THE IMPACT OF KNOWLEDGE SPILLOVERS ON EXPORT PERFORMANCE OF COUNTRIES: A PANEL DATA APPROACH

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SEREN ÖZSOY

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I certify that this thesis satisfies all the requirements as a thesis for the degree of Master of Science

Prof. Serdar SAYAN
Director of the Graduate
School of Social Sciences

This is to certify that I have read this thesis and that it in my opinion is fully adequate, in scope and quality, as a thesis for the Degree of Master of Science in the field of Economics of Graduate School of Social Sciences.

Thesis Advisor

Asst. Prof. Burcu FAZLIOĞLU

(TOBB University of Economics and Technology, International Entrepreneurship)

Thesis Committee Members

Asst. Prof. Ünay TAMGAÇ TEZCAN

(TOBB University of Economics and Technology, Economics)

Assoc. Prof. Başak DALGIÇ

(Hacettepe University, Economics)

I hereby declare that all information in this document has been obtained and presented in accordance with academic rules and ethical conduct. I also declare that, as required by these rules and conduct, I have fully cited and referenced all material and results that are not original to this work.

Seren ÖZSOY

ABSTRACT

THE IMPACT OF KNOWLEDGE SPILLOVERS ON EXPORT PERFORMANCE OF COUNTRIES: A PANEL DATA APPROACH

ÖZSOY, Seren
M.Sc., Economics
Supervisor: Asst. Prof. Burcu FAZLIOĞLU

The aim of this thesis is to investigate whether inflows of FDI and innovative activities act as a channel of knowledge spillovers in improving export performance of countries. In measuring export performance, sophistication of a countries' export basket and the value of exports of high technology products are utilized. A rich panel data with 114 countries that comprises both developed and developing countries for the period from 2002 to 2015 is used in the analysis. Generalized Method of Moments (GMM) dynamic panel estimator developed by Arellano and Bond (1991) is utilized to control for potential endogeneity and dynamic nature of the problem.

Estimation results indicate that the level of financial development, the quality of human capital and globalization of a country have a determinative role on the relation between knowledge spillover channels and the quality of exports in terms of sophistication and technology content.

Overall, patent applications generally positively affect sophistication of exports. However, FDI serves as a channel for knowledge spillovers to benefit the sophistication level of exports only for developed, more educated, financially developed and globalized countries. The results of the study demonstrate a weaker relationship between knowledge spillovers and technology content of exports with respect to sophistication of exports.

Key Words: Knowledge Spillovers, Sophistication of Export, Patent Applications, Foreign Direct Investments

ÖZ

BİLGİ YAYILIMLARININ ÜLKELERİN İHRACAT PERFORMANSINA ETKİSİ: PANEL DATA YAKLAŞIMI

ÖZSOY, Seren
Yüksek Lisans Tezi, Ekonomi
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Bu tezin amacı, doğrudan yabancı sermaye girişlerinin ve yenilikçi faaliyetlerin ülkelerin ihracat performansının iyileştirilmesinde bilgi yayılımı kanalı olarak hareket edip etmediğini araştırmaktır. İhracat performansının ölçülmesinde, bir ülkenin ihracat sepetinin sofistikasyonu ve yüksek teknoloji ürünlerinin ihracatının değeri kullanılmaktadır. Analizde, 2002'den 2015'e kadar hem gelişmiş hem de gelişmekte olan ülkeleri kapsayan 114 ülke ile zengin bir panel veri kullanılmıştır. Potansiyel içsellik problemini kontrol etmek için Arellano and Bond (1991) tarafından geliştirilen Genelleştirilmiş Momentler Metodu (GMM) dinamik panel tahmincisi kullanılmıştır.

Tahmin sonuçları, bir ülkenin insan sermayesinin niteliğinin, finansal gelişiminin ve küreselleşme düzeyinin, bilgi yayılım kanalları ve ihracatın kalitesi (sofistikasyon ve teknoloji içeriği açısından) arasındaki ilişkide belirleyici bir role sahip olduğunu göstermektedir.

Genel olarak, patent başvuruları sofistike ihracatı olumlu yönde etkilemektedir. Bununla birlikte, DYY, sadece gelişmiş, daha eğitimli, finansal olarak gelişmiş ve küreselleşmiş ülkelerde sofistike ihracat için bilgi yayılım kanalı görevi görmektedir. Çalışmanın sonuçları sofistike ihracata kıyasla, bilgi yayılımı ve teknoloji içerikli ihracat arasındaki ilişkinin daha zayıf olduğunu göstermektedir.

Anahtar Kelimeler: Bilgi Yayılımları, Sofistike İhracat, Patent Uygulamaları, Doğrudan Yabancı Yatırımlar

To mom Yasemin, sisters Ceren and Ecem

husband Cihat

None of my success would have been possible without their support and love

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ABRREVIATION LIST

ANBERD	:	Analytical Business Enterprise Research and Development database
BRİC	:	Brazil, Russia, India and China
EU	:	European Union
EXPY	:	Sophistication of Export
FDI	:	Foreign Direct Investments
GDP	:	Gross Domestic Product
GFDD	:	Global Financial Development
GMM	:	Generalized Method of Moments
ILO	:	International Labor Organizations
IPC	:	International Patent Classification
ISIC	:	Standard Industrial Classification of All Economic Activities
MAR	:	Marshall-Arrow-Romer
M&A	:	Merger and Acquasitions
OECD	:	Organisation for Economic Co-operation and Development
OLS	:	Ordinary Least Squares
PRODY	:	Sophistication Level of Each Product
RCA	:	Revealed Comparative Advantage
R&D	:	Research and Development
SITC	:	Standard International Trade Classification
TFP	:	Total Factor Productivity
UIS	:	UNESCO Institute for Statistics
UK	:	United Kingdom
UN	:	United Nations

UNCTAD	:	United Nations Conference on Trade and Development
UNESCO	:	United Nations Educational, Scientific and Cultural Organization
WDI	:	World Development Indicators
WGI	:	Worldwide Governance Indicators
WITS	:	World Integrated Trade Solution

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CHAPTER I

INTRODUCTION

With international economic integration, and revolutionary developments in the field of information technologies the world has become as a single global market. In this global market where international borders and distances are abolished, the most important component of the economy become knowledge[1]. Accordingly, in the last two decades there has been an increasing interest in the exchange and diffusion of knowledge among firms and countries, namely knowledge spillovers[2].

The regarding literature has not yet reached a consensus on how knowledge spillovers occur. While some studies claim that foreign direct investment (FDI) as the underlying mechanism of knowledge spillovers (Javorcik 2004; Newman et al. 2015; Azeroual 2016; Lu et al. 2017); others focused on international merger and acquisitions (Finkelstein and Haleblian 2002; Shimizu et al. 2004; Bertrand and Zuniga 2006; Stiebale 2013); innovation activities (Coe and Helpman 1995; Jaffe and Trajtenberg 1999; Acs et al. 2009; Francasco and Marzetti 2015) international mobility of human capital (Le 2010; Kerr 2013; Bosetti et al 2015; Miguelez 2016) university-industry collaboration (Varga 2000; Leten et al. 2014; Scandura 2016) and importing products (Grossman and Helpman 1991; Hsu and Chuang 2014; Belitz and Mölders 2016; Zhiyuan et al. 2017) as a channel for knowledge spillovers. Although each of these channels is an indirect and direct source of knowledge, FDI and innovation

[1] Knowledge is a concept with the dimension of both "tacit" and "explicit" knowledge. "Tacit knowledge" is informal, abstract, subjective, empirical and intellectual, however explicit knowledge is formal, objective, storable and easily communicable.

[2] The dimension of tacit knowledge is closely related to knowledge spillovers because of the its intrinsic properties.

activities are found to be more influential than others. For this reason, FDI and patent applications are chosen as the main spillover channels in this thesis.

The main premise underlying FDI spillovers is that interacting with foreign firms the new and advanced technologies information about foreign markets and managerial skills are transferred to host countries. Through information and demonstration effects the domestic firms can benefit from multinational firms' knowledge about foreign markets. As multinational companies bring new technologies to local markets, domestic firms can improve their productivity. Besides, technology spillovers can arise through human capital mobility from multinational companies to local firms (Liu and Zou 2008). There exists a vast literature that investigates the effect FDI on productivity (Harris 2003; Hu and Jafferson 2003; Javorcik 2004; Liu 2008; Liang 2017). Also, another literature suggests that multinational companies can influence export decisions of domestic firms by establishing close relations with local companies (Görg and Greenaway 2004; Kneller and Pisu 2007). However, compared with the studies analyzing impact of FDI on productivity little effort has been spent on how inflows of FDI affects the export performance of firms. This is contrary to the fact that FDI might clearly impact on the export performance of domestic firms (Rodriguez-Clare 1996; Aitken et al. 1997).

In addition to FDI, innovation activities (such as R&D, Patents and Entrepreneurial Activities), plays an important role in creating knowledge spillovers. To illustrate, the number of patent applications reflect the knowledge density of the community and leads to overflow of knowledge. Recent studies show that firms' export performance and decisions can also be affected by innovation activities (Bernard and Jensen 1999; Aw et al. 2007; Caldera 2010; Turco and Maggioni 2015). However, little effort has been made as to how innovative activities affect countries' export performance.

Previous studies that used knowledge spillover channels in particular FDI and patents, generally focus on their effects on economic performance of countries in terms of growth or productivity of host economies. In terms of FDI while some of the regarding studies reveal positive impacts of knowledge spillovers due to transfer of advanced technologies (Chuang and Lin 1999; Haskel et al. 2002; Javorcik 2004; Lee 2006), others find negative or no effects of knowledge spillovers on host country economies due to market stealing or competition channels (Hadded and Harrison 1993, Aitken and Harrison 1999; Djankov and Hoekman 2000; Liu 2008). On the other hand, the studies investigating patent applications as a channel for knowledge spillovers generally find a positive relationship (Jaffe and Trajtenberg 1999; Meo and Usmani 2014; Sandu and Ciocanel 2014; Ying et al. 2014). Besides, a number of studies assert that the contribution of knowledge spillover in terms of FDI or innovative activities is highly dependent on country specific factors such as the depth of financial markets, the quality of human capital, and institutional quality (Cohen and Levinthal 1990; Borensztein et al. 1998; Alfaro et al. 2010; Liang 2017)

Against this background, the purpose of this thesis is to examine the impact of knowledge spillovers on export performance of host countries. Particularly, this thesis investigates whether FDI or patent applications act as a channel of knowledge spillovers in improving the export performance of countries. Putting one step further, we conceptualize that it is not the quantity of exports but the quality of export matters for economic development. Accordingly, unlike previous studies, we ask "does international knowledge spillover affect the quality of a countries' exports?" To do so, we use the value of exports of high technology products and sophistication of export baskets as indicators of quality of exporting. Exports of high technology products reflect the technological intensities of exported products, whereas export

sophistication signifies the income level of the export basket. Besides, with a novel approach we investigate whether the education, financial development and globalization level of countries have determinative role on the relation between knowledge spillover channels and quality of exports.

In order to test this relationship empirically we construct a rich panel data with 114 countries that comprises both developed and developing countries for the period from 2002 to 2015. The estimation method utilized in the analysis is Generalized Method of Moments (GMM) dynamic panel estimator developed by Arellano and Bond (1991) which permits us to control for potential endogeneity and govern the dynamic nature of the problem.

We contribute to the limited literature on the impact of knowledge spillovers from FDI and innovation activities on export performance of countries in many ways. Firstly, this thesis contributes to the literature by examining FDI or patents applications effects on export sophistication of countries. Such an analysis is important as starting with works of (Hausmann et al. 2007; Lall et al. 2006) recent literature has shown that an increase in the "sophistication" of a country's export basket is found to be a key component of economic growth (Hausmann et al. 2007; Jarreau and Poncet 2012). In fact, Hausmann et al. (2007) revealed that some products can be labeled as more sophisticated, in the way that they can be related with higher productivity levels, and those countries that export those products will perform better. To the best of our knowledge this study is one of the first studies that analyze the impact of patent applications on export sophistication of countries. In terms of FDI-sophistication literature, although there is limited number of studies analyzing the role of FDI on export diversification, upgrading or sophistication, those studies do not control for other potential knowledge spillover channels such as innovative activities. In

particular, unlike the previous studies, the impacts of FDI and patent applications are measured within the same model. Next, with a novel approach we contribute by analyzing the role of absorptive capacity of the host countries in terms of financial development, human capital and globalization level in governing this relationship. Finally, this study offers the possibility to compare the effect of knowledge spillovers on exports of high technology products and sophisticated exports.

The rest of the thesis is organized as follows: In Chapter 2, after describing the concept of knowledge and knowledge spillovers the literature on knowledge spillover channels is explained. Next, the literature regarding the effects of knowledge spillovers on exports is given. In Chapter 3, Data, methodology and estimation results are presented. Finally, Chapter 4 provides some concluding remarks and recommendations for future research.

CHAPTER II

BACKGROUND LITERATURE

This chapter begins with an overview of the concept of knowledge and knowledge spillovers. Then, the literature on knowledge spillover channels is presented. The last part focus on the impact of the knowledge spillover channels on the quality of Exports.

2.1. The Concept of Knowledge & Knowledge Spillover

2.1.a. The Concept of Knowledge

Although knowledge is a concept that is frequently discussed in all branches of sciences in the literature, the types of knowledge gain more importance in specific areas such as knowledge economy and knowledge management[3]. It is important to note how knowledge, information and data are differentiated before touching on the separation of knowledge types.

According to Carlson (2015), there are significant differences between data, knowledge and information. He defines the data as “transmitted, measurable, and easily transfer objective facts or observations.” Information is defined as the analyzed and processed form of data. On the other hand, Thierauf (1999) defines data as "unstructured facts and figures". According to Karlsson and Grasjö (2014), “information can be expressed as messages or data that can be easily coded, transferred, and stored at low cost”. Also, “information is found in answers to questions that begin with such words as who, what, where, when, and how many” (Ackoff 1999).

[3] “Knowledge management involves activities related to the capture, use and sharing of knowledge by the organisation” (OECD glossary)

Leonard and Sensiper (1998) describe knowledge as: "information is that relevant, actionable and based on experience." They see the knowledge is a "subset of information, subjective, and linked to meaningful". A detailed description is made by Gamble and Blackwell (2001) which describe knowledge as "a fluid mix of framed experience, values, contextual information, expert insight, and grounded intuition that provides an environment and framework for evaluating and incorporating new experiences and information". Also Carlson (2015) denotes that knowledge is valuable information that emerges from the human mind, containing synthesis, reflection and context, difficult to transfer, often confused as Tacit. From these definitions, overall knowledge can be explained as subjective information based on experience.

Among various knowledge types the most distinctive types are "tacit knowledge" and "explicit knowledge".

- Tacit Knowledge

The concept of tacit knowledge is first used by Polanyi (1966). According to Polanyi (1966), all knowledge has a tacit dimension, and the knowledge is personal. Karlsson and Grasjö (2014) state that "most knowledge is tacit, because knowledge is the output of a long-term learning and it is specific". He also notes the difficulty of coding and storing information due to its "intrinsic, complexity and indivisibility" properties. According to Gamble and Blackwell (2001) tacit knowledge is embodied and informal knowledge. This type of knowledge includes personal beliefs, values and perspectives. It is sourced by talents and learning in the sense that "learning by doing" "learning to learning" learning by using" are key elements for tacit knowledge. Alavi ve Leidner (2001) imply that "tacit knowledge represents internalized knowledge that one may not be consciously aware of it". According to Nanoka (1991) it is subjective,

experiential, created here and now. Also, Boateng (2006) describes that this type of knowledge is “informal, experiential in nature and is acquired after it has been used for a while”. Howels (1996) states that tacit knowledge is difficult to transfer, encode, and standardize.

Sternberg and Joseph (2000) note that “tacit knowledge takes one of two forms: 1) knowledge embodied in people and social networks (Horvath 2000; Gamble and Blackwell 2001), 2) knowledge embedded in the processes and products that people create”. “Knowledge is locked in processes, products, culture, artifacts or structures”. It is often intrinsic information that emerges in the process (Gamble and Blackwell 2001).

- Explicit knowledge

Gamble and Blackwell (2001) used formal and represented knowledge words for explicit knowledge. They state that explicit information is storable. According to Alavi and Leidner (2001), explicit information represents the information that one holds in the mental focus, easily communicated to others. Nanoka (1991) notes that explicit knowledge is rational and objective, also it appears then and there. Boateng (2006) signs that information is open (formal) when it is based on scientific evidence that can be valid for a reasonable period of time and tested for validity.

From these definitions, it is possible to summarize tacit knowledge and explicit knowledge as follows; tacit knowledge is informal, abstract, subjective, empirical, and intellectual, however explicit knowledge is formal, objective, storable and easily communicable.

- Other types of knowledge

In addition to the discrimination of explicit and tacit knowledge types, different categorization has been made in knowledge in order to simplify economic analysis.

The first category is related with know-what. Know-what mentions to knowledge about reality and it is close to information which is disseminated as data. The second category of knowledge is associated with know-why. Know-why is related to scientific knowledge. It is extremely important for technological development and product and process advances. This type of knowledge is accessible from universities and research laboratories. The third category of knowledge is know-how. This type of knowledge mentions to capabilities to perform and it can be related to the skills of craftsmen. It has a crucial role in whole economic activities. Know-how is developed and maintained within a firm or research team. The last category of knowledge is know-who. "Know-who" cover information about "who knows what" and "who knows how to do what". It is important in economies where the skills are widespread due to a highly developed business division between organizations and specialists. For modern executives and organizations, the use of know-who is important for response to the change (Lundvall and Johnson 1994; OECD 1996).

2.1.b. The Concept of Knowledge Spillovers

The concept of the knowledge spillovers is a prevalent term in the literature which is used for knowledge diffusion, knowledge dissemination, knowledge externalities, knowledge transfers and knowledge migration etc. Although the descriptions of knowledge spillovers are similar, they contain minor differences. These definitions are mainly focused on exchange of ideas irrespective of their dimension and scope.

Cohen and Levinthal (1989) describe knowledge spillovers as “any original, valuable knowledge generated in the research process which becomes publicly accessible, whether it be knowledge fully characterizing an innovation, or knowledge of a more intermediate sort”. Grossman and Helpman (1991) points that knowledge spillover is related to public good characteristics of knowledge, as non-rival and non-excludable. According to them, knowledge is non-rival because one idea can be used at the same time in different places and non-excludable because of difficulty extracting compensation of different usage of others. Jaffe (1996) defines knowledge spillover “Knowledge created by one agent can be used by another without compensation, or with compensation less than the value of the knowledge. Knowledge spillovers are particularly likely to result from basic research, but they are also produced by applied research and technology development.” Also, according to Jaffe et al. (2000) “the non-rival nature of knowledge as a productive asset creates the possibility of knowledge spillovers, whereby investments in knowledge creation by one party produce external benefits by facilitating innovation by other parties.”

In his study of economic growth and the relationship between the concentration of people and the firm in cities, Carlino (2001) defined the knowledge spillover as "exchange of ideas among individuals" that promotes innovation and creativity, because innovation of a company can encourage innovations and technical progress of other companies. Eapen (2012) describes knowledge spillover as “informal flows of technological knowledge form foreign to local firms”. Similarly, Ko and Liu (2015) notes that the knowledge spillover is “unintentional flow of knowledge from one network party to another.” According to Runiewicz-Wardyn (2013), technological expansion in one industry rises the productivity of the other firms which is in both the

same industry and in the other regions' industries through knowledge spillover and dynamic externalities.

The regarding the literature define different mechanisms governing knowledge spillovers through different spillover variable utilized in studies. To illustrate, while Aslanoğlu (2000) states foreign direct investment (FDI) as a channel for knowledge spillovers, Grilliches (1992) gives a different description of knowledge spillover through R&D as "working on similar things and now benefiting much from other's research".

In the light of the knowledge spillover definitions in the literature, it is possible to summarize the remarkable features of the concept of knowledge spillover;

- Knowledge spillover is pure public property with non-rival and non-excludable properties.
- Knowledge spillover can arise as intended or nonintended.
- Knowledge spillover is closely related to the type of tacit information. In particular, the fact that the knowledge that emerges in the tacit knowledge type is abstract, emerges in the process, distinguishes the knowledge spillover from the open and formal transfer of knowledge.
- Knowledge spillover is the flow of informal and indirect information between economic actors, the product of information accumulation

2.1.c. The Classification of Knowledge Spillovers

Pioneering the concept of knowledge spillovers, and the seminal work of Grilliches (1979) two types of knowledge spillovers are described: "rent spillovers" and "pure knowledge spillovers". Related to the exchange of goods rent spillovers are rival and excludable. Coe and Helpman (1995) provides evidence for rent spillovers. In the

regarding study, a strong correlation was found between R&D embodied trade and Total Factor Productivity (TFP) growth.

