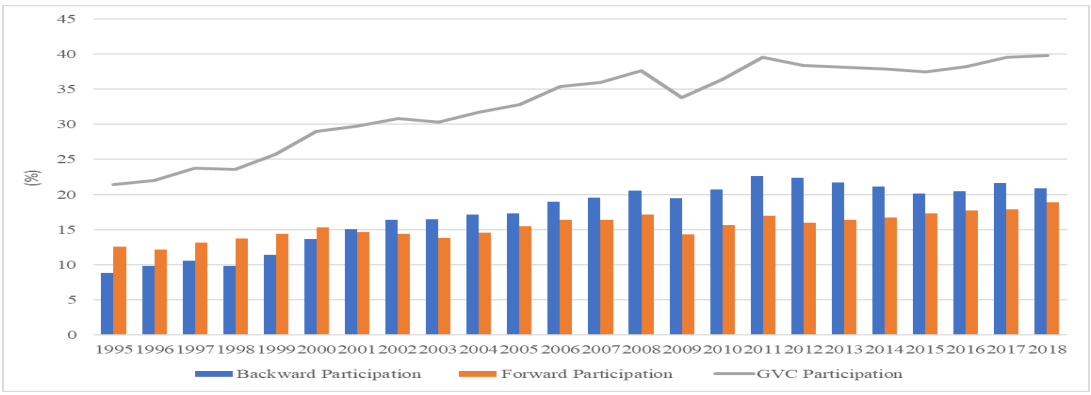


Figure 4.1. Türkiye's GVC Participation, Backward Participation and Forward Participation

Source: TiVA Database, 2021

Compared to 1995, both forward participation rate and backward participation rate were higher in 2018. Nevertheless, the increased GVC integration of Türkiye is attributed more to the increase of its backward linkage rather than that of forward linkage. As Figure 4.2 presents, backward participation constituted 41.3% of GVC participation in 1995. In 2018, backward participation constituted 52.6% of GVC participation.

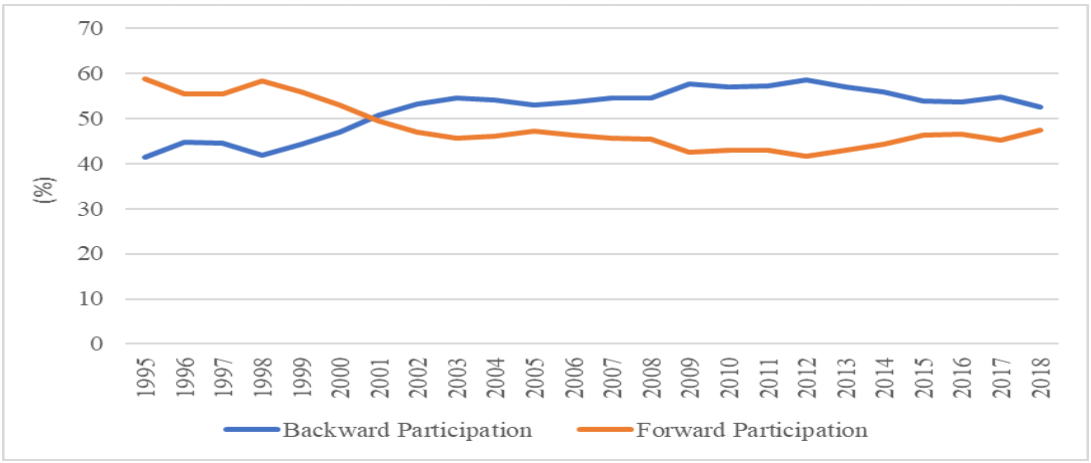


Figure 4.2. Percentage Share of Türkiye's Backward Participation and Forward Participation in GVC Participation

Source: Author's calculation based on TiVA Database, 2021

During 1995-2000, forward participation rates were higher than backward participation rates. The situation reversed in 2001. Since then, backward participation

rates have been higher than forward participation rates until 2018. As our primary interest resides in the possible relationship between GVC integration and innovation performance, the first step might be to present the participation of industries into GVCs according to technology intensity of industries. In this vein, one of our contributions in this study is to merge the industry classification in the TiVA database with the technology intensity definition of manufacturing industries. To this end, we use the NACE Rev.2 Technology Intensity Definition developed by the EUROSTAT, which is the aggregation of manufacturing industries into categories based on their technology intensity. In its sectoral approach, the EUROSTAT defines technological intensity as R&D expenditure/value added (Eurostat, 2022). It classifies 24 manufacturing industries into four categories; namely, high-technology industries, medium high-technology industries, medium low-technology industries and low-technology industries. The reason behind using this classification is our intention to merge the data on participation into GVCs, which we obtain from the TiVA database with the data on industries according to technological intensity. These two sets of data, which are based on the classification of manufacturing industries, ISIC Rev.4. and NACE Rev.2. respectively, are the same at the 2- digit level and hence we can compile aggregates accordingly. The correspondence between TiVA definition and Eurostat technology intensity classification of industries is tabulated below in Table 4.2.

Table 4.2. Correspondence between TiVA Industry Codes and Eurostat Definition of Technology Intensity of Manufacturing Industries

TiVA Code	Industry Description	ISIC Rev.4 Code	Eurostat Technology Intensity Classification
D10T12	Food products, beverages and tobacco	10-12	Low
D13T15	Textiles, wearing apparel, leather and related products	13-15	Low
D16	Wood and of products of wood and cork, except furniture; articles of straw and plaiting materials	16	Low
D17T18	Paper products and printing	17-18	Low
D19	Coke and refined petroleum products	19	Medium low

Table 4.2. (continued)

D20	Chemicals and chemical products	20	Medium high
D21	Pharmaceuticals, medicinal chemical and botanical products	21	High
D22	Rubber and plastic products	22	Medium low
D23	Other non-metallic mineral products	23	Medium low
D24	Basic metals	24	Medium low
D25	Fabricated metal products, except machinery and equipment	25	Medium low
D26	Computer, electronic and optical products	26	High
D27	Electrical equipment	27	Medium high
D28	Machinery and equipment n.e.c.	28	Medium high
D29	Motor vehicles, trailers and semi-trailers	29	Medium high
D30	Other transport equipment	30	Medium high
D31T33	Furniture, other manufacturing and repair and installation of machinery and equipment	31-33	Low[34]

Source: TiVA Database (2021) and Eurostat

By matching these two datasets, we can point out some issues regarding the aggregations of manufacturing industries based on technological classification and GVC participation of industries. The reason why we do the below analysis is to gain insight and constitute a solid ground for further detailed analyses. We calculate the backward participation of low-technology industries, medium low-technology industries, medium high-technology industries and high-technology industries by using the OECD's formulation, which is explained in detail in Chapter 3. Hence, our calculation regarding the backward participation, i.e., foreign value-added share of gross exports, is simply defined as below:

Backward participation = (foreign value-added content in a domestic industry's exports / gross exports of industry i) × 100

[34] The industry of repair and installation of machinery and equipment (NACE Rev2 Code 33) is classified under medium low-technology group according to Eurostat definition. Nevertheless, there is no separate correspondence to that industry in the TiVA database since the data in TiVA database is not disaggregated at that level but rather aggregated with the industries of furniture and other manufacturing (NACE Rev2 Codes 31 and 32), which are classified under the low-technology group. As it is not possible to disaggregate the data in the TiVA database, we assume the whole group is classified as a low technology group.

In other words, foreign value-added share of gross exports (abbreviated in Guilhoto *et al*. (2022) as EXGR_FVASH, percentage) "*is defined as foreign value added embodied in gross exports EXGR_FVA (c,i,p*[35]*) as a percentage of total gross exports, EXGR (c,i,p)*" (Guilhoto *et al.*, 2022, p.27) and expressed in mathematical formula as:

$$EXGR_FVASHc,i = \frac{\sum pEXGR_FVAc,p,i}{\sum pEXGRc,p,i} \times 100$$

In this vein, Figure 4.3 presents our calculation regarding the backward participation of manufacturing industries according to technology classification.

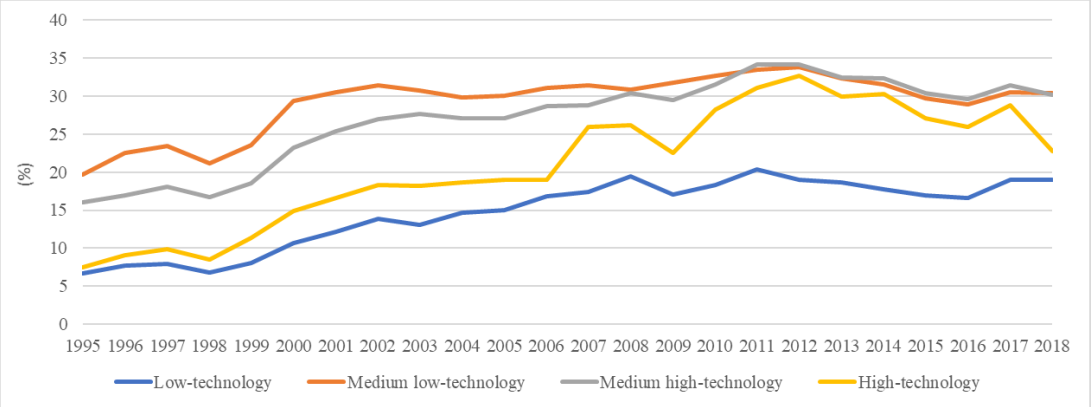


Figure 4.3. Backward Participation of Manufacturing Industries According to Technology Intensity (1995-2018)

Source: Author`s own calculations based on merged data obtained from OECD TiVA database and Eurostat Technology Classification of Manufacturing Industries

In line with the overall increase in foreign value-added share in Turkish exports, foreign value-added share of gross exports had a rising trend in all technology categories between 1995 and 2018 in Türkiye. In 1995, 6.7% of low-technology exports, 19.6% of medium low-technology exports, 16% of medium high-technology exports and 7.5% of high technology exports was foreign-value-added. The foreign value-added shares increased to 19%, 30.4%, 30.2% and 22.8% in 2018, respectively. In other words, backward linkages in all technology groups increased.

[35] "p" denotes partner country.

The foreign value-added share of gross exports was the highest in the medium low-technology group in years from 1995 to 2010. However, the medium-high technology group surpassed the medium low-technology group in 2011, and the backward participation was the highest in this group until 2017. In 2018, backward participation of the medium low-technology group was the highest again, which is though not much higher than that of medium high-technology group. Throughout 1995-2018, the largest increase in foreign value-added share of gross exports was recorded in the high-technology group. There was a 15.3 percentage point increase in foreign value-added share of exports in high-technology industries. During the same time interval, the increase in the foreign value-added share of the medium high-technology (14.2% point) follows that of the high technology industries.

The analysis can be enriched by examining the developments in each industry group that comprise different technology groups. Therefore, in the following we are going to delve into descriptive analysis of industries separately under each technology group. In this vein, Figure 4.4 shows the backward participation rates of five industry groups (namely, "food products, beverages and tobacco", "textiles, wearing apparel, leather and related products", "wood and wood products", "paper products and printing" and, "furniture, other manufacturing and repair and installation of machinery and equipment") that constitute the low-technology group.

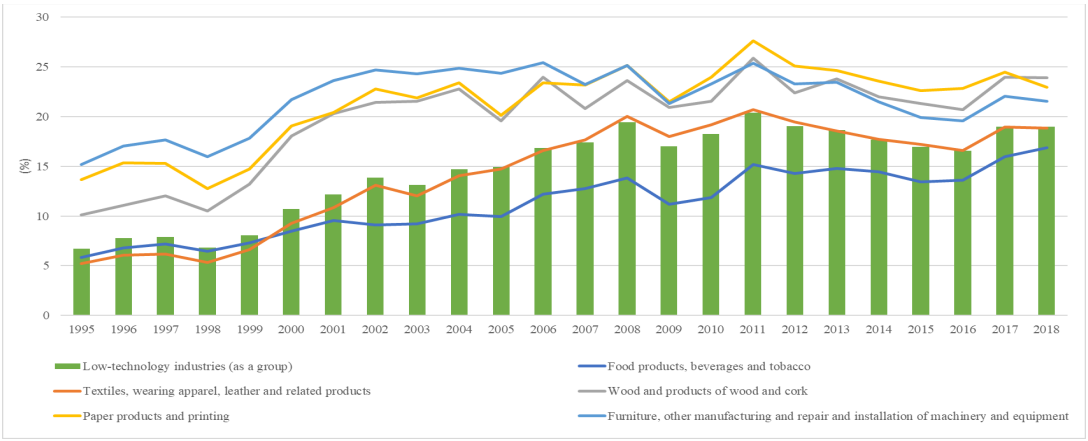


Figure 4.4. Backward Participation of Low-Technology Manufacturing Industries (1995-2018)

Source: Author's own calculations based on merged data obtained from OECD TiVA database and Eurostat Technology Classification of Manufacturing Industries

Throughout 1995-2018, the backward participation rates of three industries ("wood and wood products", "paper products and printing" and, "furniture, other manufacturing and repair and installation of machinery and equipment"), remained above the backward participation rate of the low-technology group as a whole. On the other hand, the backward participation rates of "food products, beverages and tobacco", "textiles, wearing apparel, leather and related products" remained below the average of the low-technology group. Although there was an increasing trend in backward participation rates of all industries, the relative contribution of each industry to the increase in backward participation rate of the low-technology group changed during the aforementioned period. For instance, while the contribution of "furniture, other manufacturing and repair and installation of machinery and equipment" was the highest to the backward participation rate of the low technology group in 1995, the contribution of wood and wood products was the highest in 2018. Overall, throughout the period 1995-2018, the highest contribution was driven by paper products and printing.

Figure 4.5 shows the backward participation rates of five industry groups (namely, "coke and refined petroleum products", "rubber and plastics products", "other non-metallic mineral products", "basic metals", and "fabricated metal products") that constitute the medium low-technology group.

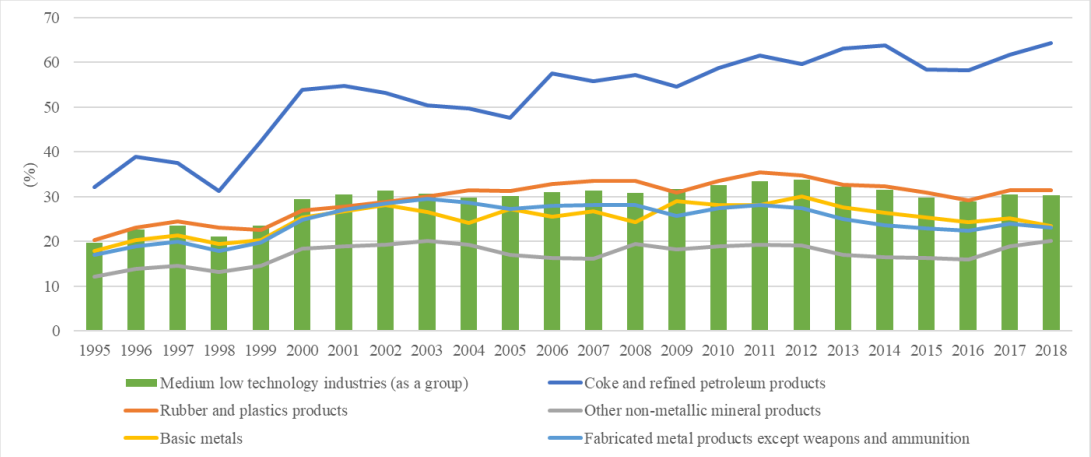


Figure 4.5. Backward Participation of Medium-Low Technology Manufacturing Industries (1995-2018)

Source: Author's own calculations based on merged data obtained from OECD TiVA database and Eurostat Technology Classification of Manufacturing Industries

The only industry group is coke and refined petroleum products of which backward participation rate remained above that of the medium low-technology group throughout 1995-2018. On the other hand, the backward participation rates of other non-metallic mineral products, basic metals, and fabricated metal products remained below the average of the medium low-technology group. Overall, throughout the period 1995-2018, while the highest contribution to the backward participation of the medium low-technology group was driven by "coke and refined petroleum products" and "rubber and plastics", respectively, the lowest contribution stemmed from other non-metallic mineral products. Figure 4.6 shows the backward participation rates of five industry groups (namely, "chemicals and chemical products", "electrical equipment", "other machinery and equipment", "motor vehicles, trailers, and semi-trailers", "other transport equipment") that constitute the medium high-technology group.

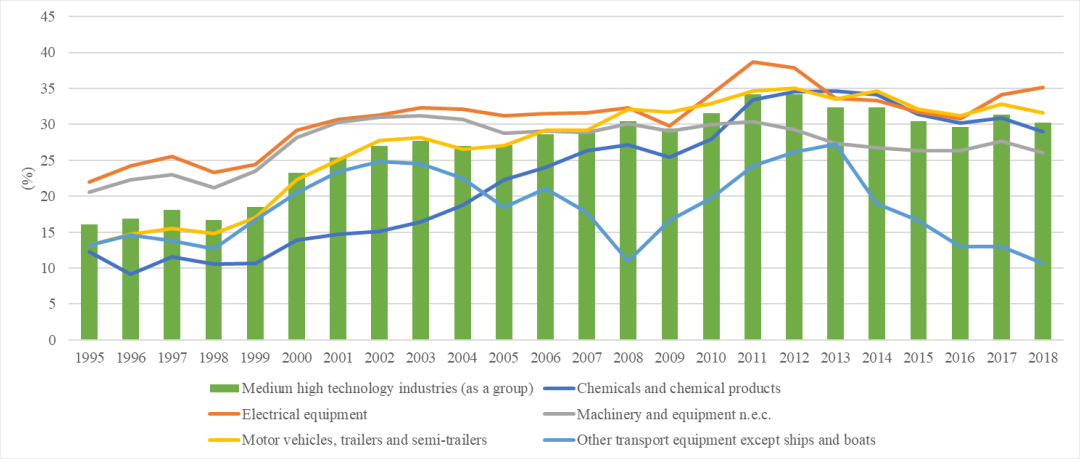


Figure 4.6. Backward Participation of Medium High-Technology Manufacturing Industries (1995-2018)

Source: Author's own calculations based on merged data obtained from OECD TiVA database and Eurostat Technology Classification of Manufacturing Industries

Throughout 1995-2018, the only industry in the medium high-technology group of which backward participation rate remained above that of the medium high-technology group as a whole is electrical equipment. Moreover, there was an increasing trend in the backward participation rate of this industry. Throughout the term, the highest contribution to the backward participation of the medium high-technology group also came from this industry. The backward participation rate of

"motor vehicles, trailers, and semi-trailers" began to surpass the (average) backward participation rate of the medium high-technology group in 2002. Throughout the term, following the industry of electrical equipment, "motor vehicles, trailers, and semi-trailers" is the second industry group that contributed most to the increase in the backward participation of the medium high-technology group.

Although there was an overall increasing trend in backward participation rates of "electrical equipment", "motor vehicles, trailers, and semi-trailers", and "chemical and chemical products", the relative contribution of each industry to the increase in backward participation rate of the medium high-technology group changed during the aforementioned period. For instance, while the contribution of "chemical and chemical products" was the lowest to the backward participation rate of the medium high-technology group in 1995, it became the third industry (following "electrical equipment", "motor vehicles, trailers, and semi-trailers", respectively) that contributed most in 2018.

Figure 4.7 shows the backward participation rates of two industry groups (namely, "pharmaceuticals", "computer, electronic and optical products") that constitute the high-technology group.

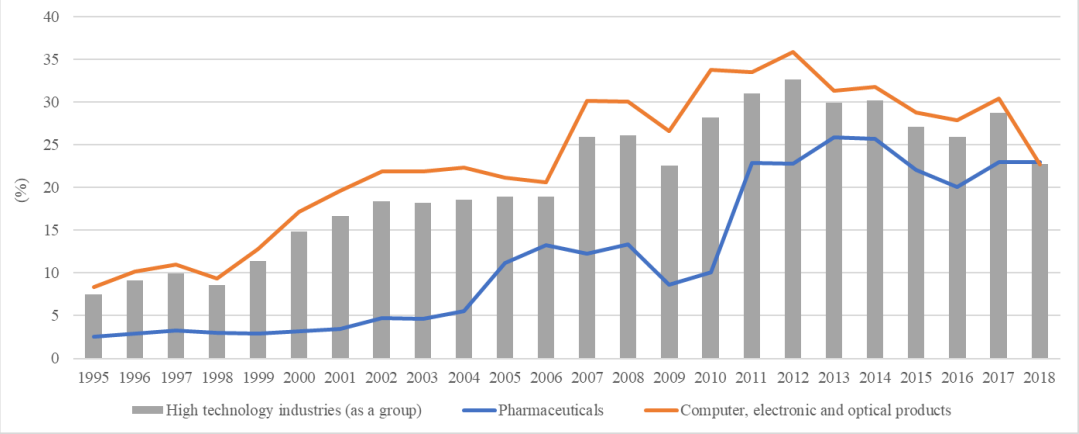


Figure 4.7. Backward Participation of High-Technology Manufacturing Industries (1995-2018)

Source: Author's own calculations based on merged data obtained from OECD TiVA database and Eurostat Technology Classification of Manufacturing Industries

Compared to 1995, the backward participation rates of both pharmaceuticals and computer, electronic and optical products increased in 2018. Throughout 1995-2017, the backward participation rate of computer, electronic and optical products exceeded that of pharmaceuticals. In 2018, the backward participation rate of pharmaceuticals was greater than that of computer, electronic and optical products, albeit two rates (23% and 22.7%, respectively) were very close to each other. In a similar vein, we calculate the forward participation of low-technology industries, medium low-technology industries, medium high-technology industries and high-technology industries by using the OECD's formulation, which is also explained in detail in Chapter 3. Our calculation regarding the forward participation is based on the formula below.

Domestic value added in exports of intermediate products as a share of total gross exports (EXGR_INTDVASH, percentage) is "*defined as domestic value added in gross exports of intermediate products, by industry i in country c, as a percentage of total industry exports, EXGR (c,i). It reveals the share of industry exports that consists of domestic value added destined for further production within direct partner' economies either to meet partner' final demand or to be embodied in exports by direct partners. It can be considered as a measure of forward linkages in GVCs (*p.32)*"* (Guilhoto *et al.*, 2022,).

$$EXGR_INTDVASHc,i = \frac{\sum pEXGR_INTDVAc,i,p^{36}}{\sum pEXGRc,i,p} \times 100$$

Forward participation of industries according to all technology levels except low-technology decreased in 2018 compared to 1995. In 1995, 63% of medium low-technology exports, 38.4% of medium high-technology exports and 35.4% of high technology exports were domestic-value-added. The domestic value-added shares decreased to 60.2%, 32.3%, and 32.1%, respectively. The domestic value-added share of the low-technology group exports, however, increased by a 2.3 percentage point (from 23.2% in 1995 to 25.5% in 2018). In other words, forward linkages in all technology groups except for the low-technology group decreased.

[36] "p" denotes partner country.

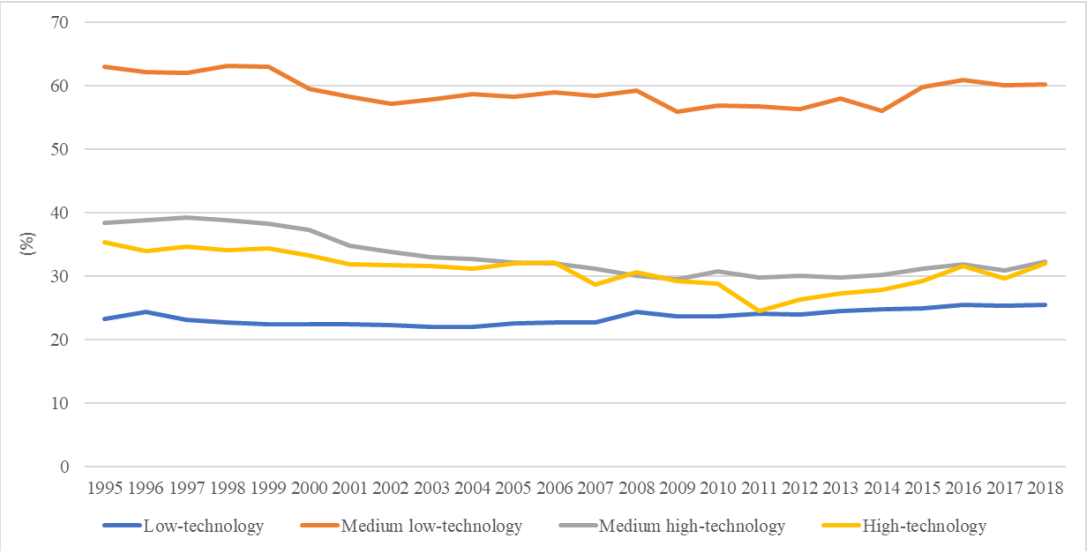


Figure 4.8. Forward Participation of Manufacturing Industries According to Technology Intensity (1995-2018)

Source: Author's own calculations based on merged data obtained from OECD TiVA database and Eurostat Technology Classification of Manufacturing Industries

The decrease in domestic value-added share of gross exports was the highest in the medium high-technology group. There was a 6.1 percentage point decrease in the domestic value-added share of exports in the medium-high technology group. During the same period, the decrease in the domestic value-added share of the high-technology (3.3%) follows that of the medium high-technology industries. As Figure 4.8 presents, in the period of 1995-2018, while the domestic value-added share of gross exports was the highest in the medium low-technology group, that of the low-technology group was the lowest. However, as stated above, the domestic value-added share increased from 23.2% to 25.5% in the low-technology group between 1995 and 2018.

