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Summary:

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List of Abbreviations

Abbreviation	Explanation
AS	Ahn and Schmidt Estimator
cce	Constant Correlated Effects
ECI	Economic Complexity Index
FDI	Foreign Direct Investment
FE	Fixed Effects
GATT	General Agreement on Tariffs and Trade
GCC	Golf Cooperation Council
GDP	Gross Domestic Product
GMM	Generalized Method of Moments
GNI	Gross National Income
IPR	Intellectual Property Rights
LSDV	Least Square Dummy Variable
OLS	Ordinary Least Squares
R&D	Research and Development
TRIPS	The Agreement on Trade-Related Aspects of Intellectual Property Rights
U.S.	United States (of America)
UNESCO	United Nations Educational, Scientific, and Cultural Organization
WIPO	World Intellectual Property Organization
WIPO	World Intellectual Property Organization
WTO	World Trade Organization

Abstract

The Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS), was the first step towards the establishment of a globally harmonized Intellectual Property Rights (IPR) framework. The negotiations and the signing of the agreement led to political and scholarly disputes arguing for and against this harmonization process.

The discussions polarized towards the economic impact on developing countries. This work reviews this discussion and takes it as a starting point in order to test the hypothesis that a stricter intellectual property rights protection framework has a positive effect on the innovation process and technology diffusion in developing countries.

To test this hypothesis, I used the Economic Complexity Index (ECI) as a tool that is accounting for the complexity of an economy and thus reflecting the amount of knowledge that is used in an economy. The use of this index is motivated by criticism that empirical work is receiving for using measures of innovation that do not seem theoretically sound or have methodological problems.

I review the historical circumstances that led to the signing of TRIPS, as well as the economic theory related to IPR.

The empirical results show that using the Economic Complexity Index as the dependent variable, serving as a "proxy" for knowledge stored in an economy, and using control variables, which explain complexity according to economic theories, leads to not rejecting the hypothesis that IPR have a positive economic impact on innovation and technology diffusion in developing countries.

Keywords: economic complexity, TRIPS, innovation, developing countries, economic complexity index, technology transfer

Zusammenfassung (Abstract)

Das TRIPS Abkommen hat den Schutz der geistigen Eigentumsrechte weltweit harmonisiert. Die Verhandlungen und die Unterzeichnung des Abkommens haben zu wissenschaftlichen Meinungsverschiedenheiten zwischen Befürwortern und Gegnern dieser Harmonisierung geführt.

Die Meinungen scheiden sich hauptsächlich bezüglich der wirtschaftlichen Folgen für Entwicklungsländer. Diese Arbeit knöpft an dieser Diskussion an und testet die Hypothese, dass ein strengerer Schutz geistiger Eigentumsrechte die Innovation und die Technologie-Verbreitung in Entwicklungsländern fördert.

Um diese Hypothese zu testen wurde der Economic Complexity Index (ECI) als ein Werkzeug benutzt welches den Komplexitätsgrad einer Volkswirtschaft misst und die Menge an Wissen das in dieser vorhanden ist reflektiert. Die Nutzung des ECI ist motiviert durch die Mängel welche Forscher bei der Nutzung anderer Variablen, welche Innovation messen sollen, geäußert haben.

Es werden die historischen Zusammenhänge der Unterzeichnung des TRIPS Abkommens überarbeitet, sowie die ökonomische Theorie der geistigen Eigentumsrechte.

Die empirischen Befunde dieser Arbeit zeigen das die Hypothese nämlich, dass geistige Eigentumsrechte einen signifikant positiven Einfluss auf Innovation und Technologie-Verbreitung in Entwicklungsländern haben, nicht verworfen wird.

Introduction

The scope of this work is to discuss the implementation of a global intellectual property rights mechanism, via the TRIPS Agreement[1], and its possible relation to innovation in developing countries.

The content of TRIPS will be briefly highlighted without going further into the legal aspects regarding its implementation and relation to other issues of International Law. [2]

The scope of this work is not to give a detailed historical analysis of how intellectual property rights were established, neither to give insight in the various historical attempts to institutionalize intellectual property rights internationally and nationally.

What is summed up under the term "intellectual property rights" is a culmination of different legal and economic procedures such as patents, copyrights, trade secrets and trademarks[3].

The following lengthy citation of Thomas Jefferson, for whom it is said that he "played a key role establishing the early days of the U.S. patent system" (Granstrand, 2000, p. 54) is not only of historical importance but also shows the context in which the discussion about intellectual property rights is usually taking place:

"If nature has made any one thing less susceptible than all others of exclusive property, it is the action of the thinking power called an idea, which an individual may exclusively possess as long as he keeps it to himself; but the moment it is divulged, it forces itself into the possession of every one, and the receiver cannot dispossess himself of it. Its peculiar character, too, is that no one possesses the less, because every other possesses the whole of it. He who receives an idea from me, receives instruction himself without lessening mine; as he who lights his taper at mine, receives light without darkening me. That ideas should freely spread from one to another over the globe, for the moral and mutual instruction of man, and improvement of his condition, seems to have been peculiarly and benevolently designed by nature, when she made them, like fire, expansible over all space, without lessening their density in any point, and like the air in which we breathe, move, and have our physical being, incapable of confinement or exclusive appropriation. Inventions then cannot, in nature, be a subject of property. Society may give an exclusive right to the profits arising from them, as an encouragement to men to

[1] TRIPS: Agreement on Trade-Related Aspects of Intellectual Property Rights, Apr. 15, 1994, Marrakesh Agreement Establishing the World Trade Organization, Annex 1C, 1869 U.N.T.S. 299, 33 I.L.M. 1197 (1994)
[2] For more details on legal issues of the TRIPS Agreement see for example, (Arup C. , 2000) or (Helfer, 2004)
[3] For the historical background on the different legal mechanisms see for example, (Penrose, 1959), (Machlup, An Economic Review of the Patent System, 1958) on patents, (Goldstein, 1997) on copyrights, (Coleman, 1992)on trade secrets, or (Diamond, 1983) on trademarks

pursue ideas which may produce utility, but this may or may not be done, according to the will and convenience of the society, without claim or complaint from anybody"

as found in (David P. A., 1993, p. 26)

In the above quote we see that, from early on, innovation is treated as an idea that can spread easily in society, in other words it is treated as a form of public information. Jefferson further argues that they may or not be ways to grant exclusive rights for the benefit from applying this idea, but the nature of the idea itself is such that it cannot be contained. In economic terms, innovation is therefore a public good as it is a non-rival and non-exclusive in its use.