On the other hand, pure spillovers are mostly result from the investment on research and development (R&D) and are non-rival and non-excludable. Pure spillovers are also known as idea-creating spillovers (Feldman and Kogler 2010). In search for pure knowledge spillovers patent citation data can be used (Jaffe et al. 1993, 1996, 1998)[4].

Glaeser et al. (1992) provides an alternative classification of the concept of knowledge spillovers. Glaeser et al. (1992) classifies knowledge spillovers (referred to also as information externalities) as "MAR Spillovers, Jacobs Spillovers and Porter Spillovers". In 1890, Alfred Marshall developed the theory of knowledge spillovers, which later received as "MAR (Marshall-Arrow-Romer) Spillovers" because it was expanded by Kenneth Arrow (1962) and Paul Romer (1986). According to this theory, the concentration of firms in the same industry in a city helps to transfer information between firms and expedite innovation and growth (Carlino 2001; Glaeser 1992). Runiewicz-Wardyn (2013) supported the existence of MAR spillovers, saying "increasing specialization in a particular industry accelerates knowledge spillover among firms."

In 1969 Jane Jacobs developed another knowledge spillover theory which is called as "Jacobs Spillovers". Jacobs (1969) asserts that, unlike MAR Spillovers that focuses on firms within an industry, Jacobs spillovers are associated with the diversity of the industry in one place. Jacobs (1969) argues that a different urban environment from an industry promotes innovation; because it includes people with different backgrounds and abilities; thus exchange of ideas between people with various perspectives is

[4] Patent documents can refer to previous patent documents such as scientific writings, and since the cited patent contains information from the cited patent, "patent citation" show the spillover effects.

facilitated. “This change can lead to the development of new ideas, products and processes” (Carlino 2001; Glaeser 1992). One example of the Jacobs spillovers is “the brassiere industry, which grew out of dressmakers' innovations rather than the lingerie industry”. At the same time, local competition may accelerate the adoption of technology (Jacobs 1969; Glaeser 1992).

According to Porter's cluster-based theory (1990), specializing in a local industry and cooperating against industries that compete with companies in the same industry or cooperating against related industries, triggers the innovation and learning process (Runiewicz-Wardyn 2013; Glaeser 1992). Porter (1990) gives examples of “Italian ceramics and gold jewelry industries”. In these industries, hundreds of firms are settled together and strongly contend to innovate. According to Porter (1990) competition has an increasing effect on innovations despite the possible reduction of innovation. He concludes that secondary effect is more important than primary.

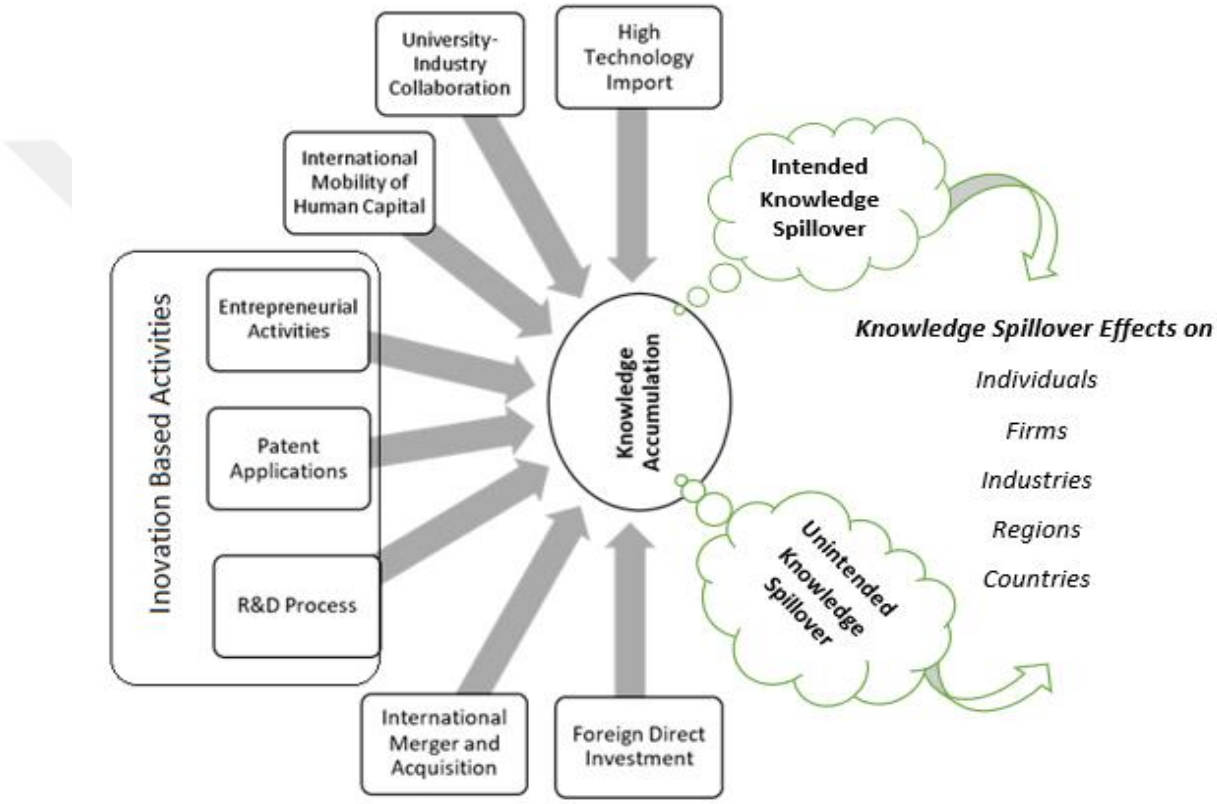
To sum up briefly, MAR Spillovers and Porter Spillovers cover the knowledge spillovers concept within the industry, while Jacobs’s spillover covers the inter-industry knowledge spillover concept. Theories on the MAR spillovers and Porter spillovers differ in terms of the role of competition. Unlike the theory of MAR spillovers, Porter and Jacobs spillovers both emphasize the role of competition and argue that, monopoly may harm innovation and lead competition to accelerate.

In addition to this classification of knowledge spillovers, intranational-international and intra-industry and inter-industry categories are also used in the literature. MAR, Jacobs and Porter Spillover classifications cover the intra-industry and inter-industry relationships. However, international - intranational spillovers classification is closely related to the scale and impact area of spillovers. Accordingly, knowledge spillover is found to be more intra-national (Branstatter 2001).

2.2. The Mechanisms and Channels of Knowledge Spillovers

In the literature on knowledge spillovers several mechanisms of how knowledge accumulation and diffusion occur has been defined. In Figure 2.1. below, the channels that provide the formation of knowledge are summarized.

Figure 2.1. The Mechanism of Knowledge Spillovers



2.2.a. Foreign Direct Investments

FDI can be seen as the most prevalent channel in the knowledge spillover literature as it has direct and indirect influences on the host countries economy. These influences are often addressed by researchers because they determine the economic performance, productivity and competitiveness of the host countries.

Beginning with the concept of FDI, Markusen (1995) defines FDI "as investments in which the firm acquires a substantial controlling interest in a foreign firm or sets up a subsidiary in a foreign country." According to OECD, Benchmark Definition Edition 4 (2008), FDI, "Direct investment is a category of cross-border investment made by a resident in one economy (the direct investor) with the objective of establishing a lasting interest in an enterprise (the direct investment enterprise) that is resident in an economy other than that of the direct investor".

According to World Investment Report by UNCTAD,

> "FDI implies that the investor exerts a significant degree of influence on the management of the enterprise resident in the other economy. Such investment involves both the initial transaction between the two entities and all subsequent transactions between them and among foreign affiliates, both incorporated and unincorporated. FDI may be undertaken by individuals as well as business entities. Flows of FDI comprise capital provided (either directly or through other related enterprises) by a foreign direct investor to an FDI enterprise, or capital received from an FDI enterprise by a foreign direct investor".

Countries undertake foreign direct investments as through investing abroad firms can reach to new markets, new resources, gain efficiency in production and obtain strategic assets (Caves 1974; Dunning 2006). Another reason for the realization of foreign direct investments can be mainly due to the idea of benefiting from low prices and consequently achieving high efficiency (Aitken and Harrison 1993; Borensztein et al. 1998; Alfaro et al. 2004).

Host countries provide incentives to attract FDI because (Saggi and Glass, 2002). Blomström and Kokko (1998) describe countries' such efforts to attract foreign direct investment as "the prospect of acquiring modern technology, interpreted broadly to

include both product, process, and distribution technology, as well as management and marketing skills".

The effects of FDI on the host countries are examined in two sub-categories as general effects and spillover effects.

2.2.a.i. General Effects of Foreign Direct Investment

The general effects of FDI comprise all direct (creating employment, providing tax revenue to the state, bringing foreign exchange to the host country) and indirect effects of FDI such as technology and knowledge spillovers. These effects play a decisive role on growth, employment, level of international competition and productivity. For this reason, many researchers focus on the impact of FDI on home and host countries.

In his pioneering study Caves (1974), investigate the effects of FDI categorize the benefits provided by FDI in three groups as "Allocative Efficiency", "Technical Efficiency" and "Technology Transfers". FDI carries technology in the form of a package that includes expertise, talent and financial resources from developed countries to developing countries. Other benefits of FDI in host countries are increasing competition in domestic and international markets, improving the quality of human capital, increasing wages, increasing institutional quality and legal system (OECD 2001). In addition FDI is not only a contributing factor to resource utilization, but also offers opportunities for learning by observing from multinationals in the local markets (Alfaro et al. 2004). Besides, FDI promotes the level of development in the host country by increasing the amount of investment in the country, creating new business areas, providing added-value through production of foreign companies, and providing managerial skills acquisition.

Foreign firms can greatly contribute to economic development by increasing domestic competition and consequently lead to further productivity, lower prices and more efficient resource distribution. Increased competition can encourage capital investments to gain more than competitors. Moreover, the impact of FDI is more important on competition in the market for services such as telecommunications, retail trade where exports are not a general option, because service needs to be started at the delivery point (OECD 2002). FDI also has a significant effect on the employment conditions in the domestic markets. Thanks to the advantages of "technological know-how, easy access to capital and modern management practices", multinational corporations provide high quality workers, pay higher prices and offer better working conditions. With FDI, foreign-owned companies in host countries seem to be improving in terms of wages and employment conditions such as working hours (OECD 2008). Paying more fees by foreign companies causes the average wages to increase in domestic firms as well. FDI's spillover effect on employment is weaker than direct effect (Aitken and Harrison 1999; Hu et al. 2005; Blalock and Gertler 2008; Dalgıç and Fazlıoğlu 2015).

Empirical studies investigating the general effects of FDI on the country's economies have generally made analysis on growth at macro scale.

The studies that analyze the effects of FDI on host countries have not yet reached a consensus. Although many of the studies that have been conducted reveal that FDI has a positive effect on growth (Alam et al. 2006; Mahmoodi and Mahmoodi 2016; Ridzuan et al. 2017) due to the benefits mentioned above, there are a number of studies that argue that there isn’t any relationship (Carkovic and Levine 2002; Lipsey 2002). Studies that find negative results argue that foreign direct investments dampen the competitive power of domestic firms and reduce their investments (OECD 2001).

In terms of productivity, FDI is found to be more productive than domestic investment for 12 Latin American countries in the years of 1950-1985 (De Gregoria 1992). Borensztein et al. (1996) tested the influence of FDI on economic growth by cross-country regression analysis of panel data on 69 developing countries during the 1970-1979 and 1980-1989 decade periods. Their results show that investments promote to the economic growth of the host country through capital accumulation. Alam et al. (2006) observed causality for both the short-run and the long-run, from the FDI to the growth, in the 1980-2009 period for 19 OECD countries. Mahmoodi and Mahmoodi (2016) point long-term causality between growth and FDI for 8 European and 8 Asian developing countries. Similarly, in his time series analysis conducted for Singapore, Ridzuan et al. (2017) reveal that FDI contributes to economic growth. Contrary to these studies, Carkovic and Levine (2002) notes that FDI don't have a strong influence on economic growth in the analysis of 72 countries for the years 1960-95.

The impact of FDI on economic growth can vary according to country-specific factors. The OECD (2001) reported that in less developed countries the impact of FDI on growth would be smaller due to "threshold externalities". Developing countries must catch up a certain level of education and technological infrastructure before taking advantage of foreign assets. Defective and underdeveloped financial markets can prevent an individual from enjoying all the advantages of foreign direct investment.

Studies supporting this outcome and linking the effect of FDI on growth to a certain threshold and financial development level are available in the literature. To illustrate, Blomström et al. (1992), which examines the impact of FDI on economic growth according to the income level of 78 developing countries find a positive effect of FDI

on growth only for higher income developing countries. For example, Borensztein et al. (1998) demonstrate that the positive impact of FDI on economic growth is dependent on the high-educated human capital. If the level of education of the people who host the FDI and the quality of the employees are below a certain threshold, the transfer of knowledge and technology are prevented and no positive benefit can be obtained. Hermes and Lensink (2003), addressing the role of the financial system in relation to FDI and economic growth, found that FDI has a positive effect on growth in countries with an advanced financial system. Similarly, Alfaro et al. (2004, 2009 and 2010) reveal that the influence of FDI on countries with well-developed financial markets is positive and significant otherwise it is unclear.

In addition to the decisive role of highly educated human capital and well-developed financial markets, the institutional quality and trade regime is also influential on the impact of FDI on growth. In this respect analyzing FDI in 80 countries, Durham (2004) presents an evidence for the positive impact of FDI on growth for countries with a certain level of institutional development. The connection between FDI and economic growth depends on country-specific characteristics such as liberalized trade regime, quality of education and human capital, and macroeconomic stability (Zhang 2001).

2.2.a.ii Spillover Effects of Foreign Direct Investment

The main premise underlying FDI spillovers is that the investment firms are technologically ascendant to the domestic firms and that the knowledge they possess is transferred to the domestic firm by means of interactions, which in turn leads to an increase in productivity (Newman at al. 2015). Findlay (1978) states that the diffusion of knowledge through FDI and the increase in technical progress in the invested

country resulted in a "contagion effect" from further technologies and managerial skills. The main benefit provided by FDI on the host country is the technology transfer and spillover efficiency that arises when the advanced technology and managerial skills embedded in FDI are transferred to domestic facilities due to the presence of international firms (Zhang 2001).

FDI influences home economies through altering market structures, employment effects, competition effects and knowledge spillovers (Lipsey 2002). Also, FDI spillover effect emerged as a result of various activities in the host country. These activities can be described as “labor and management training, technological copying, direct licensing of technology, and vertical linkages in the production and distribution value chain.” (Blomström et al. 1999).

The channels that are effective in creating FDI direct or indirect knowledge spillover are explained in four groups;

i. Vertical linkages; “Multinational corporations can transfer technology to firms that supply intermediate goods or to buyers of their own products”.

ii. Horizontal linkages; “local firms in the same industry may assimilate technologies through imitation or develop their own technologies because of increased competition from multinational companies”.

iii. Labor migration; “educated or formerly employed by MNE may transfer information to the other firm when they change jobs or establish their own businesses”.

iv. Internationalization of R&D; “R&D activities of multinational companies abroad can contribute to the development of local knowledge capacity” (OECD 2001).

There are also two channels that play a role on the spillover effect of FDI. Firstly, multinational companies bring new technologies to local markets. The demonstration effect of inward FDI can encourage local firms to learn by doing innovative activities through monitoring of the multinational firms' R&D project, thus domestic firms can be more productive. Secondly, technology spillovers from multinational corporations can arise through human capital mobility or the shift of educated executives and skilled workers (formerly worked in foreign or multinational companies) to local firms or to establish their own business (Liu and Zou 2008).

According to Lu et al. (2017), the overall spillover effect of FDI is determined by the balance between agglomeration and competition effects. The benefits that local firms provide from multinationals (through the imitation of foreign firms' technology, managerial skills and market structures) and the provision of special quality inputs from the suppliers and contribution to the pool of workers are called "agglomeration effects". On the other hand, when the more productive multinational firms appear on the market, the domestic companies lose their market share and the productivity of the firm decreases. This effect is the "competition effect".

Studies focusing on the spillover effect of FDI often reveal the spillover effects on productivity. According to these studies, if the existence of foreign investments increases or decreases the productivity of domestic firms, the effect of spillover can be mentioned. There exists a vast literature that investigates existence of productivity spillovers namely the effect of spillovers created by FDI on technology transfers and productivity (Chuang and Lin 1999; Aitken and Harrison 1999; Javorcik 2004; Keller and Yeaple 2009; Liang 2017). Still, the literature is inconclusive on the sign of this relationship or whether there exists any.

Most researchers in this area have shown that FDI positively affect productivity. In studies that claim that FDI leads to positive productivity gains, two reasons have been explained for this effect. Firstly, domestic companies can increase their productivity by employing employees and observing foreigners in the country. Secondly, increasing competition in the domestic market with the appearance of foreigners pushes domestic firms to search for new technology, which increases Research and Development (R&D) investments and increases productivity.

The studies that investigate the relation between FDI and TFP is done at the micro level either on firm or industry basis. For instance, Blomstrom and Wolf (1994) empirically demonstrate that foreign firms in Mexico have a positive impact on productivity. In a study of Taiwan firm level data, Chuang and Lin (1999) find that a 1% increase in the rate of foreign investment in the industry would conclude an increase in domestic firm productivity from 1.40 per cent to 1.88 per cent. In addition, Görg and Strobl (1999) with Ireland, Liu Wang (2003) with China, Harris (2003) with UK (United Kingdom) data set obtain the positive effects of FDI on productivity. Markusen and Weneble (1999) also theoretically show that multinational firms' connections to independent suppliers are positively influential in the development of independent firms in the host country. Haskel et al. (2002) find positive spillover effect using plant-level panel data covering 1973-1992 and UK manufacturing. A 10% increase in the existence of foreigners in the UK industry is reason for a 0.5% increase in the TFP of indigenous plants in the industry. Similarly, Javorcik (2004) explains the positive spillover effect of FDI on domestic firms in the upstream and downstream industries with using firm-level data from Lithuania. Moreover, Lee (2006) concludes that the knowledge spillover caused by inward FDI is significant while outward FDI

is insignificant in study covering the years 1981-2000 and the productivity of 16 OECD countries.

In studies that claim FDI has no positive effect on productivity are presented negative, weak or ambiguous effect. Especially these studies note that domestic producers cannot cope with increasing competition and are excluded from the market. Aitken and Harrison (1999), describe it as a "market-stealing effect". Among the examples of studies which find a negative relation between FDI and TFP; in their study on Moroccan manufacturing firms Hadded and Harrison (1993), find no evidence for a positive effect of foreign firms on productivity. Similarly, Aitken and Harrison (1999) conclude that the increase of foreign direct investment decreased the efficiency of Venezuelan plants. Moreover, Djankov and Hoekman (2000) find that a ten-percent increase in foreign assets results in a 1.7% drop in domestic Czech firms' sales. Also, Aslanoğlu (2000), reveals no significant contribution of FDI on the productivity of local firms in the Turkish manufacturing industry. Hu and Jafferson (2003) provide evidence for a significantly negative effect of FDI on domestic firms' productivity and sales in the Chinese electronics and textile industry. Damijan et al. (2003) support this view and, accordingly, he finds evidence that FDI does not create spillover effects within the industry. Accordingly, some studies empirically show that, the spillovers associated with FDI increase the long-term productivity growth rate while causing a decline in productivity level in the short term (Liu 2008). The negative impact in the short term may arise from the learning/adaptation costs of the new technology transferred, while returns in terms of firm performance can be seen in the long term.

The direction and size of the impact of FDI on productivity may depend on firms' or countries characteristics. The first criterion that plays a role in the impact of FDI on productivity is the concept of "absorptive capacity", which is defined as the power to

adopt and use firms' new technological and managerial knowledge (Cohen and Levinthal 1990; Liang 2017). There are two measures for the absorptive capacity of firms. The first one can be summarized as "skilled labor & education" since knowledge transfers will be beneficial if human capital is on a certain threshold. The second one is the investment in R&D. The high level of R&D investments made by the firms indicates a higher capability to adopt the new technology (Azeroual, 2016; Liang 2017). Investigating chemical and pharmaceutical companies in Indonesia Suyanto et al. (2009) shows that domestic firms with R&D are more likely to benefit from spillover than firms without R&D. It is stated that, the greater the absorptive capacity of a firm, the greater the benefit from FDI spillover (Chen et al. 2011; Azeroual, 2016). Girma (2002) demonstrate that higher absorptive capacity of firms eases firms to embody the technological externalities brought by multinational firms.