With an aim to examine forward participation in detail, we next analyze the industries separately under each technology group. In this vein, Figure 4.9 shows the forward participation rates of five industry groups (namely, "food products, beverages and tobacco", "textiles, wearing apparel, leather and related products", "wood and wood products", "paper products and printing" and, "furniture, other manufacturing and repair and installation of machinery and equipment") that constitute the low-technology group.

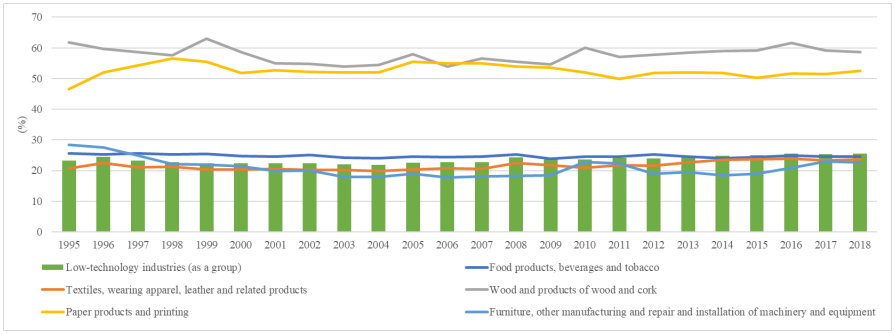


Figure 4.9. Forward Participation of Low-Technology Manufacturing Industries (1995-2018)

Source: Author's own calculations based on merged data obtained from OECD TiVA database and Eurostat Technology Classification of Manufacturing Industries

Throughout 1995-2018, the forward participation rates of "wood and products of wood and cork" and "paper products and printing" were higher than that of the low-technology group as a whole. On the other hand, the forward participation rates of "textiles, wearing apparel, leather and related products" and "furniture, other manufacturing and repair and installation of machinery and equipment" were not as high as the aforementioned ones. The forward participation rate of "food products, beverages and tobacco", however, remained almost stable during the term albeit a bit lower in 2018 than it was in 1995. Figure 4.10 shows the forward participation rates of five industry groups (namely, "coke and refined petroleum products", "rubber and plastics products", "other non-metallic mineral products", "basic metals", and "fabricated metal products") that constitute the medium low-technology group.

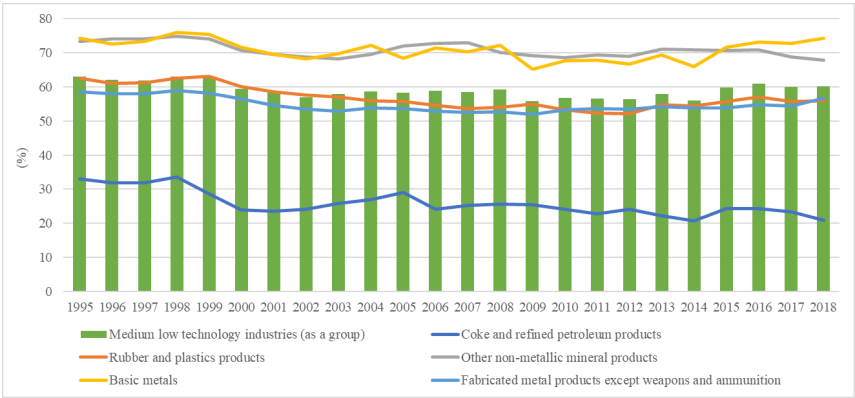


Figure 4.10. Forward Participation of Medium Low-Technology Manufacturing Industries (1995-2018)

Source: Author's own calculations based on merged data obtained from OECD TiVA database and Eurostat Technology Classification of Manufacturing Industries

Regarding the industries under medium low-technology group, there was not so much a striking change in forward participation rates except for that of coke and refined petroleum products. While the forward participation rate of coke and refined petroleum products was 33% in 1995, it decreased to 20.9% in 2018. On the other hand, the forward participation rates of the two industries that contributed most throughout the term, i.e., basic metals and other non-metallic mineral products, remained above 65%. The forward participation rates of the "rubber and plastics products" and "fabricated metal products" remained above 50% and ranged between approximately 52%-63%. Figure 4.11 shows the forward participation rates of five industry groups (namely, "chemicals and chemical products", "electrical equipment", "other machinery and equipment", "motor vehicles, trailers, and semi-trailers", "other transport equipment") that constitute the medium high-technology group.

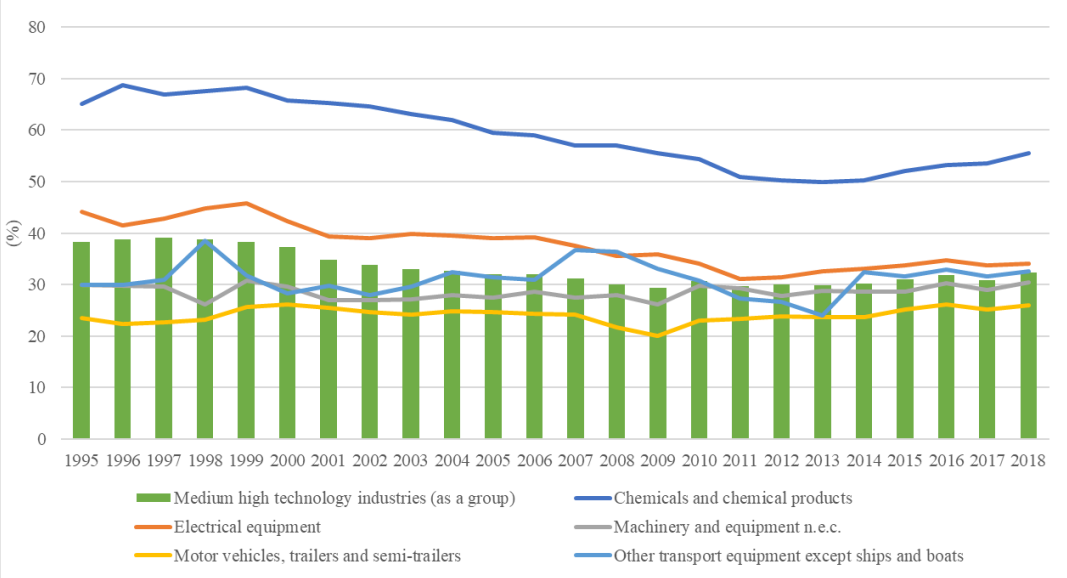


Figure 4.11. Forward Participation of Medium High-Technology Manufacturing Industries (1995-2018)

Source: Author's own calculations based on merged data obtained from OECD TiVA database and Eurostat Technology Classification of Manufacturing Industries

As stated above, there was a declining trend in the forward participation rate of the medium high-technology group during 1995-2018. The situation is clear in the two industries, which also contributed to the forward participation most, namely "chemicals and chemical products" and "electrical equipment". While the forward

participation rates of these two industries were 65.1% and 44.1%, respectively in 1995, the rates were 55.6% and 34.1% in 2018. This almost corresponds to 10% points decrease in forward participation rates. On the other hand, the forward participation rates of "motor vehicles, trailers and semi-trailers", and "other machinery and equipment" remained below that of the medium high-technology group as a whole. Figure 4.12 shows the forward participation rates of two industry groups (namely, "pharmaceuticals", "computer, electronic and optical products") that constitute the high-technology group.

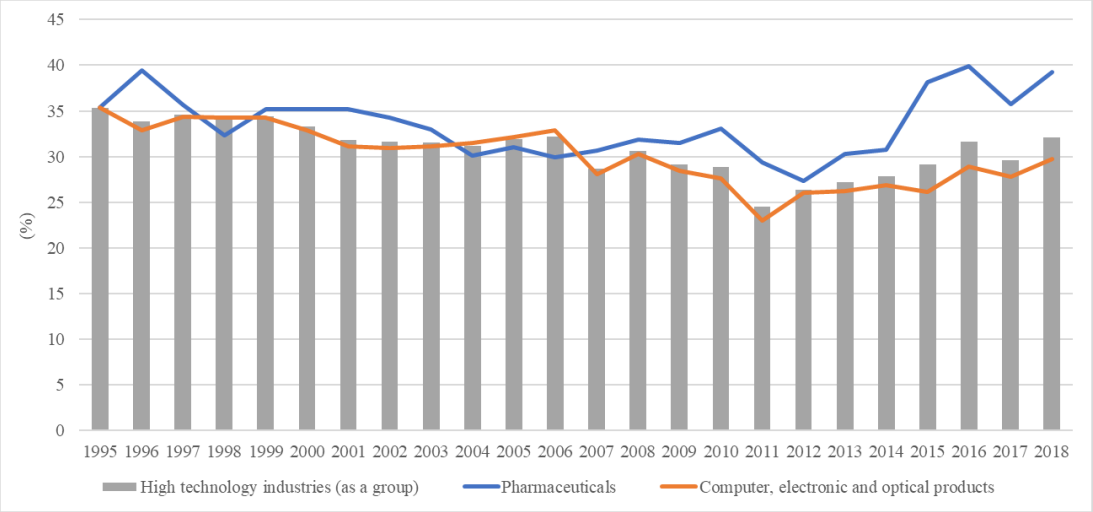


Figure 4.12. Forward Participation of High-Technology Manufacturing Industries (1995-2018)

Source: Author's own calculations based on merged data obtained from OECD TiVA database and Eurostat Technology Classification of Manufacturing Industries

Although there was a declining trend in forward participation rates of high technology industries, the situation reversed after 2011. Nevertheless, the forward participation rate of "computer, electronic and optical products" still did not reach the level of the beginning of the period, which was 35.4% in 1995 and 29.7% in 2018. The forward participation rate of pharmaceuticals after decreasing to the lower level of 27.3% in 2012 from the initial level of 35.4% in 1995, it reached 39.2% in 2018.

Additionally, more insights can be gained by joining together the two sides of GVC participation of industries according to technology intensity classification. In this

vein, Figure 4.13 brings together the backward participation rate and forward participation rate of the low-technology industries group during 1995-2018. Moreover, GVC participation (defined as the sum of backward participation rate and forward participation rate), and the difference between backward participation rate and forward participation rate (given as percentage points) are also presented to put a whole structure.

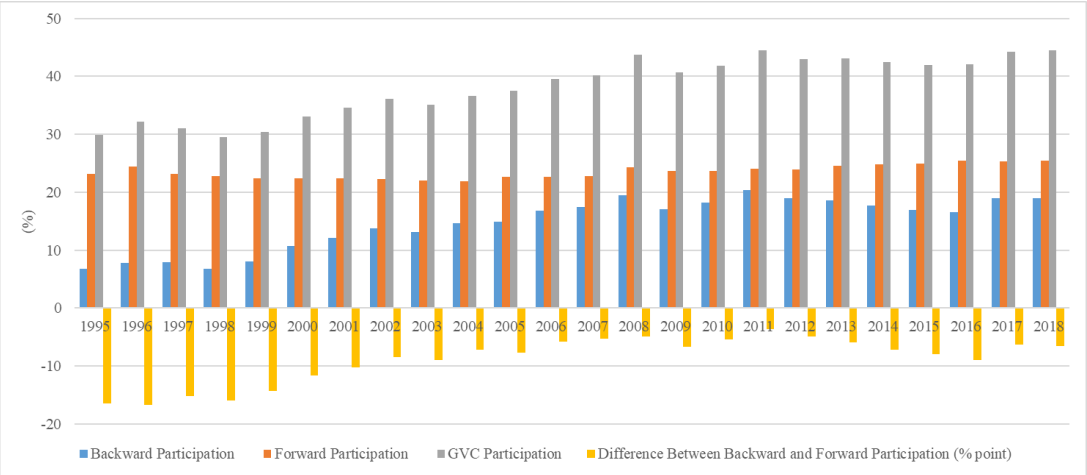


Figure 4.13. GVC Participation of Low-Technology Manufacturing Industries (1995-2018)

Source: Author's own calculations based on merged data obtained from OECD TiVA database and Eurostat Technology Classification of Manufacturing Industries

Regarding the low-technology group, it can be stated that forward participation rates always remained higher than those of backward participation during 1995-2018. Moreover, even though there was an increase in forward participation rate, it might not be regarded as a huge jump. While the forward participation rate was 23.2% in 1995, it was 25.5% in 2018. On the other hand, the increase in backward participation rate was striking throughout 1995-2018. While the backward participation rate was 6.7% initially, it reached 19.0% in 2018. Consequently, the GVC participation rate of low-technology group reached 44.5% in 2018, it was 29.9% in 1995. Consequently, it can be stated that the increase in GVC participation can be attributed more to the increase in backward participation rate rather than that of forward participation rate. The same conclusion can also be inferred from the

difference between backward participation and forward participation rates. The difference shrank from 16.4% in 1998 to 6.6% in 2018.

Figure 4.14 shows the GVC participation rates of the medium low-technology group. Similar to that of the low technology group, GVC participation of the medium low-technology group also increased. While it was 82.6% in 1995, it reached 90.6% in 2018. Moreover, the increase in GVC participation can be attributed to the increase in backward participation rate. Nevertheless, the forward participation rate remained above the backward participation rate throughout the term.

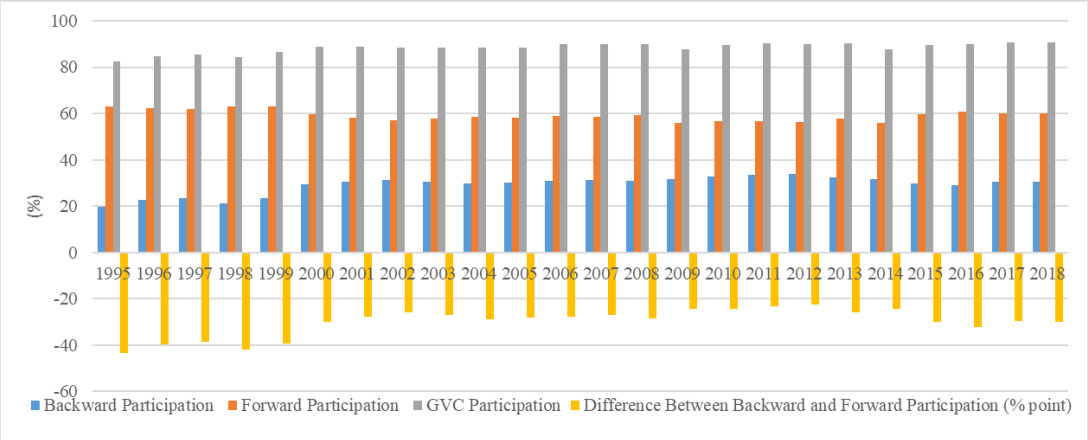


Figure 4.14. GVC Participation of Medium Low-Technology Manufacturing Industries (1995-2018)

Source: Author's own calculations based on merged data obtained from OECD TiVA database and Eurostat Technology Classification of Manufacturing Industries

Figure 4.15 shows the GVC participation rates of the medium high-technology group. GVC participation of the medium high-technology group also increased. While it was 54.4% in 1995, it reached 62.5% in 2018. Moreover, the increase in GVC participation can be attributed only to the increase in backward participation rate since the forward participation rate decreased. Notably, the backward participation rate and forward participation rate were 16% and 38.4% in 1995, the rates were 30.2% and 32.3% in 2018, respectively. While the forward participation rate was higher than backward participation rate between 1995 and 2007, the situation reversed since 2008. From then until 2015, backward participation rate remained above forward participation rate. While the difference between forward

participation rate and backward participation rate was 22.3% at the beginning of the period, when it came to 2018, the difference decreased to about 2.1%. Consequently, the backward and forward participation rates were close to each other.

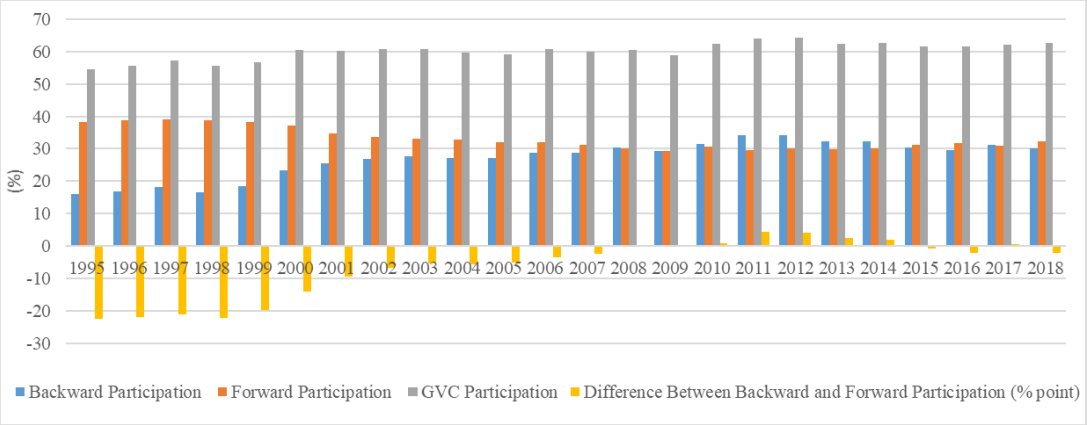


Figure 4.15. GVC Participation of Medium High-Technology Manufacturing Industries (1995-2018)

Source: Author's own calculations based on merged data obtained from OECD TiVA database and Eurostat Technology Classification of Manufacturing Industries

Figure 4.16 shows the GVC participation rates of the high-technology group. Similar to all technology groups mentioned above, the GVC participation of the high-technology group also increased during 1995-2018. While it was 42.8% in 1995, it reached 54.9% in 2018. Likewise to the medium high-technology group, the increase in GVC participation can be attributed only to the increase in backward participation rate since the forward participation rate decreased. The backward participation rate and forward participation rate were 7.5% and 35.4% in 1995, the rates were 22.8% and 32.1% in 2018, respectively. While the forward participation rate was higher than backward participation rate for most of the years (i.e., between 1995 and 2010), the situation reversed between 2011-2014. The backward participation rate remained above forward participation rate until 2015. While the difference between forward participation rate and backward participation rate was 27.9% at the beginning of the period, when it came to 2018, the difference decreased to about 9.3%.

To sum up, throughout the period between 1995 and 2018, GVC participation and backward participation rates increased and the contribution of the backward

participation rate to the increase in GVC participation was witnessed in all technology groups. Moreover, the forward participation rates decreased except for the low-technology group. Nevertheless, forward participation rates remained above backward participation rates for the low-technology group and the medium low-technology group. Although this was also valid for the medium high-technology group and the high technology groups for most of the time, there were also some years that backward participation rates remained above forward participation rates.

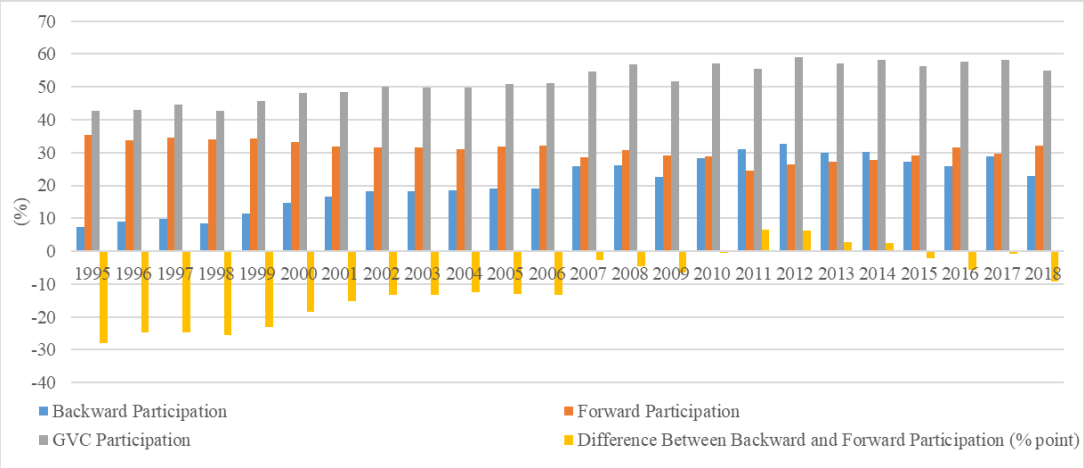


Figure 4.16. GVC Participation of High-Technology Manufacturing Industries (1995-2018)

Source: Author's own calculations based on merged data obtained from OECD TiVA database and Eurostat Technology Classification of Manufacturing Industries

Interestingly, the technology groups whose forward participation rates decreased most, i.e., the medium-high technology group and the high-technology group, were also the same groups whose backward participation rates increased most. In other words, the largest decrease in forward participation rate was witnessed in the medium-high technology group and the high-technology group, respectively. The largest increase in backward participation rate was witnessed in the high-technology group and the medium-high technology group, respectively. This finding is consistent with that of Gündoğdu and Saraçoğlu (2016). As mentioned in Section 4.1, they also found that the vertical specialization of medium high-technology and high-technology industries increased more compared to those of low-technology industries and medium low-technology industries. All in all, a substantial part of international trade of Türkiye's manufacturing industries according to technology

intensity was carried out in the context of GVCs. Figure 4.17 presents the share of each technology group exports in Türkiye's total exports. Compared to the year 2000, the share of low-technology and high-technology groups in total exports decreased in 2018 while the share of medium low-technology and medium high-technology groups increased. In 2018, the medium high-technology group has the highest share (34.4%) in Türkiye's total exports. The medium high-technology group is followed by the low-technology and medium-low technology groups, the shares of which were 31.1% and 26.1%, respectively. Finally, the high-technology group has the lowest share (3%) in total exports. In 2018, GVC participation was as high as 90.6% in the medium-low technology group (i.e., the group whose backward participation rate and forward participation rate were the highest in all technology groups). On the other hand, the smallest participation (44.5%) was witnessed for the low-technology group.

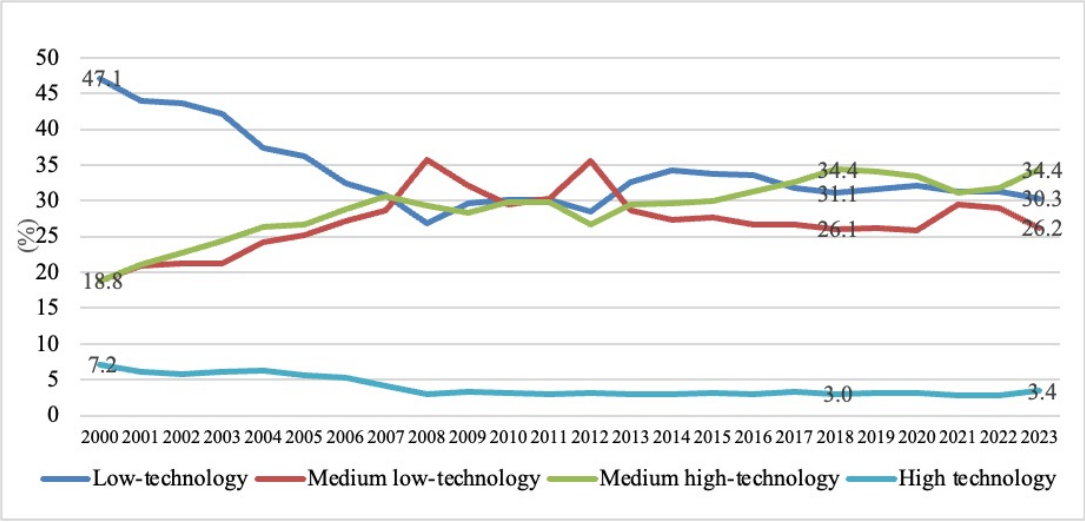


Figure 4.17. The Share of Each Technology Group in Türkiye's Total Exports (2000-2023)

Source: Author's own calculations based on data obtained from TURKSTAT. The foreign trade data is based on Special Trade System.