What we see also in the above quote from Jefferson is the tension between protection of the inventor, considering the risk he undertook and the resources that he invested in his efforts, and the free access to new inventions which lead to the well-being of the community.

The topic on which classical economic theory mostly focused its attention, namely to find the optimal bargain between these two tendencies, is referred to in economic literature as the "patent bargain" (Jensen, 2007). The optimal patent bargain, helps to understand the analysis of intellectual property rights in a closed economy. I will briefly mention this analysis and give later a bit more weight to the analysis of IPR in the so called "North-South" context, referring to economic relations between developed (North) and developing economies (South).

What is more important, in the above quote from Jefferson, is the implicit claim that knowledge can be spread in society without effort once it has been articulated and codified.

Knowledge can be seen also in a different way. The philosopher Michael Polanyi wrote extensively on the tacit dimension of knowledge, as he stated, "we know more than we can tell" (Polanyi, 1967, p. 4) arguing that there may exist an aspect of knowledge that cannot be codified and transferred easily.

I will show briefly how this tacit dimension of knowledge enters the measurement of complexity of an economy, as proposed by Hausmann and Hidalgo (2011) and I will use this notion of complexity to test if a stricter intellectual property regime, as proposed by TRIPS, leads to greater economic complexity.

I will also review the empirical work dealing with the effects of the implementation of TRIPS, highlighting the disagreement points between scholars.

In the empirical part I am conducting a panel data analysis of 68 developing countries, regressing their economic complexity indices on the perceived protection of IPR and controlling for other variables in order to test the hypothesis that stronger IPR has a positive relation to economic complexity.

1. Historical Background of TRIPS

A brief overview of the historical process that led to the signing of TRIPS, within the framework of the World Trade Organization Agreement (WTO), will give a good insight to the economic and political issues that are related to the protection of intellectual property rights.

The WTO Agreement of 1994[4], that formed the World Trade Organization, is the final agreement of the multilateral trade negotiations that started in 1986, the so-called Uruguay Round of GATT[5], the General Agreement on Tariffs and Trade. The WTO was formed as an international organization which institutionalizes the trade relations among its members. It incorporates the previous GATT Agreement of 1947[6] and the new GATT Agreement of 1994.

TRIPS itself is an annex to the WTO Agreement and as such it is binding for all members of the WTO (Art II (2) WTO Agreement). The WTO Agreement contains also annexes in the form of plurilaterral trade agreements (Annex 4, WTO Agreement) which are biding only for the members that signed these specific agreements, no legal biding arises from these agreements for other members who did not sign them.

The objective of the WTO Agreement, as stated in the Preamble is „to reduce distortions and impediments to international trade in order to develop an integrated, more viable and durable multilateral trading system encompassing the General Agreement on Tariffs and Trade, the results of past liberalization efforts, and all of the results of the Uruguay Round of Multilateral Trade Negotiations "(Preamble WTO Agreement, 1994)

TRIPS is establishing the link between protection of intellectual property rights and freedom of international trade but also warns that it has to be ensured „that measures and procedures to enforce intellectual property rights do not themselves become barriers to legitimate trade"(Art IV (5), WTO Agreement, 1994) The above objective is enforced by two provisions that are applicable to all intellectual property rights, namely by Art. 8(2) and Art. 40 of the TRIPS Agreement.

The TRIPS Agreement clarifies, under Sections 1 to 7 of Part II (2), that the term „intellectual property " covers the following:

[4] WTO Agreement: Marrakesh Agreement Establishing the World Trade Organization, Apr. 15, 1994, 1867 U.N.T.S. 154, 33 I.L.M. 1144 (1994)
[5] Final Act Embodying the Results of the Uruguay Round of Multilateral Trade Negotiations, Apr. 15, 1994, 1867 U.N.T.S. 14, 33 I.L.M. 1143 (1994)
[6] General Agreement on Tariffs and Trade, Oct. 30, 1947, 55 UNTS 194; 61 Stat. pt. 5; TIAS 1700

- copyright and related issues
- trademarks
- geographical indications
- industrial design
- patents
- layout-designs (topographies) of integrated circuits
- protection of undisclosed information

Under Part I, Article 1 (1), the Agreement introduces minimum IPR protection standards that must be respected by all members, but it does not establish a uniform IPR protection regime.

Analyzing the implementation mechanisms of TRIPS or the legal aspects of incorporating the treaty in domestic laws is beyond the scope of this work. As Arup states: " So, while some strive to ensure that TRIPS is a self-contained source of law, its many soft spots mean that other texts and processes will enjoy a sphere of operation too." (Arup C. , 2008, p. 8) He concludes further that, although TRIPS is harmonizing international intellectual property law and leads to greater conversion, there is still room for many competitive as well as cooperative encounters between countries, shaping practices according to their interests, and IPR is far from being harmonized globally. (Arup C. , 2008)

This work will go by the assumption that developing countries have conceded to strengthen IPR protection, it cannot be denied however that this strengthening has not been uniform.

1.2 Negotiations that led to the TRIPS Agreement

Besides the implementation of domestic laws that protect individual intellectual property, governments have always pursued means to protect the intellectual property rights of their individuals and companies abroad. These concerns have been addressed in the past by bilateral agreements and

by international conventions such as the Paris Convention[7] and the Revised Berne Convention[8]. These conventions have not been very effective in protecting intellectual property rights. They left the enforcement of the provisions to national legislature. (Anawalt, 2003, p. 59) In the early 1960s developing countries started questioning the Berne and Paris Convention and started to promote ideas about the diffusion of knowledge and argue against the use of IPR as rent seeking. This led developed countries to question the efficiency of this fora in promoting their interests.