Another factor that determines the effect of FDI on productivity is the origin country of FDI. FDI from different sources has different effects on productivity; because they do not have the same technological components, the same quality and the same specialization (Helpman et al. 2004). In this regard, Banga (2006) reaches the conclusion that FDI from Japan has more influence on total productivity with regards to FDI from US and for firms in the Indian automotive, chemical and electrical industries. Also, examining Chinese manufacturing firms Lin et al. (2009), reveal that FDI from Taiwan, Macao and Hong Kong create negative spillovers, while other foreign firms largely from OECD countries tend to bring positive spillovers. Some researches point out that FDI-originated spillover is a geographical dimension (Wang and Wu, 2015; Lin and Kwan 2016). Wand and Wu (2015) emphasize that the inter-sectoral spillover effect is more significant than intra-sectoral spillover effect. Also, Lin and Kwan (2016) show that domestic firms take an advantage from FDI in the

neighboring region. Kim et al. (2015) point out that the FDI effect from developed countries is stronger than the less developed ones. Moreover, Azeroual (2016) analyzes the impact of FDI from France and Spain on the manufacturing sector in Morocco for the period 1985-2012. The result of the study is that FDI from Spain has a positive and statistically significant effect while FDI from France has a negative effect especially in industries with high and medium-technology

One of the determinants of the technology transfer process is the "technology openness" between home and host counties. There are two different views on why technology is the factor that affects FDI. First, "Technological catch up hypothesis" is the higher level of utilization of FDI among domestic and foreign firms, among which technology gap exists. Second, the gap between the skills of local people and the technology brought by foreign firms should not be too great to be easy to learn and assimilate (Azeroual 2016). In addition, the spillover effect of FDI on productivity varies according to the technology of firms and sectors (Chuang and Hsu, 2004; Keller and Yeaple 2009). In this regard, Chuang and Hsu (2004) analyze the low-technology and high-technology industries and state that there are significant results for both groups, also the spillover effect in the low technology industry group is greater. On the other hand, Keller and Yeaple (2009) reveal that the FDI spillover effect is particularly higher in the high-technology sectors, compared to the low-technology sectors. According to the results of this research, small firms with lower efficiency provide more benefits from FDI spillover than high efficiency firms.

Some studies explain the effect of FDI's productivity spillover on domestic firms with upstream and downstream linkages (Javorcik 2004). In her pioneering study Javorcik (2004) argues that the backward linkages to local suppliers of multinational companies are the most likely channel to create spillover. According to her, it can

happen in three ways; “(i) the transfer of knowledge directly from foreign customers to local suppliers, (ii) product quality and well-timed delivery requirements brought by multinational companies that encourage domestic suppliers to enhance production, management and technology; and (iii) multinational entry requirements for intermediate products that enable local suppliers to benefit from the economies of scale”. She tests this idea with the Lithuania firm level data and finds that there is positive productivity gain from FDI between domestic suppliers and foreign firms. Similarly, Liu (2008) and Gorodnichenko et al. (2014) reveal that backward linkages are an important channel for spillover in Chinese firms. In addition, Newman et al (2015) analyzes whether the link between domestic and foreign firms explains FDI spillover by using the data from 4000 manufacturing companies in Vietnam. The results of the study show that positive spillover from FDI companies in downstream sectors and that firms in upstream sectors have a negative influence on productivity of downstream local firms.

In addition to the FDI literature described above, international mergers and acquisitions (M&A) also play a role in knowledge spillover process. The purchase of companies in other countries in the center provides an important opportunity for the company to acquire new knowledge and skills. This provides access to resources such as knowledge base, technology and human capital of the new company (Shimizu et al. 2004).

The fact that the different operations of M&A are located in different countries also leads to new knowledge acquisition and diffusion. However, cross-border M&A have new factors that hinder their ability to learn and improve their skills. One of them is knowledge asymmetry (Shimizu et al. 2004).

The knowledge spillover role of mergers and acquisitions can also emerge based on past experiences. In the past, knowledge obtained from acquisitions made with different companies is transferred to the new firm that was purchased. Finkelstein and Haleblian (2002) note that in the study of the utility of previous purchasing experiences, only the effect of using experience in similar acquisitions may be positive.

2.2.b. Mergers and Acquasitions

It is also possible to explain the knowledge spillover effect of M&A with efficiency gains from R&D; because one of the determinants of the investment in R&D activities is external sources of knowledge. Cross-border mergers and acquisitions are also an investment tool that allows different know-how to be brought together, thus external knowledge arise in this process. In this respect, Bertrand and Zuniga (2006) examine the effects of M&A on private R&D investments with generalized method of moments (GMM) estimation techniques given in OECD countries between 1990 and 1999. As a result of the mentioned work, cross-border M&A is proven to increase R&D investments. Furthermore, Stiebale (2013) analyzes the impact of cross-border acquisitions on the innovation capacity of acquirers through combination of firm-level survey data with M&A data in Germany. The study remarks that cross-border purchases have invested more in R&D.

2.2.c Innovation Based Activities

Another key important mechanism behind knowledge spillovers is innovation-based activities which involves investment in R&D, patent applications or citations and entrepreneurial activities.

It is emphasized in the knowledge spillover literature that the spillover effect of knowledge arises the result of research activities (Grilliches 1992; Cohen and Levinthal 1989).

The definition of R&D by OECD (2009), which is "Research and development (R&D) comprise creative work undertaken on a systematic basis in order to increase the stock of knowledge (including knowledge of man, culture and society) and the use of this knowledge to devise new applications", emphasize that R&D activities increase the knowledge accumulation.

Studies explaining the knowledge spillover effect in the context of R&D activities is generally discussed through TFP (see for example Fazlıoğlu et al. 2018). R&D Spillover effects is first introduced by Coe and Helpman (1995). They find that both domestic R&D intensity and trading partner's R&D expenditures' impacts positively on domestic TFP for OECD countries. Moreover, it is shown that the impact of R&D spillover is greater for more open economies, namely R&D spillover is associated with trade openness.

Following Coe and Helpman (1995), many researchers focus on R&D spillovers. For instance, Engelbrect (1997), extend the Coe and Helpman's (1995) R&D spillover approach by using human capital for an international knowledge spillover channel and concludes that both domestic and international R&D have a significant impact on TFP. Seck (2012) also explores spillover mechanisms in developing countries, and provides evidence that a 10 percent increase in foreign R&D stock leads to an increase of more than 2 percent in total factor productivity. Moreover, Pueyo et al. (2008) show the existence of R&D spillovers on industries grouped by technological intensities. Similarly, Nishioka and Ripoll (2012) reveal that embodied R&D is significantly related with industry level TFP. Besides, Francasco and Marzetti (2015) investigate

whether relatively intense commercial relations are related to international R&D spillovers, particularly from the trade flows in 24 advanced countries between 1971 and 2004. They reveal that international R&D spillovers are associated with trade patterns.

Patent applications, are also extremely important for creation of knowledge spillovers because it reflects the knowledge density of the community and leads to overflow of knowledge. Patents do not only entitle the applicant to ownership and protection, but also contain extensive knowledge of what is it:

> "A patent document contains a large amount of information, all of which has potential for statistical analysis. This is not only true for the bibliographic information gathered on the front page, but also even for the abstract, the claims, and the description of the invention, which can be subjected to textual analysis. For statistical purposes, information contained in a patent document can be grouped into three distinct categories: ● Technical description of the invention. ● Development and ownership of the invention. ● History of the application*"* (OECD Patent Statistics Manuel 2009)

Two alternative measures of patents are used in knowledge spillover studies. While one of them is "patent citations", the other is the patent applications made by the foreigners in the host countries. Patent documents may include references from previous patents, such as scientific articles, and these references can be interpreted as knowledge spillover between the cited and citing patents.

The pioneer and most cited study in the literature with patent citations is Jaffe et al. (1993)'s study on the geographic localization of knowledge spillover. He notes that the patent citations are against Krugman's idea that "knowledge flows are invisible, they leave no paper trail by which they may be measured and tracked". On the contrary,

if a patent is granted, its form contains knowledge about inventor, its employer and technological antecedents, and a citation to a patent indicates that the knowledge in the cited patent passes to citing patent. Briefly, “a citation of patent X by patent Y means that X represents a piece of previously existing knowledge upon which Y builds”. Jaffe (1993) examines citations to patents applied by domestic companies and universities. He shows that, there is localized knowledge spillovers in the United States. Also, he notes that the use of knowledge produced within a region is easier than to distant regions. Similarly, Jaffe and Trajtenberg (1999) supported the geographical localization of knowledge spillover with patent citation data. According to the results of the study, patents in the same company are more likely to refer to each other, and patents belonging to the same patent class refer more to each other than to patents of different patents. In addition, patents in the same country are more cited than others. Furthermore, Mourseth and Verspagen (2002) measures the effect of geographical distance, national boundaries and language differences on the flow of knowledge in the European region with "patent citations" data. As a result, it is concluded that the geographical distance has negative and substantial effect on the knowledge flows and that the flows of knowledge are denser between the countries than it is between the regions. It is also noted that the flow of knowledge is industry specific and patent quotations are often made between sectors with technological links or territories belonging to the same language group.

Like patent citations, patent applications made by foreign affiliated units can be seen also as a source of knowledge spillovers. The patents cover the traces of the person who finds the invention on them, and include the technical knowledge of the patented thing. For this reason, foreigners' patent applications in different countries indicate that knowledge flows to the applicant country.

There are several reasons why foreign investors make patent applications in a country. The first of these can be explained by the protection of property rights. The higher the degree of protection of property rights, the more foreign patents will be entered into that country. Secondly, the foreign investor may have current trade relations with the country to which the patent application is filed, or it may have the potential of commercial cooperation. The size of a country's foreign trade can also lead to the attraction of more foreign patents. The third is the desire of foreign investors to use the technology. The fact that countries have higher technology level shows that there is more potential to use more patented technology (Xu and Chiang 2005).

Another channel we address under innovation-based activities that play a role in the creation of knowledge spillover is entrepreneurship activities. Entrepreneurial activities are included in the knowledge spillover with "knowledge spillover theory of entrepreneurship". According to the knowledge spillover theory of entrepreneurship, “investment in the creation of new knowledge will generate opportunities for entrepreneurship as a mechanism for knowledge spillovers” (Audretsch and Lehmann 2005).

Knowledge Spillover Entrepreneurship refers to the process of establishing a new company based on the knowledge created in an organization and transforming it into a new product or service in a new organization. Entrepreneurship is an important channel for the dissemination of knowledge because it makes the knowledge and ideas commercialize and facilitate spreading. Entrepreneurs generate new knowledge as using new knowledge (Audretsch et al. 2008).

According to OECD (1998), “Entrepreneurs are agents of change and growth in a market economy and they can act to accelerate the generation, dissemination and

application of innovative ideas. In doing so, they not only ensure that efficient use is made of resources, but also expand the boundaries of economic activity."

Audretsch et al. (2008) point out that the potential of individuals to create knowledge spillovers through entrepreneurship is not homogeneous and constant across geographical areas. He describes the region with the “legal, institutional and social factors and powers that are favorable for entrepreneurship” as areas which have a high level of "entrepreneurial capital". Territories with high entrepreneurial capital allow entrepreneurs to get knowledge and use it to launch new firms, while regions with small entrepreneurial capital hinders entrepreneurs. In other words, firms in regions with high levels of entrepreneurial capital continue to function as knowledge spillover channels and contribute to economic growth.

The new knowledge maintained by entrepreneurs is also influential on other actors. With the use of new knowledge and the increase of new economic enterprise, knowledge is added to existing knowledge stock and knowledge is processed, also knowledge diversity is increased. In addition, if an attempt by using new knowledge fails, this failure is also source of new knowledge and creates learning effect (Audretsch et al. 2008).

Audretsch et al. (2008) empirically examine the role of entrepreneurship in the knowledge spillover process and entrepreneurial capital is found to have a significant positive impact on regional economic growth. High investment in knowledge positively affects knowledge-based entrepreneurship. Following Audretsch et al. (2008), Acs et al. (2009) developed a theoretical model explaining knowledge spillover in entrepreneurship. He explains entrepreneurship as “it is a function of the following factors: knowledge stock, existing firms' R&D investments and obstacles to entrepreneurship such as risk aversion, legal and bureaucratic restrictions, labor

market rigidities, taxation, lack of social acceptance etc". Acs et al. (2009) indicates that the knowledge accumulation has a positive effect on the level of entrepreneurship.

Audretsch and Lehmann (2006) investigate whether entrepreneurship theory of knowledge spillover applies to regions. The data used in analysis contains 281 companies in Germany and university-specific variables collected from 73 public universities. They demonstrate that universities in regions where knowledge investments are high and universities that invest more in knowledge creates further technological initiatives. Also, companies near universities are influenced by the university's knowledge capacity and regional knowledge accumulation. So, the knowledge creators are clustered around the knowledge, and it is obvious that knowledge theory of entrepreneurship has a spatial dimension.

2.2.d. International Trade

International trade is a two-way channel that both leads to knowledge spillover and is influenced by knowledge created through other knowledge spillover channels mentioned earlier.

2.2.d.i. Imports

Studies addressing international trade with the aim of creating knowledge spillovers generally focus on the impact of purchasing goods and services from abroad; because imported goods or services allow the transfer of embedded knowledge within them. This tacit knowledge can be formed in two different ways as technical and managerial knowledge for goods and services. The knowledge and skills used in the production phase of goods are kept in the mechanism of imported goods. By examining the structure of the imported goods, new knowledge can be obtained and used for new production. In particular, imports of products with high knowledge and technology

level leads to denser knowledge flows. Furthermore, in addition to the transfer of technical capabilities with imported goods and services, managerial skills can be transmitted across trade partners. Benefits of R&D activities in developed countries are transferred to developing countries through capital and intermediary imports (Grossman and Helpman 1991). In addition, trade leads to knowledge spillovers by increasing dialogue between developed and developing countries.

A pioneering study of the knowledge spillovers effect through imports in the literature is conducted by Coe and Helpman (1995). In this study, external R&D stock variables weighted with import shares were created to measure the impact of foreign R&D investments on the productivity of the domestic country. The results of analysis indicate that the more engaged a country is in trade, the greater the potential impact of foreign technologies on the TFP of that country's manufacturing process.

Following Coe and Helpman (1995), foreign R&D stock weighted by import share of foreign trade partners is used as knowledge spillover variable in many studies. Keller (1998) uses randomly generated import shares instead of the spillover variable created by import of foreign trade partners. Also, Lichtenberg and Potterie (1998) concludes that imports from countries where R&D investments are intensive, increase the impact of R&D on TFP. The contribution of Xu and Wang (1999) to above studies is to present an improved model by including the unweighted R&D variables. They used the R&D stock weighted by interstate distances to control knowledge spillover. In this study, it is proved that the capital goods imports is cause more R&D spillover.

Lee (2009) investigates the role of information technology trade on international knowledge spillover through 17 OECD countries for the period 1981-2000. He finds that the imports of information technologies increase the productivity in the economy, imports of other goods except information technologies negatively affect productivity.

Besides, Mendi (2007) notes that using 16 developed OECD countries for the period 1971-1995, the efficiency effect of the import on countries is heterogeneous. Their findings show that the efficiency impact of technology through import is not significant in the G7 countries but significant in the OECD countries outside the G7.

As in the FDI channel, the absorption capacity of the countries is also influential in the knowledge spillover that comes with the import channel. Seck (2003) finds that the most favorable channel for R&D spillover is imports, and examines the factors that influence absorption capacity, which determines the degree of countries' utilization of technology transfer. He obtains that developing countries with stronger institutions, qualified human capital and more external activities provides more benefits.

Some studies also examine the role of imports in creating knowledge spillovers at the firm and industry level. Schiff et al. (2002) analyze the impact of technology spillovers through the import of capital goods and intermediate goods for the manufacturing industry in developing countries in the period 1976-1998. The results indicate that North-South and South-South foreign trade relations have a positive effect on TFP. Pueyo et al. (2008) analyzes the effects of inter-sectoral and intra-sectoral spillovers on productivity using panel cointegration techniques for 6 developed countries and 10 manufacturing industries in 1979-2000. According to the consequences of the analysis, the new technology formed within a sector at the national level has significant positive effects on the total factor productivity of the other sectors.

The knowledge spillover which is inextricably linked to the import channel has an impact on innovation capacity of firms. Some studies examine the impact of intermediate product imports on innovation capacities; while others focus on the impact of importing high-technology products on innovation. As an example of these studies, Zhiyuan et al. (2017) examined the relationship between imports and

innovations over importer firms in the manufacturing industry in China. They find that both imports of intermediates and export activities were positively influential on the R&D stock of importing companies. Moreover, the results show that imports from high-income countries have further boosted innovation. Examining the impact of knowledge spillover on innovation performances of using Taiwanese firms in high-technology industries Hsi and Chuang (2014) show that when firms' assimilation capacities taken into account, the effect of exports and imports on innovation performance is higher than other spillover channels (R&D, presence of MNE). Consistent with the previous studies, Belitz and Mölders (2015) find the positive impact of the importing activities on TFP only in developing countries.

2.c.2.ii. Exports

Exporters may access to new knowledge that is not available in their country of origin. In literature, it appears that the superiority of internationalized firms is sourced by the effects of self-selection and post-entry. According to "self-selection hypothesis", only the most productive firms choose their export markets because of the sunk costs and the different levels of productivity in the same sector. In particular, Melitz (2003) is based on the assumption that the monopolistic competition model has additional costs for firms launch in international markets. Companies that exceed only certain threshold levels can benefit positively in international markets. Another factor that drives self-selection in exports is variable costs. Firms can create their self-selection regardless of sunk costs because of the variable costs related to the knowledge of foreign markets, transportation, marketing, advertising and foreign distribution channels. In addition, learning in international markets, scale economies, interaction with foreign customers and a more intense competitive environment can

increase the export productivity of firms. According to the post-entry mechanism, importing of capital goods create potential learning opportunities through knowledge spillovers, quality effects and diversity effects. Salomon and Shaver (2005) find that for the Spanish manufacturing firms over 1990-1997, exporters can access to a variety of information not found in the interior market, and learning encourages the innovation. Wei and Liu (2006) argue that exports are a positive influence in expanding intra-industry productivity in a firm-based work in the Chinese production sector with the export channel. Alvarez and Lopez (2008) analyze the spillover effect of exports on other plants in both the same sector and vertically related industries. In the analysis covering the years 1990-1999 for the production facility of gauze, they reach the result that the export of domestic and foreign owned facilities increased supplier productivity. Chang et al. (2012) find a positive relationship between exports and patent applications used as a proxy for innovation in the domestic country in the analysis of 37 countries over the period covering 1994-2005. Also, Dalgıç et al. (2015) indicate that international trade contribute to productivity of Turkish manufacturing firms.

To conclude, as shown in the studies in this area, international trade activities are an important channel for knowledge spillover between companies, companies and countries that are trading partners.

2.2.e. International Skilled Labor Mobility

"Human capital is embodied in people and contains knowledge about new technologies and materials, production methods, or organizational structures, it is expected that the international mobility of people will help diffuse knowledge among

countries" (Le 2010). The knowledge spillover role of international skilled labor mobility will be addressed after defining "skilled labor migrants".

There are different definitions for skilled labor migrants. There are three different definitions of highly skilled migrants regarding education, occupation and wages. “Highly skilled will be considered to include post-secondary education that is university-level but that may involve a vocational, technical or professional qualification of shorter duration than a bachelor’s degree” (Chaloff and Lemaitre 2009). Unesco's definition of "highly skilled and business migrants" is as follows; “People with qualifications as managers, executives, professionals, technicians or similar, who move within the internal labour markets of trans-national corporations and international organizations, or who seek employment through international labour markets for scarce skills” (Unesco n.d.).

On the European Union framework, the following definition is used: “Highly qualified migrant or highly skilled migrant is a third-country national who seeks employment in a Member State and has the required adequate and specific competence, as proven by higher professional qualifications” (Europen Migration Network n.d.).

The use of international skilled labor mobility as a channel of knowledge spillover can be examined from three perspectives. The first of these is the transfer of skilled labor from multinational firms to domestic firms, the second is international skilled labor migration, and the third is temporary foreign work experience.

Common view of researchers studying the effect of knowledge spillover through skilled labor movement from multinational firms to domestic firms is transfer of knowledge and technology with educated workforce hired by other firms. Djankov and Hoekman (2000) show that the level of education in foreign firms is higher than

domestic firms. Fosfuri et al. (2001) also reveal that the trained workforce at multinational companies creates technology spillover of starting to work in domestic firms.

In Hoekman et al. (2005) study the spillover effect created by international human mobility is greater than the spillover effect created by foreign firms and MNE's workers who are engaged in domestic firms. It is also emphasized that developing countries should choose policies that encourage temporary mobilization to benefit from international human mobility. They argue that temporary international mobility brings new knowledge and skills to domestic economies, while permanent brain migrations reduce the prosperity of domestic economies.