4.2.3. Basic Structure of the Econometric Model

This section investigates the role of GVC participation on Türkiye's innovation performance and analyses whether Türkiye exhibits a similar pattern with respect to the overall pattern. We apply the same aforementioned econometric modelling

techniques and use the same variables in Chapter 3[37]. To recall the basic structure of the model, we write the following equations for Türkiye to be estimated. Robust standard errors corrected for clustering at industry level are reported. By dividing the number of patents and business enterprise R&D expenditure by population and taking natural logarithms, we derive the following equations to be estimated:

$$lusptogp_{it} = \alpha_i + \beta_1\, lrdpdcop_{it} + \beta_2\, lklco_{it} + \beta_3\, lfvash_{it} + \varepsilon_{it} \quad (1)$$

$$lusptogp_{it} = \gamma_i + \beta_4\, lrdpdcop_{it} + \beta_5\, lklco_{it} + \beta_6\, lintdvash_{it} + \nu_{it} \quad (2)$$

where the subscript ***i*** denotes industry; ***lusptogp_it*** is the number of patents granted by the USPTO divided by population and expressed in natural logarithm; our control variables, ***lrdpdcop_it***, is the business enterprise R&D data by industry, which follows ISIC Rev. 4, divided by population and are expressed in US dollars at PPP at constant prices and in natural logarithm; ***lklco_it***, is a proxy for capital intensity[38], which is measured as the ratio of gross fixed capital formation in US dollars at constant prices to employment, expressed in natural logarithm; ***lfvash_it*** is a measure of backward participation and it is the foreign value added in gross exports for domestic industry i, as a percentage of total industry exports, expressed in natural logarithm, ***lintdvash_it*** is a measure of forward participation and it is the domestic value added in gross exports of intermediate products by industry i, as a percentage of total industry exports, expressed in natural logarithm.

The latter two represent our key variables of investigation, which are explained in detail and expressed in mathematical formulas both in Chapter 3 and Section 4.2. We investigate the role of GVC participation at industry level on innovation performance. Hence, the latter two variables represent our key variables. $\boldsymbol{\alpha_i}$ ***and*** $\boldsymbol{\gamma_i}$ are industry fixed effects. We use them because we can control for unobservable time-constant industry heterogeneity. ε_{cit} and ν_{cit} are the error components. While we do not expect a clearly defined positive or negative sign for the variables, *lfvash_it*,

[37] See Chapter 3.4 for a detailed discussion of empirical strategy and modelling.

[38] See Chapter 3 above for a discussion of the measurement of capital intensity.

lintdvash_it, and *lklco_it*, we expect a positive sign for *lrdpdcop_it* since R&D expenditure is considered as one of the determinants of innovation.[39]

Regarding the effect of backward participation, Table 4.3 presents our basic structure of the model, which is estimated by both OLS, simple panel models, i.e., fixed effects model and random effects model, and instrumental variable (2SLS, G2SLS) panel models to reveal whether endogeneity is required to be considered.

As discussed in Chapter 3, the GVC participation rates (*i.e*., fvash and intdvash) are instrumented for Türkiye in the dataset with the GVC participation rates of its respective regional hub country (i.e., Germany for Europe).

The postestimation test results (obtained by xttest0 and xtoverid commands in STATA) reveal that the random effects model is preferred to OLS and fixed effects models.

Besides, in fixed effects 2SLS IV model and RE G2SLS IV models, F-statistics exceed the Stock-Yogo (2005) critical values. The endogeneity test reveals that we do not reject the null hypothesis that the regressor is exogenous at 5% significance level.

The effect of backward participation is found insignificant in both simple random effects model and RE G2SLS model, which is different from the results of the overall pattern of other countries that is found in Chapter 3.

In contrast, the findings of the cross-country industry-level analysis in Chapter 3 have revealed that the effect of backward participation is positive and statistically significant at 1% significance level.

These findings indicate that Türkiye does not conform to the general outlook of other countries regarding innovation outcomes driven by backward participation. This

[39] See Section 3.5 above for a discussion of the expected signs of the variables.

suggests that the mechanisms highlighted in the GVC literature such as access to high-quality and cheaper inputs, transfer of knowledge and the exposure to import competition may not have functioned effectively in Türkiye during the period under study.

Regarding the effect of forward participation, Table 4.4 presents the estimation results. While the estimation results of the RE model reveal that the effect of forward participation is negative, the estimation results of the RE G2SLS model turns out to be insignificant.

The estimation results are not clear cut but, in any case, they do not indicate a positive effect of forward participation on innovation performance.

The results regarding the effect of forward participation on innovation performance are consistent with that of the overall pattern observed in other countries, as presented in Chapter 3.

Specifically, the findings of the cross-country industry-level analysis also reveal that the effect of forward participation on innovation performance is not significantly positive.

The absence of a positive effect of forward participation suggests that the expected mechanisms may not have functioned effectively. The discussion in Chapter 3 may also be drawn upon to help explain the underlying causes.

Without ensuring knowledge acquisition and dissemination, the positive implications of forward participation may remain limited.

Moreover, merely satisfying the demands of outsourcing firms and primarily producing products with standardized technologies and know-how may constrain the development of domestic innovation capabilities (see Section 5.1 below for further discussion).

Table 4.3. The Effect of Backward Participation into GVCs on Türkiye's Innovation Performance (Basic Structure)

VARIABLES	(1) Model1 OLS	(2) Model2 Fixed Effect	(3) Model3 Random Effect	(4) Model4 Fixed Effect 2SLS IV	(5) Model5 Random Effect G2SLS IV
lfvash	0.628*	0.878	0.778	1.886**	0.939
	(0.356)	(0.804)	(0.505)	(0.843)	(0.686)
lrdpdcop	0.253*	0.307***	0.336***	0.285**	0.334***
	(0.123)	(0.103)	(0.066)	(0.109)	(0.069)
lklco	0.152**	0.253	0.169	0.190	0.175
	(0.069)	(0.247)	(0.132)	(0.223)	(0.136)
Constant	-19.803***	-20.820***	-20.477***		-20.986***
	(1.046)	(2.579)	(1.614)		(2.201)
Observations	227	227	227	226	227
R-squared	0.240	0.200	0.2393	0.158	0.2385
F-Stat	3.799	16.39		15.52	18.84
Prob > F	0.0285	0.000	0	0.000	0.000
Degree of Freedom	18	18	3	17	3
Number of panelid		19	19	18	19
Wald			53.77	36.062	75.689

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.10

The dependent variable is the number of patents granted by the United States Patent and Trademark Office (USPTO)" (lusptogp)" by priority date, industry i and year t, which is transformed by the author from technology domains & IPC classification into ISIC Rev.4 and it is expressed in natural logarithm. Regressions cover period 1995–2018. The postestimation test reveals that the random effect estimation is preferred to fixed effect estimation and OLS estimation. In FE 2SLS and RE G2SLS IV models, F-statistics exceed the Stock-Yogo (2005) critical values.

Table 4.4. The Effect of Forward Participation into GVCs on Türkiye's Innovation Performance

VARIABLES	(1) Model1 OLS	(2) Model2 Fixed Effect	(3) Model3 Random Effect	(4) Model4 Fixed Effect 2SLS IV	(5) Model5 Random Effect G2SLS IV
lintdvash	-0.756**	-2.881***	-1.186**	-9.685	-0.443
	(0.347)	(0.820)	(0.575)	(14.426)	(0.613)
lrdpdcop	0.199	0.321***	0.306***	0.310	0.314***
	(0.119)	(0.088)	(0.066)	(0.181)	(0.068)
lklco	0.172**	0.237**	0.193	0.067	0.203
	(0.070)	(0.102)	(0.137)	(0.366)	(0.133)
Constant	-15.175***	-7.775***	-13.827***		-16.542***
	(1.276)	(2.979)	(2.058)		(2.274)
Observations	227	227	227	226	227
R-squared	0.244	0.216	0.2414	-0.048	0.2290
F-Stat	3.770	18.78		5.799	16.97
Prob > F	0.0292	0.000	0	0.00641	0.000
Degree of Freedom	18	205	3	17	3
Number of panelid		19	19	18	19
Wald			60.92	2.533	320.863

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.10

Notes: The postestimation test reveals that the random effect estimation is preferred to fixed effect estimation and OLS estimation. In RE G2SLS IV model, F-statistics exceed the Stock-Yogo (2005) critical values.

4.2.4. The Issue of Technology Intensity Classification

This section investigates the effect of Türkiye's GVC participation on its innovation performance by considering the technology intensity classification of industries. In a similar fashion in Chapter 3, by doing so, we test whether or not the effects differ according to the technology intensity classification of industries[40]. As it is in Section 4.2, the Eurostat's technology intensity definition of manufacturing industries is used.

4.2.4.1. The Effect of Backward Participation According to Technology Intensity Classification

Table 4.5 presents the estimation results of Türkiye's backward participation on innovation performance according to low-technology classification. For standard FE and RE panel estimations, the postestimation test reveals that the random effect estimation is preferred to fixed effect estimation[41]. In 2SLS FE model, F-statistics exceed the Stock-Yogo (2005) critical values. The instrument is not weakly identified. In RE G2SLS model, F-statistics do not exceed the Stock-Yogo (2005) critical values. The instrument is not weakly identified. The endogeneity tests reveal that we do not reject the null hypothesis that the regressor is exogenous.[42] Regarding the low-technology classification, the effect of Türkiye's backward participation into GVCs on innovation performance is insignificant. The cross country-industry analysis, however, finds that for low-technology industries, the effect of backward participation is negatively significant.

[40] Table 4.13 summarizes the findings.

[41] For the first time in our work, The Breusch and Pagan Lagrangian multiplier test for random effects, which is used to make a choice between OLS estimation and RE estimation in our work reveals that there are no random effects and OLS is preferred to RE model. Indeed, OLS and RE models provide the same estimation results. This can be due to the fact that "because the estimate of the variance of the unobserved effect is negative, in which case Stata sets it to zero, and then GLS is equal to OLS". (https://www.statalist.org/forums/forum/general-stata-discussion/general/1138438-random-effects-is-the-same-as-ols)

[42] We conduct postestimation tests to choose between FE and RE models. For the instrumental variable models, we assess the identification and check for weak instruments using the Stock-Yogo F statistics. We perform the same tests for all technology groups to determine the appropriate model (throughout Chapter 3 and Chapter 4).

Table 4.6 presents the estimation results of Türkiye's backward participation on innovation performance according to medium low-technology classification. Grounded on both FE 2SLS model and RE G2SLS model, regarding the medium low-technology classification, the effect of Türkiye's backward participation into GVCs on innovation performance is statistically insignificant, which differs from the results of the cross-country analysis.

The estimation results of Türkiye's backward participation on innovation performance according to medium high-technology classification are given in Table 4.7. As the IV models are underidentified and the instruments turn out to be weak, we prefer FE model. Regarding the medium high-technology classification, based on the FE model, the effect of Türkiye's participation in GVCs on innovation performance is significant and positive, which is a similar result to that of cross-country analysis.

Regarding the high-technology classification, we do not interpret the estimation results (Table 4.8). In 2SLS FE IV model and G2SLS RE IV models, the results of the overidentification tests are not reported[43]. The model reports warning that as the estimated covariance matrix of moment conditions is not of full rank possibly due to insufficient numbers of clusters, it is not healthy to interpret the standard errors and test results. In OLS, FE and RE models, F statistics and Wald Chi(2) statistics could not be calculated possibly due to insufficient number of clusters.

All in all, the findings suggest that the effect of importing inputs for exports on innovation performance varies across technology intensity groups. When manufacturing industries are classified according to their technology intensity, the effect becomes statistically significant and positive only in the medium high-technology group, which is a similar result that aligns with the cross-country analysis presented in Chapter 3. This indicates that mechanisms such as access to high-quality and cost-effective inputs, knowledge acquisition and dissemination, and exposure to

[43] Overidentification tests are used to check the validity of the instruments in IV models. These tests are performed throughout our study to ensure the reliability of the instruments and the model.

import competition may have partially worked in the case of Türkiye during the period under study (see Section 5.1 below for further discussion).

4.2.4.2. The Effect of Forward Participation According to Technology Intensity Classification

The estimation results of Türkiye's forward participation on innovation performance are presented in this Section.

Table 4.9 shows the estimation results regarding the low-technology classification. In FE 2SLS model, F-statistics do not exceed the Stock-Yogo (2005) critical values. The instrument is weakly identified.

In RE G2SLS model, F-statistics exceed the Stock-Yogo (2005) critical values. The instrument is not weakly identified.

In FE 2SLS IV model and G2SLS IV model, the endogeneity tests reveal that we do not reject the null hypothesis that the regressor is exogenous. Moreover, for standard FE and RE panel estimations, the postestimation test reveals that OLS is preferred to standard RE model[44].

Grounded on the estimation results of the RE G2SLS model, the effect is negative and statistically significant. This finding, indicating the absence of a positive effect, is consistent with the result we obtain from the cross-country analysis.

Table 4.10 presents the estimation results of forward participation on innovation performance according to medium low-technology classification. According to the estimation results of the RE G2SLS model, the effect of GVC participation on innovation performance of medium low-technology group is statistically insignificant. This finding differs from that of the cross-country analysis.

[44] For this case, the (xtoverid) test to choose between standard fixed effect model and random effect model does not work since the RE estimates are degenerate and equivalent to pooled OLS.

As depicted in Table 4.11, regarding the medium-high technology classification, as the endogeneity test indicates the presence of endogeneity, we prefer RE G2SLS model[45].

According to the estimation results of the RE G2SLS model, the effect of GVC participation on innovation performance of medium high-technology group is positively significant. In contrast, the effect in this group is found to be negative in the cross-country analysis presented in Chapter 3.

Table 4.12 presents the estimation results regarding the high-technology classification. Nevertheless, we cannot interpret the estimation results.

Similar to the estimation results regarding the high-technology classification in Section 4.4.1, the results of the overidentification tests are not reported in 2SLS FE model and G2SLS IV model[46].

The model reports warning that as the estimated covariance matrix of moment conditions is not of full rank possibly due to insufficient numbers of clusters, it is not healthy to interpret the standard errors and test results.

Consequently, similar to the findings of the cross-country analysis, the effect of being an input provider for other countries' exports becomes less clear when the industries are classified according to their technology intensity.

In the case of Türkiye, while forward participation does not have a positive effect on innovation performance in the low-technology and medium low-technology groups, it has a positive effect in the medium high-technology group (see Section 5.1 below for further discussion).

[45] xtoverid test to choose between standard fixed effect model and random effect model does not work since the RE estimates are degenerate and equivalent to pooled OLS.

[46] Overidentification tests are used to check the validity of the instruments in IV models. These tests are performed throughout our study to ensure the reliability of the instruments and the model.

Table 4.5. The Effect of Backward Participation into GVCs on Türkiye's Innovation Performance According to Low-Technology Classification

VARIABLES	(1) Model1 Low-tech OLS	(2) Model2 Low-tech Fixed Effect	(3) Model3 Low-tech Random Effect	(4) Model4 Low-tech Fixed Effect 2SLS IV	(5) Model5 Low-tech Random Effect G2SLS IV
lfvash	-1.009	-0.817	-1.009	3.191	-0.540
	(0.708)	(1.097)	(0.708)	(3.054)	(3.226)
lrdpdcop	0.283**	0.334	0.283***	0.049	0.304*
	(0.075)	(0.240)	(0.075)	(0.476)	(0.134)
lklco	0.559***	0.318	0.559***	0.120	0.495
	(0.093)	(0.366)	(0.093)	(0.604)	(0.381)
Constant	-14.724***	-15.201***	-14.724***		-16.043
	(1.920)	(3.285)	(1.920)		(9.039)
Observations	49	49	49	48	49
R-squared	0.490	0.221	0.4900	-0.178	0.4842
F-Stat	68.94	78.48		80684	104.9
Prob > F	0.000671	0.000520	0	0.000	0.0001
Degree of Freedom	4	4	3	3	3
Number of panelid		5	5	4	5
Wald			206.8	11.101	6.801

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.10

Notes: Postestimation test reveals that RE is preferred to FE model. In IV models, the endogeneity tests reveal that we do not reject the null hypothesis that the regressor lfvash is exogenous at 5% significance level.

Table 4.6. The Effect of Backward Participation into GVCs on Türkiye's Innovation Performance According to Medium Low-Technology Classification

VARIABLE	(1) Model1 Medlow-tech OLS	(2) Model2 Medlow-tech Fixed Effect	(3) Model3 Medlow-tech Random Effect	(4) Model4 Medlow-tech Fixed Effect 2SLS IV	(5) Model5 Medlow-tech Random Effect G2SLS IV
lfvash	-0.106	0.709	-0.106	1.221	0.829
	(0.558)	(1.349)	(0.558)	(2.008)	(1.532)
lrdpdcop	0.640***	0.704***	0.640***	0.714***	0.721***
	(0.112)	(0.095)	(0.112)	(0.118)	(0.107)
lklco	0.094	-0.016	0.094	-0.035	-0.026
	(0.214)	(0.276)	(0.214)	(0.280)	(0.277)
Constant	-17.905***	-20.422***	-17.905***		-20.855***
	(1.542)	(4.420)	(1.542)		(5.027)
Observations	55	55	55	55	55
R-squared	0.244	0.144	0.244	0.142	0.1954
F-Stat	75.76	42.40		17.33	34.71
Prob > F	0.000558	0.00173	0	0.00934	0.000900
Degree of Freedom	4	4	3	4	3
Number of panelid		5	5	5	5
Wald			227.3	22.053	29.320

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.10

Notes: In IV models, F-statistics exceed the Stock-Yogo (2005) critical values.

Table 4.7. The Effect of Backward Participation into GVCs on Türkiye's Innovation Performance According to Medium High-Technology Classification

VARIABLES	(1) Model1 Medhigh-tech OLS	(2) Model2 Medhigh-tech Fixed Effect	(3) Model3 Medhigh-tech Random Effect	(4) Model4 Medhigh-tech Fixed Effect 2SLS IV	(5) Model5 Random Effect G2SLS IV
lfvash	1.804*	1.226***	1.722**	2.730*	-3.686
	(0.800)	(0.259)	(0.778)	(1.004)	(14.058)
lrdpdcop	-0.324	0.488	-0.042	0.482	0.405
	(0.298)	(0.324)	(0.225)	(0.376)	(1.125)
lklco	0.170	0.283	0.148	0.180	-0.253
	(0.199)	(0.377)	(0.196)	(0.412)	(0.869)
Constant	-23.103***	-22.558***	-23.127***		-4.355
	(3.179)	(1.649)	(2.946)		(48.543)
Observations	76	76	76	76	76
R-squared	0.133	0.346	0.3459	0.284	0.1245
F-Stat	7.818	371.4		44.86	0.171
Prob > F	0.0378	0.0000	0.00684	0.00155	0.911
Degree of Freedom	4	4	3	4	3
Number of panelid		5	5	5	5
Wald			12.17	10.097	0.835

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.10

Notes: The postestimation test reveals that the fixed effect model is preferred to the random effect model. The endogeneity test reveals that we do not reject the null hypothesis that the regressor lfvash is exogenous at 5% significance level.

Table 4.8. The Effect of Backward Participation into GVCs on Türkiye's Innovation Performance According to High-Technology Classification

VARIABLES	(1) Model1 High-tech OLS	(2) Model2 High-tech Fixed Effect	(3) Model3 High-tech Random Effect	(4) Model4 High-tech Fixed Effect 2SLS IV	(5) Model5 Random Effect G2SLS IV
lfvash	1.986	1.479	1.986	1.710	1.816
	(1.564)	(1.242)	(1.564)	(0.836)	(1.213)
lrdpdcop	-0.133	0.043	-0.133	-0.007	-0.098
	(0.295)	(0.150)	(0.295)	(0.273)	(0.339)
lklco	0.120	1.622	0.120***	1.571	0.124**
	(0.032)	(0.521)	(0.032)	(0.467)	(0.014)
Constant	-22.668	-26.539*	-22.668***		-22.208**
	(5.280)	(2.226)	(5.280)		(4.327)
Observations	31	31	31	31	31
R-squared	0.331	0.558		0.555	0.3302
Number of panelid		2	2	2	2
F-Stat				1.394	
Prob > F				0.541	
Degree of Freedom				1	
Wald				55.595	50.778

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.10

Notes: We do not interpret the estimation results since it is not healthy. In OLS, FE and RE models, F and Wald Chi(2) statistics could not be calculated possibly due to insufficient number of clusters. In IV models, the model reports the warning that the estimated covariance matrix of moment conditions is not of full rank possibly due to insufficient number of clusters.

Table 4.9. The Effect of Forward Participation into GVCs on Türkiye's Innovation Performance According to Low-Technology Classification

VARIABLES	(1) Model1 Low-tech OLS	(2) Model2 Low-tech Fixed Effect	(3) Model3 Low-tech Random Effect	(4) Model4 Low-tech Fixed Effect 2SLS IV	(5) Model5 Low-tech Random Effect G2SLS IV
lintdvash	-1.112*	0.229	-1.112**	7.972	-1.691***
	(0.451)	(0.193)	(0.451)	(6.818)	(0.266)
lrdpdcop	0.207**	0.282	0.207***	0.497	0.144**
	(0.074)	(0.196)	(0.074)	(0.292)	(0.046)
lklco	0.360**	0.278	0.360***	0.275	0.328***
	(0.096)	(0.462)	(0.096)	(0.430)	(0.067)
Constant	-14.119***	-18.293***	-14.119***		-12.324***
	(1.387)	(0.480)	(1.387)		(0.837)
Observations	49	49	49	48	49
R-squared	0.501	0.204	0.5010	-0.110	0.4922
F-Stat	138.2	1206		19.22	48.12
Prob > F	0.000171	0.000	0	0.0184	0.000413
Degree of Freedom	4	4	3	3	3
Number of panelid		5	5	4	5
Wald			414.7	5.970	63.924

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.10

Notes: In RE G2SLS IV model, the endogeneity tests reveal that we do not reject the null hypothesis that the variable *intdvash* is exogenous.

Table 4.10. The Effect of Forward Participation into GVCs on Türkiye's Innovation Performance According to Medium Low-Technology Classification

VARIABLES	(1) Model1 Medlow-tech OLS	(2) Model2 Medlow-tech Fixed Effect	(3) Model3 Medlow-tech Random Effect	(4) Model4 Medlow-tech Fixed Effect 2SLS IV	(5) Model5 Medlow-tech Random Effect G2SLS IV Robust
lintdvash	0.015	-5.073	0.015	-7.243	-0.103
	(0.604)	(3.551)	(0.604)	(20.753)	(0.444)
lrdpdcop	0.661***	0.680***	0.661***	0.676**	0.680***
	(0.083)	(0.119)	(0.083)	(0.154)	(0.058)
lklco	0.079	-0.051	0.079	-0.076	0.066
	(0.207)	(0.265)	(0.207)	(0.324)	(0.170)
Constant	-18.290***	2.456	-18.290***		-17.798***
	(2.697)	(14.401)	(2.697)		(1.946)
Observations	55	55	55	55	55
R-squared	0.244	0.163	0.2437	0.159	0.2433
F-Stat	827.1	11.58		6.792	86.74
Prob > F	4.85e-06	0.0193	0	0.0476	0.0001
Degree of Freedom	4	4	3	4	3
Number of panelid		5	5	5	5
Wald			2481	4.567	127.981

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.10

Notes: In RE G2SLS IV model, the endogeneity tests reveal that we do not reject the null hypothesis that the variable *intdvash* is exogenous.

Table 4.11. The Effect of Forward Participation into GVCs on Türkiye's Innovation Performance According to Medium High-Technology Classification

VARIABLES	(1) Model1 Medhigh-tech OLS	(2) Model2 Medhigh-tech Fixed Effect	(3) Model3 Medhigh-tech Random Effect	(4) Model4 Medhigh-tech Fixed Effect 2SLS IV	(5) Model5 Medhigh-tech Random Effect G2SLS IV
lintdvash	1.222	-1.679	1.222	-3.066	3.465**
	(1.672)	(1.222)	(1.672)	(2.140)	(1.232)
lrdpdcop	-0.126	0.395	-0.126	0.314	0.020
	(0.214)	(0.439)	(0.214)	(0.545)	(0.362)
lklco	0.163	0.376	0.163	0.384	0.427
	(0.322)	(0.404)	(0.322)	(0.430)	(0.267)
Constant	-21.532**	-12.828**	-21.532***		-30.386***
	(6.736)	(3.446)	(6.736)		(5.130)
Observations	76	76	76	76	76
R-squared	0.057	0.329	0.0573	0.312	0.0484
F-Stat	0.261	257.1		1106	4.658
Prob > F	0.850	0.000	0.853	0.000	0.0654
Degree of Freedom	4	4	3	4	3
Number of panelid		5	5	5	5
Wald			0.784	29.368	149.089

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.10

Notes: In RE G2SLS model, the endogeneity test shows that we reject the null hypothesis that the variable intdvash is exogenous.