Issues arose within the World Intellectual Property Organization (WIPO), which is a sub-organization of the United Nations discussing intellectual property related issues. Developing countries could, because of their voting power, block proposals from developed countries and advance their own proposals. This led the U.S. to shift the forum of the discussion to a terrain where the U.S. would have more bargaining power. Accordingly, in the 1980s issues on IPR started to be linked to trade related issues, and the U.S. began to promote the idea that these discussions should take in place during the GATT negotiations. (Drahos, 2002, p. 166)

As intellectual property rights became ever more important for industrialized nations, especially by facing the growing competition by the "Asian Tigers", the government of the United States decided to act unilaterally.

During the 1980s the U.S. using Section 301, an amendment to the Trade Act of 1974[9], started to put pressure on countries that were not sufficiently protecting IPR. The 1988 U.S. Omnibus Trade and Competitiveness Act[10] even enhanced this procedure by demanding from U.S. trade representatives to engage in negotiations with countries that were not complying in IPR protection, and, if these countries remained non-cooperative, to impose trade sanctions on them. (Drahos, 2002, p. 169)

The pressure for developing countries was tremendous because they could not compensate easily the loss of access to the U.S market and they had no bargaining power over the United States.

However, the deficits of the multilateral agreements could not be solved by bilateral agreements in a manner that would ensure IPR protection globally.

[7] United International Bureaux for the Protection of Intellectual Property (BIRPI). (1968). Paris Convention for the Protection of Industrial Property of March 20, 1883, as revised at Brussels on December 14, 1900, at Washington on June 2, 1911, at the Hague on November 6, 1925, at London on June 2, 1934, at Lisbon on October 31, 1958, and at Stockholm on July 14, 1967. Geneva: United International Bureaux for the Protection of Intellectual Property (BIRPI.)

[8] World Intellectual Property Organization. (1982). Berne Convention for the Protection of Literary and Artistic Works: Texts. Geneva: World Intellectual Property Organization.

[9] Trade Act of 1974, P.L. 93-618

[10] Omnibus Trade and Competitiveness Act of 1988, P.L. 100-418

As Katzenberger and Kur observe, “Bilateral agreements on intellectual property, which can guarantee broader protection in this respect, can only be asserted against uncooperative states by exerting political or economic pressure. Yet such pressure can only be exerted by a few, powerful, states or groups of states, such as the US or the European Community..” (Katzenberger & Kur, 1996, p. 17) To establish an international order of IPR protection trough bilateral agreements would be a very time consuming and legally very complex attempt.

The GATT negotiations, that started in 1947 and culminated in the in the WTO Agreement of 1994, promised a far more effective ground to establish standards for the protection of intellectual property. This was so because in the WTO Agreement the protection of intellectual property rights was linked with the negotiations on international free trade. Especially the reduction of custom duties and trade barriers and hence the access to large markets of developed countries was a strong motive for developing countries that convinced them to adapt stronger IPR regulations. (Katzenberger & Kur, 1996)

The discussion regarding the nature of the negotiations that took place can be classified into different narratives. The next chapter will review these narratives to provide a better understanding of the different viewpoint that different scholars hold on the issue.

1.3 Different Narratives on the Negotiations

There exist many different narratives on the negotiation procedure of the TRIPS Agreement and on the reasons of the outcome.[11] As summarized by Yu (2006) these different narratives can be labeled as:

I. The bargain narrative

II. The coercion narrative

III. The ignorance narrative

IV. The self-interest narrative

I will briefly outline each narrative to highlight the different opinions and interpretations related to the adoption of the TRIPS Agreement.

I. <u>The bargain narrative</u>

[11] For a more extensive analysis of the negotiation process see (Drahos, BITs and BIPs: Bilateralism in Intellectual Property, 2006)

The bargain narrative says that less developing countries chose to agree on protecting IPR because in exchange developed countries would lower trade barriers and tariffs on textile and agricultural goods. This narrative sounds reasonable as it is widely accepted that textile and agricultural goods are much more important for the economies of developing countries than intellectual property rights. This fact is underlined by the disagreement that arose in international fora on issues related to agriculture products e.g. the WTO Ministerial Conference in Cancun broke up on disagreement on how to handle subsidies in the agricultural sector (Elizabeth, 2003).

Against the bargain narrative speaks the fact that since the U.S. enforced the Omnibus Act the bargaining power of the developing countries had been reduced. They were forced to agree on a multilateral framework to avoid bilateral negotiations with the United States.

II. The coercion narrative

The coercion narrative views the TRIPS Agreement as an "imperialistic" agreement forced upon less developed nations by the powerful industrialized countries. Scholars who defend this narrative examine the TRIPS Agreement and claim that in specific cases the agreement regulates in favor of developed countries and against the interests of developing countries. For example Keith Maskus makes this case about geographical origins: "the evolving language in TRIPS on geographical indications remains largely . . . confined to wines and spirits, while many developing countries point to food products that could be protected to their advantage, such as Basmati rice and Darjeeling tea" (Maskus K. E., 2000, p. 239)

One can say that the coercion narrative isolates the TRIPS agreement from its context, the agreement was negotiated while simultaneously other topics would be discussed within the WTO agreement. That means that if the TRIPS agreement is biased towards the developed countries that can be because the bargain for these concessions had been made in other fields in which the developing countries benefited.

III. The ignorance narrative

The ignorance narrative states that developing countries and the people that represented them during the negotiations simply did not understand the importance of the issues that TRIPS should regulate. That means, that either they did not understand the agreement on a technical and juridical level or they simply did not understand, for cultural reasons, the importance of IPR or were simply unprepared to negotiate about this subject.

This narrative can easily be rejected by simple historical facts. Since the 1960s, at a time that coincides roughly with the end of colonization for most countries, developing countries tried numerous times to

renegotiate the provisions of the Bern Convention and the Paris Convention. In the case of the Bern Convention this led to the signing of the Stockholm protocol. Yu argues that:

"..it was the breakdown of the 1981 Diplomatic Conference in Nairobi over the revision of the Paris Convention that forced developed countries to shift to the General Agreement on Tariffs and Trade (GATT)/WTO forum." (Yu P. , 2006, p. 376)

IV. The self-interest narrative

The fourth narrative, that differentiates from the other three narratives substantially, is the self-interest narrative. This narrative says that developing countries signed TRIPS, and therefore adopted stricter IPR protection, out of self-interest. The argument suggests that developing countries have a demand for research in different technologies than developed countries. Therefore, their main scope should be to enforce a stronger IPR protection mechanism to promote domestic research and development of new technologies specifically for their domestic markets.