According to the 2001 report of International Labor Organizations (ILO) examining the effects of skilled labor migration from developing countries to developed countries, this migration has negative effects such as the restriction of economic growth in the developing countries, however it increases the knowledge density and productivity in the country. One of the positive beneficial effects is that international skilled labor migration encourages higher education in the country. People who want to migrate to benefit from the opportunities of developed countries, tend to be more educated. Another benefit is the "feedback effect". This effect arises when immigrants return to the origin country and acquire technology and knowledge. Immigrants provide technology and knowledge spillover through their network of domestic researchers, even if they don’t return to own country. Saxenian (2005) explains that Chinese and Indian engineers in the Silicon Valley who have close relationships with their countries, accelerate the development and entrepreneurship of information technology industries in their own countries. Similarly, Beine et al. (2008) reveal that brain drain defined as "the international transfer of resources in the form of human capital and

developing countries" increase the number of skilled labor living in developing countries. Moreover, Kerr (2008) demonstrates that immigration is a channel of knowledge spillover, using patent citation made by non-US residents to US residents' patent. Miguelez (2016) notes that immigrant inventors in industrialized countries help to internationalize creative activities in the country of origin with a strong relationship between skilled immigrants and international co-patenting.

In the literature there is considerable evidence that brain drain increases innovation in the migrating country. Hunt and Loiselle (2010) who analyze the relationship between skilled labor migration and innovation in the United States using 1940-2000 period patent data, conclude that the increase in the number of graduate immigrants with science and engineering degrees and the increase in the number of patents are positively related. Besides, Kerr (2013) proves with the empirical support for high-skilled immigrants in America are an important part of America's innovation. He also points that high-skilled immigrants continue business and technology sharing with their own countries. Furthermore, Miguelez and Moreno (2013) state that the external knowledge density accelerates local innovation through high-skilled labor mobility and international collaborations by estimating the fixed-effect model for the 276 regions of 29 European countries. Similarly, Bosetti et al (2015)'s study which analyzed the influences of talented immigrants on the formation of knowledge between 1995 and 2008 in 20 European countries, show that these immigrants contribute to both private knowledge and public knowledge accumulation. Ramirez et al. (2016) report that the strong relationship between high skilled migrant-innovation is due to the fact that the large innovation capacity of countries increases the potential for attracting more skilled labor.

International business visits are one of the knowledge spillover tools within the concept of international skilled labor mobility that allows new technologies and knowledge to be transferred face-to-face. Hovhannisyan and Keller (2015) examine the effect of business visits from US on the innovation of foreign countries, using patent data from 37 sectors in different countries. The average 10% increase in business travel increases patents in the host country by 0.2%. Study of Piva et al. (2017) which analyze the impact of business visits on productivity shows that business visits increase productivity.

Another type of knowledge spillover provider that can be dealt with in international skilled labor mobility is "expatriates", which gained international business experience. Anderson et al. (2014) define expatriates as persons who are in the status of immigrants and pursue legal work abroad. They note the separation from immigrants in terms of having or not having work because there are also immigrants who don't pursue any work in the responsibility of expatriates. For this reason, they describe four different types of expatriates, combining the types of expatriates used in different areas of the literature: "Assigned expatriates, inter-self-initiated expatriates, intra-self-initiated expatriates and drawn expatriates". The distinction between these types is made according to criteria such as whether the employment decision in different countries is to be given to an institution or independently, or whether the partner of the employment contract is old or new.

Vance (2016) defines expat-prenaur as "an individual temporary living abroad who initiates an international new venture (self-employment) opportunity in a host country". These people may have entrepreneurship purpose or see new venture opportunities while working under Assigned Expatriates or Self-Initiated Expatriates. According to him, these people also strengthen entrepreneurship in local economies

and contribute to economic development. They also continue to be beneficial in the long term owing to the wealth of knowledge spillover which is provided to the local labor market.

Expatriates gain technical and managerial skills while they are abroad and contribute to the knowledge spillover when they return to the country of origin. They also positively affect the economies of the host country since they will continue economic activity.

Testing expatriation as a knowledge spillover channel is usually done through organizations. Tsang (1999) empirically investigates the role of expatriates on knowledge spillover in Singaporean multinational companies in China. The results show that efficient expatriations contribute to the accumulation of knowledge within the multinational firm Similarly, Downes and Thomas (2000) confirm the existence of knowledge spillover through expatriation. Gonzalez and Chakraborty (2014) support that the expatriation-based learning provide knowledge spillover to affiliates. While knowledge spillover to affiliates is related to "repatriation", external knowledge spillover can begin before "repatriation".

As a result, international skilled labor mobility can be considered as a channel which emerges in different forms, mediates for accessing new information both in the country of origin and in the country of destination, and accelerates the international knowledge spillover. In both countries this channel encourages innovation, increases the level of education, improves productivity in production, and ensures growth.

2.2.f. Universities

The important role of universities in the international knowledge spillover is emerging within the context of international student mobility. International higher

education student mobility is a knowledge spillover channel that handles students with diverse knowledge and competencies by transferring that knowledge beyond the borders and transferring new equipment acquired during the time spent in the foreign country to the local country.

The underlying idea behind this channel is that the technological knowledge buried in human beings, as in physical capital and intermediate goods, is spread between international human movement and economies (Park 2004; Le 2010).

Students who go to developed countries from developing countries receive technological know-how including R&D through training or post-schooling experiences. They can contribute to productivity by returning to their countries or by having close contact after their training. Park (2004), who examines the role of technology transfer in this flow of students, examined the impact of international student mobility and R&D spillovers on total factor productivity of countries using the cointegration method for 21 OECD countries and Israel for 1971-1990. Le (2010) developed the dataset for Park's study and used the same method to analyze the data given in the 1998-2015 period for 76 developing countries. In this study, the student variable is identified by weighting it with foreign R&D capital. Similarly, it has found strong evidence that international students create R&D spillover.

Individuals who return to their countries after the international student movement play a role in the flow of knowledge by continuing to communicate and collaborate with the people in countries where they have studied. Kahn and Mac Garvie (2012) compared local colleagues and scholars who benefited from Fulbright scholarships provided by America and returned to their countries after finishing their doctorates or post doctorates. They claim that researchers using the Full-Bright scholarship collaborated with their American counterparts to produce more articles and contribute

to the scientific development of their country. Jonkers and Tussen (2008) found similar findings in a case study on Chinese researchers According to Chinese researchers the correlation analysis of past education mobility, publications' results and international joint studies show that scientific outputs are related to international co-operation and individual characteristics of researchers. Baruffaldi and Landoni (2012) confirmed the effects of international links on returning to the country and their scientific productivity. The results indicate that researchers with high connections are more likely to return to their own countries and their scientific productivity is higher. According to news on the Wall Street Journal in 2017, the reason behind the North Korean nuclear advance has been shown to be experts who complete their doctorate and gain technological knowledge in other countries, especially in China.

In addition to student mobility, universities provide knowledge spillover through collaborations with industry.

Knowledge transfer between universities and industry brings science, innovation etc. to the market and contributes to economic growth (OECD 1998). It also offers opportunities to increase interest in educational missions of universities and to develop new research directions. Through these collaborations, universities and industry can transfer each other economically beneficial knowledge and skills that demanded by industry and require advanced training.

The university-industry collaborations comprise a wide range of interactions between targeted companies and universities to exchange knowledge, research, science and technology. “Research collaborations include research partnerships, contract research, research consortia, consulting and founding of co-operative research centers” (Scandura 2016).

According to Audretsch and Lehman (2005), there are two main mechanisms that accelerate the dissemination of knowledge to colleagues from universities. The transfer and transmission costs of the knowledge in articles are low, it can be reached from various sources. For this reason, the articles do not influence the spatial dimension, and this spillover channel does not explain the location preference of companies. The second one is the employment of students graduated from universities. At this stage, geographical distance from the university-university relations is also important (Audrestch and Lehman 2005). Employment of college graduates is an important channel for the company university interaction (Schartinger et al. 2001; Varga 2000).

Leten et al. (2014) have examined the influence of universities on the technological performances of neighboring firms through university graduates and scientific publications. In order to control the economic and technical value differences of the patents used as technological performance indicators, used the patent number of the firm by weighting it with the number of citations made in fixed period of five years. In the study of 101 Italian regions and 4 sectors, it has been shown that both the university graduates and the scientific publications increase the technological performance of the firm with the panel fixed effect method.

Scandura (2016) examines the impact of UK firms' R&D on university-industry collaboration. In this research, "a novel source of data made up of U-I projects funded by the UK Engineering and Physical Sciences Research Council between 1997 and 2007 and firm-level data available through the UK Office for National Statistics" was used. They found a meaningful and positive impact with the hypothesis that participating in the projects increase firms' per capita R&D spending.

Bellini et al. (2018) tested the conceptual model, which was established to analyze the determinants and utilities of the university-industry collaboration, with the structural equality model. They found that the experience of past cooperation increases the gain from university-industry cooperation. Also, trust and know-how between collaborations play an important role for the collaborative experiences and relationships among their benefits.

2.3. Knowledge Spillover Effects on Exports

International trade is a bi-directional channel that allows for the transfer of new technical and operational knowledge embedded in goods and services, as well as it is influenced by knowledge arise through FDI, Innovation Based Activities, International student mobility, import activities and other spillover channel. The aim of this thesis is to examine the impact of knowledge spillovers on export performance of host countries. Specifically, we proxy knowledge spillovers with FDI and patent applications. Thus, this thesis investigates whether FDI or patent applications act as a channel of knowledge spillovers in improving the export performance of countries. Putting one step further, we conceptualize that it is not the quantity of exports but the quality of export matters. Therefore, in this subsection first the regarding literature on the effect of our proxies on export performance of countries will be reviewed. Next, the literature on the impact of our proxies on quality of exports will be summarized.

Foreign companies can influence export decisions of domestic firms by establishing close relations with domestic companies (Görg and Greenaway 2004; Kneller and Pisu 2007; Wagner 2007). However, compared to the impact of FDI on productivity (i.e. productivity spillovers)[5], little effort has been put on how FDI inflows the export

[5]See among others, Hu and Jafferson 2003; Harris 2003; Javorcik 2004; Keller and Yeaple, 2009; Blalock and Gertler, 2008; Liang 2017.

performance of firms. It is in spite of the fact that entering of firms to international market can decrease the cost of access to foreign markets for non-exporting firms. Non-exporting companies have a chance to learn how to export from the export experience of other companies. It is known as export spillovers (Aitken et al. 1997).

The current literature on export spillover shows that foreign direct investment has an influence on the domestic firms' export decision and performance through intra-industry (horizontal) and inter-sector (vertical) links. According to this literature, exporting behavior of firms might be affected by basically from three channels: (i) acquisition of further knowledge about foreign market (knowledge externalities), (ii) enhancing innovative capabilities of domestic firms (iii) through expanded rivalry (Rodriguez-Clare 1996; Aitken et al. 1997; Greenaway et al. 2004).

The scope of export spillovers sourced by foreign direct investment varies depending on whether horizontal or vertical links exist between local and multinational firms. In the literature considering the influence of multinational companies on export behavior, the focus is mainly on horizontal links where domestic firms take advantages from multinational firms in their respective sectors. Horizontal links have two opposite effects on firms. While increasing competition affects firms' export behavior positively, a reduction in market share and a restriction on access to skilled labor can negatively affect export performance (Blalock and Gertler 2008). Another channel of export spillover is vertical links. Close relationships with multinational companies in the lower and upper sectors, and providing resources from them, can encourage firms to export. In addition, it is important criteria for foreign affiliates that local companies acquire international standards in quality, production technology and managerial skills. Generally, horizontal links cause export spillover, particularly with competitive

channels, while other channels are more obvious for vertical linkages (Dalgıç and Fazlıoğlu 2016).

Another channel that affects firms' export decisions is innovation activities. Process improvements and product upgrades under the influence of innovation activities on firms' exports are two different components. (Caldera 2010; Turco and Maggioni 2015). The firms, which are innovating and getting cost advantages in their production processes, are more likely to export because their sales will be higher compared to firms that do not innovate. Also, product developments affect the export decision (Bernard and Jensen 1999; Bernard and Jensen 2004). Product innovation and the production of products suitable for customer demand enable more market dominance and export opportunties.

When the impact of innovation types on exports is addressed, it is concluded that the effect of product innovation is greater than process innovation. The variety of products that innovative firms have, makes them forward from their competitors in international markets (Caldera 2010). While product innovation is preliminary in exports to developing countries, process innovation in export to richer markets strenghtens product innovation (Turco and Maggioni 2015).

A group of studies examining the effect of innovation on exports in the literature has taken the investments in the R&D as an innovation indicator and supports a positive relationship between innovation and exports. (Cassiman and Martiez-Ros 2005; Aw et al. 2007; Girma et al. 2008)

2.3.a. Export Sophistication

Another criteria that can be used to determine the quality of an export basket of a country is sophistication of exports. In recent years, a new literature has arisen, arguing

that "sophistication" of a country's export is an important component of economic development and growth. In particular, it has been researched what countries export products based on the idea that specialization in some products will bring more growth than others. According to Hausmann et al. (2007) “some traded goods are associated with higher productivity levels than others and that countries that latch on to higher productivity goods (through the cost discovery process just described) will perform better”. Sophisticated products that require a higher level of production can provide more knowledge spillover. In addition, the performances of countries producing these products are higher than those of other countries. Over time, the sophistication of the production structure of a country may develop with a quality improvement of formerly produced goods or the passage of new, more sophisticated products.

The difference of export sophistication from export of high technology products is that exports of high technology products, which are measured by the R&D intensity reflects the level of technological development of countries, while export sophistication indicates the income and growth level of countries (Hausmann et al. 2007).

The classification in the following table shows that exported products may have different levels of sophistication at different technology levels.

In this table, product grouping with low technology-low sophistication and high technology-high sophistication is consistent with classical trade theory. It shows that low-income countries will produce simple products that require low technology, while advanced countries will produce high-technology products. High technology-low sophistication refers to the export of countries like China, where high-technology production in countries with low wages is included in the fragmented process. Due to

the constraints of resources and logistic, low technology high-income countries consist of the product groups that cannot slip into low-income countries.

Technology Level	**Sophistication Level**	
	Low	**High**
Low	Technologically simple products whose export production has shifted to low wage areas	Technologically simple products whose export production has shifted to low wage areas remains in high wage areas because of trade distortions, resource availability, logistical needs to be near main markets
High	Technologically advanced products with fragmentable process located in low wage areas	Technologically advanced products with fragmentable process where high wage countries retain strong comparative advantage
Note: The sophistication level is based on the average income of exporter of a product, the level rising with income. The technology level is based on the R&D intensity of the core industrial process.		

Table 2.1. Export Sophistication and Technology intensity (Lall 2006)

The term of export sophistication is provided to the literature by Hausmann et al. (2007), hence the studies in this field are fairly new. In the study of Hausmann et al. (2007), the sophistication index, which indicates the quality of exports, has been established. With this index, the authors found a high correlation between the quality and income levels of exports of countries. However, the study concludes that China's export basket is more sophisticated than its income level. This result has led many researchers to focus on China in their analysis.

In the regarding literature "self-discovery" (Rodrik 2006) "foreign direct investments" (Rodrik 2006; Xu and Lu 2009; Weldemicael 2012; Cheah 2013; Iwamoto and Nabeshima 2018) "financial development" (Huang and Chen 2014; Yu and Hu 2015), "human capital accumulation" (Wang and Wei 2010; Anand et al. 2012 Huang and Chen 2014; Fang et al. 2015; Yu and Hu 2015) and R&D investments (Zhu and Fu 2013; Fang et al. 2015; Yu and Hu 2015) are found to be the reasons behind high sophistication. A number of studies in the literature concluded that the origin of FDI also matter for sophistication level of countries (Xu and Lu 2009). For instance, Xu and Lu (2009) reveal that FDIs from OECD countries are positively connected with sophistication of Chinese exports but, FDIs from Hong Kong, Macau and Taiwan have no impact on it. In addition, Wang and Wei (2010) attribute this high performance of China to the influence of policies that increase the quality of exports. Also, analysis of Chinese cities has shown that export sophistication is more intense in cities with high-level human capital. Furthermore, Anand et al. (2012) show that the indicators of "educated workforce, external liberalization and good information flows" have an impact on the both product and service export sophistication. Particularly, highly skilled labor and good information transfer have a notable prescription for the sophisticated service sector. Besides, Weldemicael (2012) point that while the FDI have a positive effect on export sophistication, the distances to major markets is negatively affect export sophistication. Moreover, Huang and Chen (2014) obtain that there is a Granger causality relation between FDI in the service sector of China and sophistication of service sector export by using time series data between 1997 and 2012. Fang et al. (2015) analyze the impact of financial development, FDI, R&D expenditures and human capital on export sophistication, with a panel data covering 31 provinces and municipalities in China from 2002 to 2008 and confirm the relation

between them. The study of Yu and Hu (2015) on export sophistication of Chinese manufacturing industry indicate that the role of R&D investments and financial development is high while the role of FDI is low.

The study of Zhu and Fu (2013) indicate that the effects of factors that are effective in export sophistication vary according to the income groups of countries. While institutional quality and education increase export sophistication in low income countries, R&D and Capital/labor have same impact on sophistication for high-middle income countries. In addition, while FDI and import are significant in the long term for sophistication export, product fragmentation and outsourcing affect in the short term.

The impact of FDI on studies of countries' sophistication exports is mixed. Harding and Javorcik (2012) claim that FDI did not increase export sophistication by the analysis consisting of 105 countries data covering the years 1984-2000. In another study, Cheah (2013) finds that FDI's services have a significant non-linear impact on export sophistication in the analysis of fixed effect estimates with data from 86 countries. Similarly, Iwamoto and Nabeshima (2018) find that both the stock value and inward value of the FDI have a significant effect on export sophistication for 175 countries between 1980 and 2007.

2.3.b. Exports of High Technology Products

High technology products are generally defined as products with a high R&D intensity. Factors that represent the power to have innovative capacities such as R&D, innovation, and patents are frequently discussed in the literature as positive influencing factors in exports of high-technology products. This result is robust to different countries and country groupings (OECD, EU, Asian developed, developing etc.) and

to different methods. To illustrate, Seyoum (2005) tested the determinants of exports of high technology products for developed and developing countries. Findings show that the technological infrastructure measured by telephone per worker, the human capital measured by the number of scientists and engineers per capita, the inward FDI and the demand conditions are positive effects of exports of high technology product. In addition, focusing on major developing countries Montobbio and Rampa (2005) reveals that the increase in exports in high-technology industries is influenced by technological competitiveness (innovation), FDI, productivity and initial level of technical. Ivus (2010) analyzes the relationship between patent rights in developing countries and high-technology exports of developed countries confirms a strong impact on more sensitive industries such as scientific instruments and medical products. Tebaldi (2011) show that inflow of FDI, trade openness, human capital directly increases export of high technology products, but political institutions indirectly increase high-technology export for developed and developing countries. Besides, Abedini (2013) investigates the factors behind the high-technology export for developing and developed countries that met about 95% of the world's export of high technology products needs in the period 1995-2008. The consequences of the analysis show that while FDI is the decisive factor in exports of high technology products in the developing countries, technological infrastructure, R&D and Skilled Labor are decisive in the developed countries

In addition to total R&D and patents as well as scientific articles, research documents, the number of persons working in knowledge-intensive services, business or public R&D is used as determinant of high-technology export[6].

[6] Within the framework of European countries, Meo & Usmani (2014) shows the relationship between Patent, R&D and High technology export with 47 countries in 1997-2011. It also demonstrates that there is a positive correlation between indexed journals, number of universities and high-technology exports. Sandu and Ciocanel (2014), using the European Union's rich data set, point a

For OECD countries, Braunerhjelm and Thulin (2008) reveal that R&D investments are an important factor in determining high-technology exports among OECD countries. The result of the empirical analysis covering the 1981-1999 period of 19 OECD countries indicates that a 1% increase in R&D investments rises the exports of high technology products by about 3%. Also, it notes that FDI outflow and market size have no specific impact on high-technology product exports. Moreover, Shelton et al. (2015) states that both business sector R&D spending and total R&D expenditure have a positive effect on high-technology product exports for OECD countries[7].

One of analyzes for the Asian country group is Alemu (2013) for the 11 developing countries of the Western Asian country group. The empirical findings of this analysis with the data set covering the years 1994-2010 show that the export of high technology products, the scientific infrastructure measured by R&D researcher of the country and the inward FDI are positively related. In another study within this region, Ismail (2013) examines the impact of innovation through multinational companies' investments, both on the export of high technology products and high technology import. The results of the analysis with 11 exporting Asian countries and 30 other importing countries in Asia demonstrate that the positive impact of the innovation by multinational companies on the high-technology exporters is different in terms of importer countries. Since Asian countries reduce their dependency on high-technology product imports by monitoring the activities of multinational companies, importer countries are negatively influenced by multinationals' innovative activities. Similarly, Göçer (2013b) states that R&D expenditures positively affect export of high

causal relationship between the volume of public and private research and development expenditures, the human resources worked in knowledge intensive activities and the level of high-technology exports.

[7] In addition, patents, SCI publications and researchers have high correlation with high-tech exports.

technology products for 11 developing Asian countries including Turkey in the period 1996 and 2012.

As an example of studies with narrower country groups, Ying et al. (2014) reveal that R&D and patents are directly related to high-technology product exports in the BRIC (Brazil, Russia, India and China) countries, but not FDI. In addition, Kılıç et al. (2014) proves that R&D spending increases high-technology product exports with Dumitrescu and Hurlin causality analysis method using panel data covering G8 countries in the period 1996-2011.