Table 4.12. The Effect of Forward Participation into GVCs on Türkiye's Innovation Performance According to High-Technology Classification

VARIABLES	(1) Model1 High-tech OLS	(2) Model2 High-tech Fixed Effect	(3) Model3 High-tech Random Effect	(4) Model4 High-tech Fixed Effect 2SLS IV	(5) Model5 High-tech Random Effect G2SLS IV
lintdvash	-6.977	-4.646	-6.977***	9.757	9.757
	(2.634)	(2.668)	(2.634)	(93.250)	(94.961)
lrdpdcop	0.326	0.376	0.326	0.348	0.348
	(0.307)	(0.203)	(0.307)	(0.138)	(0.141)
lklco	-0.080*	1.378*	-0.080***	3.150	3.150
	(0.010)	(0.154)	(0.010)	(11.173)	(11.378)
Constant	7.254	-5.785	7.254		-58.663
	(8.427)	(9.334)	(8.427)		(361.011)
Observations	31	31	31	31	31
R-squared	0.355	0.532	0.355	-0.496	0.0188
Degree of Freedom	1	1	1	1	0
Number of panelid		2	2	2	2
F-Stat				0.00365	0.0106
Prob > F				0.9995	0.9997
Wald				0.079	0.083

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.10

Notes: We do not interpret the estimation results since it is not healthy. In OLS, FE and RE models, F and Wald Chi(2) statistics could not be calculated possibly due to insufficient number of clusters. In IV models, the model reports the warning that the estimated covariance matrix of moment conditions is not of full rank possibly due to insufficient number of clusters.

Table 4.13. Summary of the Findings (The Case of Türkiye)

GVC Participation Type	Industry	Estimated Effects on Innovation	Preferred Model and Explanation
Backward Participation	Overall	Insignificant	Both RE model and RE G2SLS IV model estimation
	Low-technology	insignificant	Both IV models (FE 2SLS IV model estimation and RE G2SLS IV model estimation)
	Medium low-technology	insignificant	Both IV models (FE 2SLS IV model estimation and RE G2SLS IV model estimation)
	Medium high-technology	Significantly positive	FE model
	High-technology	n.a.	In 2SLS FE IV model and G2SLS RE IV models, the results of the overidentification tests are not reported. As the estimated covariance matrix of moment conditions is not of full rank possibly due to insufficient numbers of clusters, it is not healthy to interpret the standard errors and test results.
Forward Participation	Overall	Insignificant/ significantly negative	While the effect is statistically significant and negative in RE model, it turns out to be insignificant in RE G2SLS IV model. In any case, the effect does not turn out to be positive.
	Low-technology	Significantly negative	RE G2SLS IV model estimation
	Medium low-technology	insignificant	RE G2SLS IV model estimation
	Medium high-technology	Significantly positive	RE G2SLS IV model estimation
	High-technology	n.a.	In 2SLS FE IV model and G2SLS RE IV models, the results of the overidentification tests are not reported. As the estimated covariance matrix of moment conditions is not of full rank possibly due to insufficient numbers of clusters, it is not healthy to interpret the standard errors and test results.

4.2.5. Dynamic Model Structure

As a further step, we extend our model by incorporating the lagged value of the dependent variable, so that we may consider different time-variant innovation

patterns led by industry-specific technological shocks as well as the effect of past innovation performance of firms (Belloc, 2018; Peters, 2009).

Table 4.14 and Table 4.15 show the estimation results of our dynamic model structure for backward participation and forward participation, respectively. Regarding the effect of backward participation, Table 4.14 presents our dynamic panel structure of the model, which is estimated by both OLS, simple panel models, i.e., fixed effects model and random effects model, and instrumental variable (2SLS, G2SLS) panel models. For standard FE and RE panel estimations, the postestimation test reveals that the fixed effect estimation is preferred to random effect estimation. In both IV models, F-statistics exceed the Stock-Yogo (2005) critical values. The instrument is not weakly identified.

In FE 2SLS IV model, the endogeneity tests reveal that we do not reject the null hypothesis that the regressor is exogenous. In RE G2SLS IV model, the endogeneity tests reveal that we reject the null hypothesis that the regressor is exogenous. Due to the presence of endogeneity, RE G2SLS IV model is preferred. The estimation results reveal that the effect of backward participation is insignificant.

Regarding the effect of forward participation, Table 4.15 presents our dynamic panel structure of the model, which is estimated by both OLS, simple panel models, *i.e.,* fixed effects model and random effects model, and instrumental variable (2SLS, G2SLS) panel models. The post estimation test results reveal that the fixed effects model is preferred to the random effects model. In the FE 2SLS model, F-statistics do not exceed the Stock-Yogo (2005) critical values. The endogeneity test reveals that we do not reject the null hypothesis that the regressor lintdvash is exogenous at 5% significance level. In the RE G2SLS model, F-statistics exceed the Stock-Yogo (2005) critical values. The endogeneity test reveals that we reject the null hypothesis that the regressor lintdvash is exogenous at 5% significance level. As the endogeneity test indicates the presence of endogeneity, we prefer RE G2SLS model. According to the estimation results of the RE G2SLS model, the effect of forward participation on innovation performance is statistically insignificant.

Table 4.14. The Effect of Backward Participation into GVCs on Türkiye's Innovation Performance: Dynamic Panel Structure

VARIABLES	(1) Model1 OLS Robust	(2) Model2 Fixed Effect Robust	(3) Model3 Random Effect Robust	(4) Model4 Fixed Effect 2SLS IV Robust	(5) Model5 Random Effect 2GLS IV Robust
lusptogplag1	0.564***	0.297***	0.462***	0.268**	0.560***
	(0.041)	(0.077)	(0.033)	(0.106)	(0.049)
lrdpdcop	0.078	0.197	0.167*	0.187	0.078
	(0.085)	(0.132)	(0.088)	(0.143)	(0.070)
lfvash	0.344*	0.825	0.446*	1.322	0.027
	(0.190)	(0.814)	(0.253)	(1.127)	(0.382)
lklco	0.084**	0.181	0.078	0.178	0.093**
	(0.036)	(0.287)	(0.054)	(0.291)	(0.041)
Constant	-8.763***	-15.182***	-10.948***		-7.890***
	(1.240)	(3.541)	(1.265)		(1.857)
Observations	181	181	181	180	181
R-squared	0.497	0.303		0.294	
F-Stat	162.5	104.9		54.49	68.80
Prob > F	0	0	0	4.04e-09	1.17e-10
Degree of Freedom	17	17	4	16	4
Number of panelid		18	18	17	18
Wald			363.9		

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.10

Table 4.15. The Effect of Forward Participation into GVCs on Türkiye's Innovation Performance: Dynamic Panel Structure

VARIABLES	(1) Model1 OLS Robust	(2) Model2 Fixed Effect Robust	(3) Model3 Random Effect Robust	(4) Model4 Fixed Effect 2SLS IV Robust	(5) Model5 Random Effect 2GLS IV Robust
lusptogplag1	0.585***	0.305***	0.496***	0.219	0.591***
	(0.038)	(0.075)	(0.036)	(0.133)	(0.037)
lrdpdcop	0.055	0.178	0.116	0.099	0.053
	(0.076)	(0.133)	(0.084)	(0.264)	(0.079)
lintdvash	-0.277	-2.018*	-0.349	-6.355	-0.087
	(0.166)	(1.009)	(0.229)	(7.813)	(0.204)
iklco	0.085*	0.173	0.086	0.147	0.093**
	(0.043)	(0.277)	(0.059)	(0.280)	(0.042)
Constant	-6.319***	-5.277	-7.710***		-6.910***
	(0.875)	(4.064)	(1.258)		(0.995)
Observations	181	181	181	180	181
R-squared	0.489	0.304		0.185	
F-Stat	89.14	60.55		22.32	88.83
Prob > F	0	7.84e-10	0	2.22e-06	0
Degree of Freedom	17	17	4	16	4
Number of panelid		18	18	17	18
Wald			277.1		

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.10

CHAPTER 5

CONCLUSIONS, POLICY IMPLICATIONS AND RECOMMENDATIONS

5.1. Concluding Remarks

In this section, we present our main findings and relate them to the existing literature. Table 5.1 summarizes the main findings of thesis regarding the overall effects of different types of integration into GVCs on innovation performance[47].

Table 5.1. Summary of the Main Findings (Overall Effects)

	Cross-Country Analysis		**Türkiye**	
	Backward Participation (a)	Forward Participation (b)	Backward Participation (c)	Forward Participation (d)
Overall Effect	Positive	Insignificant/ Negative	Insignificant	Insignificant/ Negative

Source: Author's Analysis

(a). Backward participation (Cross-Country Analysis): Based on the cross-country analysis (including 41 countries), the effect of importing intermediate inputs for exports (i.e., backward participation) on innovation performance is found to be positive. As discussed thoroughly in Chapter 2, this result supports certain arguments proposed in the relevant literature, asserting that backward participation may have positive effect on innovation outcome. Firstly, due to easier access to a large range of (cheap) intermediate goods (with higher quality), building backward linkages within

[47] We summarize and interpret the main findings of the static model. The findings of both static models and dynamic models are in general consistent with each other. (They are fully consistent in the case of Türkiye. The exception is the effect of backward participation on innovation performance in the cross-country analysis.)

GVCs is one way of removing or decreasing constraints and costs in the production process. This would lead to increase in productivity, product variety and product quality through innovation and help to overcome export costs and produce for foreign markets (Halpern *et al*., 2005; Bas and Strauss-Khan, 2011; Kasahara and Lapham, 2013 cited in Lo Turco and Maggioni, 2013; Xing *et al*., 2021). Second, the literature also emphasizes the role of backward linkages within GVCs in knowledge acquisition, dissemination, and sources of technology (Morrison *et al.*, 2008). Knowledge spillovers from suppliers can contribute to product quality, process improvements, and development of human capital, thereby enhancing innovation performance. Furthermore, the exposure to import competition led by backward linkages within GVCs leads to the reallocation of domestic sources toward the most competitive firms and pushes local firms producing these inputs to innovate by investing in new technologies and skills (Ziemann and Guérard, 2016). As discussed in OECD (2015, p.49), the degree of competitive pressure affects "*the diffusion of existing technologies from the most advanced national firms to the rest of the economy*". The decrease in market share and profits of low-productivity (or import-competing) firms leads to increase in incentives to invest in and absorb better technologies (OECD, 2015). Our findings suggest that at least one of these mechanisms work properly, as the overall effect on innovation performance is positive.

(b). Forward participation (Cross-Country Analysis): Based on the cross-country analysis, the effect of providing inputs for the other countries' exports (i.e., forward participation) on innovation performance is found to be statistically insignificant or negative depending on the model we choose. In any case, these results indicate the absence of a positive effect on innovation performance in the overall pattern; but rather raise some doubts on the positive implications of forward participation in GVCs on innovation performance. Several arguments in the literature mainly emphasize the importance of forward linkages for gaining and disseminating knowledge within GVCs (see Chapter 1 and Chapter 2). In this context, learning through exporting and knowledge spillovers from outsourcing (lead) firms are stated as the key channels that countries benefit from forward linkages. For the smooth functioning of GVCs and efficient production, lead outsourcing firms are expected to

convey the know-how and technology to local suppliers. Hence, domestic innovation capabilities can be improved accordingly. Moreover, forward linkages may put pressure on firms to converge to international production and product standards (OECD, 2016). In order to meet international requirements related to quality, environment and labor standards and, delivery time, firms may be forced to innovate. Nevertheless, these aforementioned arguments are not fully supported by our findings.

Then, the answer to the question of why the effect is not positive can be found within some alternative arguments proposed in the literature regarding economics of knowledge and innovation studies. One such argument lies within the discussion regarding the "*willingness of lead outsourcing firms to disseminate knowledge*" (Xing *et al.*, 2021). Outsourcing firms might be unwilling to convey knowledge to its suppliers in their core competency areas. As a result, outsourcing lead firms tend to be selective and behave carefully to disseminate which part of knowledge it transfers. Even though knowledge transfer in complementary areas might be expected to occur, it should not be taken for granted in competency areas of lead outsourcing firms that are core to their competitiveness.

Another argument that may help explain our findings concerns the issue of absorptive capacity, as discussed in knowledge economics and innovation studies. Knowledge might not be transferred as expected due to the inadequacy of absorptive capacity of knowledge receivers. Different degrees of technological capabilities and absorptive capacity of local producers can influence to the extent to which they benefit from integrating into GVCs (Morrison *et al.,* 2008; Piermartini and Rubínová, 2021). The discussion is also related to the literature on types of knowledge (Cowan *et al*., 2000; Keller, 2014; Piermartini and Rubínová, 2021). Compared to tacit knowledge, codified knowledge is generally expected to be transferred more easily within a GVC. However, if there is some part of knowledge that is non-codifiable, knowledge transfer is assumed to be more difficult and can be achieved by face-to-face interactions between knowledge deliverers (in technology headquarter countries) and knowledge receivers (in host countries). Consequently, proximity matters for the acquisition of tacit knowledge embedded in individuals as

well as organizations (Foray, 2004; Balconi *et al.*, 2007; Foray, 2007). Distance between these different actors could hamper personal interactions and, thereby knowledge sharing, which may also risk functioning of GVCs. In this vein, distance matters in global value chains. Baldwin (2014) also points to the relevance of distance to explain the concentrated regional networks within the chains.

In addition to geographical proximity, which enhances interactive learning, social embeddedness plays a key role in building trust and gaining benefits from geographical proximity. Innovation does not occur in isolation; rather, it depends on the interaction of agents with their environment (Fagerberg, 2005). In this regard, our findings align with the findings of Bucini and Finotti (2016). As we recall from Chapter 2, Bucini and Finotti (2016) argue that although product innovation thrives on global activities, the contiguity between certain research and development activities and manufacturing activities can support innovation. They discuss how the choice to co-locate research and development activities and production activities affects the geography of innovation by providing evidence from the Italian low-technology manufacturing industries (specifically, furniture and fashion leather items).

Governance structure of GVCs may be related to all the aforementioned issues. As discussed in Chapter 2, different governance structures can explain the extent or the absence of the effect as well as the mechanisms through which the effect occurs, as governance structures reveal the power relations between the actors within the chain. Governance structures, which are characterized by the complexity of the knowledge shared between actors, the codification of knowledge in production, and the level of supplier competence determine control and coordination mechanisms of the chain (Gereffi *et al*., 2005; Frederick and Gereffi, 2009; Gereffi and Fernandez-Stark, 2016). In this vein, the finding of the absence of positive effect can imply the existence and/or domination of hierarchical type of governance structures rather than that of market type of governance structure. As discussed thoroughly in Chapter 2, in hierarchical types of governance, the ability to codify transactions and the capabilities in the supply base are low, while the degree of explicit coordination,

power asymmetry between partners, and the complexity of transactions are high (Gereffi *et al*., 2005).

To sum up, providing inputs for other countries' exports without ensuring knowledge acquisition and spillovers, regardless of the reasons for the lack of knowledge sharing, and being locked into already-established governance relationships within the chains may hinder countries from innovating. Furthermore, locked-in countries that merely satisfy the needs of the outsourcing firms that are explicitly directed to them, tend to continue producing the same or similar products using standardized technology and know-how, without improving their innovation capabilities. As our findings suggest, this might provide an explanation for the absence of a positive effect on innovation performance.

(c). Backward participation (Türkiye): For the case of Türkiye, we find that the overall effect of importing intermediate goods for exports does not have a significant effect on innovation performance. This finding is different from the result we obtain from the cross-country analysis. To put it more clearly, it indicates that Türkiye does not align with the general outlook of the other countries and differs from them with respect to the effect of backward participation on innovation performance. This suggests that the mechanisms highlighted in the GVC literature such as access to qualified and/or cheaper inputs, transfer of knowledge and the exposure to import competition did not fully work for Türkiye during the period under study.

Several arguments similar to those stated in item (b) above can be put forward to explain the underlying reasons, in particular those related to the acquisition and dissemination of knowledge, recalling that the main mechanism is expected to work through knowledge spillovers from suppliers. In addition, as mentioned in Section 2.2, the study by Lo Turco and Maggioni (2013) may help explain why the innovation performance of firms may not improve through importing inputs for exports. As noted, by investigating the effect of importing on the probability of exporting, Lo Turco and Maggioni (2013) find evidence that the cost-saving channel of imports (i.e., importing cheaper inputs) work, rather than the technology channel of imports (i.e., upgrading the quality of products) on the probability of exporting by

Italian manufacturing firms. As in the case of Italian firms, if the increase in backward linkages mostly stems from the imports of cheaper inputs rather than the imports of high-quality imports, this may be advanced as another explanation for why importing for exports may not enhance overall innovation performance in Türkiye.

Moreover, it can also be argued that importing inputs for exports may not lead to knowledge acquisition and, consequently, to an increase in innovation performance if the use of imported inputs does not go beyond simple assembling activities. Even though the World Bank report (2022) indicates that Türkiye's focus is not merely limited to simple assembly, this issue should still be kept in mind, as the effect of imported inputs for exports may heavily depend on their intended use.

Additional accounts for the absence of a significant effect of backward participation on innovation performance may lie within the works by Ito *et al*. (2023) and Lee (2019). As discussed in Chapter 2, Ito *et al*. (2023) suggest that being a central hub, rather than being embedded in GVCs, matters for developing new technologies. This in turn may suggest that Türkiye's current position in GVCs may not be optimal for enhancing innovation performance. Furthermore, heavy reliance on GVCs may limit the development of local innovation and technological capabilities. As noted by Lee (2019), a country can benefit from integrating into GVCs only after it has built up its own innovation capabilities. Although GVCs might help acquire knowledge in the early stages of integration, what truly matters for innovation is the local capabilities.

Last but not least, it is important to account for the differences across industries rather than generalizing overall patterns, and to interpret our results considering the technology intensity classification of industries accordingly (see Table 5.2 below).

(d). Forward participation (Türkiye): The effect of providing inputs for the other countries' exports is found to be either statistically insignificant or negative for Türkiye. This result is consistent with the findings from the cross-country analysis. Similar to the findings of the cross-country analysis, it puts some caution to several arguments within the GVC framework that highlight the positive implications of

forward participation. Once again, the question of why the expected mechanisms do not fully work, and thereby yielding the absence of positive effect, can be explained by the arguments in the literature regarding economics of knowledge and innovation. The remarks stated in item (b) regarding the cross-country analysis also remain valid and can be put forward for the case of Türkiye.

In addition, the work of Taymaz *et al*. (2011) is quite intuitive to provide valuable insights for interpreting our results regarding the estimated effect of forward participation on innovation performance. As discussed in detail in Section 4.1, one of their key findings is that, even though Türkiye has managed to transform its export structure since the 1950s (the export shares of machinery, automotive, and consumer electronics, which are classified as medium-high technology industries, began to increase in the 1990s at the expense of the export shares of textiles and wearing apparel, which are low-technology industries), Türkiye's relative position in international production has not improved. They argue that the underlying reason for this finding is that Türkiye has specialized in the exports of products with standardized technologies and low cost.

Although the relationship between integration into international production chains and innovation performance is not directly established in the work by Taymaz *et al*. (2011), they nonetheless provide valuable insights. This work not only highlights the significance of the technology intensity of the traded goods, but also critically reveals that specialization in production stages rather than specialization in individual products becomes crucial. In other words, what truly matters is that for which parts of the production (i.e., production stages) the country is integrated in the chain even though the chain is itself related to the product/industry with higher technology intensity (see motor vehicle product example in Section 4.1). As a result, the structural transformation in exports does not always guarantee an improvement in the relative position of the country in the GVC world.

In order to gain further insight into this issue, we can also relate our results regarding the effect on innovation performance to earlier research in the literature regarding productivity and value-added, which is nevertheless not directly related to innovation

performance (see Chapter 4). Earlier findings regarding the effect on productivity likewise do not yield a unique outcome. For instance, while the World Bank (2020) reports that the average value-added and productivity levels of GVC exporters outperform those of domestically oriented (non-GVC) firms, Kılıçaslan *et al.* (2021) find that being a supplier in GVCs does not have a significant effect on productivity. The ambiguous results regarding the effect of value chain integration on productivity may also be relevant for explaining why the expected mechanisms do not fully work in the case of Türkiye. In sum, while participation in GVCs may generally be viewed as a pathway to enhancing innovation, Türkiye's experience suggests that integration into GVCs, whether through backward or forward participation, may not necessarily yield significant improvements in overall innovation performance. Furthermore, the partially differing results from the cross-country analysis emphasize the complexity of understanding the effects of GVC integration on innovation. In addition to the overall pattern of innovation performance, interpreting the estimated results by the technology intensity of industries may provide further insight to discuss whether and how the results differ from the overall effects. Table 5.2 summarizes our main findings regarding the effects of different types of integration into GVCs on innovation performance when we analyze the manufacturing industries according to their technology intensity.

Table 5.2. Summary of the Main Findings (Technology Intensity Classification)

Effect According to Technology Intensity of Manufacturing Industries	**Cross-Country Analysis**		**Türkiye**	
	Backward Participation (e)	Forward Participation (f)	Backward Participation (g)	Forward Participation (h)
Low-technology	Negative	Insignificant/ negative	Insignificant	Negative
Medium low-technology	Negative	Positive	Insignificant	Insignificant
Medium high-technology	Positive	Negative	Positive	Positive
High-technology	No Effect	Negative	N.A.[48]	N.A.

Source: Author's Analysis

[48] Regarding the high-technology group, we do not interpret the estimation results. The model reports the warning that the estimated covariance matrix of moment conditions is not of full rank possibly due to insufficient numbers of clusters. F and Wald Chi (2) statistics, which are used to test the significance of coefficients to ensure more accurate inferences, could not be calculated possibly due to insufficient number of clusters.

(e). Backward participation (Cross-Country Analysis – Technology Intensity Classification): We find that the effect of backward participation differs when we classify the manufacturing industries according to their technology intensity. The cross-country analysis indicates that while the overall effect is positive (see Table 5.1), this result only holds for the medium high-technology group when manufacturing industries are classified according to their technology intensity. Interestingly, importing intermediate inputs for exports of the low-technology group and medium low-technology group exerts a negative effect on innovation performance. This suggests that the above-mentioned expected mechanisms including the knowledge spillovers from suppliers do not fully operate except for the medium high-technology group.

Indeed, our findings support several alternative arguments in the relevant literature. Therefore, the discrepancy may be better understood by relating the results to the prior research. The works by Buciuni and Finotti (2016), Dang and Dang (2020), Hue and Korwatanasakul (2023), Ito *et al*. (2023), and Lee (2019) advance relevant arguments and find evidence pointing to either the absence of any positive effect or the presence of a negative effect of backward participation on innovation (see Chapter 2).

By investigating Italian low-technology industries, Buciuni and Finotti (2016) argue that the contiguity between production activities and development activities supports innovation. Some development activities, such as including prototype development, is closely linked to the manufacturing activities of the skilled workers. In that regard, local firms function as hubs of product development activities in low-technology manufacturing industries, which is particularly evident in furniture and fashion leather goods. Accordingly, one possible explanation for the negative impact might be that the detachment of production and some development activities may hinder innovation. This might be the case in low-technology industries where the production and development activities take place in different countries.

Dang and Dang (2020) find a negative effect of backward participation on the product innovation of firms in Vietnam. They argue that backward linkages help to

improve existing products at the expense of developing new products. Similarly, Hue and Korwatanasakul (2023) investigate the impact of GVC participation on labor productivity, which might serve as a proxy for innovation. Their argument suggests that heavy reliance on foreign inputs and technologies may worsen domestic technology development. In addition, Ito *et al*. (2023) argue that simply being embedded in GVC network does not matter alone; rather, being a central hub in GVCs is crucial for developing new technologies. In their words, "*embeddedness alone does not seem to clearly translate into more innovation*" (p.14).

Last but not least, Lee (2019) argues that the effect of GVC participation on economic development and innovation capabilities is nonlinear and dynamic. In the early phases of economic development, participation into GVCs help countries to acquire knowledge from external sources and develop local capabilities. Nevertheless, heavy dependence on GVCs may hamper the development of local capabilities in the long run. Lee (2019) highlights the need for countries to detach from GVCs and develop their own local innovation capabilities. Only after establishing local capabilities, countries might re-enter GVCs with stronger innovation capabilities. Lee (2019) suggests that this dynamic can be observed in the decline of foreign value-added shares in the exports of Korea and Taiwan, which are considered to be successful economies. All in all, these studies provide valuable insights into the absence of a positive effect (either insignificant or negative) of backward linkages on innovation performance.