Edmund Kitch argues that if domestic firms choose to use technology in an environment that does not protect intellectual property, after their establishment they have no reason to change to a stronger IPR protection system because that would undermine their vested interest. (Kitch, 1994)

According to that logic there were domestic "cartels" trying to prevent developing countries to adopt more rigorous IPR because of vested interests in their "pirate" economy, the TRIPS negotiations played the role of the outsider who bypasses the domestic "cartels" and enforces an IPR protection system that will increase social welfare.

The self-interest narrative, although economically sense full, does not fit well with the historic realities of the negotiations. Moreover, the self-interest narrative, in the same manner like the ignorance narrative, examines the TRIPS Agreement out of its broader context within the WTO Agreement. Developing countries had to accept the negotiations on the TRIPS agreement as a part of the overall negotiations of the WTO. That is obvious from the fact that members that joined the WTO in later rounds had to accept TRIPS to partake in the WTO, which means that it is purposely strategically linked to the overall package of trade liberalization.

The participation of developing countries in the negotiations of the TRIPS Agreement can be seen as deviation from their fundamental preferences. It is however in line with their strategic preferences, which means that under the conditions at which the negotiations started the TRIPS Agreement was a strategic compromise to gain benefits in a field that was from fundamental value, namely free trade and the reduction of tariffs and trade barriers related especially to agricultural goods.[12]

[12] An interesting account of the negotiating strategy of developing countries, and their gradual move towards pragmatism, can be found in the analysis from Woll. (Woll, 2008)

Some authors challenge all-together the idea that sovereign governments played the most important role in the negotiations. Susan Sell argues that non-state actors, such as industrial lobby groups and private companies, heavily influenced governments during the whole negotiation process. (Sell, 2003)

Okediji (2003) argues, that state actors where manipulated by private interests, and negotiated favorable terms for those private interests rather that for the whole of society.

One can assume realistically that during the negotiations for the TRIPS Agreement lobbying groups played an important role, not maximizing social warfare but protecting their individual interests.

This quick presentation of the different interpretations regarding the implementation of TRIPS is hinting towards the differentiated views regarding IPR that are held by various economic and political actors.

In the next chapter I will therefore outline how economic theory treats the subject of IPR in order to put the conflicting views in the context of economic theory.

2. Economic Theory of Intellectual Property Rights

This chapter will discuss economic theories of intellectual property rights. First, economic theory regarding the closed economy will be briefly reviewed. This work examines IPR in the open economy, nevertheless many arguments used in the debate favoring IPR protection derive their arguments in part from the analysis of the closed economy. Thus, it is helpful to have the theory regarding the closed economy in mind. After that, I will review the economic theory of IPR in an open economy, as it more relevant for this work.

Historically the first episode, that enacts the birth of the modern patent, already had the purpose to enact domestic economic growth. In the year 1624 the British Parliament forced the Crown to adopt the “Statute on Monopolies”. All monopolies should be declared illegal, except monopolies that should be granted to “the true and first innovator” of a new product (Kurz, 2000, pp. 168-171)Unsurprisingly, the “true and first innovator” should be from England (Kaufer, 1989, p. 6) We see that proponents of domestic laissez-faire simultaneously tried to protect the domestic economy from foreign inventors. Thus, we can trace the protection of intellectual property back to protection of the innovative behavior in the domestic economy.

The tradeoff between giving temporally monopoly rights and fostering innovation and public welfare characterizes the discussion of monopoly rights from its early stages.

Although the origin of patenting practices can be traced long back in history, only after the Second World War economic theory started to produce theoretical frameworks of IPR[13], for example, the now seminal the works of Arrow (1962), Nordhaus (1969) or Scherer (1972), all of them working within the framework of neoclassical economic theory. Coincidentally (or maybe less so) that was exactly the time in which R&D started to play a significant role in the Cold War confrontation. (Granstrand, 2000)

The next subchapter discusses the economic theory regarding IPR in a closed economy. It will not give a comprehensive analysis of the different economic models that have been used by economists to study the implications of IPR, it rather is thought as a very general overview that should be helpful to follow the discussion.

2.1 IPR and the closed economy

Economic theory treats knowledge as a public good. A public good is non-rival in consumption and non-excludable, although some authors argue that non-excludability is not a necessary condition for knowledge to create problems in a free market environment. (see (Jones, 2002), or (Romer, 1990)). These characteristics lead to insufficiencies in the market mechanism; the problem of free-riding emerges.

The innovator, by not being able to safeguard his invention, due to the public character of knowledge, cannot regain the sunk-costs that arise from the research activity. That is because the moment he publicly reveals the new gained knowledge imitators can copy him without having to pay the costs of research. In such an environment, nobody would like to invest in research. For example, Arrow (1962) argues that insufficient protection of intellectual property rights leads to inefficient R&D level in the long-term. This loss is referred to as “dynamic loss”, since society loses the opportunity to gain new knowledge.

In order to avoid this dynamic loss society can, by implementing a mechanism of intellectual property protection, aim to protect the innovator and thus promote research in new knowledge. This can be done by transferring, in different legal ways, exclusive economic rights to the innovator such that he is able to regain his sunk-cost.

However, this very mechanism leads to a “static loss” for society since monopoly rights are reducing social welfare.

[13] See (Machlup & Penrose, The patent controvetsy in the nineteenth centrury, 1950) for a historical review

To find the optimal balance between static and dynamic loss is the “holy grail” of the classical economics of IPR.

We see that the assumption on the explicit nature of knowledge, and therefore its treatment as a public good, straightforwardly leads to a call for regulation, as with many public goods.