Extending the dataset beyond the analysis of specific country groups, Sara et al. (2012) using the data from 120 countries analyzes the relationship between the innovation capacity of the country and the share of high-technology product exports in total exports of manufactured products This study tests the relationship between export of high technology products and seven independent variables that are defined as innovation, Business Sophistication (Quality of business network), Practice and Education, Technological Availableness, Infrastructure, Business, Trade Freedom. The findings confirm that the impact of innovation is very high, others have not significant impact on high-technology export.

In addition to studies with different countries in the literature, there are also studies conducted within a given country with data sets covering different regions, industries or firms of that country. As an example, Liu and Lin (2006) state that Foreign Patent Rights has a significant impact on export of three high-technology industries which are “semiconductor, information and communication equipment” from 1989 to 2000 in Taiwan. According the study, the degree of high-technology exports is related with openness to imports.

To this extent, the literature shows that product literature is shaped around studies using variables such as R&D, Patents, Skilled Labor, and Scientific publications, which are potential innovation indicators, which chose innovation as the determining factor. Also, FDI which we have discussed in detail in the section on knowledge spillover channels, is an effective channel for export of high technology products. The new technical information coming to the country through FDI can lead to more efficient R&D activities, increased innovation and thus higher technological product production and exports.

An important study measuring the impact of FDI on high-technology export Zhang (2015) questioned the impact of FDI on export competitiveness of the Chinese manufacturing sector, with data from 31 regions of China and 21 production sectors covering 2005-2001. This study points out that FDI is the key to China's export success, because the impact of FDI on China's export capacity is higher in labor-intensive and low-technology sectors. It is also emphasized that FDI with export of high technology products coming from Western countries is more important than FDI coming from developing countries. In addition, Topalli (2015) examines the impact of FDI on high-technology exports through data from Turkey, Thailand, Singapore, South Korea, India and Brazil for the period 1998 and 2013. The consequences demonstrate that there is bidirectional causal relation between foreign direct investment and high-technology product exports. In other words, FDI increases export of high technology products, also export of high technology products attract foreign direct investment.

In the literature it is obvious that unless impact of innovation is calculated, FDI show a positive impact on export of high technology products. This positive impact is sourced by advanced and invisible knowledge coming through FDI.

CHAPTER III

DATA, METHODOLOGY and ESTIMATION

In this chapter, the data used for analysis will be defined first, then the methodology and estimation model will be explained.

3.1. The Data

As mentioned before, the aim of this thesis is to investigate the impact of knowledge spillovers on quality of the export baskets. For this reason, the value of sophistication of exports and exports of high technology products are chosen to proxy the quality of exports. Hence sophistication of export indices and level of exports of high technology products of countries are used as the dependent variables. FDI and patent applications are the knowledge spillover variables identified from the literature that are used as main independent variables. In addition, various conditioning variables are used for the testing of the hypothesis.

To examine the regarding relationship, we conduct a panel data of 114 countries that includes both developed and developing countries between 2002 and 2015 (see the Appendix A.1. for the list of countries).

In this section, our dependent variables, selected knowledge spillover indicators and conditioning variable set will be explained respectively.

3.1.a. Export Sophistication Indicator

The sophistication index, developed by Hausmann et al. (2007) who are authors of the most referential studies on export sophistication, is defined as "income level of country's exports". The basic logic behind the creation of this index is based on the

idea that some products are more sophisticated which need more expertise and countries that specialize in sophisticated goods demonstrate higher performance in terms of Gross Domestic Product (GDP) per capita. According to their definition, if a product is produced by rich countries, it is sophisticated. Hausmann et al. (2007) measures the sophistication level of each product with the index called PRODY. "This index is a weighted average of the per capita GDPs of countries exporting a given product, and thus represents the income level associated with that product." Then, using PRODY's of products the sophistication level of the exports of the countries are measured by the EXPY index. "EXPY is a weighted average of the PRODY for that country, where the weights are simply the value shares of the products in the country's total export"

More formally, when m is index of countries and n is index of goods, total export of country m can be written as:

$$X_m = \sum_n x_{mn}$$

Assume Y_m is the per-capita GDP of country *m, and* the productivity level related to the product *s*, $PRODY_s$, is represented as:

$$PRODY_s = \sum_m \frac{(x_{ms}/X_m)}{\sum m\,(x_{ms}/X_m)} Y_m.$$

Here, x_{ms}/X_m shows the value-share of goods in export basket of the country. Also, $\sum_m (x_{ms}/X_m)$ sums up the value-share of whole exporting countries. Therefore,

$PRODY_s$ indicates "a weighted average per capita GDPs, where the weights correspond to the Revealed Comparative Advantage (RCA) of each country in good *s*.

Also, the productivity level related to country *c*'s export basket, $EXPY_c$, is described by

$$EXPY_c = \sum_n \left(\frac{x_{cn}}{X_c}\right) PRODY_n$$

"$EXPY_c$ is weighted average of the $PRODY_n$ for that country, where the weights are simply the value shares of the products in the country's total exports" (Hausmann 2007).

The sophistication of exports (EXPY) data is taken from The World Integrated Trade Solutions Database (WITS) for the period between 2002 and 2015. The logarithm of the export sophistication (Sophex) is used as the dependent variable.

3.1.b. Indicator for Exports of High Technology Products

Export of high technology products is defined as "export of product with high R&D intensity such as in aerospace, computers, pharmaceuticals, scientific instruments, electrical machinery, chemistry, non-electrical machinery and armament." (WITS 2018)

There are different classifications of high technology exports. The United Nations (UN) plays a substantial role on providing the uniformity of the classification of high technology products. Two categories of UN are used in this context. These are "International Standard Industrial Classification of All Economic Activities (ISIC)" and "Standard International Trade Classification (SITC)" as the Commodity Indexes

for the Standard International Trade Classification. As the name implies, SITC includes the Product classification while ISIC includes the industrial classification.

The product approach is based on determining the technological intensities of products produced in the manufacturing industry by R&D expenditures / total sales method. The grouping of products is done on the basis of SITC. Last version of SITC Rev. 4 includes the following high-technology export products group. A detailed list of the products in these product groups is given in Appendix A.2.

In the sectoral approach,

> "The manufacturing industries is classified according to technological intensity and based on the Statistical classification of economic activities in the European Community (NACE) at 2-digit level. The level of R&D intensity served as a criterion of classification of economic sectors into high-technology, medium high-technology, medium low-technology and low-technology industries" (Eurostat 2018).

In this classification, the technology density is measured by R&D expenditures/ value added method.

For service sector activities, according to NACE Rev.2 two sectoral groups is identified as knowledge-intensive services and less knowledge intensive services, which is determined by 2 digit levels. In this context,

> "High-technology knowledge intensive services include motion picture, video and television program production, sound recording and music publish activities; programming and broadcasting activities; telecommunications; computer programming, consultancy and related activities; Information service activities; scientific research and development" (Eurostat 2018).

Finally, another approach for data on "high-technology and biotechnology patents aggregated on the basis of the International Patent Classification (IPC) 8th edition" is used by EU. This group includes "aviation, communication technology, computer and automated business equipment, lasers, micro-organism and genetic engineering, and semiconductors IPC groups" (Eurostat 2018).

In this thesis, the data on exports of high-technology goods is taken from The World Development Indicators (WDI). Here, high technology export is accounted according to product approach, because as "industrial sectors specializing in a few high-technology products can also produce low-technology products, the product approach is more suitable for international trade" (World Bank 2009). Also, the logarithm of the exports of high technology products value is used as the alternative dependent variable.

3.1.c. Selected Knowledge Spillover Indicators

As explained in the chapter of background literature, there are many channels that provide the spread of the knowledge from different sources. We determine the main knowledge spillover indicators as the Foreign Direct Investment [8] and the Patent Applications[9]. Both of these variables are taken from "World Development Indicators". In our estimation model, we used the foreign direct investment net inflows as a percentage of GDP (FDI) and the number of patent applications per million people

[8] *"Foreign direct investment are the net inflows of investment to acquire a lasting management interest (10 percent or more of voting stock) in an enterprise operating in an economy other than that of the investor. It is the sum of equity capital, reinvestment of earnings, other long-term capital, and short-term capital as shown in the balance of payments." (https://tcdata360.worldbank.org/indicators/BX.KLT.DINV.WD.GD.ZS?country=TUR&indicator=1541&viz=line_chart&years=1970,2016)*

[9] *"Patent applications are worldwide patent applications filed through the Patent Cooperation Treaty procedure or with a national patent office for exclusive rights for an invention--a product or process that provides a new way of doing something or offers a new technical solution to a problem. A patent provides protection for the invention to the owner of the patent for a limited period, generally 20 years." (https://tcdata360.worldbank.org/indicators/IP.PAT.NRES?country=TUR&indicator=2011&viz=line_chart&years=1960,2016)*

(Patent) to eliminate the size of country. Also, we use foreign direct investment net inflows current dollars.

3.1.d. Conditioning Variable Set

One of the objectives of this paper is to investigate the effects of knowledge spillovers on quality of exports in terms of sophistication and technology. To control for other factors that contribute to quality of exports, our estimation model comprises a set of conditioning variables.

The conditioning variable set includes the logarithm of GDP per capita (GDP) which is taken from the World Integrated Trade Solution database. Another conditioning variable is the logarithm of the gross saving to GDP ratio (Saving) obtained by World Development Indicators (WDI). Also, the logarithm of the population (Population) that is taken from WDI is used as a conditioning variable to account for country size. Besides, we take the rule of law [10] index (Law) from The Worldwide Governance Indicators (WGI) in order to capture governance quality.

Moreover, among the indicators of financial depth in the country, we use the data of domestic credit to private sector[11] indicator taken from Global Financial Development Database (GFDD).

In addition to financial development, we control the educational level of a country. For this reason, Enrolment in tertiary education is obtained from UIS (Unesco Institute for Statistics).

[10] *"Rule of law captures perceptions of the extent to which agents have confidence in and abide by the rules of society, and in particular the quality of contract enforcement, property rights, the police, and the courts, as well as the likelihood of crime and violence."*
(http://info.worldbank.org/governance/wgi/pdf/rl.pdf)

[11] *"Domestic credit to private sector refers to financial resources provided to the private sector, such as through loans, purchases of nonequity securities, and trade credits and other accounts receivable, that establish a claim for repayment"*
(http://www.worldbank.org/en/publication/gfdr/data/global-financial-development-database)

To examine whether the impact of knowledge spillovers on countries differentiates with respect to their financial development and education level, we create two dummy variables Findev and EducLevel for financial development and education respectively. The regarding dummies is equal to 1 when the actual value of the variable is bigger than its mean in a certain year, and 0 otherwise. In other words, these dummies variable takes 1 if a country is more financially developed (or educated) with respect to others and 0 otherwise.

Finally, in order to measure of the role of globalization on the relation between knowledge spillover and export quality, The KOF Index of Globalization which is taken from KOF Swiss Economic Institute comprises three sub-indices including "economic, social and political dimensions of globalization" (Potrafke, 2015). Components of the 2016 KOF Index of Globalization is shown in the Appendix A.3.

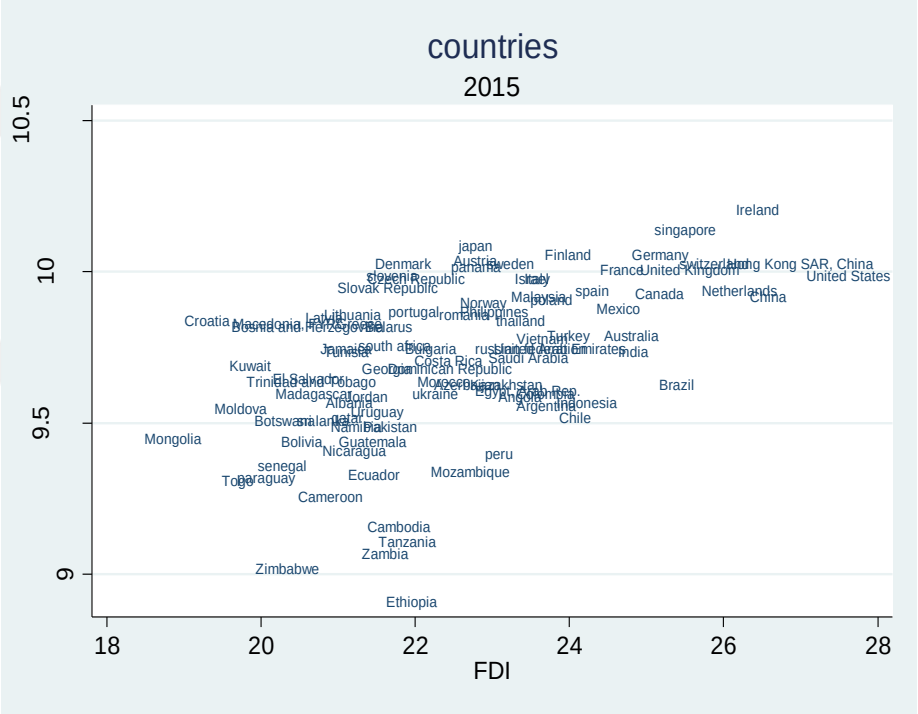
Similar to the creation of the dummy variables for financial development and education a dummy variable for globalization the GlobLevel is created. This dummy variable takes 1 if a country is more globalized with respect to others and 0 otherwise.

Descriptive statistics of the variables used in the model are presented in Table 3.1.

Variable	Definition	Mean	Std. Dev.	Min	Max
Sophex	Logarithm of Export Sophistication	9.69	0.27	8.53	10.21
HighEx	Logarithm of Export of High Technology Products (Current US $)	19.71	3.58	6.12	27.05
GDP	Logarithm of GDP Per Capita	9.43	1.07	6.41	11.77
Patent	Logarithm of Number of Patent Application	3.04	2.21	-4.34	7.97
FDI	Logarithm of the ratio of FDI to GDP	1.11	1.12	-4.61	4.47
FDI_INF	Logarithm of the FDI net inflows (Current US $)	21.63	1.97	12.15	27.32
Law	Rule of Law Index	0.03	1.01	-2.03	2.10
Saving	Logarithm of Ratio of Gross Saving to GDP	3.00	0.75	-1.71	4.43
Population	Logarithm of Population	16.54	1.42	13.38	21.04
Credit	Domestic Credit to Private Sector (% of GDP)	54.15	46.33	0.00	233.40
Liquid	Liquid liabilities to GDP (%)	59.15	44.53	0.00	348.75
Private	Private credit by deposit money banks to GDP (%)	55.11	45.32	0.55	219.12
Secondary	Secondary School Gross Enrollment Ratio % of Relevant Age Group	84.87	26.65	8.45	166.81
Tertiary	Enrolment in tertiary education (number) (per people)	0.031	0.016	0.0007	0.07
Globalization		62.60	15.81	31.06	92.83

Table 3.1. Descriptive Statistics of the Variables

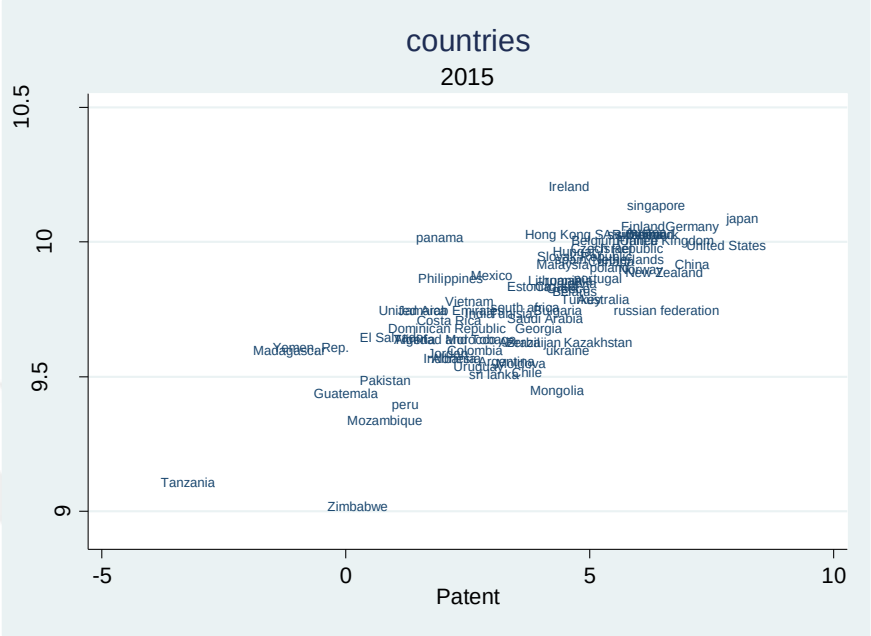
Following graphs show the relation between FDI, Patent, Export Sophistication and High Technology Export for all countries in 2015. Firstly, Graph 3.1. shows that there is a generally positive relationship between FDI and Sophistication Export. Countries with high FDI flows, such as China and Ireland, have higher sophistication of export, while in countries where FDI is low such as Moldova, sophistication of exports is also low. Surprisingly, countries like Ethiopia and Zimbabwe seem to have lower sophisticated exports despite receiving more FDI than some countries.



Graphic 3.1. The relationship between FDI and Sophistication Export in 2015 by country.

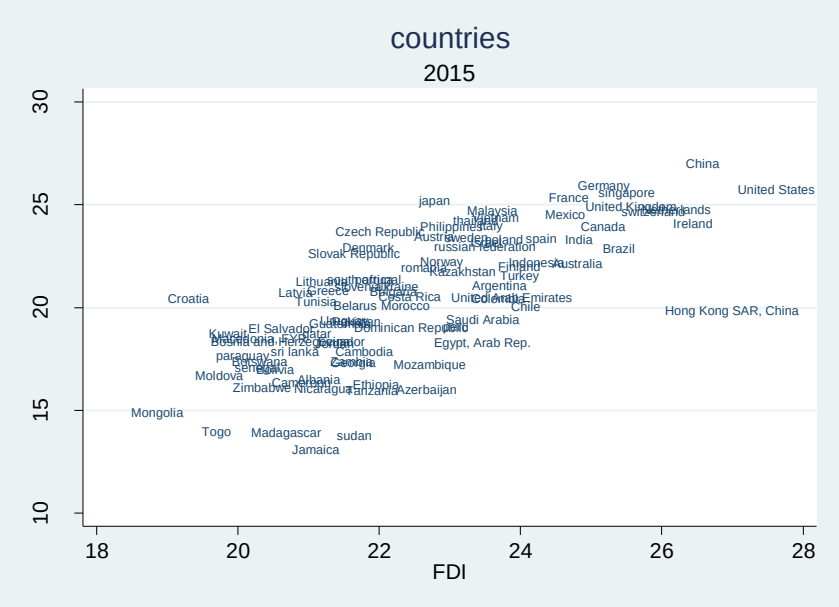
Following Graph 3.2. also indicates the relationship between the count of patent applications per million people and sophistication of export is positive. It is obviously

seen that in countries like Japan and United States both the count of patent applications per million people and the level of sophistication export is high.

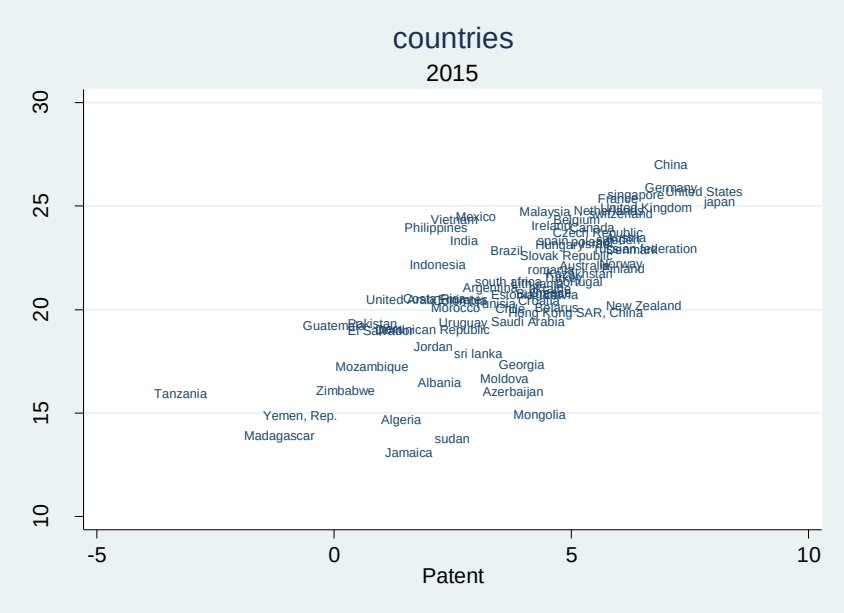


Graphic 3.2. The relationship between Patent and Sophistication Export in 2015 by country.