(f). Forward participation (Cross-Country Analysis – Technology Intensity Classification): Based on the cross-country analysis, we find that the effect of providing inputs for other countries' exports on the innovation performance varies according to the technology intensity classification of industries. While forward participation affects medium low-technology industries positively, it negatively affects medium high-technology and high-technology industries. These findings support the arguments regarding knowledge acquisition and spillovers to some extent, indicating that the notion of learning by exporting only partially holds.

(g). Backward participation (Türkiye – Technology Intensity Classification): In the case of Türkiye, the effect of importing inputs for exports across different

technology intensity groups generally aligns with the overall outcome, with the exception of the medium high-technology group. Backward participation has a positive effect on innovation performance in medium high-technology group. However, it does not have a positive effect on the low-technology and medium low-technology industries.

(h). Forward participation (Türkiye – Technology Intensity Classification): In the case of Türkiye, the effect of being an input provider for other countries' exports becomes less clear when the industries are classified according to their technology intensity. While forward participation does not have a positive effect on innovation performance in the low-technology and medium low-technology groups, it has a positive effect in the medium high-technology group.

To sum up, our findings suggest that the effect of integration into GVCs on innovation performance differs according to the type of the integration (i.e., backward participation and forward participation). Moreover, the effect may be country-specific, as evidenced by the case of Türkiye. Last but not least, the effects may differ from the overall pattern when the industries are investigated according to their technology intensity.

At the global level, the effect of importing inputs for exports (i.e., backward participation) has a positive overall effect on innovation performance across industries. However, when we group industries according to their technology intensity, we see that importing inputs for exports only enhances the innovation performance of the medium high-technology industries, while it negatively affects the innovation performance of the low-technology industries and medium low-technology industries[49]. Additionally, we find that while providing inputs for other countries' exports (i.e., forward participation) positively affects the innovation performance of the medium low-technology industries, the effect is either insignificant or negative in other technology groups.

[49] While the medium-high technology group consist of chemicals and chemical products, electrical equipment, machinery and equipment n.e.c., motor vehicles, trailers and semi-trailers, and other transport equipment, the low-technology group includes food products, beverages and tobacco, textiles, wearing apparel, leather and related products, wood and products of wood and cork, paper products and printing, furniture and other manufacturing.

The findings also suggest shows that even industry group-specific analysis alone may be insufficient to draw comprehensive policy conclusions. Further detailed country-specific analysis needs to be conducted for providing insights tailored to the country in question. Focusing on the case of Türkiye, we investigate how Türkiye differs from other countries in terms of the effects of GVC participation on innovation performance. We find that importing intermediate inputs for exports does not have a significant overall effect on the innovation performance of Türkiye. This result does not align with that of the cross-country analysis. However, an exception to this finding emerges when industries are analyzed by their technology intensity; specifically, the effect is found to be positive in the medium-high technology group.

Moreover, while the overall effect of forward participation is found to be insignificant in the case of Türkiye, the effect varies across industries with different technology intensities, which is a finding that aligns with that of the cross-country analysis. Accordingly, these findings suggest that if we fail to account for differences across both industry groups and countries, the results may lead to misleading interpretations, thereby hindering us from taking effective policy actions (see Section 5.2 below for further discussion).

Grounded on the findings discussed above, thus, our work makes several contributions to the understanding of the nexus between GVC participation and innovation. By directly linking the fields of GVC and innovation, it is among the limited but growing body of research. While the scope of the work, covering 41 countries and 19 industries from 1995 to 2018, undoubtedly enhances its contribution, its investigation on the mutually exclusive effects of both backward and forward participation, emphasizing the different types of GVC participation, also provides further insights into the earlier research.

Furthermore, as this work is not only limited to cross-country industry-level analysis but also provides an in-depth examination of Türkiye's innovation performance with respect to GVC participation, it both provides evidence on differences among countries and stands out as one of the few studies focusing specifically on Türkiye. Drawing from this dual perspective, the thesis offers several policy recommendations

and may contribute to the discussion regarding how and at what level policies should be made. Our findings suggests that when promoting GVC participation to increase innovativeness, what truly matters is the nuanced approach that considers both country and industry specific features, rather than relying on a global or country-wide national policies (see Section 5.2 below). Finally, our work suggests that the underlying sources of observed disparities may not only lie within the GVC approach in international trade; instead, they should also be sought in the knowledge economics and innovation studies, which are closely related to international trade.

5.2. Policy Implications and Recommendations

Based on the evaluation of the findings from our research, this section draws several policy implications and proposes recommendations for both foreign trade policy and science and technology policy. Table 5.3, presented at the end of this section, provides a summary of the key insights and policy recommendations discussed herein.

1. The benefits of integration into GVCs should not be taken for granted:

Our thesis proposes that the benefits of integration into GVCs should not be taken for granted when it comes to innovation performance. As participation in GVCs is not sufficient per se, policymakers should avoid proposing general policy recommendations that focus solely on further integration into GVCs.

Instead, policymakers should establish specific or tailored objectives (i.e., promoting backward and/or forward participation at the industry level) and frame policy recommendations accordingly. In our case, this refers to enhancing innovativeness through participating in GVCs. Given that integration into GVCs is often inevitable in the contemporary global economy, policymakers should act prudently to ensure that the integration serves to improve the innovation performance of the country (see the discussion on medium high-technology industries in point 6 below). In this regard, being aware of the fact that there is no automatic mechanism and predetermined path to follow is crucial when formulating effective policy recommendations.

A general narrative that suggests GVCs always benefit countries, implicitly acknowledging the notions of the automatic mechanism and predetermined path to follow, can also be found in policy documents at both the national and international levels. The World Bank (2022, p.36), for example, assumes GVC-led development. World Bank (2022) argues that GVC participation would increase exports, investment, value-added, and, thereby assuming that GVC participation is one of the most important tools for enhancing productivity growth in Türkiye.[50] The World Bank (2022, p.36) states that "overall, GVCs constitute a high potential and high return development agenda for Türkiye". These implications highlight the overall positive effect of GVC participation on productivity and growth. At the national level, the Twelfth Development Plan in Türkiye (2024-2028, pp. 22, 62-65) also contains several arguments suggesting that participation in GVCs enhances access to technology and increases high value-added exports.

Our thesis, which includes both the global (cross-country) and country-specific (Türkiye) analyses), suggests that the effect of participating in GVCs on innovation performance is not uniform. As discussed in Chapter 1 and Chapter 2, the implications and consequences of GVC integration are multivarious including the effects on growth, development, productivity and innovativeness. Indeed, a similar conclusion regarding Türkiye is found in Erkök's (2020) analysis, where she argues that high levels of participation do not necessarily lead to a reduction in the trade deficit, nor would the level of economic development and the level of employment be equally high.

Focusing on the effect on innovation performance, which is just one aspect of the broader issue, our thesis suggests that, even from a single aspect (i.e., innovativeness), the effect of integration into GVC is not uniform. Although GVC phenomenon needs to be taken into account in trade and development policies, it remains unclear whether GVC integration can always ensure that countries benefit in the same way. In this context, the evidence from both our cross-country and country-specific analyses contributes to the discussion that GVC participation alone is not sufficient to enhance innovation performance.

[50] For further discussion of the views of the World Bank, see World Bank (2022).

2. Avoid the one-size-fits-all-way trade policy approach:

As the effects of integration into GVCs on innovation performance do not present a uniform fashion, policymakers should refrain from a one-size-fits-all-way approach. In order to capture the benefits in terms of innovation performance, policymakers should avoid proposing solely global level policies. Furthermore, nationwide recommendations alone may not be sufficient to reap the benefits. Consequently, in addition to considering the features of the country in question, policymakers should also consider the discrepancies in industry features. In our research, this corresponds to the industry groupings based on different technology intensities.

Our thesis finds that the effect of integration into GVCs on innovation performance differs depending on the country in question (as demonstrated in the case of Türkiye), the industry groups with different levels of technology intensity, and the type of integration (i.e., backward and forward participation). In this regard, it is crucial for policymakers to consider these differences in the effects of backward and forward participation when formulating policy, and to develop tailored policy recommendations accordingly.

Policymakers should not propose the same recommendations for all countries at the global level but should instead differentiate policies based on the country in question. Our thesis suggests that discrepancies between countries can lead to different outcomes on innovation performance. For instance, our separate analysis for the case of Türkiye reveals that we should pay attention to how the effects of GVC participation on innovation performance differ for Türkiye compared to other countries. In cases where similarities outweigh differences, it may not be appropriate to attribute any policy gap to Türkiye. However, when significant differences occur, it becomes crucial to understand the reasons behind them. For example, while the overall effect of forward participation on innovation performance is similar in both the cross-country analysis and the case of Türkiye, the overall effect of backward participation differs between the two.

Since our research reveals that the effect of GVC participation on innovation performance varies across industry groupings with different levels of technology

intensity, formulating a nationwide industrial policy alone may prove inadequate. Indeed, at this point, our thesis contributes to the existing literature, which discusses the merits of nationwide versus industry specific industrial policy recommendations. If the effect on innovation is industry-specific, we should first analyze how innovation outcomes are affected across industries with varying degrees of technology intensity, and only then should we draw policy recommendations accordingly.

To exemplify the issue, while we find that, at the global level, the overall effect of importing inputs for exports is positive, the outcomes differ when industries are grouped according to their technology intensity. Specifically, backward participation enhances the innovation performance of the medium high-technology industries, while it negatively affects that of the low-technology and medium-low technology industries. Additionally, we find that providing inputs for other countries' exports has a positive effect only in medium low-technology industries. Therefore, the findings of our cross-country analysis suggest that if the distinctions between industry groups with their specific properties are not taken into account, it becomes unclear that countries will benefit from policy actions.

3. GVC policy should strongly be complemented by industrialization and innovation policies:

Since several arguments in the literature suggesting positive implications of GVC participation for innovation do not fully hold, policymakers should investigate the underlying reasons by seeking them not only within the GVC framework in international trade, but also in the related fields such as knowledge economics and innovation studies. Even though the issue may initially, albeit mistakenly, seem to be only related to the GVC phenomenon, policymakers should not overlook this issue and should instead develop policy recommendations by integrating the insights from both knowledge economics and innovation studies. As our findings reveal that these two policy areas are quite complementary, policymakers should design policies across different areas coherently in such a way that they align with each other.

Our thesis reveals that there is no automatic mechanism that connects GVC participation to innovation. Linking the GVC literature to the innovation literature helps us to shed light on why the effects of GVC participation are not automatic. Studies on innovation tell us that we should pay due respect to industry-specific and country-specific factors such as absorptive capacity, the tacitness and codification of knowledge, proximity, learning mechanisms, and institutional frameworks. As the literature suggests, these issues may be highly relevant both at the industry level and at the national level. Hence by relating insights from innovation studies to GVC analysis, we are able to discuss the role of such concerns regarding trade policy analysis, which is often ignored in such one-size-fits-all approaches or in automatic consequence literature, proposing that GVC participation is inherently virtuous for economic growth.

4. In order to enhance the innovation performance through participation in GVCs, knowledge acquisition and dissemination mechanisms should function properly.

In relation to item 3, knowledge should be effectively acquired by the receiving integrators through the linkages within GVCs. Hence, policymakers should improve the absorptive capacity of these agents by investing more in higher level education, vocational education and training, and lifelong learning; increasing the number of research and development personnel; and boosting face-to-face interactions for the transmission of tacit knowledge, particularly through foreign direct investment.

GVC participation may have a positive impact on innovation when acquisition and dissemination of knowledge are effectively achieved. However, the positive effects of integration into GVCs on innovation may not occur when there are obstacles in the acquisition and dissemination of knowledge. Any mechanism that hampers the smooth functioning of the transmission mechanism of knowledge can frustrate the policies for GVC integration. Therefore, the policies should be aimed to ensure well-functioning transmission mechanisms between agents. Here, part of the policy making also lies within the education policy of countries. The acquisition and dissemination of knowledge are clearly related to human capital formation, which is developed through schooling, vocational education and training, and industry-

specific human capital investment (Gibbons and Waldman, 2004). In other words, the absorptive capacity of firms within industries may be one of the factors that can explain why integration into GVCs does not always lead to the desired outcomes.

5. Governance structures of GVCs may affect the degree (of willingness) of both knowledge sharing and the codification of knowledge.

In relation to item 4 above, when designing policies, policymakers should pay sufficient attention to establish the relations within GVC in a way to ease knowledge spillovers and to support learning mechanisms, such as setting up more market type of governance rather than building hierarchical type. To this end, policymakers should put effort to improve the institutional framework, including strengthening the rule of law and improving contractual conditions and relations. This may include monitoring, implementation and enforcement of laws and rules, as well as establishing efficient dispute settlement mechanisms. For example, contracts should be carefully designed to ensure that lead firms convey their knowledge. Improving the legal and institutional infrastructure to secure knowledge transfer through legal means is also essential. Indeed, even though the World Bank (2020) proposes strong GVC participation, the argument that there is no automatic link between GVC participation and innovation can also be found in its reports. World Bank notes that the real challenge for Türkiye is to use existing and future GVC participation to become a more innovative economy, which "*may require a longer transition*" (World Bank, 2022, p.30).

6. Policymakers should prioritize the industries to which resources, including financial resources and human capital, should be allocated.

Rather than pursuing general policies such as increasing the integration of all industries and allocating resources accordingly, policymakers should set up policies that take into account the type of GVC linkages and the certain industry groups where innovation performance improves with GVC integration. For example, both the cross-country analysis and the case of Türkiye reveal that backward participation has a positive effect on innovation performance of the medium high-technology

industry group. Based on our research, we may recommend prioritizing policy actions for the medium high-technology group as a starting point. In this context, inward processing regime may be evaluated according to the framework developed herein. Specifically, tax exemptions or reductions for imports used by exporters may be designed to ensure that backward participation positively affects innovation performance.

A more disaggregated level of investigation may also provide further insights into how to develop policies regarding the medium high-technology industry group. A comparison of the industries within the medium high-technology industry group yields additional findings.

Recall that throughout the term 1995-2018 the highest contribution to the increase in backward participation rate in the medium high-technology group came from the manufacture of electrical equipment (see Section 4.2).

Based on our descriptive analysis, we also observe that the manufacture of electrical equipment industry was among the industries with a relatively high number of patents granted,[51] compared to other industries within the medium high-technology industry group. Over the aforementioned period, the average share of patents granted in the electrical equipment industry was 35.9% of the total patents granted in the medium high-technology industry group, representing the second highest share among industries.

A similar pattern is also observed in the manufacture of other machinery and equipment. The manufacture of other machinery and equipment was among the industries characterized by both relatively higher backward participation rates and a relatively larger number of patents granted. Indeed, over the same time period, the industry recorded the highest average share of patents granted in the medium high-technology industry group, accounting for 40.1% of the total. Therefore, the findings derived from the descriptive statistics indicate that the industries with relatively

[51] The number of patents granted by the USPTO, which is the statistics we use in our analysis.

higher backward participation rates on average are also the ones that have a relatively higher number of patents granted on average within the medium high-technology industry group, suggesting a positive association between the two.

The comparison between the manufacture of other machinery and equipment and the manufacture of motor vehicles, trailers and semi-trailers serves as a good case in point for capturing the differences across industries. Both industries are classified within the medium high-technology industry group and exhibited similar backward participation rates, averaging 24% throughout the 1995-2018 period.

However, their innovation outputs differed significantly. While the average share of patents granted to the manufacture of motor vehicles, trailers and semi-trailers accounted for 5.5% of the medium high-technology industry group, that of other machinery and equipment was substantially, constituting 40% of the total.

Accordingly, the question arises as to why these two industries, despite having similar backward participation rates and being classified within the same technology intensity group, differ in terms of their innovation performance. The underlying reasons for the relatively low innovation performance in motor vehicles, trailers and semi-trailers needs to be investigated.

Undoubtedly, backward participation may account for part of the explanation, since additional factors may determine innovation performance. However, the difference between these industries may, at least in part, still be attributed to the insights derived from our analysis, as evidenced by the findings presented above.

This may necessitate further research to investigate to explore certain aspects and factors, such as the degree of absorptive capacity, the type of knowledge (tacit versus codified), governance structures within the chain, institutional infrastructure, and other relevant issues related to knowledge transmission, including the level of foreign direct investment, that may help explain the difference in innovation performance between the manufacture of motor vehicles, trailers and semi-trailers and the manufacture of other machinery and equipment.

In contrast to the medium high-technology group, policies concerning the low-technology group may not be prioritized, since the evidence indicates the absence of a positive effect of backward participation on innovation performance in this group. Notably, several earlier studies in the literature even suggest that separating manufacturing activities from certain research and development activities in the low-technology industry group may hinder innovation; instead, the proximity between these activities may support innovation in this group (see both Chapter 2 and the discussion in Section 5.1 item e above).

Consequently, when developing policy frameworks, policymakers should be aware of the differences across industries and allocate resources accordingly. This may include investment in vocational training, efforts to attract foreign direct investment, the establishment of new and strict regulations to improve institutional infrastructure and contractual relations.

Furthermore, several policy documents emphasize the reduction of import dependency as one of the main policy objectives of Türkiye (Twelfth Development Plan 2024-2028, 2023, pp. 62, 86-87, 90; Industry and Technology Strategy 2023, 2019, pp.51-52). Considering this issue, the multifaceted and long-run effects of initially distinct policy areas must be carefully investigated to ensure that they reinforce one another (see item 3 above).

While the formulation of policies to enhance backward linkages may not initially appear to be relevant, our research suggests that these linkages may enhance innovation, as evidenced within the medium high-technology industry group (see Table 5.2 above).

Through GVC-led innovation, the short-run deteriorating effects on the trade balance may diminish over time. Improvements in innovation outcomes can lead to an increase in exports through both widening the range of exported products and increasing the share of higher value-added exports, thereby strengthening international competitiveness. In other words, the sustainability of exports can be achieved through innovation. Through learning from suppliers and the acquisition of

knowledge, we expect that higher-quality domestic inputs are going to be produced and increasingly used for exports in the long run. This, in turn, may reduce reliance on importing inputs for exports for the sake of being competitive via accession to higher-quality inputs, and diminish the deterioration in external balances in the long run.

Ziemann and Guérard (2016, pp.25-26) also suggest that while backward participation tends to increase and forward participation either stagnates or declines in the "*earlier stages of integration*", in the "*later stages*", knowledge spillovers enable domestic firms to produce and "*replicate parts of the production process*".[52]

Thus, while increasing backward participation linkages may have a disruptive effect on the trade balance in the short run, it may have a corrective effect in the long run; thereby, contributing to the reduction of import dependency by acquiring and developing new production capabilities.

To sum up, the implementation of trade policy must ensure sustainable export growth for a country. Our thesis suggests that one unintended consequence of trade policy may be its effect on the innovation performance. In this context, leveraging trade links through participation into GVCs may enhance the innovation performance.

Consequently, designing policy measures that ensure the effective functioning of the knowledge acquisition mechanism within GVCs becomes essential to benefit from GVC participation.

Although several insights can be drawn from our research, which contributes to the current strand of literature, there remain areas that require further research. As the issue involves multifaceted aspects, it can be explored within a broader analytical framework. The research can be extended in several directions. Our empirical findings reveal that the effect of GVC participation on innovation performance differs across industries and countries.

[52] In this vein, Ziemann and Guérard (2016, pp.25-26) give the example of the progress witnessed in the later phases of integration of car components and shipbuilding industries in Türkiye.

This points to an urgent need for further studies (both qualitative and quantitative) on the effect of GVC participation on firm-level innovation performance.

Moreover, the issue of incomplete transfer of knowledge should be thoroughly considered and integrated into the analysis. This may necessitate the exploration of relevant factors, such as the degree of absorptive capacity, the type of knowledge, governance structures within the chain, institutional infrastructure, and other issues related to knowledge transmission.

Although it is quite challenging to find appropriate measures for the relevant variables at higher levels of disaggregation, greater effort should be devoted to addressing this issue and developing methods to identify the differentiated impacts of these factors.

Regarding the role of proximity, the econometric framework of the research can also be enhanced by applying spatial regression models.

Given the increasing role of services in the international fragmentation of production, the research also warrants an extended study that more thoroughly incorporates the analysis of services. Such an extension may provide deeper insights into the GVC-innovation nexus by acknowledging service-related factors that may otherwise be overlooked.

Last but not least, recent developments in the global economy and international trade, particularly the pandemic and the rise of protectionist trade policies, may undoubtedly have significant repercussions for the future of GVCs, revealing their vulnerabilities and potential effects on innovation performance.

Consequently, these developments give rise to new and noteworthy research areas that warrant considerable attention and an in-depth investigation. Accounting for the potential extensions mentioned above in future studies may provide a more comprehensive and nuanced understanding of the effects of GVC participation on innovation performance.

Table 5.3. Summary of Policy Implications and Recommendations

Policy Implications	Key Finding	Policy Recommendation	Supporting Evidence	Policy Tools	Policy Layer
The benefits of integration should not be taken for granted.	Integration into GVCs may not always automatically benefit countries.	Avoid assuming uniform benefits from GVC participation and adopting policy frameworks that focus solely on deeper GVC integration	Findings from both cross-country analysis and the case of Türkiye reveal that GVC participation do not always enhance innovation performance	Assessment of backward and forward linkages, analysis of industry-specific trade and innovation patterns	Macro, Meso
One-size-fits-all-way trade policy approach should be avoided.	The effect of GVC participation on innovation performance differs across countries and industries.	Develop tailored policy frameworks that enhance innovation performance and account for both country and industry-specific characteristics	Backward and forward participation levels are associated with differences in innovation performance across countries and industries.	Formulating adaptive policies based on the examination of backward and forward linkages, industry-specific trade and innovation patterns, Conducting country benchmarking, Collaborating with industry stakeholders	Macro, Meso

Table 5.3. (continued)

GVC policy should strongly be complemented by industrialization and innovation policies.	GVC policy and industrialization and innovation policies are complementary; therefore, GVC policy alone may be insufficient.	Design policies across different areas, such as GVC, industrialization, and innovation policies, in a coherent and coordinated manner so that they align with each other	Factors such as absorptive capacity, types of knowledge, proximity, learning mechanisms, and institutional frameworks may be highly relevant to GVC framework and trade policy analysis.	Developing integrated strategy plans at both national and industry levels by relating insights from innovation studies to GVC analysis	Macro, Meso

Table 5.3. (continued)

Knowledge acquisition and dissemination mechanisms should function properly to ensure GVC-led innovation.	Any factor that hampers the effective functioning of the transmission mechanism of knowledge may undermine the benefits from GVC participation.	Strengthen knowledge acquisition and dissemination mechanisms within GVCs Enhance absorptive capacity Develop human capital	Obstacles to knowledge acquisition and dissemination may account for the absence of desired outcomes regarding the effect of GVC participation on innovation performance.	Investing in education, vocational training, and lifelong learning, Increasing the number of R&D personnel, Boosting face-to-face interactions for transmission of tacit knowledge, Attracting FDI that supports knowledge transfer, Participating in international research programs and improving access to related funding	Micro, Meso, Macro, Mega

Table 5.3. (continued)

Governance structures of GVCs may affect the degree (of willingness) of both knowledge sharing and the codification of knowledge.	Improving the legal and institutional framework is essential to facilitate knowledge transfer.	Establish governance structures that are more conducive to knowledge sharing Set up market type of governance rather than building hierarchical structures	Market type of governance structures, where the ability to codify transactions is high and the degree of power asymmetry is low, promote knowledge transfer.	Improving the legal and institutional framework, Strengthening the rule of law, Enhancing contractual conditions, Establishing efficient dispute settlement mechanisms	Macro, Meso

Table 5.3. (continued)

Policymakers should prioritize the industries to which resources, including financial resources and human capital, should be allocated	Backward participation benefits medium high-technology industries compared to other industries	Prioritize policy actions in industries where innovation performance improves with GVC participation	Both the cross-country analysis and the case of Türkiye indicate that backward participation has a positive effect on the innovation performance of medium-high technology industries.	Industry-specific tax exemptions and reductions under inward-processing regimes, selective incentives	Macro, Meso

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APPENDICES

A. APPENDIX TABLES

Table A.1. Variable List

Variable	Short Description	Source
usptog	The number of patents granted by the United States Patent and Trademark Office (USPTO) by priority date, which is transformed from technology domains & IPC classification into ISIC Rev.4	OECD Patents by Technology Database and the author's own calculation. The data transformation is done by the author using the EUROSTAT's corresponding table IPC V8 – NACE Rev.2
usptogp	Per capita usptog	Author's calculation by using population data in the OECD Database
lusptogp	The natural logarithm of usptogp	Author's calculation based on usptog data
fvash	Measure of backward participation: Foreign value-added share of gross exports for domestic industry i in country c, percentage	OECD TiVA database, 2021 edition
lfvash	The natural logarithm of fvash	Author's calculation based on OECD TiVA database, 2021 edition
intdvash	Measure of forward participation: Domestic value added in gross exports of intermediate products by industry i in country c, as a percentage of total industry exports	OECD TiVA database, 2021 edition
lintdvash	The natural logarithm of intdvash	Author's calculation based on OECD TiVA database, 2021 edition
rdpdco	Business enterprise R&D data by industry (main activity orientation), which follows ISIC Rev. 4 and are expressed in US dollars at PPP at constant prices.	OECD Analytical Business Enterprise Research and Development (ANBERD) database

Table A.1. (continued)

rdpdcop	Per capita rdpdco	Author's calculation by using population data in the OECD Database
lrdpdcop	The natural logarithm of rdpdcop	Author's calculation based on rdpdco data
klco	Measure of capital intensification. It is the ratio of gross fixed capital formation in US dollars at constant prices to employment.	Authors calculation based on data obtained from OECD Input-Output Database (IOTs 2021) and OECD Trade in Employment (TiM 2021) Database
lklco	The natural logarithm of klco	Author's calculation based on klco data
ins1fvash	The instrument variable for fvash. The variable fvash is instrumented for each country in the dataset with the fvash of its respective regional hub country (the US for America, Germany for Europe and Japan for Asia)[53]	Author's instrumenting the data in the OECD TiVA Database Edition 2021
lins1fvash	The natural logarithm of ins1fvash	Author's calculation based on OECD TiVA Database Edition 2021
ins1intdvash	The instrument variable for intdvash. The variable intdvash is instrumented for each country in the dataset with the intdvash of its respective regional hub country (the US for America, Germany for Europe and Japan for Asia)	Author's instrumenting the data in the OECD TiVA Database Edition 2021
lins1intdvash	The natural logarithm of ins1intdvash	Author's calculation based on OECD TiVA Database Edition 2021
pop	Population	OECD Population Statistics

[53] The instrumenting strategy is grounded on the works of Baldwin and Lopez-Gonzales' (2019); Constantinescu *et al*., (2019), Montalbano, P. and Nenci, S. (2020).