Other than being a public good, innovation or knowledge can cause market failure for different reasons. It can be seen as a private good with positive externalities. Take for example the application of new knowledge for commercial use, although the new knowledge effects positive the profits of other firms by its potential use, there might be no pricing mechanism to make these firms pay for it, therefore the innovative firm is losing profits. (Greenhalgh & Rogers, 2010)

There can be other causes which can lead to market failure such as indivisibilities, uncertainty and capital markets that cannot price risk. Greenhalgh and Rogoers (2010) are giving the example of the development of new software. The research demands high fixed costs and initial investments but the actual costs for production and reproduction are very low, these lead, when we assume perfect market competition and prices tend to be equal to marginal costs, to a lower price and therefore to lower profits for the firm undertaking the software development.

It must be mentioned that in order to restore incentives for research, other solutions than the assignment of property rights have been proposed and enforced.

These different approaches include the public provision of the public good, for example research in fundamental science is provided in most countries by the government sector, although often the private sector is called to contribute.

Another example is the use of subsidies. The government can use tax reductions or transfer payments to restore the profitability of research.

A mixture of all the above solutions is applied government policy in most countries.

The above analysis focuses on overall welfare and innovation in a closed economy. The analysis gets more interesting when applied to open economies, especially in the “North-South” context.

2.2 IPR in the Open Economy

Since TRIPS is an annex to the WTO Treaty it makes sense to discuss the implication of IPR on a global level.

To give a short an example, we can think of the fact that if the monopoly rent goes to a foreign interest holder it results in a static loss for the country that uses this technology. If we assume also that developing countries have a rather small domestic market in which foreign firms will not invest heavily order to build products adopted to local demand, than obviously we deal also with a welfare loss for that country (Maskus K. E., 2000).

In the quote above lies the main argument of adversaries of stronger IPR protection in developing countries, namely that the extracted monopoly profit will not translate in dynamic growth in the developing country but only enrich the already developed nation. We can add other possible negative effects. For example, it is possible that a country has an imitative industry that, due to stronger IPR regulations, will go out of business, the welfare losses through higher unemployment should also be considered in that case.

Additionally, as Maskus (2000) argues, the shutting down of illegal local industries increases the market power of foreign firms, which he calls the *market power effect*. This effect however is counterbalanced by the market expansion effect which arises because demand for the imported product is raised. It is reasonable to argue that for large countries with imitative capabilities the market power effect will outweigh the market expansion effect, leading to a welfare loss (Maskus & Penubarti, 1995)

To overcome this objection against a stronger IPR protection developed countries have argued that developing countries will benefit nevertheless, by adopting stronger IPR, from opening up the channel of technology transfer.

The next chapter is reviewing what exactly is meant by technology transfer and what the relation to IPR is.

2.3 The Role of Technology Transfer

A brief historic review is needed in order to put the argument of international technology transfer in the context of IPR and economic development. Developing countries expressed from early on the concern that strengthening IPR will be an obstacle for domestic economic growth, as seen in the previous chapter. Their arguments of course reflect protectionist view related to the discussion about the protection of infant industries which can be traced back to Hamilton (1966) or List (1841), back when Germany and the U.S.A. still could be considered developing economies.

The arguments run against the generally dominant perspective among economists which was that the main challenge for technological development is the generation of socially useful information. But for

a long enough time, both developed and developing countries agreed that technology is an external stock to a firm or organization and can be easily transferred und used by it. The disagreement point was on the role of IPR, namely of stronger IPR are promoting or hindering these technology transfer. These concerns and the balanced between the two conflicting views are present in the TRIPS Agreement.

But as Roffe and Sampath (2012) argue during the 1970s a change occurred in the approach to technology transfer. This shift occurred due to practices that developing countries adopted successfully and due to new theories on the nature of knowledge. The new view on technology transfer started to account for the tacit nature of knowledge thus giving more focus on domestic institutional reforms connecting economic with non-economic agents. Most of the arguments in favor of technology transfer started being disputed such as the role of higher Research and Development spending (R&D), imports and stronger IPR.

The below table is taken from Roffe & Sampath (2012) and summarizes the changing attitudes regarding knowledge and its transfer.

Conventional perspectives	Contemporary perspectives
1. Information and knowledge is a stock subject to a linear process of information processing.	1. Capabilities formation is a heuristic process that is different from information gathering.
2. Information, particularly of relevance to inventive activity and capabilities, is easily transferable in a codified form. IPRs help to protect this.	2. Capabilities formation calls for knowledge, which has both a codified and a tacit nature, and the tacit domain is often as important, if not more.
3. Information is universally available and freely accessible to all as public good, including patent information.	3. Such knowledge is embedded in historical, economic, and cultural contexts and for this reason local knowledge is important.
4. Accumulation of knowledge through already available information is a simple and relatively costless process.	4. Accumulation of knowledge requires explicit investment into technological learning and is time-consuming.
5.Economic agents possess certain resources or assets that allow them to absorb external information (equated to knowledge) and learning is endogenous.	5. Knowledge is a social phenomenon that grows in a process characterized by a wide variety of learning mechanisms, access to patenting may be one of them.

Table 1

The call for IPR protection from the side of developed nations relies broadly on perceptions about knowledge that are represented in the left-hand side of the above table.

Many arguments in favor of stronger IPR come from a strand of economic theory that focuses on the importance of property rights in the functioning of free market economies. [14]

The reluctance to accept the mechanism of technology transfer without criticism is reflected in the Articles of the Treaty itself. Especially Article 7 and 8 of the Treaty are interpreted by scholars as safeguarding mechanisms which give developing countries the possibility to interpret the Treaty according to the "public interest" of the societies.[15]

I will highlight the most common measures of technology transfer that scholars are using and discuss their possible shortcomings in order to show how difficult it is to observe technology transfer directly in macroeconomic data.

2.4 Channels of technology transfer

A review of the proposed channels through which technology transfer can happen will also reveal the inherent difficulty to measure effective technology transfer. Channels through which technology transfer can happen are:

- Imports

  In economic theory imports of technological advanced goods can lead to technology diffusion, which will lead not only to increased welfare effects but also to more advanced production capabilities and thus to growth. For example, high quality intermediary goods that can be used for the manufacturing of more complex products.