Moreover, Graph 3.3 and Graph 3.4 respectively demonstrate that FDI inflows and the number of patent applications per million people have positive relationship exports of high technology products.

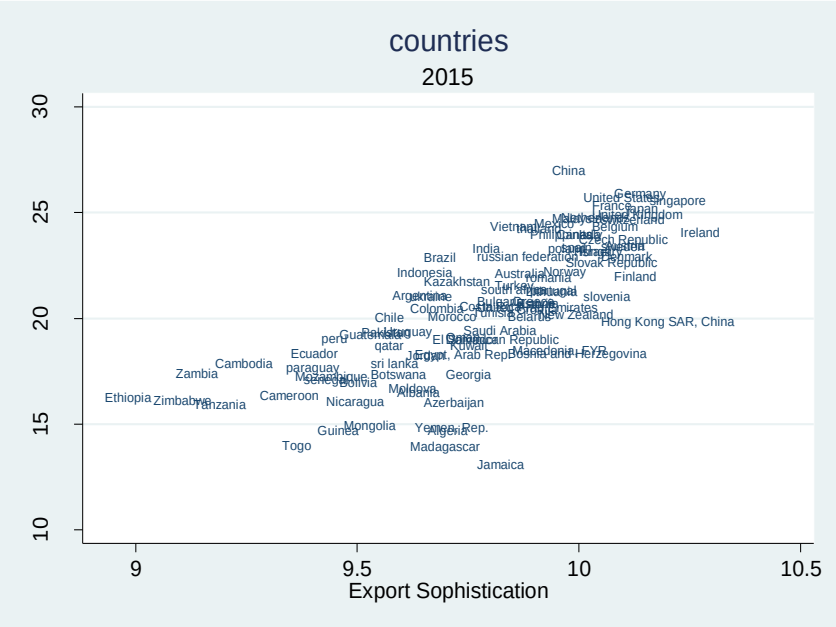


Graphic 3.3. The relationship between High Technology Export and FDI in 2015 by Country.



Graphic 3.4. The relationship between High Technology Export and Patent in 2015 by Country.

Finally, Graph 3.5 shows the positive relationship between sophistication export and exports of high technology products. Although the sophistication export values of China and Jamaica are close to each other, the difference between the level of exports of high technology products is high. Namely, sophistication exports and exports of high technology products do not represent same thing.



Graphic 3.5. The relationship between High Technology Export and Export Sophistication in 2015 by Country.

3.2. The Methodology

In this thesis, to analyze the impact of knowledge spillovers in terms of patents and foreign direct investments, an unbalanced panel data set is constructed for 114 developed and developing countries (see the Appendix A.1. for the list of countries).

Panel datasets comprise the both time series and cross sectional dimensions of the data, and the use of panel data techniques provides some advantages (Baltagi 2005). One of the advantages of panel data techniques is that it can be applied in the analysis

of dynamic processes. Dynamic panel data models unlike static panel data models, are models with lagged dependent variables.

As the relationship between knowledge spillovers and exports are dynamic in nature, we apply a dynamic specification. Besides, "the inclusion of the lagged dependent variable is merited by the fact that its introduction can also serve as a proxy for the unobserved serially correlated state variables" (Kostevc 2005). Accordingly, the estimation equation involving the lag of the dependent variable is expressed as:

$$Y_{it} = \varphi Y_{i,t-1} + ßX'_{it} + U_{it} \qquad (1)$$

$$U_{it} = \mu_i + u_{it}$$

Where Y_{it} is the sophistication of export in country i and year t, X'_{it} is a vector of knowledge spillover indicators and conditioning variables and U_{it} is an i.i.d. error term. Equation (1) represents a standard dynamic panel data specification. In such a dynamic specification, lagged values of dependent variables among the explanatory variables require careful selection of the estimation methodology. Since the dependent variable Y_{it} is associated with the error term "U_{it}" containing individual effects "μ_i", $Y_{i,t-1}$ also is associated with error terms, and the standard predictors as in ordinary least squares methodology give inconsistent and biased results. Also, country-specific effects cause that the Ordinary Least Squares (OLS) estimator is biased. In this case, the assumption that there is no relationship between error terms and explanatory variables is invalid. Alternatively, the fixed effects estimator which removes country-specific effects cannot be used because of bias, which is caused by the inclusion of lagged dependent variables. In order to prevent this bias, GMM estimators are often used (Bond 2002). We use Arellano and Bond (1991)'s difference GMM estimator.

In the GMM developed by Arellona and Bond (1991) that is called "Arellano–Bond linear dynamic panel-data estimation", GMM estimator use instrumental variables generated from within the model itself. The main advantage is they provide instruments that are otherwise difficult to find for Specifically, the first difference model is first transformed by using the vehicle variable matrix, then the obtained model is estimated by the generalized least squares method (Tatoglu 2018).

Arellano-Bond GMM estimators is designed for the following situations (Roodman 2006);

- Short time periods and large number of cross sections panels
- The existence of a linear functional relationship
- In dynamic processes, the current value depends on the past values situations
- When the arguments are not strictly external
- The presence of cross-sectional heterogeneity
- Section specific autocorrelation and varying variance.

Under these circumstances, the consistency of the GMM estimator depends on two basic tests. The first is the Arellano–Bond tests for serial correlation in the first-differenced errors. GMM estimator doesn't allow any autocorrelation in the idiosyncratic errors. The second is the Sargan (1958) J test of the over identifying restrictions. Null hypothesis for Arellano-Bond test represents that there is no autocorrelation, hence it should not be rejected. Also, Sargan test of over identifying restrictions shouldn't be rejected because null hypothesis is that over identifying restrictions are valid.

3.3. Estimation

In this thesis, first of all the link between export sophistication and knowledge spillover variables in terms of Patent and FDI is explored. Then Equation (1) takes the following form:

$$Sophex_{i,t} = \alpha + Sophex_{i,t-1} + \beta_1 Patent_{i,t-1} + \beta_2 FDI_{i,t-1} + \beta_3 FDI_{i,t-2} + \delta Controls + \varepsilon_{it} \quad (2)$$

Where the subscript i denotes countries and t indexes year. As mentioned in the data section, dependent variable $Sophex_{it}$ measures the logarithm of export sophistication index of country i, at time t. To avoid endogeneity, we lag the knowledge spillover variables. Moreover, we also include the second lag of the FDI variable, since knowledge is accumulated in course of time and affects export.

In order to measure the effects of FDI and patent applications on sophistication of countries, firstly, we run the regressions on the whole sample of countries. The results from the GMM regressions are reported in Table 3.2. Columns (1) and (2) indicate the results when patent is used as only knowledge spillover variable, while columns (3) and (4) show the estimation results for only using of FDI. Also, Columns (5) and (6) present the results that both patent application and FDI are used together as knowledge spillover variables.

In Table 3.2., patent applications are found to have a positive and statistically significant effect on export sophistication and this result do not alter even after controlling for patent applications. In fact, one percent increase in the number of patent applications increases the following year's export sophistication level by about 0.02

percent. This result is in line with studies (Zhu and Fu 2013; Fang et al. 2015; Yu and Hu 2015). However, FDI doesn't seem to have any significant effect on export sophistication for the whole sample. Given the knowledge spillover literature including FDI, our results are consistent with the studies finding no significant effect of FDI on export sophistication. Some of the researchers reveals that the spillovers through FDI positively affects host countries by bringing advanced technologies and managerial skills (Blomstrom and Wolf 1994; Görg and Strobl 1999; Javorcik 2004; Lee 2006). On the other hand, some of them notes that FDI negatively affect host economies when domestic market cannot compete foreign firms and lose their market share (Hadded and Harrison 1993; Aitken and Harrison 1999; Djankov and Hoekman 2000; Hu and Jafferson 2002; Liu 2008). Thus, our initial results indicate that the negative competition effects of FDI may balance out the productivity and knowledge benefits when countries are taken as a whole. To summarize, our results confirm that patents applications which create knowledge spillovers, positively impacts on the export sophistication of countries. However, FDI do not bring about any improvements on export quality.

	(1)	(2)	(3)	(4)	(5)	(6)
	All	All	All	All	All	All
L.Sophex	-0.117*	-0.123**	-0.158	-0.161	-0.0906	-0.0928
	(0.0622)	(0.0565)	(0.206)	(0.201)	(0.0762)	(0.0698)
L.Patent	**0.0270****	**0.0270****			**0.0302*****	**0.0299****
	(0.0116)	(0.0119)			(0.0113)	(0.0118)
L.GDP	-0.0248	-0.0375	0.0798*	0.0750	-0.0268	-0.0370
	(0.0274)	(0.0267)	(0.0468)	(0.0486)	(0.0288)	(0.0269)
Population	0.169	0.196	0.0599	0.0590	0.151	0.172
	(0.137)	(0.152)	(0.102)	(0.107)	(0.134)	(0.155)
Saving	0.0202	0.0204	0.0319*	0.0318*	0.0186	0.0183
	(0.0137)	(0.0136)	(0.0190)	(0.0189)	(0.0138)	(0.0139)
Law		0.0525*		0.0327		0.0387
		(0.0307)		(0.0337)		(0.0438)
L.FDI			0.000319	0.000498	-0.00283	-0.00244
			(0.00348)	(0.00351)	(0.00366)	(0.00384)
L2.FDI			-0.00522	-0.00490	-0.00476	-0.00430
			(0.00398)	(0.00390)	(0.00357)	(0.00364)
Constant	8.179***	7.881***	9.386***	9.466***	8.234***	7.984***
	(2.699)	(2.848)	(2.974)	(2.948)	(2.736)	(2.982)
Observations	828	828	905	905	679	679
Number of id	88	88	105	105	86	86

Table 3.2. GMM estimates on sophistication of exports for all countries.
Robust standard errors are in brackets. ***, ** and * indicate statistical significance at the level of 1%; 5% and 10%, respectively.

The direction and size of the impact of knowledge spillovers on exports may depend on absorptive capacity of countries (Cohen and Levinthal, 1990; Girma 2002; Liang 2017). We conceptualize that the higher the absorptive capacity of a country the more it can benefit from knowledge income level, financial development, education and globalization levels of countries. Namely, we analyze the association between FDI, patent applications and export sophistication according to criteria that are associated with country specific factors such as income level of countries, financial development level, educational development level and globalization level.

Firstly, we question whether there are any systematic differences in the impact of spillovers on sophistication of exports between developed and developing countries. Since we are interested in studying cross country variations in knowledge spillover efficiency, we separate our sample into subsamples of developed and developing countries[12]. In order to investigate this question, benchmarking regression is run separately for two sub-samples. Thus, different estimates of all explanatory variables between two samples are made possible.

The results from these estimations are reported in Table 3.3. Columns (1), (3) and (5) indicate the results from developed countries, while columns (2), (4) and (6) shows the estimation outcomes from undeveloped countries. The results show that the patent applications have significantly positive effect on export sophistication in both developed and undeveloped countries. The results imply that the number of patent applications that represent innovation in a country contributes to more sophisticated export for all countries. Unlike patents, FDI results vary from the developed countries to undeveloped countries. The coefficient of FDI is statistically positively significant for developed countries, whereas it is statistically negatively significant for

[12] See Appendix A.1. for the list of developed and developing countries that comprises the developing countries and economies in transition.

undeveloped ones[13]. Thus, we find that FDI serves as a channel for knowledge spillovers to benefit the sophistication level of exports only for developed countries.

This paradoxing result can be attributed to the worse investment climate conditions and appropriate government policies and in developing countries. As reported OECD (2001), in less developed countries the impact of FDI would be smaller due to "threshold externalities" and developing countries must have reached a certain level of education, technology and infrastructure before taking advantage of foreign assets.

Motivated by these observations, next we investigate whether the relationship between knowledge spillover variables and sophistication differs with respect to financial development level of countries, and we run the benchmark regressions separately for the four subsamples. We divide the sample into two groups: “financially developed” versus “financially non-developed” countries and countries with “high human capital” versus “low human capital”. Hence, following regressions that are reported from Table 3.4. to Table 3.8., is explored in order to reveal the role of financial development and educational level.

[13] This result also explains the the statistically insignificant coeffiecent for all countries that presented in Table 3.2.

	(1)	(2)	(3)	(4)	(5)	(6)
	Developed	Developing	Developed	Developing	Developed	Developing
L.Sophex	0.559***	-0.0184	0.443***	-0.0209	0.447***	-0.0224
	(0.139)	(0.139)	(0.124)	(0.126)	(0.119)	(0.118)
L.Patent	**0.00886****	**0.0266***	**0.00935***	**0.0293****	**0.00905***	**0.0287***
	(0.00442)	(0.0154)	(0.00492)	(0.0140)	(0.00511)	(0.0147)
L.FDI	0.00124	-0.0129	0.00132	-0.0125	0.00142	-0.0118
	(0.000978)	(0.00860)	(0.00101)	(0.00956)	(0.000875)	(0.00982)
L2.FDI	**0.00317****	**-0.0211****	**0.00316****	**-0.0226****	**0.00320****	**-0.0215***
	(0.00136)	(0.0102)	(0.00132)	(0.0114)	(0.00131)	(0.0118)
L.GDP	0.00541	0.0561	0.0196	-0.0622	0.0140	-0.0665
	(0.0215)	(0.0632)	(0.0184)	(0.0655)	(0.0139)	(0.0650)
Saving	0.0300***	0.0276	0.0170**	0.0288	0.0155**	0.0285
	(0.00662)	(0.0242)	(0.00783)	(0.0240)	(0.00701)	(0.0245)
Population			-0.215**	0.332*	-0.215**	0.342*
			(0.102)	(0.182)	(0.102)	(0.190)
Law					0.0121	0.0354
					(0.0234)	(0.0533)
Constant	4.186***	9.226***	8.756***	4.599	8.764***	4.486
	(1.197)	(1.685)	(1.416)	(3.239)	(1.389)	(3.386)
Observations	276	326	276	326	276	326
Number of id	32	44	32	44	32	44

Table 3.3. GMM estimates on sophistication of exports for developed and undeveloped countries. Robust standard errors are in brackets. ***, ** and * indicate statistical significance at the level of 1%; 5% and 10%, respectively.

In order to demonstrate the role of financial development level of countries on the link between knowledge spillover and export sophistication, we use three financial indicators: liquid liabilities, domestic credit to private sector, and private credit by deposit money banks. We conduct three alternative models to control for the robustness of the estimations results according to different financial development indicators.

With the aim of the demonstration of the difference between financially more and less developed countries, we separate countries in two groups. The countries above the average of the financial development of a given year are considered to be more developed, while the countries below are considered to be less developed. The results from the estimations that are presented in Table 3.4., Table 3.5., Table 3.6, Columns (1), (3), (5) shows the results for more financially developed countries, while columns (2), (4), (6) indicates results for less financially developed countries.

Table 3.4. represents the output of the GMM estimation results where financial development indicator is liquidity of liabilities. The coefficient of patents continues to be still positively significant for all countries yet the signs of the coefficient of FDI vary according to financial development level of countries. In more financially developed countries FDI contributes to export sophistication, whereas less financially developed countries it doesn't contribute at all. The results reflect the fact that positive spillovers from FDI arise when the country has developed financial markets.

Previous studies corroborated our findings. For example, Alfaro et al. (2004, 2009 and 2010), reveal that the influence of FDI on countries with well-developed financial markets is positively significant otherwise it is unclear. Also Hermes and Lensink (2003), addressing the role of the financial system in relation to FDI and economic growth, found that FDI has a positive effect on growth in countries with an advanced

financial system. Furthermore, some of the researchers who study determinative factors of export sophistication note that financial development is one of the determinants of export sophistication (Fang et al. 2015; Yu and Hu 2015; Anand et al. 2012). There are different reasons why financial development is one of the determinants of sophisticated exports. First, financial development can provide comparative advantage in exporting sophisticated products (Yu and Hu 2015). For industries dependent on foreign financing, the cost of finding resources in economies where financial markets are developed is less (Rajan and Zingales 1998). Moreover, financial development promotes the accumulation of capital by reducing moral hazard and adverse selection. Thus, technical progress and sophisticated product production are increased. Finally, the reduction in moral hazard and adverse selection contribute to the sophistication of exports because of the increase in the efficiency of R&D process and the improvement of absorptive capacity of FDI.

Table 3.5. and Table 3.6. report the outcomes of the GMM estimation results where financial development indicator is “domestic credit to private sector” and “Private credit by deposit money banks” respectively. From these tables, it can be seen obviously that the results don’t change even if financial indicators are different. In other words, patent’s impact of export sophistication still remains statistically positively significant and FDI’s impact depends on financial development level of countries.

	(1) More Financially Developed	(2) Less Financially Developed	(3) More Financially Developed	(4) Less Financially Developed	(5) More Financially Developed	(6) Less Financially Developed
L.Sophex	0.380***	-0.0625	0.320*	-0.0624	0.315*	-0.0662
	(0.140)	(0.119)	(0.164)	(0.115)	(0.169)	(0.104)
L.Patent	**0.0245***	**0.0260*****	**0.0238***	**0.0260*****	**0.0247****	**0.0254*****
	(0.0130)	(0.00850)	(0.0125)	(0.00824)	(0.0123)	(0.00916)
L.FDI	0.00123	-0.00852	0.00139	-0.00886	0.00149	-0.00844
	(0.00120)	(0.00690)	(0.00111)	(0.00699)	(0.00108)	(0.00714)
L2.FDI	**0.00296***	**-0.0167****	**0.00352****	**-0.0177****	**0.00356****	**-0.0167****
	(0.00178)	(0.00794)	(0.00164)	(0.00806)	(0.00163)	(0.00825)
L.GDP	0.0466	-0.00197	0.00216	-0.0146	0.00110	-0.0308
	(0.0364)	(0.0496)	(0.0287)	(0.0345)	(0.0286)	(0.0311)
Saving	0.0243***	0.0214	0.0238***	0.0223	0.0238***	0.0220
	(0.00538)	(0.0221)	(0.00395)	(0.0211)	(0.00449)	(0.0214)
Population			0.180*	0.105	0.172*	0.141
			(0.101)	(0.213)	(0.0957)	(0.252)
Law					0.0204	0.0474
					(0.0199)	(0.0583)
Constant	5.487***	10.19***	3.447*	8.559*	3.627**	8.159*
	(1.425)	(1.447)	(1.811)	(4.425)	(1.801)	(4.876)
Observations	313	357	313	357	313	357
Number of id	42	53	42	53	42	53

Table 3.4. GMM estimates on sophistication of exports for more financially developed and less financially developed countries where financial development indicator is **liquidity of liabilities**. Robust standard errors are in brackets. ***, ** and * indicate statistical significance at the level of 1%; 5% and 10%, respectively.

	(1) More Financially Developed	(2) Less Financially Developed	(3) More Financially Developed	(4) Less Financially Developed	(5) More Financially Developed	(6) Less Financially Developed
L.Sophex	0.250	-0.0771	0.210	-0.0777	0.209	-0.0795
	(0.157)	(0.142)	(0.168)	(0.133)	(0.170)	(0.122)
L.Patent	**0.0293****	**0.0299*****	**0.0310*****	**0.0294*****	**0.0320*****	**0.0287*****
	(0.0117)	(0.00975)	(0.0114)	(0.00937)	(0.0109)	(0.0104)
L.FDI	0.000368	-0.0102	0.000677	-0.0102	0.000760	-0.00962
	(0.00118)	(0.00909)	(0.00104)	(0.00945)	(0.00103)	(0.00967)
L2.FDI	0.00234	**-0.0179****	**0.00271***	**-0.0200****	**0.00283***	**-0.0190***
	(0.00172)	(0.00904)	(0.00157)	(0.00957)	(0.00158)	(0.00979)
L.GDP	0.0360	-0.0185	-0.00296	-0.0493	-0.0117	-0.0609
	(0.0363)	(0.0668)	(0.0250)	(0.0495)	(0.0224)	(0.0398)
Saving	0.0140**	0.0268	0.0152***	0.0308	0.0158**	0.0301
	(0.00640)	(0.0303)	(0.00571)	(0.0280)	(0.00619)	(0.0285)
Population			0.151	0.210	0.147*	0.236
			(0.0941)	(0.247)	(0.0891)	(0.283)
Law					0.0470**	0.0391
					(0.0229)	(0.0681)
Constant	6.879***	10.47***	5.111***	7.191	5.235***	6.886
	(1.575)	(1.829)	(1.980)	(5.136)	(1.938)	(5.598)
Observations	346	333	346	333	346	333
Number of id	47	52	47	52	47	52

Table 3.5.. GMM estimates on sophistication of exports for more financially developed and less financially developed countries where financial development indicator is **"domestic credit to private sector".**

Robust standard errors are in brackets. ***, ** and * indicate statistical significance at the level of 1%; 5% and 10%, respectively.