Table A.2. Country List

N.	Country	N.	Country
1	Argentina	22	Korea
2	Australia	23	Latvia
3	Austria	24	Lithuania
4	Belgium	25	Luxembourg
5	Canada	26	Mexico
6	Chile	27	Netherlands
7	China (People's Republic of)	28	New Zealand
8	Chinese Taipei	29	Norway
9	Czech Republic	30	Poland
10	Denmark	31	Portugal
11	Estonia	32	Romania
12	Finland	33	Singapore
13	France	34	Slovak Republic
14	Germany	35	Slovenia
15	Greece	36	Spain
16	Hungary	37	Sweden
17	Iceland	38	Switzerland
18	Ireland	39	Türkiye
19	Israel	40	United Kingdom
20	Italy	41	United States
21	Japan		

Table A.3. Industry List (ISIC Rev.4 – TiVA 2021 Concordance)

N.	Industry Description	ISIC Rev.4 Code	TiVA Code
1	Food products, beverages and tobacco	10, 11, 12	D10T12
2	Textiles, wearing apparel, leather and related products	13, 14, 15	D13T15
3	Wood and of products of wood and cork, except furniture; articles of straw and plaiting materials	16	D16
4	Paper products and printing	17, 18	D17T18
5	Coke and refined petroleum products	19	D19
6	Chemicals and chemical products	20	D20
7	Pharmaceuticals, medicinal chemical and botanical products	21	D21
8	Rubber and plastic products	22	D22
9	Other non-metallic mineral products	23	D23
10	Basic metals	24	D24
11	Fabricated metal products, except machinery and equipment	25	D25
12	Computer, electronic and optical products	26	D26
13	Electrical equipment	27	D27
14	Machinery and equipment n.e.c.	28	D28
15	Motor vehicles, trailers and semi-trailers	29	D29
16	Other transport equipment	30	D30
17	Furniture, other manufacturing and repair and installation of machinery and equipment	31, 32, 33	D31T33
18	Construction	41, 42, 43	D41T43
19	IT and other information services	62, 63	D62T63

Source: Guilhoto *et al.* (2022)

Table A.4. NACE Rev.2 – IPC V8 Concordance

NACE Rev.2		IPC V8				
10	Manufacture of Food Products [10]	A23J	A01H	A01J	A21D	A23B
		A23C	A23D	A23F	A23G	A23J
		A23K	A23L 1/*	A23L 3/*	A23P	C12J
		C13B	C13F	C13J	C13K	
11	Manufacture of Beverages [11]	A23L 2/*	C12C	C12F	C12G	C12H
12	Manufacture of Tobacco Products [12]	A24B	A24D	A24F		
13	Manufacture of Textiles [13]	D04D	D04G	D04H	D06C	D06J
		D06M	D06N	D06P	D06Q	
14	Manufacture of Wearing Apparel [14]	A41B	A41C	A41D	A41F	
15	Manufacture of Leather and Related Products [15]	A43B	A43C	B68B	B68C	
16	Manufacture of Wood and of Products of Wood and Cork, except Furniture; Manufacture of Articles of Straw and Plaiting Materials [16]	B27D	B27H	B27M	B27N	
17	Manufacture of Paper and Paper Products [17]	B42F	D21C	D21H	D21J	
18	Printing and Reproduction of Recorded Media [18]	B41M	B42D	B44F		

Table A.4. (continued)

NACE Rev.2		IPC V8
19	Manufacture of Coke and Refined Petroleum Products [19]	C10G C10L
20	Manufacture of Chemicals and Chemical Products [20]	A01N A01P A61K 8/* A61Q A62D B01J B09B B09C B27K C01B C01C C01D C01F C01G C02F C05B C05C C05D C05F C05G C06B C06C C06D C07B not A61K except A61K 8/* C07C not A61K except A61K 8/* C07F not A61K except A61K 8/* C07G not A61K except A61K 8/* C08B C08F C08G C08H C08J C08K C08L C09B C09C C09D C09F C09G C09H C09J C09K C10B C10C C10H C10J C10K C10M C10N C11B C11C C11D C12S not A61K except A61K 8/* C14C C23F C23G C25B C40B not A61K except A61K 8/* D01C D01F D06L F17C F17D F25J F42B F42D G21F
21	Manufacture of Basic Pharmaceutical Products and Pharmaceutical Preparations [21]	A61K A61K except A61K 8/* A61P C07D C07H C07J C07K C12N

Table A.4. (continued)

NACE Rev.2		IPC V8
22	Manufacture of Rubber and Plastic Products [22]	B29B B29C B29D B60C B67D C08C
23	Manufacture of Other Non-Metallic Mineral Products [23]	B28B B28C B32B C03B C03C C04B E03D
24	Manufacture of Basic Metals [24]	B21C B22D C21B C21C C21D C22B C22C C22F C25C C25F G21H
25	Manufacture of Fabricated Metal Products, except Machinery and Equipment [25]	A01L A44B A47H B21G B22F B63G C23D C25D E05B E05C E05D E05F E06B F16B F16T F17B F22B F22G F24J F27D F41A F41B F41C F41F F41G F41H F41J F42C G21B G21C G21D G21J

Table A.4. (continued)

NACE Rev.2		IPC V8
26	Manufacture of Computer, Electronic and Optical Products [26]	A61N B81B B81C B82B B82Y C30B F15C G01B G01C G01D G01F G01H G01J G01K G01L G01M G01N G01Q G01R G01S G01V G01W G02B G02C G02F G03B G03C G03H G04B G04C G04D G04F G04G G04R G05B G05F G06C G06D G06E G06F G06G G06J G06N G06T G08B G08C G09C G11C G12B G21K H01C H01F H01G H01J H01L H01Q H01S H03B H03C H03D H03F H03G H03H H03J H03K H03L H03M H04B H04H H04J H04K H04L H04M H04N H04Q H04R H04S H04W H05G H05H H05K
27	Manufacture of Electrical Equipment [27]	A21B A45D A47G A47J A47L B01B B60M B61L D06F E06C F21H F21K F21L F21M F21P F21Q F21S F21V F21W F21Y F24B F24C F24D F25C F25D G08G G10K H01B H01H H01K H01M H01P H01R H01T H02B H02G H02H H02J H02K H02M H02N H02P H02S H05B H05C

Table A.4. (continued)

NACE Rev.2		IPC V8				
28	Manufacture of Machinery and Equipment N.E.C. [28]	A01B	A01C	A01D	A01F	A01G
		A01K	A01M	A21C	A22B	A22C
		A23N	A24C	A41H	A42C	A43D
		A47K	A62C	B01D	B01F	B02B
		B02C	B03B	B03C	B03D	B04C
		B05B	B05C	B05D	B06B	B07B
		B07C	B08B	B21B	B21D	B21F
		B21H	B21J	B21K	B21L	B22C
		B23B	B23C	B23D	B23F	B23G
		B23H	B23K	B23P	B23Q	B24B
		B24C	B24D	B25B	B25C	B25D
		B25F	B25G	B25H	B25J	B26B
		B26D	B26F	B27B	B27C	B27F
		B27G	B27J	B27L	B28D	B30B
		B31B	B31C	B31D	B31F	B33Y
		B41B	B41C	B41D	B41F	B41G
		B41J	B41K	B41L	B41N	B42B
		B42C	B43M	B44B	B44C	B60S
		B61B	B65B	B65C	B65F	B65F 1/*
		B65F5/*	B65F 7/*	B65F 9/*	B65G	B65H
		B66B	B66C	B66D	B66F	B67B
		B67C	B68F	C10F	C12L	C13C
		C13D	C13G	C13H	C14B	C23C
		D01B	D01D	D01G	D01H	D02G
		D02H	D02J	D03C	D03D	D03J
		D04B	D04C	D05B	D05C	D06B
		D06G	D06H	D21B	D21D	D21F
		D21G	E01C	E01D	E01F	E01H

Table A.4. (continued)

NACE Rev.2		IPC V8
28	Manufacture of Machinery and Equipment N.E.C. [28]	E02C E02D E02F E05G E21B E21C E21D E21F F01B F01C F01D F01K F01M F01N F01P F02C F02G F02K F03B F03C F03D F03G F04B F04C F04D F04F F15B F15D F16C F16D F16F F16G F16H F16K F16M F16N F16P F22D F23B F23C F23D F23G F23H F23J F23K F23L F23M F23N F23R F24F F24H F25B F26B F27B F28B F28C F28D F28F F28G G01G G03G G05D G05G G06K G06M G07B G07C G07D G07F G07G G09D G09G G10L G11B H05F
29	Manufacture of Motor Vehicles, Trailers and Semi-Trailers [29]	B60B B60D B60G B60H B60J B60K B60L B60N B60P B60Q B60R B60T B60W B62D F01L F02B F02D F02F F02M F02N F02P F16J G01P

Table A.4. (continued)

NACE Rev.2		IPC V8
30	Manufacture of Other Transport Equipment [30]	B60F B60V B61C B61D B61F B61G B61H B61J B61K B62C B62H B62J B62K B62L B62M B63B B63C B63H B63J B64B B64C B64D B64F B64G B65F 3/* E01B F03H
31	Manufacture of Furniture [31]	A47B A47C A47D A47F
32	Other Manufacturing [32]	A45F A61G A63G B62B G10F A41G A42B A44C A45B A45C A46B A46D A61B A61C A61D A61F A61H A61J A61L A61M A62B A63B A63C A63D A63F A63H A63J A63K B01L B04B B43K B43L B44D B65D B68G C0F C12M not A61K except A61K 8/* D07B F16L F23Q G01T G03D G03F G09B G09F G10B G10C G10D G10G G10H G21G
42	Civil Engineering [42]	E02B E03B E03C
43	Specialised Construction Activities [43]	E03F E04B E04C E04D E04F E04G E04H
62	Computer Programming, Consultancy and Related Activities [62]	G06Q

Source: Van Looy *et al.* (2015)

Table A.5. Eurostat Technology Intensity Definition of Manufacturing

Classification	Industry	NACE Rev.2 – 2-digit codes
High-technology Industries	Manufacture of basic pharmaceutical products and pharmaceutical preparations	21
	Manufacture of computer, electronic and optical products	26
Medium-high-technology industries	Manufacture of chemicals and chemical products	20
	Manufacture of electrical equipment; Manufacture of machinery and equipment n.e.c.; Manufacture of motor vehicles, trailers and semi-trailers; Manufacture of other transport equipment	27 to 30
Medium-low-technology industries	Manufacture of coke and refined petroleum products	19
	Manufacture of rubber and plastic products; Manufacture of other non-metallic mineral products; Manufacture of basic metals; Manufacture of fabricated metals products, excepts machinery and equipment	22-25
	Repair and installation of machinery and equipment	33
Low-technology industries	Manufacture of food products, beverages, tobacco products, textile, wearing apparel, leather and related products, wood and of products of wood, paper and paper products, printing and reproduction of recorded media	10 to 18
	Manufacture of furniture; Other manufacturing	31 to 32

Source: Eurostat

Table A.6. Summary Statistics (Cross-Country Industry-Level Data)

Variable	Observation	Mean	Std. Dev.	Min	Max
usptogp	17,796	5.01	.0000182	0	.0002955
fvash	18,696	29.15934	13.91482	0	87.28
intdvash	18,696	40.87807	17.3574	0	91.33
rdpdcop	11,166	19.41833	55.31356	0	1057.239
klco	17,816	51.35475	273.8317	.0003213	26176.24

Table A.7. Summary Statistics (Türkiye Industry-Level Data)

Variable	Observation	Mean	Std. Dev.	Min	Max
usptogp	431	3.41	6.86	0	4.51
fvash	456	22.57651	10.75745	2.02	63.66
intdvash	456	42.14789	16.90577	17.56	75.76
rdpdcop	414	2.66081	5.289708	0	46.39217
klco	456	24.83212	39.47437	.0282992	208.6786

Table A.8. Correlation Matrix (Cross Country Industry-Level Data)

Variable	usptogp	fvash	intdvash	rdpdcop	klco
usptogp	1.0000				
fvash	0.0185 (0.0135)	1.0000			
intdvash	-0.0807 (0.0000)	-0.3332 (0.0000)	1.0000		
rdpdcop	0.7710 (0.0000)	-0.0312 (0.0010)	-0.0846 (0.0000)	1.0000	
klco	0.0507 0.0000	0.0280 (0.0002)	-0.1077 (0.0000)	0.0291 (0.0029)	1.0000

Table A.9. Correlation Matrix (Türkiye Industry-Level Data)

Variable	usptogp	fvash	intdvash	rdpdcop	klco
usptogp	1.0000				
fvash	0.2329 (0.0000)	1.0000			
intdvash	-0.2999 (0.0000)	-0.1594 (0.0006)	1.0000		
rdpdcop	0.1863 (0.0002)	-0.1179 (0.0164)	-0.1294 (0.0084)	1.0000	
klco	0.4354 (0.0000)	0.0636 (0.1753)	-0.2837 (0.0000)	0.3214 (0.0000)	1.0000

B. CURRICULUM VITAE

PERSONAL INFORMATION

Surname, Name: Gökten Gürpınar, Selin
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Marital Status:
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EDUCATION

Degree	Institution	Year of Graduation
PhD	Middle East Technical University Science and Technology Policy Studies	2025
MSc	The London School of Economics and Political Science International Political Economy	2012
MSc	Middle East Technical University Economics	2008
BSc	Middle East Technical University Economics	2005

WORK EXPERIENCE

Year	Place	Enrollment
2019-Present	Republic of Türkiye Ministry of Trade	Head of Department
2018 July	Republic of Türkiye Ministry of Trade	Head of Section

2018 June	Republic of Türkiye Ministry of Economy	Head of Section
2011-2018	Republic of Türkiye Ministry of Economy	Foreign Trade Expert
2010-2011	Republic of Türkiye Undersecretariat of the Prime Ministry for Foreign Trade	Foreign Trade Expert
2007-2010	Republic of Türkiye Undersecretariat of the Prime Ministry for Foreign Trade	Associate Foreign Trade Expert
2006-2007	Middle East Technical University Department of Economics	Research Assistant

FOREIGN LANGUAGES

English (advanced)

C. TURKISH SUMMARY / TÜRKÇE ÖZET

Bu tez, küresel değer zincirlerine (KDZ) eklemlenmenin yenilik performansı üzerindeki etkisini farklı KDZ katılım türlerini (geri katılım ve ileri katılım) analiz ederek incelemektedir. Küresel değer zincirleri, 1990'lı yılların başından itibaren küresel ekonomi ve uluslararası ticarette önemli bir olgu olarak kabul edilmektedir. KDZ'nin farklı gelişmişlik düzeylerindeki ülkeler üzerinde ticaret ve yatırım akımları, ekonomik büyüme, gelir yaratımı ve istihdam gibi alanlarda etkileri bulunmaktadır (Gereffi vd., 2001; Baldwin, 2012; OECD, 2013). Bu çok yönlü etkileriyle birlikte KDZ olgusu, politika yapıcılarının gündeminin de kaçınılmaz bir parçası haline gelmiştir.

KDZ, "*ticaret-büyüme-kalkınma bağlantıları, ticaret-rekabet gücü bağlantısı ve ticaret-yönetişim seçeneklerinde*" (Taglioni ve Winkler, 2016, s. xiii) değişikliklere neden olarak ticaret ilişkilerini dönüştürmüştür. Gelişmiş ülkelerin yanı sıra gelişmekte olan ülkelerin de KDZ'lere katılım yoluyla ekonomik faydalar elde edebileceği ileri sürülmektedir (OECD, 2016; Dünya Bankası, 2020, Dünya Bankası, 2022, Ziemann ve Guérard, 2016). Bu bağlamda, OECD (2016), KDZ'lere katılımın ihracat pazarlarını genişleterek ve çeşitlendirerek ticareti, yatırım akımlarını ve bilgi yayılmalarını artırdığını belirtmektedir.

Küreselleşmeden elde edilen kazanımların küresel değer zincirleri kapsamında ülkeler arası ve ülke içi dağılımsal etkilerini anlamak önemlidir. Her ne kadar olumlu etkiler genellikle küresel değer zincirlerine katılımla ilişkilendirilse de küresel değer zincirlerine katılımın her zaman tüm ülkeler için ekonomik büyümeyi ve refah düzeyinin artmasını garanti etmeyebileceği yönünde bazı eleştiriler de bulunmaktadır (Dünya Bankası, 2022). Kowalski vd.'nin (2015) belirttiği gibi, küresel değer zincirlerinden kaynaklanan faydalar tek tip bir şekilde ortaya çıkmamakta ve KDZ ile ilişkili kazanımlar tek tip bir şekilde ele alınmamaktadır. Bazıları, gelişmekte olan ülkelerin küresel değer zincirlerine katılımından kaynaklanan ekonomik faydaları

sorgulamaktadır (UNCTAD, 2014). Özellikle, kalkınmanın küresel değer zincirlerine katılım yoluyla otomatik olarak gerçekleşmediği ileri sürülmektedir. Makroekonomik şokların iletimini kolaylaştırarak oynaklık ve kırılganlığa yol açabileceği nedeniyle, KDZ'ye katılım riskli olarak değerlendirilebilmektedir. Bu kırılganlıklar nedeniyle ülkeler arasında politika tutarlılığının sağlanması önem teşkil etmektedir (OECD, 2013).

Yukarıda bahsi geçen ve birçok akademisyen ile politika yapıcının ilgisini çeken tartışmayı göz önünde bulundurarak, bu çalışmanın amacı, KDZ'ye eklemlenmenin ülkelerin kalkınması için bir çözüm olup olmadığını araştırmak ya da KDZ'ye katılımın ekonomiler açısından olumsuz sonuçlar doğurduğunu iddia etmek değildir. Aksine, bu çalışma, eğer böyle bir ilişki varsa, KDZ'ye katılımın ülkelerin yenilik performansı üzerindeki muhtemel etkisini incelemeye yöneliktir. Bu ilişkinin, ekonomik kalkınma açısından önemli sonuçlar doğurabileceği düşünülmektedir.

Çalışmada, ülkeler arası sektör düzeyinde yapılan analizlere ek olarak, Türkiye üzerine özel bir vurgu da yapılmaktadır. Söz konusu ilişkiye dair yapılan incelemeye dayanarak, bu tez bilim ve teknoloji politikaları ile dış ticaret politikalarına yönelik bazı politika önerileri de geliştirmektedir. KDZ'ye eklemlenmenin yenilik performansı üzerindeki olası etkilerine odaklanarak, bu çalışma ilgili literatüre katkı sağlamayı hedeflemektedir.

KDZ olgusu, iktisat, işletme ile sosyal politikalar ve kamu politikaları gibi farklı disiplinlerdeki bakış açılarıyla incelenebilmektedir. Bu çalışma, KDZ'yi ağırlıklı olarak iktisat literatürünün bakış açısıyla ele almaktadır. Park vd. (2013) tarafından da ifade edildiği üzere, bu bakış açısı genellikle KDZ'yi uluslararası ticaret teorisi çerçevesinde incelemeyi amaçlamaktadır. Bu kapsamda, öncelikli olarak uzmanlaşmaya ve üretimin parçalanmasına neden olan unsurlar irdelenmektedir. Ayrıca, KDZ'nin ölçümüne ilişkin zorluklar ve dağılımsal etkileri de bu bakış açısının konuları arasında yer almaktadır.

KDZ'ye ilişkin literatür, bu olguyu çok yönlü olarak ele almaktadır. Bazı çalışmalar KDZ'yi kavramsal düzeyde incelerken (Antràs, 2020), diğerleri üretim faktörleri

donanımı, ticaret maliyetleri, pazar büyüklüğü, coğrafi konum ve kurumsal yapı gibi unsurlar da dahil olmak üzere KDZ'nin belirleyicilerini anlamaya odaklanmaktadır (Baldwin, 2016; Dünya Bankası, 2020). Buna ilaveten, KDZ'ye katılımın etkilerini inceleyen çalışmalar da bulunmaktadır. Bu etkiler arasında toplam gelir, verimlilik, gelir dağılımı (yoksulluk ve eşitsizlik), sanayileşme gibi konular yer almaktadır (Dünya Bankası, 2020). KDZ üzerine yapılan bazı araştırmalar ise doğrudan KDZ katılımının ölçülmesine ve nicel analizine odaklanmaktadır (Hummels vd., 2001; Johnson ve Noguera, 2012; Koopman vd., 2012, 2014). Antràs ve Chor'un (2022) da belirttiği üzere, KDZ olgusuna disiplinler arası bir bakış geliştirmek isteyenler, Gereffi ve diğerlerinin (2019) çalışmasına başvurabilirler. Dünya Kalkınma Raporu (Dünya Bankası, 2020) ise, KDZ konusunu politika çıkarsamaları da dahil olmak üzere çeşitli yönleriyle ele alan önemli çalışmalardan biridir.

Bununla birlikte, bu tez daha dar kapsamlı ve özgül bir çerçeveye sahiptir. KDZ literatürünün tüm boyutlarını bu tür bir çalışmada kapsamak mümkün değildir. Şüphesiz, KDZ'lere ilişkin tüm konular, ayrı çalışmalarda ele alınmayı hak edecek kadar önemli ve kapsamlıdır. Bu tez ise, KDZ'ye eklemlenmenin yenilik üzerindeki muhtemel etkilerini irdelemeye odaklanmaktadır. Uluslararası ticarette KDZ olgusuna ilişkin mevcut literatürü, yenilik çalışmalarıyla bağlantılı olarak incelemek amaçlansa da KDZ ve yenilik ilişkisini sağlıklı bir biçimde ele alabilmek için KDZ'lerin temel hususlarına ilişkin sağlam bir kavrayışa sahip olmak önemlidir.

Küresel değer zincirlerini tarihsel bir perspektiften inceleyerek başlamak amacıyla, çalışma Baldwin (2006, 2013 ve 2016) tarafından sunulan çalışmalarda ileri sürülen küreselleşmenin tarihsel çerçevesinden faydalanmaktadır. Baldwin (2006, 2013 ve 2016), üç kademeli kısıt perspektifiyle oluşturulan belirgin aşamaları veya ayrışmaları olan küreselleşme fikrini öne sürmektedir. Bu kısıtlar, üretim ve tüketimin ayrılmasını sınırlayan malların, fikirlerin ve insanların hareketliliğine ilişkin maliyetler olarak tanımlanmaktadır. Baldwin (2016), bu maliyetlerin zaman içinde azalıp gevşemesine rağmen, hepsinin aynı anda veya aynı miktarda azalmadığını öne sürmektedir. Ulaşım maliyetleri önemli ölçüde ve daha erken bir dönemde azalırken, fikirlerin ve insanların hareketliliğine ilişkin maliyetler aynı hızda azalmamıştır.