  The empirical evidence regarding imports as a mechanism of technology transfer is mixed. Some authors argue that imports do not lead to technology diffusion (Keller, 1998), (Eaton & Kortum, 1996), while others find that the right composition of imports leads to technology spillovers (Coe & Helpman, 1995), (Xu & Wang, 1999), (Lumega-Neso, Olarreaga, & Schiff, 2005). It is very likely that the overall effect depends on the technology level of the receiving country.

- Foreign Direct Investment

  Proponents of stronger IPR also argue that a very important channel for knowledge transfer is through foreign direct investment (FDI). It is argued that if an investment is held that is

[14] See for example major writers in Property Economics such as Bethel, Pipes or De Soto, see (Steiger, 2008) for an overview on Property Economics

[15] See the extensive analysis of (Yu P. K., 2009) regarding Articles and 7 and 8 of the TRIPS Treaty

implementing a new process of production into the economy, the knowledge of this process will gradually spillover to society. This, according to theory, can happen through various channels, it can happen trough labor training, imitation, access to international trade and distribution networks (Falvey, Foster, & Greenaway, 2006)

A review of the literature of spillover effects due to FDI conducted by Görg and Greenaway (2003) concludes that while theoretically grounded, empirically the evidence is not overwhelming in favor of that notion.

- Licensing

  Licensing is also a possible vehicle for technology transfer. Licensing agreements can come in many forms (distribution rights, production rights, geographical limits of the license, time limits etc.), therefore licensing is very difficult to be identified and to be measured directly. For licensing to be a successful technology transfer mechanism, the technological development of the host country may play a key role again (Maskus K. E., 2004)

- Patent accessibility

  Is measured by patent applications filed in different national patent offices, these data are often well document and publicly available.

  The holder of a patent must disclose to the national patent office granting the patent all information related to his invention. Supporters of stronger IPR argue that this is an additional channel of technology transfer, since domestic companies can access this information and start their own inventive activities. But as Pugatch (2004) argues not all the information regarding the innovative process is disclosed in patents, it is often not possible to redevelop an invention from patent information. Furthermore, Pugatch argues that the amount of counterfeit goods suggest that countries do not rely on information embedded in patents in order to reverse engineer goods.

We see that the almost all mechanisms proposed for technology transfer rely on the explicit nature of knowledge, only in the case of labor training the tacit element of knowledge is recognized. It is assumed that the very existence of a product or a procedure can have spillover effects to the overall economy. These assumptions take the institutional and cultural background as neutral. In other words, it is assumed that what works in some country can work also in another.

While this may be the case for very abstract procedures there is evidence that this do not hold for all activities. Many authors have highlighted the great importance of adaption of technology to local circumstances. For example, the Korean shipbuilder Hyundai started its own shipyard activity by

importing designs from a Scottish firm. In the beginning Hyundai failed to implement the technology because Korean workers lacked the "tacit" knowledge that the shipbuilders in Scotland had. Hyundai was forced to invest in its own designs and research. (Amsden, 1989).

Similarly, other authors show that in the case of Korea only a small amount of technology that was finally mastered domestically arrived through FDI or plant contracts and licensing. (Evenson & Westphal, 1995). About other regions, such as Latin America, similar claims have been made. (Katz & Kosacoff, 2000).

Another evidence for the "tacit" nature of knowledge is the fact that research suggests that technology diffusion happens typically through turnover of skilled workers and managers who have acquired the new knowledge. For example, it has been shown that foreign firms after losing their personnel to imitators lose also market share to local firms (Evenson & Westphal, 1995, p. 2257)

Similarly, in the case of Taiwan, it has been argued that movement of workers from foreign subsidies to domestic firms played a major role in knowledge diffusion (Hou & Gee, 1993). There is also the example of the Colombian cut flower industry, as Rhee and Belot (1990) show it started by a sole investment of an American businessman, Thomas Keller, who set up the company Floamericana, after its early success domestic start-ups started imitating its production and marketing methods, this process was driven by key staff who embodied the knowledge and moved to other companies or started their own companies.[16]

These case studies can be used to make the argument that the import of technology, in either form, may not be enough to ignite a spillover of knowledge in a developing country. One can suspect that other factors, such as cultural, environmental, geographical and institutional factors, will play the key role in technology diffusion.

Of course, this possible conclusion does not help us to identify which are the policies and strategies developing countries should adopt that will lead them to the path of growth. Some argue that enforcement of stronger IPR rights does not lead a country to such a path by itself.

The next chapter is reviewing some empirical studies that focus on the impact of stronger IPR protection on developing economies.

[16] For more examples for the importance of tacit knowledge in technology diffusion see (Hausmann & Rodrik, 2003)

3. Review of Empirical Studies related to IPR Protection

3.1 The choice of indicators for innovation and technology transfer

Before discussing empirical studies related to TRIPS, I will briefly mention the limits of established measures of innovation and technology transfer. Because of the different measures used in empirical research, the discussion regarding the effects of TRIPS on developing economies can range widely depending on which measure each scholar is using. Some authors focus on the overall effect as measured by GDP, other focus more on the innovation process using different "proxy" variables to measure innovation, while others discuss the effects on trade.

While it is straightforward that innovation cannot be captured by figures on GDP or trade, the limitations of measures of innovation must be addressed in more detail. Technology transfer is also very difficult to measure directly as seen earlier. From now on I will not distinguish between innovation and technology transfer, but simply categorize both as an accumulation of knowledge. So, the overall question that this work is really addressing is, "Is TRIPS inducing knowledge-based transformation in developing economies?".

I will highlight the limits of indicators which are used traditionally to measure innovation, in order to explain the need for a different variable that is theoretically more related to innovation and especially knowledge, namely the ECI which I used in my empirical work.

The most commonly used indicators for innovation are:

R&D Efforts

R&D efforts are one of the most available data on innovation. They get regularly measured since the 1950s. They are either measured as expenditures in R&D or as the number of individuals employed in R&D.

The main benefit of R&D as an indicator is its availability and its conceptual relatedness to innovation. The main drawback of using R&D as an indicator of innovation is that it observes the input in the innovation process and not the output. As every input and procedure, it R&D can be used in various degrees of efficiency, the outcome has not to be necessarily innovative.