	(1) More Financially Developed	(2) Less Financially Developed	(3) More Financially Developed	(4) Less Financially Developed	(5) More Financially Developed	(6) Less Financially Developed
L.Sophex	0.363**	-0.0783	0.328**	-0.0793	0.325*	-0.0803
	(0.147)	(0.135)	(0.167)	(0.130)	(0.168)	(0.120)
L.Patent	**0.0231****	**0.0308*****	**0.0241****	**0.0302*****	**0.0252****	**0.0295*****
	(0.0113)	(0.00904)	(0.0111)	(0.00901)	(0.0105)	(0.0102)
L.FDI	0.00100	-0.0102	0.00139	-0.0103	0.00143	-0.00964
	(0.00119)	(0.00869)	(0.00106)	(0.00894)	(0.00112)	(0.00924)
L2.FDI	0.00278	**-0.0183****	**0.00314****	**-0.0198****	**0.00321****	**-0.0188****
	(0.00169)	(0.00882)	(0.00156)	(0.00915)	(0.00157)	(0.00945)
L.GDP	0.0356	-0.0123	-0.00535	-0.0305	-0.0141	-0.0427
	(0.0357)	(0.0634)	(0.0241)	(0.0433)	(0.0219)	(0.0352)
Saving	0.0144**	0.0273	0.0158**	0.0303	0.0164**	0.0295
	(0.00717)	(0.0298)	(0.00670)	(0.0276)	(0.00719)	(0.0282)
Population			0.158*	0.137	0.151*	0.166
			(0.0828)	(0.254)	(0.0777)	(0.298)
Law					0.0452**	0.0369
					(0.0217)	(0.0709)
Constant	5.788***	10.42***	3.876**	8.271	4.053**	7.915
	(1.437)	(1.724)	(1.817)	(5.272)	(1.801)	(5.838)
Observations	336	332	336	332	336	332
Number of id	47	53	47	53	47	53

Table 3.6. GMM estimates on sophistication of exports for more financially developed and less financially developed countries where financial development indicator is **"Private credit by deposit money banks".** Robust standard errors are in brackets. ***, ** and * indicate statistical significance at the level of 1%; 5% and 10%, respectively.

Besides, another criteria that is likely to be influential on sophistication of exports is the educational level of the countries. The benefit of advanced technological knowledge that transferred with knowledge spillover channels is only possible when a certain level of educated people is available. If the educational level of people and the quality of the employees are below a certain threshold, the transfer of knowledge and technology are prevented and no positive benefit can be obtained (Borensztein et al. 1998). Furthermore, in a few of the studies that are focus on export sophistication, education is obtained as one of factors that is effective on export sophistication (Anand et al. 2012; Zhu and Fu 2013). Thus, in order to indicate the role of education on the association between knowledge spillover channels and export sophistication, we divide our countries as educated and non-educated using two indicators which represent educational level of countries. One of these indicators is tertiary school enrollment, another of them is secondary school enrollment. We conduct two alternative models to check the robustness of results with respect to alternative indicators of education.

To reveal of the difference between more educated and less educated countries, we separate countries in two groups. The countries above the average of the human capital of a given year are considered to be more educated, while the countries below are considered to be less educated. The results from the estimations are presented in Table 3.6. and Table 3.7. Columns (1), (3), (5) show the results for more educated countries, while columns (2), (4), (6) indicate results for less educated countries.

Table 3.7. reports the output of the GMM estimation results where educational level indicator is tertiary school enrollment. In terms of educational level, the coefficients of patents are positively and statistically significant only for more educated countries. It is a surprising result because the association between patent and export sophistication is always positively statistically significant in earlier estimation results that are presented from Table 3.2. to Table 3.6. In other words, in countries with low human capital, we find that the increase in the number of patents does not have an impact on sophistication exports. This result may stem from the following observation. The number of patents shows that the potential inventions in a country and new inventions lead to the emergence of new knowledge. However, due to the low levels of human capital new knowledge can't be used efficiently to promote the quality of exports in terms of sophistication.

	(1) More Educated	(2) Less Educated	(3) More Educated	(4) Less Educated	(5) More Educated	(6) Less Educated
L.Sophex	0.455***	-0.139	0.447***	-0.124	0.434***	-0.119
	(0.0819)	(0.0870)	(0.0792)	(0.0926)	(0.0794)	(0.0886)
L.Patent	**0.0117****	0.0271	**0.0116****	0.0262	**0.0120****	0.0253
	(0.00501)	(0.0177)	(0.00497)	(0.0168)	(0.00496)	(0.0169)
L.FDI	0.00142	-0.00403	0.00135	-0.00604	0.00163**	-0.00493
	(0.000965)	(0.00896)	(0.000915)	(0.00880)	(0.000825)	(0.00867)
L2.FDI	**0.00370*****	**-0.0205***	**0.00369*****	**-0.0226***	**0.00380*****	**-0.0214***
	(0.00142)	(0.0111)	(0.00140)	(0.0120)	(0.00137)	(0.0126)
L.GDP	-0.0113	-0.0415	-0.00791	-0.102	-0.0172	-0.110
	(0.0194)	(0.0942)	(0.0165)	(0.0820)	(0.0143)	(0.0673)
Saving	0.0120***	0.0456	0.0115***	0.0505	0.0110***	0.0482
	(0.00465)	(0.0382)	(0.00427)	(0.0367)	(0.00387)	(0.0363)
Population			-0.0480	0.334	-0.0489	0.374
			(0.0840)	(0.344)	(0.0800)	(0.463)
Law					0.0312	0.0186
					(0.0195)	(0.128)
Constant	5.393***	11.21***	6.230***	5.724	6.444***	5.060
	(0.749)	(1.489)	(1.487)	(6.492)	(1.387)	(8.620)
Observations	332	189	332	189	332	189
Number of id	50	35	50	35	50	35

Table 3.7. GMM estimates on sophistication of exports for more educated and less educated countries where educational level indicator is "**tertiary school enrollment".**
Robust standard errors are in brackets. ***, ** and * indicate statistical significance at the level of 1%; 5% and 10%, respectively.

Similarly, the impact of FDI on export sophistication depends on education level of countries. As mentioned before, when the absence of educated human capital, the new advanced knowledge sourced by FDI cannot be used to produce sophisticated products and export them. Estimation results corroborate this finding because in the following Table 3.7. the coefficient of FDI is positive and statistically significant only for more educated countries.

Table 3.8. represents the output of the GMM estimation results where educational level indicator is secondary school enrollment. It is clear that secondary school enrollment is more common than tertiary school enrollment. Therefore, in terms of secondary school enrollment levels, the coefficients of the number of patent are positive and statistically significant for both more educated and less educated countries except column (4). It can be deduced from these results that secondary school education is not a distinctive education level in the use of new knowledge that is sourced by patent applications indicating for inventions. Because of the same reason, the significance of the coefficient of FDI declined according to the estimation results that used tertiary enrollment level as indicator of educational level.

	(1) More Educated	(2) Less Educated	(3) More Educated	(4) Less Educated	(5) More Educated	(6) Less Educated
L.Sophex	0.256**	-0.108	0.255**	-0.154	0.254*	-0.152
	(0.128)	(0.138)	(0.124)	(0.161)	(0.130)	(0.162)
L.Patent	**0.0151*** **	**0.0422***	**0.0151*** **	**0.0404**	**0.0156*** **	**0.0410***
	(0.00498)	(0.0252)	(0.00499)	(0.0254)	(0.00506)	(0.0235)
L.FDI	0.000279	-0.0144	0.000267	-0.00838	0.000472	-0.00793
	(0.00115)	(0.0134)	(0.00104)	(0.0109)	(0.000991)	(0.0109)
L2.FDI	0.00268	-0.0258	**0.00267***	-0.0188	**0.00287***	-0.0186
	(0.00164)	(0.0160)	(0.00158)	(0.0120)	(0.00151)	(0.0125)
L.GDP	-0.0179	-0.217	-0.0161	0.0539	-0.0314	0.0557
	(0.0250)	(0.238)	(0.0226)	(0.117)	(0.0203)	(0.115)
Saving	0.00490	0.0663	0.00473	0.0690	0.00564	0.0686
	(0.00470)	(0.0499)	(0.00457)	(0.0514)	(0.00417)	(0.0530)
Population			-0.0185	-0.836	-0.0110	-0.832
			(0.123)	(0.578)	(0.122)	(0.582)
Law					0.0377*	0.0217
					(0.0221)	(0.0887)
Constant	7.419***	12.39***	7.726***	25.25**	7.731***	25.17**
	(1.178)	(3.176)	(2.020)	(11.56)	(2.025)	(11.61)
Observations	427	137	427	137	427	137
Number of id	58	29	58	29	58	29

Table 3.8. GMM estimates on sophistication of exports for more educated and less educated countries where educational level indicator is **"secondary school enrollment**".
Robust standard errors are in brackets. ***, ** and * indicate statistical significance at the level of 1%; 5% and 10%, respectively.

In this study, we also hypothesize knowledge spillovers steaming from FDI or patent applications can improve the quality of exports of globalized countries. Thus, we investigate the role of the globalization level of countries on the relationship between knowledge spillovers variables and export sophistication. For the globalization level of countries, we use the KOF globalization index which reflects the globalization of countries in terms of economic, social and political globalization. In order to measure the effect of globalization, we separate countries in two groups, again. The countries above the mean of the globalization level of a given year are considered to be more globalized, whereas the countries below the mean are considered to be less globalized.

Table 3.9. shows the GMM results according to globalization level of countries. Columns (1), (3), (5) show the results for more globalized countries, while columns (2), (4), (6) demonstrate the outputs for less globalized countries. Estimation results indicate that the impact of patents is continuous to be positively and statistically significant. Note that the coefficient of patents in the less globalized countries are larger than those in the globalized economies. This result can be explained by the fact that innovations are one of the main determinants of sophistication in less globalized countries. As can be seen from the table, there is an important role of the globalization level on the impact of FDI in host countries. In more globalized countries, FDI has positively significant impact on the level of sophisticated export, however in the less globalized country this impact turns negative.

	(1) More Globalized	(2) Less Globalized	(3) More Globalized	(4) Less Globalized	(5) More Globalized	(6) Less Globalized
L.Sophex	0.302***	-0.0477	0.282***	-0.0518	0.280***	-0.0569
	(0.0806)	(0.157)	(0.104)	(0.141)	(0.104)	(0.125)
L.Patent	**0.0123***	**0.0268****	**0.0121***	**0.0286****	**0.0121****	**0.0277****
	(0.00655)	(0.0134)	(0.00643)	(0.0123)	(0.00617)	(0.0131)
L.FDI	0.000805	-0.0139	0.00111	-0.0160	0.00142	-0.0156
	(0.00115)	(0.0121)	(0.00112)	(0.0127)	(0.00101)	(0.0123)
L2.FDI	**0.00275***	**-0.0318*****	**0.00291****	**-0.0364*****	**0.00300****	**-0.0344****
	(0.00151)	(0.0120)	(0.00148)	(0.0132)	(0.00146)	(0.0134)
L.GDP	0.0121	0.0274	-0.00684	-0.0579	-0.0180	-0.0639
	(0.0286)	(0.0724)	(0.0253)	(0.0613)	(0.0246)	(0.0577)
Saving	0.0136**	0.0294	0.0142**	0.0342	0.0146**	0.0329
	(0.00662)	(0.0287)	(0.00611)	(0.0271)	(0.00650)	(0.0277)
Population			0.0935	0.374	0.0929	0.403
			(0.0989)	(0.253)	(0.0957)	(0.268)
Law					0.0341	0.0513
					(0.0235)	(0.0652)
Constant	6.666***	9.748***	5.515***	4.061	5.625***	3.700
	(0.681)	(1.873)	(1.128)	(4.916)	(1.037)	(5.146)
Observations	384	262	384	262	384	262
Number of id	50	41	50	41	50	41

Table 3.9. GMM estimates on sophistication of exports for more globalized and less globalized countries. Robust standard errors are in brackets. ***, ** and * indicate statistical significance at the level of 1%; 5% and 10%, respectively.

As an alternative to sophistication of exports, we also used export of high technology products as another dependent variable to measure export quality. Exports of high technology products of country reflect countries' R&D intensive exports and indicates the value added in exports. At the same time, as these products require an advanced level of knowledge and technology in their production they reflect the level of technological development of the countries.

When we run the similar (benchmark) estimation equations we could not find any significant effects of FDI and patents on the exports of high technology goods. This may occur as high technology goods require the high knowledge, advanced skills and technological adequate, benefits from knowledge spillover takes longer time to produce high technology goods than other goods. Thus, we modify our model by including up to 3 lags of patents and 4 lags of FDI.

Tables 3.10. And 3.11 present estimation results when export of high technology products is dependent variable. In table 3.10., while Column (1), (2) and (3) show the estimation outcomes for all countries, Columns (4) and (5) indicate the results from developed and undeveloped countries, respectively. According to these results, FDI and Patents have statistically significant and positive impact on export of high technology products for only developed countries.

	(1)	(2)	(3)	(4)	(5)
	All	All	All	Developed	Developing
L.HighEx	-0.0835	0.246**	-0.0676	0.599***	-0.100
	(0.113)	(0.0966)	(0.116)	(0.112)	(0.130)
L3.Patent	0.00459		-0.00937	**0.109***	-0.0666
	(0.245)		(0.268)	(0.0593)	(0.288)
L.GDP	1.814***	-1.177	1.458**	-0.560	1.272**
	(0.592)	(2.347)	(0.636)	(0.474)	(0.607)
Saving	-0.245*	0.0139	-0.300**	0.725***	-0.363**
	(0.127)	(0.143)	(0.132)	(0.166)	(0.144)
Population	1.165	3.038*	0.403	0.115	0.725
	(1.064)	(1.706)	(1.261)	(0.654)	(1.487)
Law	-0.257	0.883	-0.0983	0.478**	-0.128
	(0.430)	(1.117)	(0.533)	(0.226)	(0.705)
L4.FDI_INF		0.00502	0.0319	**0.0251****	0.0524
		(0.0577)	(0.0220)	(0.0118)	(0.0466)
Constant	-13.35	-24.37	2.106	9.166	-1.949
	(17.78)	(18.34)	(20.41)	(10.55)	(24.78)
Observations	679	752	562	246	316
Number of id	83	101	81	32	49

Table 3.10. GMM estimates on export of high technology products for all countries, developed and developing countries.
Robust standard errors are in brackets. ***, ** and * indicate statistical significance at the level of 1%; 5% and 10%, respectively.

Table 3.11. presents the results estimated according to country specific criteria such as financial development, education level and globalization level. In this table, Columns (1) and (2) show the estimation outputs for more financially developed countries and less financially developed countries respectively. Moreover, in columns (3) and (4), estimation outputs are presented for more educated and less educated countries respectively. Furthermore, estimation results that show the role of globalization level is given in Columns (5) and (6).

When the examined the whole table, it is obviously seen that globalization has not any determinative role on the relationship between knowledge spillover and export of high technology products, unlike sophistication of export. Besides, patents have positive and significant impact on export of high technology products for only more financially developed and more educated countries. Furthermore, the coefficient of FDI is positive and statistically significant for only more educated countries.

	(1) More Financially Developed	(2) Less Financially Developed	(3) More Educated	(4) Less Educated	(5) More Globalized	(6) Less Globalized
L.HighEx	0.466***	-0.108	0.392***	-0.163	0.518***	-0.141
	(0.160)	(0.123)	(0.0939)	(0.141)	(0.160)	(0.125)
L3.Patent	**0.213*** **	-0.0605	**0.246** **	-0.219	0.148	-0.107
	(0.0776)	(0.275)	(0.0960)	(0.408)	(0.0907)	(0.291)
L4.FDI_INF	0.00892	0.0702	**0.0307** **	0.0449	0.0130	0.0682
	(0.0118)	(0.0514)	(0.0147)	(0.0833)	(0.00963)	(0.0748)
L.GDP	-0.256	1.919**	-0.0275	1.475	-0.160	1.197
	(0.526)	(0.967)	(0.525)	(1.390)	(0.585)	(0.864)
Saving	-0.0307	-0.474***	-0.0574	-0.328	0.0111	-0.596***
	(0.0637)	(0.122)	(0.0685)	(0.278)	(0.0789)	(0.106)
Population	0.906	-0.952	0.156	4.663	0.0417	1.303
	(0.680)	(1.183)	(1.056)	(4.860)	(0.621)	(1.687)
Law	0.0892	0.142	0.426	0.105	0.662***	0.418
	(0.207)	(0.837)	(0.264)	(1.037)	(0.203)	(0.857)
Constant	-1.478	20.31	9.304	-71.53	10.22	-10.36
	(10.91)	(18.17)	(16.43)	(81.71)	(9.481)	(28.80)
Observations	302	260	278	146	337	198
Number of id	43	48	46	32	47	35

Table 3.11. GMM estimates on exports of high technology products for more and less financially developed countries; for more and less educated countries; for more and less globalized countries. Robust standard errors are in brackets. ***, ** and * indicate statistical significance at the level of 1%; 5% and 10%, respectively.

When we compare the results of analysis for high-technology product exports and sophisticated product exports, it is possible to say that benefit from knowledge spillover is easier in exporting sophisticated goods than exporting high technology products. To increase exports of high-technology products, there is a need for specialized, technical and advanced knowledge, not just knowledge. At the same time, the technological infrastructure and skilled human capital that enables the use of this knowledge is required.

CHAPTER IV

CONCLUSION

Nowadays, we live in an age in which, economic borders have been left behind in the face of globalization it is possible to say that the factor that determines the power of the countries is the knowledge capital. Countries with higher knowledge accumulation have the ability to produce more specialized and qualified products using advanced technologies. Therefore, they can export more sophisticated products and they gain more competitive advantages in international markets.

In recent years it has increasingly recognized in the literature that knowledge spillovers may have an important impact on export performance of countries. In this context, the foreign direct investments (FDI) and innovative activities are probably accepted as the most prominent channel of knowledge spillovers. Scholars as well as policy makers increasingly treat FDI and innovative activities based spillovers as very or the most important development effect for host country. Motivated by this facts, this thesis aims to explore the impact of knowledge spillovers through FDI and innovations that are measured by patents on countries' quality of exports. Following the seminal work of Hausmann et al. (2007) and Lall et al. (2006) we proxy the quality of exports by export sophistication index which reflects the income level of the export basket. In addition, we analyze the effect of knowledge spillovers on a countries' exports of high technology.

To examine the regarding relationship, we conduct a panel data of 114 countries that includes both developed and developing countries between 2002 and 2015. The estimation method utilized in the analysis is Generalized Method of Moments (GMM)

dynamic panel estimator developed by Arellano and Bond (1991) which permits us to control for potential endogeneity and govern the dynamic nature of the problem.

The empirical results point out that effects of knowledge spillovers contributes to sophistication of exports only when sufficient absorptive capacity is available in the host country. Also, among knowledge spillover variables innovations are found to be a more influential channel than FDI in terms of contributing to the level of export sophistication.

The main findings in this thesis reveal that innovations increase sophistication of exports for all countries, however FDI serves as a channel for knowledge spillovers to benefit the sophistication level of exports only for developed countries. This paradoxing result can be attributed to the worse investment climate conditions and appropriate government policies and in developing countries. As reported OECD (2001), in less developed countries the impact of FDI would be smaller due to "threshold externalities" and developing countries must have reached a certain level of education, technology and infrastructure before taking advantage of foreign assets.

Indeed, the results indicate that the level of financial development of countries affects the gains from foreign direct investments in terms of exporting more sophisticated goods. While FDI in financially more developed countries increases export sophistication, it is not sufficient to improve the sophistication level for less financially developed countries.

Notably, the level of education is also found to be an important criterion determining the impact of knowledge spillovers from FDI. In societies where tertiary education levels are higher, both innovations and FDI increase export sophistication, however there is no evidence for an impact for countries with lower levels of education.

Globalization level of countries is found to have a determinative role on the effect of FDI in improving export performance. FDI provides to increase export sophistication in only more globalized countries.

The results show weaker (less robust) effects of FDI and innovations on the exports of high technology goods. This may occur as high technology goods require the high knowledge, advanced skills and technological adequate, benefits from knowledge spillover takes longer time to produce high technology goods than other goods. For the future research, this study can be extended with using other spillover channels. In addition, if the impact of FDI is analyzed again according to the country of origin and / or the sectors, the effect of FDI on export quality can be more clearly revealed. Besides, the patent citation data can be used as alternative knowledge spillover criterion where the effect of information dissemination can be measured more clearly. Finally, the complexity index, which shows how complex the export baskets of the countries developed by Hidalgo and Hausmann (2009), can be used as another export quality indicator.