Buhar gücü devriminin ulaşım maliyetlerini azaltmasıyla tetiklenen ilk ayrışma (yaklaşık 1820-1990 dönemi), tüketim ve üretimin ayrılmasına, Kuzey'de (gelişmiş ülkeler) sanayileşmeye ve Güney'de (geri kalmış ve gelişmekte olan ülkeler) sanayisizleşmeye, bir başka deyişle Büyük Ayrışma'ya yol açmıştır. İkinci ayrışma (yaklaşık 1990-günümüz), bilgi ve iletişim teknolojileri devriminin etkisiyle gerçekleşmiş olup fikirlerin iletilme maliyetini ve koordinasyon kısıtlamasını azaltmış, fabrikaların uluslararası olarak ayrılmasına ve karmaşık faaliyetlerin uzaktan koordine edilmesini sağlamıştır. Üretimin uluslararasılaşmasına yol açan ikinci ayrışma, küresel değer zincirlerinin yükselişi veya küresel değer zinciri devrimi olarak da tanımlanmaktadır.

Literatür, KDZ'nin birbiriyle yakından ilişkili birkaç tanımını sunmakta ve çeşitli kavramsallaştırmaları incelemektedir. Kaplinsky ve Morris (2001, s.7), değer zincirini, "*bir ürün veya hizmetin tasarımından itibaren üretim, nihai tüketicilere teslimat ve kullanımdan sonra nihai bertarafına kadar geçen farklı aşamaları ve tüm faaliyetleri kapsayan süreç*" olarak tanımlamaktadır. Bu faaliyetler yalnızca üretim aşamalarını değil, aynı zamanda tasarım, pazarlama, lojistik ve satış sonrası müşteri desteğini de içermektedir. Değer zincirlerinin küresel karakteri, değer zincirlerinin ülkelere yayılmış olmasından kaynaklanmaktadır.

Antràs (2020), KDZ'ye ilişkin temel kavramlara genel bir bakış sunmaktadır. Antràs (2020), özellikle KDZ'nin geniş (veya geleneksel) tanımı ile dar (veya ilişkisel) tanımı arasında ayrım yapmaktadır. KDZ'nin geniş perspektifine göre, KDZ "*tüketicilere satılan bir ürün veya hizmetin üretiminde yer alan, her aşaması değer katan ve en az iki aşaması farklı ülkelerde üretilen bir dizi aşama*" olarak tanımlanmaktadır. Bir firma "*en az bir aşamada değer katıyorsa*" KDZ'ye katılmış sayılmaktadır (Antràs, 2020, s. 3). Bu tanım, özellikle ihracat için üretimde yabancı katma değerin artan kullanımını vurgulamakta ve KDZ'yi ara malı ticaretini içeren daha incelikli bir uluslararası iş bölümü olarak kavramsallaştırmaktadır. Antràs (2020), bu geniş tanımın birçok yararına rağmen, küreselleşmenin son aşamasının bazı özelliklerini göz ardı edebileceğini belirtmektedir. Bu nedenle Antràs (2020), eksik sözleşme uygulamalarının olduğu durumlarda, girdi, mal, teknoloji ve kredi

akışları da dahil olmak üzere, şirketler arası ve şirket içi işlemleri vurgulayan KDZ'nin dar (veya ilişkisel) bakış açısını da sunmaktadır.

KDZ'yi uluslararası ticaret teorisi bağlamında ele almak ve temel ticaret modellerine nasıl bağlanabileceğini anlamak, sadece bir tanımlamanın ötesine geçip KDZ'nin etkilerinin analiz edilmesinde daha da önem kazanmaktadır. Uluslararası ticaret teorisinin tarihsel olarak kökenleri Ricardo'nun karşılaştırmalı üstünlük ilkesine dayanmaktadır. Bu bağlamda, Ricardo'nun doktrinine dayanan ve Heckscher-Ohlin'den Samuelson'a uzanan klasik ticaret modelleri, ülkelerin yalnızca tam rekabet piyasalarında nihai mal ticareti yaptığı ve endüstrilerin sabit ölçekte getiri sağlayan homojen üreticilerden oluştuğu gibi varsayımlara dayanmaktadır. Ancak, bu temel varsayımların uluslararası ticarette gözlemlenen tüm stilize edilmiş olguları açıklamakta kimi zaman başarısız olması sebebiyle yeniden değerlendirilmesi gerekmektedir (Inomata, 2017).

Günümüzde, 1990'ların ortalarından bu yana bilgi ve iletişim teknolojilerindeki kayda değer ilerlemelerle yönlendirilen ve üretim faaliyetlerini ve süreçlerini daha fazla parçalayan KDZ olgusunun, klasik teorinin bir kez daha yeniden yapılanmasını ve genişletilmesini gerektirip gerektirmediğini değerlendirmek yerinde olacaktır. Baldwin (2016), ikinci ayrıştırmanın, yani küresel değer zinciri devriminin, uluslararası ticarette daha fazla yeni bulmacalar ortaya koymasıyla birlikte yeni bir zihinsel modelin gerekli hale geldiğini belirtmektedir. Bu bağlamda Inomata (2017, s.16) da "*klasik teorinin yeniden yapılandırılmasında üçüncü bir dalganın başladığını*" öne sürmektedir. Inomata (2017, s.16), yalnızca nihai malların hareketinden ziyade "*görevlerin veya bu görevler tarafından üretilen katma değerin uluslararası transferinin*" önemini vurgulamaktadır.

Bu bağlamda, üretimin parçalanmasını, dış kaynak kullanımını ve ara mallar ile görevlerin ticaretini modelleyen çalışmalar da bulunmaktadır (Feenstra ve Hanson, 1996; Jones, 2000; Deardorff, 2001; Yi, 2003; Antras ve Helpman, 2004; Grossman ve Rossi-Hansberg, 2008; Baldwin, 2016). Üretimin parçalanması üzerine yapılan çalışmalar arasında Jones (2000), nihai ürünlerin yanı sıra girdilerin artan uluslararası ticaretinin ve üretim faktörlerinin hareketliliğinin önemini vurgulayarak, geleneksel

uluslararası ticaret teorisinde yeni değişikliklerin gerekli olduğunu ileri sürmektedir. Bu nedenle Jones (2000), üretimin parçalanmasını anlamak için analitik bir çerçeve sunmaktadır. Deardorff (2001), hem Ricardian hem de Heckscher-Ohlin modellerinde, farklı ülkelerdeki üretimin parçalanmasının ulusal refah, ticaret ve üretim faktörlerinin fiyatları üzerindeki etkilerini incelemiş ve üretimin parçalanmasının, özellikle ülkenin çıktı değeri açısından önemli olduğunu bulmuştur.

Antràs ve Helpman (2004), sektör içi heterojenlik gibi Yeni-Yeni Ticaret Teorisi'nin bazı özelliklerini Grossman ve Helpman (2002) ile Antràs (2003) tarafından geliştirilen çerçeveyle birleştirerek, firmaların küresel tedarik stratejileri için teorik bir çerçeve geliştirmektedir. Grossman ve Rossi-Hansberg (2008), ara malının (parça ve bileşenlerin) ticaret edilebilirliğinin artmasına odaklanarak, daha incelikli uluslararası iş bölümünü vurgulayan görevler üzerinden ticaret olarak bilinen yeni bir paradigma çerçevesi sunmaktadır. Uluslararası ticaret teorisinde yeni düşünceye duyulan ihtiyacı ele alırken, Baldwin (2016) tarafından sunulan çalışmayı vurgulamak önemlidir. Baldwin (2016) tarafından tanımlanan 21. yüzyıl ticareti, karmaşık mal, hizmet, yatırım ve teknoloji akımlarını içermektedir. Önceleri ağırlıklı olarak Kuzey ülkeleri arasında gerçekleşen bu akışlar, artık Kuzey-Güney sınırlarını aşmaktadır.

KDZ'nin yönetişim yapısını analiz etmek, zincir içindeki aktörler arasındaki güç ilişkilerini ortaya çıkarmak ve bu ilişkilerin zincirin kontrol ve koordinasyon mekanizmasını belirlemesi açısından önemlidir. Gereffi (1994, s.97) yönetişimi "*finansal ve maddi kaynaklar ile insan kaynaklarının bir zincir içinde nasıl tahsis edildiğini ve aktığını belirleyen otorite ve güç ilişkileri*" olarak tanımlamaktadır. KDZ yönetişimi, pazar tipi, modüler tip, ilişkisel tip, tutsak tip ve hiyerarşik tip olmak üzere beş yönetişim yapısına dayanmaktadır. Bu yapılar üç değişkenle ölçülmektedir: aktörler arasında paylaşılan bilginin karmaşıklığı, üretimde bilginin kodlanması ve tedarikçi yetkinlik düzeyi. Bu KDZ yapılandırmasındaki beş farklı yapı aynı zamanda güç asimetrisinin derecesini ve KDZ içindeki ortaklar arasındaki koordinasyonun kapsamını da yansıtmaktadır. Bu yapılandırmanın bir ucunda pazar tipi, diğer ucunda ise hiyerarşik tip bulunmaktadır. (Gereffi ve Frederick, 2009; Gereffi vd., 2005; Gereffi ve Fernandez-Stark 2016). Fiyatın ilişkilerin aracı olduğu

ve işlem karmaşıklığının düşük olduğu piyasa tipi yönetişimde, işlemleri kodlama yeteneği ve tedarik tabanındaki yetenekler yüksektir. İşlemler nispeten basittir, ürün özelliklerine ilişkin bilgi kolayca iletilebilmektedir. Bu nedenle, güç asimetrisi derecesi ve ortaklar arasındaki açık koordinasyon düzeyi düşüktür. Ortakları değiştirmenin maliyetinin her iki taraf için de düşük olması sebebiyle, değişim çok az iş birliği gerektirir. Öte yandan, hiyerarşik tip yönetişimde, güç asimetrisinin derecesi, ortaklar arasındaki açık koordinasyon düzeyi ve işlem karmaşıklığı yüksektir. Tedarik tabanındaki yetenekler ve işlemleri kodlama yeteneği ise düşüktür.

Diğer taraftan, KDZ'ye eklemlenmenin yenilik performansı üzerindeki etkisinin anlaşılması, temel kanalların araştırılmasını gerektirmektedir. Bununla birlikte, KDZ'ye katılım ile yenilik performansı arasındaki bağlantıyı kurmak kolay değildir. Halpern vd.'nin (2005) öne sürdüğü gibi, literatürdeki temel argümanlardan biri, yeni ve daha gelişmiş girdilerin ithal edilmesinin, üretim süreçlerinde karşılaşılan kısıtlamaları ortadan kaldırmanın bir yolu olduğu ve böylece firma verimliliğini olumlu yönde etkilediğidir. Firma verimliliği ne kadar yüksekse, ihracat sabit maliyetleriyle yüzleşmek ve yabancı pazarlar için yeni ürünler üretmek o kadar kolay olmaktadır (Bas ve Strauss-Khan, 2011; Kasahara ve Lapham, 2013). Bu konuyla ilişkilendirilebilecek ilgili bir argüman, çok çeşitli (ucuz) ara mallara (daha yüksek kalitede) daha kolay erişimin, yenilik yoluyla ürün çeşitliliğinin ve ürün kalitesinin artmasına yol açabileceğidir (Xing vd., 2021, s.72).

Bir diğer mekanizma, küresel değer zincirlerindeki geriye dönük bağlantılardan kaynaklanan artan rekabete dayanabilmektedir. Buradaki argüman, geriye dönük bağlantılar kaynaklı ithalat nedeniyle artan rekabetin, firmaları yeni teknolojilere, süreçlere ve becerilere yatırım yapmaya ve yerel kaynakları en rekabetçi firmalara yeniden tahsis etmeye ittiğidir. Artan rekabet, düşük verimliliğe sahip ve ithalatla rekabet eden firmaların pazar paylarını ve karlarını azaltarak, daha gelişmiş teknolojileri benimsemeleri yönündeki teşviklerini artırmaktadır. Rekabet baskısının düzeyi, mevcut teknolojilerin önde gelen ulusal firmalardan daha geniş ekonomiye yayılmasını etkilemektedir (OECD, 2016; Ziemann ve Guérard, 2016). Buna ilaveten, diğer ülkelerin ihracatına girdi sağlamak, üretim standartları, ürün kalitesi,

çevre ve işgücü standartları ile teslimat zaman çizelgeleri de dahil olmak üzere uluslararası en iyi uygulamalara uyumu gerektirmektedir. Bu faktörler, "*verimlilik, yenilik ve beşeri sermaye birikimi*" arasındaki geri bildirim döngülerine katkıda bulunmaktadır (OECD, 2016).

KDZ literatürü, KDZ'ye katılımın bilginin üretimi ve yayılmasında ve dolayısıyla ilgili ülkelere fayda sağlamada oynadığı rolü vurgulamaktadır. Tedarikçilerden ve KDZ lider firmalarından bilgi yayılmaları ve ihracat yoluyla öğrenme gibi çeşitli mekanizmalar aracılığıyla işleyebilen KDZ içindeki öğrenme mekanizmaları, "*beceri geliştirme, beşeri sermaye geliştirme, ürün kalitesi ve süreç iyileştirmeye*" katkıda bulunan temel mekanizmalardır (Ziemann ve Guérard, 2016). Bu da KDZ katılımcıları için yeniliği teşvik edebilmektedir.

Diğer taraftan, bilgi transferi, KDZ'nin yönetişimi ve üretim ile yenilik faaliyetlerinin aynı yerde bulunmasıyla ilgili hususlara ilişkin olarak çeşitli zorluklar ortaya çıkabilmektedir. Kodlanmış ve örtük bilgi arasındaki ayrımı anlamak, bilgi transferine ilişkin engelleri açıklamak için önemli hale gelebilmektedir. Piermartini ve Rubínová (2021), KDZ içindeki etkileşimlerin örtük bilginin aktarımıyla nasıl ilişkili olduğunu tartışmaktadır. Bilginin en azından bir kısmı her zaman örtük (veya kodlanamaz) ise, yalnızca kişisel (veya yüz yüze) etkileşimlerle aktarılabilmektedir. Bu bağlamda, dünyanın farklı bölgelerinde ve ülkelerinde bulunan araştırmacılar arasındaki bu tür etkileşimler, kodlanamayan bilginin nihai aktarımı için beklenenden daha zor olabilmektedir.

Bilgi transferinin önündeki bazı engeller, özümseme kapasitesi ve küresel değer zincirlerindeki öğrenme mekanizmalarıyla ilgili hususlardan da kaynaklanmaktadır. Yerel üreticilerin özümseme kapasitesi, küresel değer zincirlerinden elde edilebilecek potansiyel kazanımların kapsamını etkileyebilmektedir. Piermartini ve Rubínová (2021), küresel değer zincirlerindeki etkileşimlerin bilginin yayılmasına yol açtığını, ancak bilgi alan ülkelerin küresel değer zincirlerinden kaynaklanan bu yayılmalardan ancak yeterli özümseme kapasitesine sahiplerse faydalanabileceğini tespit etmektedir. Yeniliğin gerçekleşebilmesi için ülkelerin yeni bilgiyi etkili bir şekilde özümseme ve değerlendirme kapasitesine sahip olması gerekmektedir.

KDZ'nin yönetişimine ilişkin hususlar da KDZ'ye katılım ile yenilik arasında net ve otomatik bir bağlantı kurulmasında zorluk yaratabilecek faktörlerden biri olarak değerlendirilebilmektedir. Bu husus, özellikle bilgi transferi üzerindeki etkisi açısından da ele alınabilmektedir. Bilginin daha kolay paylaşıldığı yönetişim yapılarında (örneğin, piyasa tipi yapılar veya modüler tip yapılar), yenilik, güç asimetrisi de dahil olmak üzere belirli durumların bilgi alışverişini sınırlayabileceği yönetişim yapılarına (örneğin, hiyerarşik tip) göre daha elverişli olabilmektedir. Yabancı lider firmaların yerel firmalarla teknoloji ve bilgi birikimini paylaşması durumunda yeniliğin ortaya çıkma olasılığı daha yüksektir. KDZ'de lider firmalarla etkili bir şekilde iş birliği yapabilen ülkelere bilginin yayılması olasılığı daha yüksektir.

Xing vd. (2021), yabancı lider firmanın bilgi birikimini ve teknolojiyi yerel tedarikçilere aktarmaya istekli olması durumunda, KDZ'ye katılımın yerel yenilik yeteneklerini geliştirebileceğini belirtmektedir. Yabancı firmalar, dışarıdan temin edilen ara malların/girdilerin müşterileridir ve verimli üretim ve KDZ'nin sorunsuz işleyişini sağlamak için anılan firmaların bilgi birikimini aktarma teşviki bulunabilmektedir. Öte yandan, KDZ'de üretimin parçalanması, örneğin yabancı ana şirketin bilgiyi dikkatlice bölüp tedarikçilere dağıtabilmesi nedeniyle, her zaman yerel yenilik yeteneklerinin gelişmesine yol açmayabilmektedir. Yerel üreticilere bilgi aktarma teşviki tamamlayıcı alanlarda ortaya çıkabilirken, yabancı firmaların yerel tedarikçilerin yenilik faaliyetlerine desteği, temel yetkinlik alanlarını zorlayan alanlarda gerçekleşmeyebilmektedir.

Buna ilaveten, üretim ve yenilik faaliyetlerinin aynı yerde bulunmasından kaynaklanan denge, KDZ ile yenilik arasındaki temel kanalların sorunsuz işleyişini engelleyebilmektedir. Üretim, tasarımdan uzaklaşıp başka ülkelere kaydırıldığında, üretim ve Ar-Ge faaliyetleri arasındaki sinerjinin bozulması nedeniyle yenilik faaliyetleri kısıtlanabilmektedir. Coğrafi yakınlık ve ilişkisel yakınlık, etkileşimli öğrenmede ve güven inşasında önemli rol oynayabilmektedir. Üretim ve Ar-Ge ekipleri aynı yerde bulunduğunda, etkileşimli öğrenmeye katılma ve güven inşa etme fırsatına sahip olurlar; bu da teknolojik ilerlemeye ve yeniliğe katkıda bulunmaktadır.

KDZ literatüründe sınırlı sayıda olmasına rağmen KDZ'ye katılım ile yenilik performansı arasındaki ilişkiye dair bağlantı kurulabilecek bazı çalışmalar mevcuttur. Burada bahsedilen bütün çalışmalar KDZ ile yenilik arasındaki ilişkiyi doğrudan incelemese de yenilik ile dolaylı olarak ilişkili olduğundan bazı çıkarsamalar sunabilmektedir. Bu çalışmalar genel olarak karmaşık sonuçlar ortaya koymaktadır. Bu nedenle, sonuçlara dayanarak, KDZ'ye katılım ile yenilik performansı arasındaki ilişki belirsizliğini korumaktadır. Dahası, KDZ'ye katılımın, özellikle gelişmekte olan ülkeler için yenilik performansında iyileşme sağlayıp sağlayamayacağı tartışmalı bir konu olmaya devam etmektedir. Daha yüksek katılım oranlarının yenilikçi olmayı garantileyip garanti etmediği daha fazla araştırma gerektirmektedir.

Bazı çalışmalar geriye dönük bağlantıların verimlilik (Bas ve Strauss-Kahn, 2011; Halpern vd., 2005; Kasahara ve Lapham, 2013) ve gelir (Walid, 2022) üzerinde olumlu bir etkisi olduğunu bildirirken, diğerleri verimlilik üzerinde önemsiz (Bas ve Strauss-Kahn, 2011) veya olumsuz (Hue ve Korwatanasakul, 2023) etkiler bulmaktadır. Geriye dönük bağlantıların ürün yeniliği üzerindeki etkisi de belirsizdir (olumsuz etkiler: Dang ve Dang, 2020; Ito vd., 2023; önemsiz etki: Lo Turco ve Maggioni, 2015; Thakur ve Sharma, 2025). Buna ilaveten, KDZ'ye katılım ile yenilik arasındaki ilişki dinamik ve doğrusal olmayabilir. Küresel değer zincirlerine erken dönemde dahil olmak yeniliği teşvik edebilirken, ekonomiler olgunlaştıkça yeniliği daha da teşvik etmek için yerel değer zincirlerine daha fazla güvenilebilir (Lee, 2019). Benzer şekilde, KDZ'ye ileri katılımın etkileri karmaşık sonuçlar sergilemektedir. Bazı çalışmalar işgücü verimliliği (Hue ve Korwatanasakul, 2023), gelir (Walid, 2022) ve yenilik (Ito vd., 2023) üzerinde olumlu bir etki bildirmektedir. Tersine, diğer çalışmalar ileri katılım ile yenilik arasında ters U şeklinde bir ilişki olduğunu öne sürmekte ve bu da ülkeler daha derin bir şekilde KDZ'ye eklemlendikçe azalan getirilerin meydana gelebileceğini göstermektedir (Thakur ve Sharma, 2025).

Bu tezde, KDZ'ye eklemlenmenin (ileri ve geri katılım) yenilik performansı üzerindeki etkisini incelemek amacıyla, 1995-2018 dönemini kapsayan 41 ülke ve 19 sektöre ait panel veri kullanılarak ülkeler arası sektör düzeyinde bir analiz gerçekleştirilmiştir. Bu kapsamda, çalışmanın katkılarından biri ayrı alanlardan gelen

verileri birleştirerek ve dönüştürerek kapsamlı bir veri setini oluşturmaktır. Söz konusu veri seti, KDZ katılım ölçümleri (hem geri hem de ileri katılım ölçümleri), patent, Ar-Ge harcamaları, gayrisafi sabit sermaye oluşumu, sektöre göre istihdam ve nüfus ile ilgili değişkenleri içermektedir.

TiVA veri tabanı KDZ'ye katılıma ilişkin halihazırda oluşturulmuş göstergeler sunmaktadır. Diğer ülkelerin ihracatında kullanılan yurtiçi katma değerli ihracatın toplam ihracat içindeki payı (ileri katılım göstergesi olarak) ve ihracatın içerisindeki yabancı katma değer oranı (geri katılım göstergesi olarak) da göstergeler arasında bulunmaktadır. Bu nedenle, KDZ'ye katılıma ilişkin değişkenler için TiVA veri tabanı kullanılmıştır. Araştırma verilerinin ikinci ayağını, ülke ve sektör düzeyindeki yenilik faaliyetleri ve performansıyla ilişkili değişkenler oluşturmaktadır. Bu alan için çalışmada kullanılan veri kaynakları, OECD'nin Teknolojiye Göre Patentler veri tabanı ve OECD Analitik İşletme Araştırma ve Geliştirme (ANBERD) veri tabanıdır. Çalışmada, KDZ'nin ölçümü ve yenilik faaliyetlerine ilişkin istatistiklerin yanı sıra, diğer bazı alanlarla ilgili istatistikler de kullanılmıştır. Bu istatistikler, nüfus istatistikleri, gayrisafi sabit sermaye oluşumu istatistikleri ve istihdam istatistikleridir. Çalışmada nüfus istatistikleri OECD'nin Demografi ve Nüfus İstatistikleri veri tabanından, gayri safi sabit sermaye oluşumu istatistikleri OECD'nin Girdi-Çıktı veri tabanından (IOTs 2021) ve istihdam istatistikleri OECD'nin Ticaretle Bağlantılı İstihdam (TiM 2021) veri tabanından elde edilmiştir.

Verilerin farklı alanlardaki kaynaklardan temin edilmesi sebebiyle, ülke-sektör düzeyindeki verilerin sınıflandırılması değişkenler arasında farklılık göstermektedir. Ampirik çalışma için verilerin aynı ekonomik faaliyet sınıflandırmasına göre dönüştürülmesi gerekmektedir. Bu nedenle, ISIC Rev.4 sınıflandırmasına dayalı ülke-sektör düzeyindeki veriler, ISIC Rev.4 – TiVA 2021 uyum tablosu kullanılarak dönüştürülmüş ve TiVA veri tabanının sektör sınıflandırmasına göre toplulaştırılmıştır. Buna ilaveten, tezdeki katkılarımızdan biri, TiVA veri tabanındaki sektör sınıflandırmasını patent sınıflandırmasıyla birleştirmektir. Uluslararası Patent Sınıflandırması'nın teknoloji alanlarına göre elde edilen patent sayısı verileri ISIC Rev.4 sınıflandırmasına dönüştürülmüş ve müteakiben TiVA veri tabanının sektör sınıflandırmasına göre toplulaştırılmıştır. Anılan verilerin dönüşümü için, Avrupa

Birliği İstatistik Ofisi'nin Uluslararası Patent Sınıflandırması V8 – NACE Rev.2 dönüşüm tablosu kullanılmıştır. Ayrıca, ISIC Rev.4 sınıflandırmasına dayalı olarak sektör bazında Ar-Ge harcamalarına ilişkin veriler, TiVA veri tabanının sektör sınıflandırmasına göre toplulaştırılmıştır.