What R&D expenditures are also not measuring is small scale activity of firms that do not have official R&D expenditures reported, this small-scale activity can lead to innovations that are not captured by this indicator. Another drawback of using R&D as an indicator of innovation is that is "manufacturing biased" and therefore neglects innovation in the service industry.

What also must be considered is that R&D expenditure is only one of several inputs that influence the innovation process, others such as design, market research, and employee training are not captured. Studies have shown the importance of these non-R&D factors in innovation.[17]

The frequent use of R&D as an innovation indicator can also be related with the predominance of large oligopolistic firms in the innovation process during the era after the Second World War. Using it especially in the context of developing countries, which do not have large oligopolistic corporations who produce for the world market, serves not the purpose to capture the innovation process in these countries poorly.

Patents

Data about granted patents and patent applications are usually easily available and thus a much-used indicator for innovation. They are used as an output measure of innovation, since the capture an innovation already made and not the effort made during the process.

The drawback of using patents as an indicator of innovation is that patents cannot be granted for all innovative procedures, for example the cannot be given for innovative business procedures on the internet.

It also well documented that patents can be used for strategic behavior, some patents are used just to block the entrance of competitors and do not have real commercial value. Industries in which imitation costs are low are more prone to patenting activities, whereas for other industries where the cost of imitation is high, patents are not used widely to protect innovation. (Kleinknecht, Van Montfornt, & Brouwer, 2002)

Using patents as an indicator of innovation can lead to systematic mistakes: "First, we underestimate innovation in low technological opportunity sectors. Second, we over-estimate innovative activity among firms that collaborate on R&D. Third, we underestimate the rate of small firms that innovate.

[17] See for example (Brouwer & Kleinknecht, 1997) or (Felder & et al, 1996)

And finally, we overestimate the innovation intensity of small-sized patent holders." (Kleinknecht, Van Montfornt, & Brouwer, 2002, p. 113)

FDI and Trade

Economic theory suggests that an increase in FDI not only leads to an increase in income but also to a spillover of knowledge to the domestic sector. While the conclusion sounds very straightforward we know that they are many FDIs which have more an extractive character in relation to the domestic economy. For example, the extraction of natural resources by large multinational firms is contributing to welfare and economic growth but has very limited knowledge spillover effects on the domestic economy.

Trade on the other hand may lead to an improvement of technological production capabilities through the import of technologically advanced intermediate goods. However, one can argue that such an import would help the domestic economy only if there exists already a level of sophistication in order to use these new intermediary goods in production, in case of developing nations this is likely not the case.

There are other indicators that are used by scholars to measure innovation, e.g. Total Innovation Expenditures, figures on Sales of Innovative Products, Significant or Basic Innovation figures. Those can measure innovation more directly but depend very much on the criteria these scholars choose and are generally more useful for sector analysis than for cross-country analysis.

Listing the proxies that are widely used to capture innovation and technology transfer we see the need to use a proxy that is conceptually more directly linked to knowledge and can capture innovation as well technology transfer.

This work will use an Index that captures the amount of knowledge stored in an economy more directly, namely the Economic Complexity Index (ECI). The relation between ECI and knowledge will be explained in Chapter 4 of this work, and the construction of the ECI will be explained in Appendix I.

What is particularly promising, when using the ECI, is that an increase in complexity can be seen as a combination of innovative behavior and technology transfer, so it is particularly well designed to answer the question if TRIPS is benefiting developing economies either by promoting domestic innovation or through technology transfer.

3.2 Empirical Studies

Over last two decades and vast literature has accumulated regarding topics related to IPR regulation and protection. Reviewing all the relevant literature would consume to much space in relation to the scope of this work.[18] Here I will focus on studies that deal with technology transfer and the effects of IPR on developing countries. I will mention only some of the studies regarding trade relations that I think are relevant in the "North-South" context.

3.2.1 IPR and Growth

The focus of the effect of stronger IPR protection on growth is based on the welfare argument. The argument states that stronger IPR protection affects economic growth through various channels, such as technology transfer, foreign direct investment, quality and quantity of trade, and other mechanisms which were mentioned earlier.

Falvey, Foster and Greenaway (2006) investigate the relationship between IPR protection and economic growth, using changes in GDP per capita to capture growth, and the Ginarte Park Index[19] to capture the protection of IPR.

The authors find that the relationship between IPR and growth seems marginally significant. After estimating thresholds based on initial GDP per capita the authors conclude that stronger IPR protection leads to economic growth in developed countries, with high initial per capital, as well for countries with very low initial GDP per capita. For the countries that lied in the middle no significant relationship between IPR protection and growth could be found

Similar results are reported by Liu (2016). After investigating the effects of IPR protection on economic growth for 92 countries and controlling for other variables such as R&D, FDI, Human Capital and others, he finds that a positive impact of economic growth is observable for high-income and very low-income countries but not for the countries that lie in between. As a proxy for IPR protection Liu uses the Ginarte Park Index combined by a patent rights index.

[18] For a review see (Maskus K. E., North–South models of intellectual property rights, 2015)
[19] Index measuring IPR protection constructed by Ginarte and Park (1997)

Kashcheeva (2013) is using a panel of 103 countries for the time-period 1970-2009 and finds that IPR and FDI have a strong positive effect on economic growth in most countries, however in the case of developing countries a high IPR protection lowers the positive effect of FDI. Additionally, the author finds that at the highest levels of FDI a less stringer IPR protection leads to the highest growth. Similar results are reported by Sattar and Mahnood (2011).

Other authors conclude that the result of strengthening IPR is positive on GDP growth in both developed and developing nations in Asia, while there seems to be no such effect in Latin America (Seo, Kim, & Lee, 2015).

Typically, as in the above cited works, scholars find that the effect of stronger IPR protection has a positive effect on GDP growth in developed countries and a negative effect in developing countries. Often this effect is found to be not monotonic and depended on previous technological level (Chen & Puttitanun, 2005) or on human capital levels (Grossman & Lai, 2004).