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APPENDIX

A.1. List of the Countries

A.1.a. List of Dependent Variables and Knowledge Spillover Variables in 2015

Country	Development Level	Export Sophistication (in Logarithm)	Exports of High Technology Products (in Logarithm)	FDI, net inflows (% of GDP)	Number of Patent Applications (per million people)
Australia	Developed	9,79	22,17	2,78	96,30
Austria	Developed	10,04	23,49	-2,24	255,50
Belgium	Developed	10,01	24,38	-6,40	84,21
Bulgaria	Developed	9,75	20,83	5,39	39,00
Canada	Developed	9,93	23,99	3,52	119,30
Croatia	Developed	9,84	20,45	0,32	40,24
Czech Republic	Developed	9,98	23,76	0,91	83,41
Denmark	Developed	10,03	22,96	0,42	257,39
Estonia	Developed	9,84	20,76	-3,20	22,73
Finland	Developed	10,06	22,01	7,29	235,22
France	Developed	10,01	25,37	1,80	214,74
Germany	Developed	10,06	25,95	1,56	580,05
Greece	Developed	9,83	20,86	0,65	50,83
Hungary	Developed	9,97	23,19	-4,31	57,83
Ireland	Developed	10,21	24,09	70,01	53,42
Italy	Developed	9,98	24,02	0,73	
Japan	Developed	10,09	25,24	0,13	2035,86
Latvia	Developed	9,85	20,76	3,10	68,69
Lithuania	Developed	9,86	21,30	2,34	34,83
Netherlands	Developed	9,94	24,80	19,43	130,28
New Zealand	Developed	9,89	20,22	-0,01	257,39
Norway	Developed	9,9	22,25	1,76	222,16
Poland	Developed	9,91	23,32	3,16	123,09
Portugal	Developed	9,87	21,37	1,21	89,29
Romania	Developed	9,86	21,99	2,43	49,19
Slovak Republic	Developed	9,95	22,65	1,74	42,07
Slovenia	Developed	9,99	21,08	4,02	
Spain	Developed	9,94	23,38	2,86	60,26
Sweden	Developed	10,03	23,43	1,69	207,96
Switzerland	Developed	10,03	24,70	14,36	178,38
United Kingdom	Developed	10,01	24,96	2,03	228,27
United States	Developed	9,99	25,76	2,79	898,52
Algeria	Developing	9,64	14,71	-0,24	2,23

Country	Development Level	Export Sophistication (in Logarithm)	Exports of High Technology Products (in Logarithm)	FDI, net inflows (% of GDP)	Number of Patent Applications (per million people)
Angola	Developing	9,59		9,02	
Argentina	Developing	9,56	21,09	2,01	12,57
Bangladesh	Developing			1,45	0,25
Bolivia	Developing	9,44	17,03	1,68	
Botswana	Developing	9,51	17,39	4,71	
Brazil	Developing	9,63	22,90	4,14	22,53
Cameroon	Developing	9,26	16,41	2,24	
Chile	Developing	9,52	20,09	8,44	24,94
China	Developing	9,92	27,04	2,19	706,12
Colombia	Developing	9,6	20,49	3,99	6,66
Congo, Dem. Rep.	Developing			4,62	
Congo, Rep.	Developing			21,82	
Costa Rica	Developing	9,71	20,57	5,39	3,53
Dominican Republic	Developing	9,68	19,04	3,27	1,99
Ecuador	Developing	9,33	18,39	1,33	
Egypt, Arab Rep.	Developing	9,61	18,30	2,07	
El Salvador	Developing	9,65	19,03	1,91	1,11
Ethiopia	Developing	8,91	16,29	4,07	
Gabon	Developing			4,37	
Ghana	Developing			8,50	
Guatemala	Developing	9,44	19,25	1,84	0,43
Guinea	Developing	9,39	14,71	-0,61	
Honduras	Developing			6,32	0,45
Hong Kong Sar, China	Developing	10,03	19,87	58,51	32,69
India	Developing	9,74	23,34	2,11	9,61
Indonesia	Developing	9,57	22,21	2,30	4,10
Iran, Islamic Rep.	Developing			0,53	
Israel	Developing	9,98	23,19	3,79	153,34
Jamaica	Developing	9,75	13,14	6,52	2,44
Jordan	Developing	9,59	18,26	4,27	4,48
Kenya	Developing			0,97	2,90
Kuwait	Developing	9,69	18,75	0,25	
Lebanon	Developing			4,76	18,80
Madagascar	Developing	9,6	13,95	5,31	0,12
Malaysia	Developing	9,92	24,77	3,33	41,41
Mauritania	Developing			10,36	
Mexico	Developing	9,88	24,55	3,14	10,83
Morocco	Developing	9,64	20,10	3,21	6,44
Mozambique	Developing	9,34	17,26	26,14	0,86

Country	Development Level	Export Sophistication (in Logarithm)	Exports of High Technology Products (in Logarithm)	FDI, net inflows (% of GDP)	Number of Patent Applications (per million people)
Namibia	Developing	9,49		10,22	
Nicaragua	Developing	9,41	16,11	7,45	
Nigeria	Developing			0,65	
Oman	Developing	9,68	19,13	-3,11	
Pakistan	Developing	9,49	19,37	0,60	1,10
Panama	Developing	10,02	6,12	9,70	3,53
Paraguay	Developing	9,32	17,68	1,94	
Peru	Developing	9,4	19,09	4,37	2,14
Philippines	Developing	9,87	23,99	1,93	3,69
Qatar	Developing	9,52	18,74	0,65	
Saudi Arabia	Developing	9,72	19,44	1,25	22,66
Senegal	Developing	9,36	17,12	3,00	
Singapore	Developing	10,14	25,60	23,78	265,16
South Africa	Developing	9,76	21,40	0,48	16,16
Sri Lanka	Developing	9,51	17,90	0,84	10,40
Sudan	Developing		13,79	1,78	6,91
Syrian Arab Republic	Developing				10,57
Tanzania	Developing	9,11	15,99	3,52	0,02
Thailand	Developing	9,84	24,27	2,24	
Togo	Developing	9,31	13,99	6,31	
Trinidad And Tobago	Developing	9,64		1,52	2,21
Tunisia	Developing	9,74	20,34	2,25	15,97
Turkey	Developing	9,79	21,57	2,04	68,38
United Arab Emirates	Developing	9,75	20,54	2,46	1,64
Uruguay	Developing	9,54	19,40	4,59	7,58
Venezuela, RB	Developing				
Yemen, Rep.	Developing	9,61	14,90	-0,04	0,19
Zambia	Developing	9,07	17,41	7,48	
Zimbabwe	Developing	9,02	16,13	2,45	0,57
Albania	Economies in Transition	9,57	16,53	8,74	4,86
Azerbaijan	Economies in Transition	9,63	16,06	7,63	19,07
Belarus	Economies in Transition	9,82	20,14	2,93	57,22
Bosnia And Herzegovina	Economies in Transition	9,82	18,38	2,29	
Georgia	Economies in Transition	9,68	17,36	11,31	26,61
Kazakhstan	Economies in Transition	9,63	21,77	3,35	72,46
Macedonia, FYR	Economies in Transition	9,83	18,52	2,95	

Country	Development Level	Export Sophistication (in Logarithm)	Exports of High Technology Products (in Logarithm)	FDI, net inflows (% of GDP)	Number of Patent Applications (per million people)
Moldova	Economies in Transition	9,55	16,70	3,32	18,03
Russian Federation	Economies in Transition	9,75	22,99	0,50	203,12
Turkmenistan	Economies in Transition			11,90	
Ukraine	Economies in Transition	9,6	21,05	3,35	50,30
Uzbekistan	Economies in Transition			0,10	9,20

A.1.b. List of Conditioning Variables in 2015

Country	Development Level	Private credit by deposit money banks to GDP (%)	Domestic Credit to Private Sector (% of GDP)	Liquid liabilities to GDP (%)	Enrolment in tertiary education (per people)	Globalization index
Australia	Developed	138,12	137,64	109,89		83,04
Austria	Developed	85,83	86,98	91,50	0,05	90,56
Belgium	Developed	59,44	61,55	124,05	0,04	90,99
Bulgaria	Developed	57,23	55,41	82,27	0,04	77,90
Canada	Developed		0,00			86,90
Croatia	Developed	67,09	65,47	70,67	0,04	80,96
Czech Republic	Developed	48,99	50,31	76,42	0,04	84,88
Denmark	Developed	174,37	174,09	66,52	0,06	88,67
Estonia	Developed	68,35	70,26	72,11	0,04	79,71
Finland	Developed	93,50	95,45	75,40	0,06	85,50
France	Developed	94,32	95,85	91,93		87,30
Germany	Developed	77,52	77,95	91,04	0,04	84,62
Greece	Developed	115,04	113,22	99,54		80,64
Hungary	Developed	39,24	36,12	57,67	0,03	86,24
Ireland	Developed		54,35	100,55	0,05	91,70
Italy	Developed	88,42	88,05	89,89	0,03	82,25
Japan	Developed	175,64	182,88	212,58		73,06
Latvia	Developed	49,66	48,75	61,38	0,04	71,80
Lithuania	Developed	40,85	41,81	51,49	0,05	78,75
Netherlands	Developed	113,04	111,50	122,99	0,05	92,83
New Zealand	Developed		0,00		0,06	77,99
Norway	Developed	134,51	138,42	59,15	0,05	83,67
Poland	Developed	52,18	53,65	61,96		81,11
Portugal	Developed	122,54	120,06	95,13	0,03	85,66
Romania	Developed	35,82	29,89	38,63	0,03	
Slovak Republic	Developed	50,91	53,46	63,57		83,66
Slovenia	Developed	51,70	50,20	66,07		77,86
Spain	Developed	121,45	118,86	108,25	0,04	84,85
Sweden	Developed	125,91	128,95	64,94	0,04	88,66
Switzerland	Developed	173,10	172,58	189,51	0,04	88,70
United Kingdom	Developed	134,69	134,07	136,27		87,39
United States	Developed	179,65	188,83	72,33	0,06	79,69
Algeria	Developing	20,72	21,60	74,45	0,03	53,15

Country	Development Level	Private credit by deposit money banks to GDP (%)	Domestic Credit to Private Sector (% of GDP)	Liquid liabilities to GDP (%)	Enrolment in tertiary education (per people)	Globalization index
Angola	Developing	21,64	27,22	37,85	0,01	40,54
Argentina	Developing		14,70			58,54
Bangladesh	Developing	40,95	43,93	60,15		40,80
Bolivia	Developing	54,24	58,07	69,86		52,15
Botswana	Developing	32,44	33,85	42,12	0,03	48,18
Brazil	Developing	71,26	67,86	78,71	0,04	61,05
Cameroon	Developing	15,47	16,39	21,48	0,02	44,35
Chile	Developing	106,88	110,96	51,36	0,07	72,45
China	Developing	140,40	153,34	188,36	0,03	62,45
Colombia	Developing	48,69	47,13	35,81	0,05	60,14
Congo, Dem. Rep.	Developing	6,26	6,76	12,66		
Congo, Rep.	Developing	20,73	22,06	47,27		52,14
Costa Rica	Developing	53,14	56,79	48,32	0,05	63,03
Dominican Republic	Developing	25,69	27,13	21,54	0,05	61,13
Ecuador	Developing	27,31	26,92	31,54		52,36
Egypt, Arab Rep.	Developing	24,66	26,47	72,87	0,03	62,33
El Salvador	Developing	43,52	44,86	39,06	0,03	65,19
Ethiopia	Developing		0,00			40,12
Gabon	Developing	14,95	14,63	24,92		56,39
Ghana	Developing	17,48	20,44	30,68	0,02	54,78
Guatemala	Developing	32,41	34,37	38,50	0,02	60,23
Guinea	Developing	12,72	14,38	32,70		44,76
Honduras	Developing	54,80	55,37	53,02	0,02	61,23
Hong Kong Sar, China	Developing	212,18	208,03	348,75	0,04	
India	Developing	50,25	52,62	75,51	0,02	52,50
Indonesia	Developing	36,04	39,07	33,39	0,02	64,69
Iran, Islamic Rep.	Developing		0,00			42,18
Israel	Developing	64,63	66,61	81,89	0,04	73,71
Jamaica	Developing	28,31	29,89	56,00	0,03	58,32
Jordan	Developing	68,23	70,25	122,19	0,03	68,47
Kenya	Developing	32,34	34,89	39,77		47,07
Kuwait	Developing	98,12	98,60	98,79		69,09

Country	Development Level	Private credit by deposit money banks to GDP (%)	Domestic Credit to Private Sector (% of GDP)	Liquid liabilities to GDP (%)	Enrolment in tertiary education (per people)	Globalization index
Lebanon	Developing	98,69	106,64	254,54	0,04	66,28
Madagascar	Developing	12,52	13,33	23,55		42,42
Malaysia	Developing	119,64	125,21	132,51	0,03	78,12
Mauritania	Developing		0,00		0,00	52,70
Mexico	Developing	30,16	32,70	29,26		67,89
Morocco	Developing	64,31	64,31	108,64	0,03	64,75
Mozambique	Developing	30,89	35,09	49,29	0,01	43,34
Namibia	Developing	50,68	53,79	53,52		54,37
Nicaragua	Developing	33,49	37,06	31,85		52,50
Nigeria	Developing	14,04	14,22	19,44		49,62
Oman	Developing	59,81	65,57	52,76	0,03	62,33
Pakistan	Developing	14,90	15,38	39,46	0,01	50,93
Panama	Developing	78,50	88,52	67,85		66,14
Paraguay	Developing	52,95	57,94	52,42		60,68
Peru	Developing	34,29	37,42	41,09		65,79
Philippines	Developing	39,48	41,81	71,14		56,40
Qatar	Developing	63,57	69,59	85,54	0,01	79,16
Saudi Arabia	Developing	73,32	56,63	73,11	0,05	61,81
Senegal	Developing		33,30		0,01	55,17
Singapore	Developing	131,04	129,75	128,25		83,68
South Africa	Developing	146,23	149,18	42,21		
Sri Lanka	Developing	27,52	40,73	37,47	0,01	52,07
Sudan	Developing	6,70	7,14	14,82		31,89
Syrian Arab Republic	Developing		0,00		0,04	46,73
Tanzania	Developing	13,64	15,17	22,62		38,89
Thailand	Developing	147,09	151,31	109,29	0,03	70,87
Togo	Developing	33,79	37,08	49,41	0,01	52,97
Trinidad And Tobago	Developing	48,55	37,11	68,25		60,75
Tunisia	Developing	76,21	79,60	68,60	0,03	59,95
Turkey	Developing	61,66	80,04	42,84	0,08	70,94
United Arab Emirates	Developing	74,00	76,48	86,89	0,02	75,54
Uruguay	Developing	31,05	30,02	54,83	0,04	66,80
Venezuela, RB	Developing	29,92	0,00			51,79

Country	Development Level	Private credit by deposit money banks to GDP (%)	Domestic Credit to Private Sector (% of GDP)	Liquid liabilities to GDP (%)	Enrolment in tertiary education (per people)	Globalization index
Yemen, Rep.	Developing		0,00			41,30
Zambia	Developing	17,31	19,76	18,72		49,54
Zimbabwe	Developing		0,00	0,00	0,01	43,39
Albania	Economies in Transition	36,23	35,46	84,87	0,06	61,19
Azerbaijan	Economies in Transition	35,70	38,45	39,44	0,02	57,80
Belarus	Economies in Transition	25,55	2,88	30,51	0,05	61,17
Bosnia And Herzegovina	Economies in Transition	53,16	53,71	63,06	0,03	67,06
Georgia	Economies in Transition	45,70	49,76	38,73	0,03	69,57
Kazakhstan	Economies in Transition	36,32	37,73	34,12	0,04	55,72
Macedonia, FYR	Economies in Transition	48,70	50,88	53,18	0,03	56,00
Moldova	Economies in Transition	34,61	34,76	39,21		63,32
Russian Federation	Economies in Transition	55,89	56,36	58,53	0,05	69,73
Turkmenistan	Economies in Transition		0,00			37,58
Ukraine	Economies in Transition	66,45	56,97	37,60	0,04	70,16
Uzbekistan	Economies in Transition		0,00		0,01	39,93

A.2. High-tech Aggregation by SITC Rev.4

Group	Code	Title[1]
Aerospace	(714-714.89-714.99)+	Aeroplane motors, excluding 714.89 and 714.99
	792.1+	Helicopters
	792.2+792.3+792.4+	Aeroplanes and other aircraft, mechanically-propelled (other than helicopters)
	792.5+	Spacecraft (including satellites) and spacecraft launch vehicles
	792.91+	Propellers and rotors and parts thereof
	792.93+	Undercarriages and parts thereof
	874.11	Direction finding compasses; other navigational instruments and appliances
Computers office	751.94+	Multifunction office machines, capable of connecting to a computer or a network
Machines	751.95+	Other office machines, capable of connecting to computer or a network
	752+	Computers
	759.97	Parts and accessories of group 752
Electronics-	763.31+	Sound recording or reproducing apparatus operated by coins, bank cards, etc
telecommunications	763.8+	Video apparatus
	(764-764.93-764.99)+	Telecommunications equipment, excluding 764.93 and 764.99
	772.2+	Printed circuits
	772.61+	Electrical boards and consoles < 1000V
	773.18+	Optical fibre cables
	776.25+	Microwave tubes
	776.27+	Other valves and tubes
	776.3+	Semiconductor devices
	776.4+	Electronic integrated circuits
	776.8+	Piezoelectric crystals
	898.44+	Optical media
	898.46	Semiconductor media
Pharmacy	541.3+	Antibiotics
	541.5+	Hormones and their derivatives
	541.6+	Glycosides, glands, antisera, vaccines
	542.1+	Medicaments containing antibiotics or derivatives thereof
	542.2	Medicaments containing hormones or other products of subgroup 541.5

Group	Code	Title[1]
Scientific	774+	Electrodiagnostic apparatus for medicine or surgery and radiological apparatus
Instruments	871+	Optical instruments and apparatus
	872.11+	Dental drill engines
	(874-874.11-874.2)+	Measuring instruments and apparatus, excluding 874.11, 874.2
	881.11+	Photographic cameras
	881.21+	Cinematographic cameras
	884.11+	Contact lenses
	884.19+	Optical fibres other than those of heading 773.1
	(899.6-899.65-899.69)	Orthopaedic appliances, excluding 899.65, 899.69
Electrical	778.6-778.61-778.66-	Electrical capacitors, fixed, variable or adjustable, excluding 778.61, 778.66, 778.69
Machinery	778.69)+	Electrical machines, having individual functions
	778.7+	Electric sound or visual signalling apparatus
	778.84	
Chemistry	522.22+	Selenium, tellurium, phosphorus, arsenic and boron
	522.23+	Silicon
	522.29+	Calcium, strontium and barium
	522.69+	Other inorganic bases
	525+	Radioactive materials
	531+	Synthetic organic colouring matter and colour lakes
	574.33+	Polyethylene terephthalate
	591	Insecticides, disinfectants

Group	Code	Title[1]
Non-electrical	714.89+	Other gas turbines
Machinery	714.99+	Part of gas turbines
	718.7+	Nuclear reactors and parts thereof, fuel elements, etc
	728.47+	Machinery and apparatus for isotopic separation
	731.1+	Machine-tools working by laser or other light or photon beam, etc
	731.31+	Horizontal lathes, numerically controlled
	731.35+	Other lathes, numerically controlled
	731.42+	Other drilling machines, numerically controlled
	731.44+	Other boring-milling machines, numerically controlled
	731.51+	Milling machines, knee-type, numerically controlled
	731.53+	Other milling machines, numerically controlled
	731.61+	Flat-surface grinding machines, numerically controlled
	731.63+	Other grinding machines, numerically controlled
	731.65+	Sharpening machines, numerically controlled
	733.12+	Bending, folding, straightening or flattening machines, numerically controlled
	733.14+	Shearing machines, numerically controlled
	733.16+	Punching machines, numerically controlled
	735.9+	Parts and accessories of 731 and 733
	737.33+	Machines and apparatus for resistance welding of metal, fully or partly automatic
	737.35	Machines and apparatus for arc welding of metal, fully or partly automatic
Armament	891	Arms and ammunition

A.3. 2016 KOF Index of Globalization

Indices and Variables	Weights
A. Economic Globalization	36%
i) Actual Flows	50%
• Trade (percent of GDP)	22%
• Foreign Direct Investment, stocks (percent of GDP)	27%
• Portfolio Investment (percent of GDP)	24%
• Income Payments to Foreign Nationals (percent of GDP)	27%
ii) Restrictions	50%
• Hidden Import Barriers	23%
• Mean Tariff Rate	28%
• Taxes on International Trade (percent of current revenue)	26%
• Capital Account Restrictions	23%
B. Social Globalization	37%
i) Data on Personal Contact	33%
• Telephone Traffic	26%
• Transfers (percent of GDP)	2%
• International Tourism	26%
• Foreign Population (percent of total population)	21%
• International letters (per capita)	25%
ii) Data on Information Flows	35%
• Internet Users (per 1000 people)	36%
• Television (per 1000 people)	38%
• Trade in Newspaper (percent of GDP)	26%
iii) Data on Cultural Proximity	32%
• Number of McDonald's Restaurants (per capita)	46%
• Number of Ikea (per capita)	46%
• Trade in books (percent of GDP)	7%
C. Political Globalization	27%
• Embassies in Country	25%
• Membership in International Organizations	27%
• Participation in U.N. Security Council Missions	22%
• International Treaties	26%