Ülkeler arası sektör düzeyindeki analiz için sıradan en küçük kareler regresyonu (OLS), sabit etkiler modeli (FE), rastgele etkiler modeli (RE), panel veri için araç değişkenleri (IV) tahmini (sabit etkiler iki aşamalı en küçük kareler (2SLS) araç değişkenler tahmini ve rastgele etkiler genelleştirilmiş iki aşamalı en küçük kareler (G2SLS) araç değişkenler tahmini) ve dinamik otoregresif panel veri modeli ekonometrik tahmin yöntemi olarak uygulanmıştır. Anılan panel veri modelleri, panel verinin, kesitsel veri ve zaman serisi veriye kıyasla daha fazla konunun ele alınmasına olanak sağlaması sebebiyle kullanılmıştır (Park, 2011). Ayrıca, içsellik sorununu aşmak amacıyla araçsal değişken tahmini kullanılmıştır.

KDZ'ye katılımın yenilik performansı üzerindeki genel etkilerine ilaveten, ayrıca sanayi sektörlerinin teknoloji sınıflandırmasına göre KDZ'ye katılımın etkisi incelenmiştir. Teknoloji yoğunluğu sınıflandırmasının yalnızca imalat sektörleri için mevcut olması nedeniyle, analiz imalat sektörleriyle sınırlı olup hizmetleri kapsamamaktadır. Yukarıda bahsi geçen ekonometrik modeller imalat sanayi sektörlerinin teknoloji yoğunluğu sınıflandırmasına göre de uygulanmış olup, böylelikle geri katılım ile ileri katılımın etkilerinin değişip değişmediği test edilmiştir. Bu doğrultuda, veri setindeki sektörler düşük teknoloji, orta düşük teknoloji, orta yüksek teknoloji ve yüksek teknoloji olmak üzere dört teknoloji grubuna ayrılmıştır.

Tezde, Türkiye'nin küresel değer zincirlerine katılımının yenilik performansı üzerindeki etkilerinin derinlemesine bir analizi de sunulmuş ve ülkeler arası sektör düzeyindeki analizi tamamlayan ayrı bir bölüm oluşturulmuştur. Burada akla gelebilecek önemli bir soru, KDZ-yenilik ilişkisinin tartışılmasında Türkiye'nin neden özel olarak ele alınması gerektiğidir. Türkiye'ye odaklanmanın gerekçesi çeşitli nedenlerle açıklanabilir. Bunlar arasında Türkiye'nin küresel değer zincirlerine artan katılımı, küresel ve bölgesel üretim ağlarındaki konumu ve kayda değer bir ticaret ve ekonomik hacme sahip bir ülke olması yer almaktadır.

Diğer taraftan, Türkiye'nin küresel değer zincirlerine artan katılımı tek başına ayrı bir incelemeyi haklı çıkarmaya yeterli olmayabilir. Türkiye'nin önemini daha da artıran bir diğer husus ise, 1990'ların ortalarından itibaren küreselleşmenin yeni evresinde küresel değer zincirlerine artan katılımının, 1995 yılında Avrupa Birliği ile Gümrük Birliği'nin kurulmasıyla aynı zamana denk gelmesidir. Bu uyum, bir dereceye kadar, üretimin uluslararası parçalanmasına ilişkin Baldwin (2016) tarafından sunulan sınıflandırma çerçevesinde de yorumlanabilmektedir. Bu çerçeve, Avrupa Birliği'ni bölgesel bir merkez, Türkiye'yi ise bir fabrika ekonomisi olarak konumlandırmaktadır. Bu da Türkiye'nin farklı bir örnek olarak değerlendirilmesini desteklemektedir. Türkiye ile Avrupa Birliği arasındaki Gümrük Birliği, özellikle Avrupa üretim ağları içinde Türkiye'nin küresel değer zincirlerine katılımına önemli ölçüde katkıda bulunarak ticaret ve yenilik çıktıları üzerindeki etkilerini güçlendirmiş olabilir.

Ayrıca, On İkinci Kalkınma Planı'nda da belirtildiği gibi, Türkiye, küresel değer zincirlerine katılımı daha da artırarak daha yüksek katma değerli ihracatı artırma ve teknoloji ile bilgi transferine erişimi iyileştirme konusunda bir hedef belirlemiştir. Bu stratejik taahhüt, Türkiye'nin küresel değer zincirleri içindeki konumunu güçlendirerek uluslararası rekabet gücünü ve teknolojik yeteneklerini geliştirme arzusunu vurgulamaktadır.

Küresel değer zincirlerine artan katılımına rağmen, Türkiye'nin uluslararası üretim zincirlerindeki konumu önemli ölçüde iyileşmemiştir. Özellikle, ihracat ürünlerinin ve yenilik çıktılarının gelişmişliği, emsallerine kıyasla sınırlı kalmıştır. Türkiye, uluslararası üretim zincirlerinde ileri teknolojilerden ziyade standartlaştırılmış ürünlerde uzmanlaşmıştır (Taymaz vd. 2011; Dünya Bankası, 2022). Bu durum, Türkiye'nin küresel değer zincirlerine katılımının yenilik performansı üzerindeki etkilerinin kapsamlı bir şekilde incelenmesini gerektirmektedir.

Yukarıda belirtilen özellikler, Türkiye'nin KDZ'ye katılımı ile yenilik performansı arasındaki ilişkiyi anlamaya yönelik daha ileri analizler için ilgili ve açıklayıcı bir örnek olarak ele alınmasının gerekçesini vurgulamaktadır. Böyle bir analiz, ülkelerin yenilik performansını iyileştirmek için küresel değer zincirine katılımını kullanıp

kullanamayacakları ve hangi yollarla kullanabilecekleri konusunda değerli bilgiler sağlayabilecektir.

Türkiye'ye ilişkin bölümde, Türkiye'nin küresel değer zincirlerine eklemlenmesine ilişkin daha önceki çalışmalar ve bu katılımın temel itici güçleri ile büyüme, kalkınma, verimlilik ve yenilik gibi ekonomik sonuçları kısaca ele alınmıştır. Buna ilaveten, bu bölümde Türkiye'nin küresel değer zincirine katılımının yenilik performansı üzerindeki etkileri nicel bir analizle incelenmiştir. Bu kapsamda, betimsel analiz ve ekonometrik analiz olmak üzere iki farklı nicel analiz türü uygulanmıştır.

Tez, KDZ'ye eklemlenmenin yenilik performansı üzerindeki etkisinin, katılımın türüne ve sektörlerin teknoloji yoğunluğuna göre farklılık gösterdiğini ortaya koymaktadır. Ülkeler arası ve sektör düzeyindeki analizin bulgularına göre, ihracat yapmak amacıyla yapılan ithalatın, bir başka deyişle geri katılımın, yenilik performansı üzerindeki etkisi istatistiksel olarak anlamlı ve pozitiftir. Diğer taraftan, geri katılımın etkisinin, sektörler teknoloji yoğunluklarına göre sınıflandırıldığında farklılık gösterdiği görülmektedir. Ülkeler arası sektör düzeyindeki analiz, genel etkinin pozitif olduğunu göstermektedir; ancak bu sonuç, sektörler teknoloji yoğunluklarına göre sınıflandırıldığında yalnızca orta-yüksek teknoloji grubu için geçerlidir.

Bu sonuçlar ilgili literatürde geri katılımın yenilik performansı üzerinde olumlu bir etkiye sahip olabileceğini öne süren bazı argümanları desteklemektedir. İlk olarak, daha geniş bir yelpazede (ucuz veya daha yüksek kalitede) ara malına daha kolay erişim nedeniyle, KDZ içinde geriye dönük bağlantılar kurmak, üretim sürecindeki kısıtlamaları ve maliyetleri ortadan kaldırmanın veya azaltmanın bir yolu olarak değerlendirilebilmektedir. Bu durum, verimlilikte, ürün çeşitliliğinde ve ürün kalitesinde artışa yol açabilir ve firmaların ihracat maliyetlerini azaltmalarına ve dış pazarlara üretim yapmalarına yardımcı olabilir (Halpern vd., 2005; Bas ve Strauss-Khan, 2011; Kasahara ve Lapham, 2013, aktaran Lo Turco ve Maggioni, 2013; Xing vd., 2021).

İkinci olarak, literatür, aynı zamanda KDZ içindeki geriye dönük bağlantıların bilgi edinimi, yayılımı ve teknoloji kaynakları üzerindeki rolünü vurgulamaktadır

(Morrison vd., 2008). Tedarikçilerden gelen bilgi yayılımları ürün kalitesine, süreç iyileştirmelerine ve beşeri sermayenin geliştirilmesine katkıda bulunabilir ve böylece yenilik performansını artırabilir. Dahası, KDZ içindeki geriye dönük bağlantıların yol açtığı ithalat rekabetine maruz kalma, yerel kaynakların en rekabetçi firmalara yeniden tahsis edilmesine yol açar ve bu girdileri üreten yerel firmaları yeni teknolojilere ve becerilere yatırım yaparak yenilik yapmaya iter (Ziemann ve Guérard, 2016). OECD (2015, s.49) tarafından tartışıldığı gibi, rekabet baskısının düzeyi "mevcut teknolojilerin en gelişmiş ulusal firmalardan ekonominin geri kalanına yayılmasını" etkiler. Düşük verimliliğe sahip (veya ithalatla rekabet eden) firmaların pazar payındaki ve karlarındaki azalma, daha iyi teknolojilere yatırım yapmaya ve bunları özümsemeye yol açar (OECD, 2015). Bulgularımız, bu mekanizmalardan en az birinin düzgün çalıştığını, dolayısıyla yenilik performansı üzerindeki genel etkinin olumlu olduğunu göstermektedir.

Ülkeler arası sektör düzeyindeki analize göre, diğer ülkelerin ihracatına girdi sağlamanın, bir başka deyişle ileri katılımın yenilik performansı üzerindeki etkisi, seçtiğimiz modele bağlı olarak istatistiksel olarak anlamsız veya negatif olarak bulunmuştur. Her durumda, bu sonuçlar genel örüntüde yenilik performansı üzerinde olumlu bir etkinin olmadığını göstermekte ve küresel değer zincirlerine ileri katılımın yenilik performansı üzerindeki olumlu etkileri konusunda bazı şüpheler uyandırmaktadır. Literatürdeki çeşitli argümanlar, küresel değer zincirleri içinde bilgi edinme ve yayma için ileri bağlantıların önemini vurgulamaktadır. Bu bağlamda, ihracat yoluyla öğrenme ve dış kaynak (öncü) firmalardan bilgi yayılmaları, ülkelerin ileri bağlantılardan yararlandığı temel kanallar olarak belirtilmektedir. Küresel değer zincirlerinin sorunsuz işleyişi için, öncü dış kaynak firmalarının bilgi birikimini ve teknolojiyi yerel tedarikçilere aktarması beklenmektedir. Bu itibarla, yerel yenilik yetenekleri buna göre geliştirilebilir. Buna ilaveten, ileri bağlantılar firmalar üzerinde uluslararası üretim ve ürün standartlarına yakınsama baskısı yaratabilir (OECD, 2016). Kalite, çevre ve işgücü standartları ile teslimat süresine ilişkin uluslararası gereklilikleri karşılamak için firmalar yenilik yapmaya zorlanabilir. Ancak, yukarıda belirtilen bu argümanlar bulgularımız tarafından tam olarak desteklenmemektedir.

Ayrıca, ülkeler arası sektör düzeyindeki analize dayanarak, diğer ülkelerin ihracatına girdi sağlamanın yenilik performansı üzerindeki etkisinin, sektörlerin teknoloji yoğunluğu sınıflandırmasına göre değiştiği tespit edilmiştir. İleri katılımın sadece orta-düşük teknoloji sektörleri olumlu etkilediği bulunmuştur. Bu bulgular, bilgi edinimi ve yayılma etkilerine ilişkin argümanları bir dereceye kadar desteklemekte ve ihracat yoluyla öğrenme kavramının yalnızca kısmen geçerli olduğunu göstermektedir.

Türkiye'ye ilişkin yapılan analiz sonuçlarına dayanılarak, KDZ'ye geri katılımın genel etkisinin yenilik performansı üzerinde anlamlı bir etkisinin olmadığı görülmektedir. Bu bulgu, ülkeler arası sektör düzeyindeki analizden elde ettiğimiz sonuçtan farklıdır. Daha açık ifade edecek olursak, anılan bulgular geri katılımın yenilik performansı üzerindeki etkisi açısından Türkiye'nin diğer ülkelerin genel görünümüyle örtüşmediğini ve onlardan farklılaştığını göstermektedir. Bu durum, KDZ literatüründe vurgulanan nitelikli ve/veya daha ucuz girdilere erişim, bilgi transferi ve ithalat rekabetine maruz kalma gibi mekanizmaların, incelenen dönemde Türkiye için genel örüntüde tam olarak işlemediğini göstermektedir. Diğer taraftan, sektörler teknoloji yoğunluklarına göre sınıflandırıldığında Türkiye örneğinde geri katılımın etkisinin farklılık gösterdiği görülmektedir. Geri katılımın, orta-yüksek teknoloji grubunda yenilik performansı üzerinde olumlu bir etkisi bulunurken, düşük teknoloji ve orta-düşük teknoloji sektörlerinde olumlu bir etkisi görülmemektedir.

Analiz sonuçlarına göre, diğer ülkelerin ihracatına girdi sağlamanın Türkiye'nin yenilik performansı üzerinde genel örüntüde olumlu bir etkisi bulunmamaktadır. Bu sonuç, ülkeler arası sektör düzeyindeki analiz bulgularıyla tutarlıdır. Ülkeler arası sektör düzeyindeki analiz bulgularına benzer şekilde, ileri katılımın olumlu etkilerini vurgulayan KDZ çerçevesindeki bazı argümanlara da ihtiyatlı yaklaşılmaktadır. Beklenen mekanizmaların neden tam olarak işlemediği ve dolayısıyla olumlu bir etkinin ortaya çıkmadığı sorusu, bilgi ve yenilik ekonomisi literatüründeki argümanlarla açıklanabilir. Buna ilaveten, Türkiye örneğinde, diğer ülkelerin ihracatına girdi sağlamanın etkisi, sektörler teknoloji yoğunluklarına göre sınıflandırıldığında daha az belirgin hale gelmektedir. İleri katılımın, düşük teknoloji ve orta-düşük teknoloji gruplarında yenilik performansı üzerinde olumlu bir etkisi olmasa da orta-yüksek teknoloji grubunda olumlu bir etkisi bulunmaktadır.

Ülkeler arası sektör düzeyindeki analiz bulguları ile Türkiye'ye ilişkin analiz bulgularına dayanılarak, bu tez, KDZ'ye katılımın yenilik performansı üzerindeki etkilerindeki farklılıkların bilgi ekonomisi ile yenilik çalışmaları alanlarındaki bazı unsurlardan kaynaklanabileceğini öne süren politika çıkarsamalarında bulunmaktadır. Bu kapsamda, tezde küresel değer zincirlerine eklemlenmenin yenilik performansı açısından faydalarının kendiliğinden ve garanti kabul edilmemesi gerektiği öne sürülmektedir. Zira KDZ'ye katılımın tek başına yeterli olmaması nedeniyle, politika yapıcılar yalnızca daha fazla eklemlenmeye odaklanan genel politika önerileri sunmaktan kaçınmalıdır. Bunun yerine, politika yapıcılar sektör düzeyinde geri ve/veya ileri katılımın teşvik edilmesi gibi daha özel ve hedefe yönelik amaçlar belirlemeli ve politika önerilerini buna göre şekillendirmelidir. Tezde bu, küresel değer zincirlerine katılım yoluyla yenilik performansının artırılmasını ifade etmektedir. Günümüz küresel ekonomisinde KDZ'ye katılımın çoğu zaman kaçınılmaz olduğu göz önüne alındığında, politika yapıcılar bu eklemlenmenin ülkenin yenilik performansını iyileştirecek şekilde gerçekleşmesini sağlamak için ihtiyatlı davranmalıdır. Bu bağlamda, politika önerileri geliştirirken otomatik işleyen bir mekanizma ya da izlenmesi gereken önceden belirlenmiş bir yol olmadığının farkında olmak büyük önem taşımaktadır.

Küresel değer zincirlerine katılımın yenilik performansı üzerindeki etkilerinin tek tip olmaması sebebiyle, politika yapıcılar "herkese uyan tek bir çözüm" olarak ifade edebileceğimiz bir yaklaşımdan kaçınmalıdırlar. Yenilik performansı açısından faydaların sağlanabilmesi için politika yapıcılar yalnızca küresel düzeydeki politikalara dayalı öneriler sunmaktan sakınmalıdırlar. Ayrıca, sadece ulusal düzeyde yapılan politika önerileri de bu faydaların elde edilmesi için yeterli olmayabilir. Bu nedenle, ilgili ülkenin özelliklerinin yanı sıra, sektörler arası farklılıkların da dikkate alınması gerekmektedir. Tezde bu, farklı teknoloji yoğunluklarına göre sınıflandırılmış sektör gruplarına karşılık gelmektedir.

Tez, KDZ'ye eklemlenmenin yenilik performansı üzerindeki etkisinin, ilgili ülkeye (Türkiye örneğinde gösterildiği üzere), farklı teknoloji yoğunluğuna sahip sektör gruplarına ve eklemlenmenin türüne, bir başka deyişle, geri veya ileri katılıma göre değiştiğini ortaya koymaktadır. Bu bağlamda, politika yapıcıların geri ve ileri

katılımın etkilerindeki bu farklılıkları dikkate almaları ve buna göre hedefe yönelik politika önerileri geliştirmeleri önemlidir.

KDZ'ye ilişkin politikalar sanayileşme ve yenilik politikalarıyla güçlü bir şekilde desteklenmeli ve tamamlanmalıdır. Literatürde KDZ'ye katılımın yenilik performansı üzerinde olumlu etkileri olduğunu öne süren bazı argümanların her zaman tam olarak geçerli olmaması sebebiyle, politika yapıcılar, bu durumun altında yatan nedenleri ve anılan kısıtları yalnızca KDZ çerçevesinde değil, aynı zamanda bilgi ekonomisi ve yenilik çalışmaları gibi ilgili alanlarda da araştırmalıdırlar. Konu ilk bakışta sadece KDZ olgusu ile ilgiliymiş gibi görünse de (ki bu yanıltıcı olabilir), politika yapıcılar bu durumu göz ardı etmemeli ve bilgi ekonomisi ile yenilik literatüründen elde edilen çıkarımları bütünleştirerek politika önerileri geliştirmelidir. Tezin bulguları, bu iki politika alanının birbirini önemli ölçüde tamamladığını ortaya koymaktadır. Bu nedenle, politika yapıcıları farklı alanlardaki politikaları birbirini tamamlayacak şekilde geliştirmelidir.

Küresel değer zincirine katılım yoluyla yenilik performansını artırmak için bilgi edinme ve yayma mekanizmalarının düzgün bir şekilde işlemesi gerekmektedir. KDZ içindeki bağlantılar aracılığıyla bilgi katılımcı aktörler tarafından etkili bir şekilde edinilmelidir. Bu nedenle, politika yapıcılar söz konusu aktörlerin bilgiyi edinme ve kullanma kapasitelerini, başka bir deyişle, özümseme kapasitelerini artırmak amacıyla yükseköğretim, mesleki eğitim ve öğretim, yaşam boyu öğrenme, araştırma ve geliştirme personelinin sayısının artırılması ve örtük bilginin aktarımı için yüz yüze etkileşimlerin (özellikle doğrudan yabancı yatırımlar aracılığıyla) teşvik edilmesi hususlarında daha fazla yatırım yapmalıdırlar.

Küresel değer zincirlerinin yönetişim yapıları hem bilgi paylaşımının hem de bilginin kodlanmasının (isteklilik) derecesini etkileyebilir. Politika tasarımında, politika yapıcılar KDZ içerisindeki ilişkilerin bilgi yayılımını kolaylaştıracak ve öğrenme mekanizmalarını destekleyecek şekilde kurulmasına yeterli özeni göstermelidir. Bu doğrultuda, hiyerarşik bir yapı kurmak yerine daha çok piyasa temelli yönetişim türlerinin benimsenmesi teşvik edilebilir. Bu amaçla, politika yapıcılar kurumsal çerçevenin iyileştirilmesi yönünde çaba göstermelidir. Bu, sözleşme koşullarının ve

ilişkilerinin geliştirilmesi gibi unsurları içerebilir. Ayrıca, yasa ve kuralların izlenmesi, uygulanması ve yaptırım mekanizmalarının etkinleştirilmesi ile etkili uyuşmazlık çözüm mekanizmalarının kurulması da bu çerçevede değerlendirilebilir. Bilgi transferinin yasal yollarla güvence altına alınabilmesi için hukuki ve kurumsal altyapının geliştirilmesi de önemlidir.

Politika yapıcılar, finansal kaynaklar ve beşeri sermaye de dahil olmak üzere, kaynakların hangi sektörlere tahsis edileceğini önceliklendirmelidir. Tüm sektörlerin katılımını artırmak ve kaynakları buna göre tahsis etmek gibi genel politikalar izlemek yerine, politika yapıcılar, KDZ bağlantılarının türünü ve KDZ'ye eklemlenme ile yenilik performansının arttığı belirli sektör gruplarını dikkate alan politikalar oluşturmalıdır.

Tez, ticaret politikasının sonuçlarından birinin yenilik performansı üzerinde etkisi olabileceğini öne sürmektedir. Bu bağlamda, küresel değer zincirlerine katılım yoluyla ticaret bağlantılarından yararlanmak, yenilik performansını artırabilir. Küresel değer zincirleri içindeki bilgi edinme mekanizmasının etkili bir şekilde işlemesini sağlayan politika önlemleri geliştirmek, KDZ katılımından yararlanmak için önemli hale gelmektedir.

Mevcut literatüre katkıda bulunan bu tezden çeşitli çıkarımlar elde edilebilse de daha fazla araştırma gerektiren alanlar da bulunmaktadır. Çok yönlü olması sebebiyle konu daha geniş bir analitik çerçevede incelenebilir ve bu çalışma çeşitli yönlere genişletilebilir. Tezin ampirik bulguları, KDZ'ye katılımın yenilik performansı üzerindeki etkisinin ülkeler ve sektörler arasında farklılık gösterdiğini ortaya koymaktadır. Bu durum, küresel değer zincirlerine katılımın firma düzeyinde yenilik performansı üzerindeki etkisini inceleyen hem nitel hem de nicel daha fazla yeni çalışmaya acil ihtiyaç olduğunu göstermektedir.

Ayrıca, bilginin eksik veya sınırlı aktarımı hususu kapsamlı bir şekilde ele alınmalı ve analize dahil edilmelidir. Bu durum, özümseme kapasitesinin düzeyi, bilginin türü, zincir içindeki yönetişim yapıları, kurumsal altyapı ve bilgi aktarımına ilişkin diğer konular gibi ilgili faktörlerin araştırılmasını gerektirebilir. Yakınlığın rolüne

ilişkin olarak, araştırmanın ekonometrik çerçevesi mekansal regresyon modelleri uygulanarak da geliştirilebilir. Üretimin uluslararası parçalanmasında hizmetlerin artan rolü göz önüne alındığında, bu çalışma, hizmetlerin analizini daha kapsamlı bir şekilde içeren genişletilmiş bir araştırmayı da gerektirmektedir. Böyle bir çalışma, aksi takdirde göz ardı edilebilecek hizmetlere ilişkin faktörleri dikkate alarak küresel değer zincirleri-yenilik ilişkisine daha geniş bir bakış açısı sağlayarak derin içgörüler sunulabilir.

Küresel ekonomi ve uluslararası ticarette yaşanan son gelişmeler, özellikle pandemi ve korumacı ticaret politikalarının yükselişi, küresel değer zincirlerinin geleceğine ilişkin kayda değer yansımalara sebep olabilir. Bu durum küresel değer zincirlerinin kırılganlıklarını ortaya çıkarabilir ve yenilik performansını etkileyebilir. Bu nedenle, söz konusu gelişmeler önemli ölçüde dikkat ve derinlemesine inceleme gerektiren yeni ve kayda değer araştırma alanlarını ortaya çıkarmaktadır. Gelecekteki çalışmalarda yukarıda belirtilen genişleme alanlarının dikkate alınması, küresel değer zincirlerine eklemlenmenin yenilik performansı üzerindeki etkilerini daha bütüncül ve derinlemesine anlamaya katkı sağlayabilir.

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