Al-Malawi (2015) investigates a more special case that is theoretically interesting. He examines the effects of IPR protection on the growth of the Golf Cooperation Council (GCC) states, which are all petroleum producers. The question of the effect of IPR especially in “rentier-economies”, which are living of their natural resources, is interesting since they might simultaneously be rich in terms of GDP or GDP per capita but, due to the structure of their economy, do not rely on innovation.

Interestingly, what Al-Malawi finds is that IPR do not seem to play a significant role, either positive or negative, in economic growth of the GCC states.

From the above examples the overall question arises if a harmonized IPR system is benefiting equally all countries or is even hurting very poor countries that do not have natural resources do get on a development path.

The cited works investigate the effect of IPR on economic growth and acknowledge that this effect is entering the economies through various mechanisms. Therefore, some authors focus extensively on these mechanisms and their systematic relation to IPR. The next chapter is reviewing the literature on two mechanisms on which research is heavily focusing namely trade and foreign direct investment.

3.2.2 IPR and Trade and Foreign Direct Investment

Trade is considered as a major mechanism of welfare improvement and as a potential avenue of technology transfer, scholars argue that trade in advanced technological goods tends to grow when IPR are enforced because firms do not fear that their technology will be reversed-engineered or copied.

Lesser (2002) does find a positive impact of IPR on trade, Ivus (2010) finds that a strengthening of IPR, patents rights in particular, has a positive effect on the export of patent sensitive goods from "North" to "South".

Other scholars find that this effect is non-significant for the least-developed countries and only modestly significant for developing countries (Lippoldt & Park, 2003).

But since the TRIPS is an amendment to the WTO agreement it is not surprising if there is a strong correlation with trade. After all the WTO agreement established the liberalization of international trade. Of more interest is the question if this trade is really moving the productive frontier of developing countries up, and if domestic innovation is spurred. This cannot be answered directly by looking in to trade figures.

The authors Campi and Duenas (2016) address in their work an interesting aspect related to trade, namely trade in agricultural products, which is of high importance for developing countries. They find that the strengthening of the IPR protection after TRIPS led to the decrease of the export and import of agricultural products. They conclude that, "…our results show that the strengthening of IPRs that is taking place since the signing of the TRIPS agreement had a negative and uneven effect on agricultural trade, affecting more developing countries. Our findings challenge the idea that IPRs promote trade in the agricultural sector and that there is a unique system, such as the one advocated by the TRIPS supporters, suitable for all countries and sectors." (Campi & Duenas, 2016, p.15)

The other mechanism which theoretically is considered an avenue of technology transfer, is FDI. According to economy theory FDI inflows in an economy doe not only promote growth but transform also the productive capabilities due to technology transfer, which through spillovers effects the whole of the economy.

Klein (2018) argues that signing of TRIPS promotes FDI inflows in to developing countries and thus technology transfer. He particularly tests for the harmonization of IPR, since his model considers IPR in neighbouring countries. He justifies this approach by mentioning the possibility of free riding on other countries IPR laws. If a country adopts stricter IPR, the benefits of technology transfer can

spillover to neighbouring countries, which can have the best of both worlds, namely a loose IPR system and technology transfer from spillovers from the neighbouring country. He concludes: “For developing countries that are linked by their minimal innovative capacity relative to the global frontier, the dynamic benefits of increased FDI inflows resulting from strengthened IPRs cannot be fully captured through unilateral reform. In- stead, the additional FDI flows spillover to other countries in the region, creating a free-riding incentive. However, multilateral policy reform allows for the increased FDI inflows to be shared among developing countries in such a way that each reforming country benefits. (Klein, 2018, p. 15)

Chan and Tang (2017) examine the impact of IPR on FDI inflows categorizing countries in three different income levels (high-, middle-, and low-income). They find that IPR play a significant role in determining FDI inflows. For high income countries both IPR protection as well as singing TRIPS have a significant positive effect on FDI inflows. In middle income countries there seems to be no significant relation of IPR in the long or in the short run. For low income countries IPR and TRIPS seem to be significant in the short run but not in the long run. However, the authors conclude that this insignificance is due to poor law enforcement in these countries and thus state: “A notable policy implication derived from this study is to strengthening the IPRs protection, especially both middle-income and low-income groups in the long-run. The non-significance of IPRs variable of these groups either in the long-run or short-run is partly contributed by the fact that developing countries often lack any substantial IPR protection.” (Chan & Tang, 2017, S. 388). This conclusion seems questionable since they used as a measure of IPR the Park Index, which should measure exactly the actual protection of the IPR.

Many authors work with case studies while investigating the impact of IPR on FDI. Du et al analyze FDI flows from US firms into different Chinese regions. They find that the IPR protection level of a region is a significant predictor of FDI inflows. (Du, Lu, & Tao, 2008). The same conclusion is made by Khoury and Peng (2011) which are investigating the effect of IPR to FDI inflows in 18 Latin American and Caribbean countries. The same holds true for 11 Asian countries for which Hsu and Tiao (2015) test the relation between patent protection and FDI inflows.

Javorcik (2004) is measuring IPR protection levels by the Ginarte Part Index and is testing of these levels influence FDI inflows from firms into Russia and Eastern Europe. What Javorcik found is that insufficient IPR protection discourages FDI inflows but also that existing investments projects shift in the absence of adequate protection from local production to distributive investments.

We see that the evidence suggests that strengthening IPR leads to increased inflows of FDI and to enhanced trade. We have to keep in mind that the overall trade liberalization and globalization could drive all of these phenomena simultaneously. Nevertheless, the question remains if enhanced trade and FDI leads to technology spillovers in the domestic economy. The use of the ECI should be able to tackle this question more directly.

3.2.3 IPR and Innovation

This part is most relevant to this work as it shows the ways scholars use to measure directly the effect of enforcing IPR on innovation.

Many scholars want to study the effect that IPR have on innovation directly. As previously mentioned, the shortcomings of the different proxies used for innovation should be taken under consideration.

I will stress more the conclusions and the proxies used for innovation and not review the econometric techniques that different authors are using, since that would render this chapter less informative for the understanding of the different approaches.

The authors Kanwar and Evenson (2003) use a panel of 29 countries to see if stronger IPR, measured by patent protection, influences innovation, measured by R&D expenditures. The authors find a positive relationship. It is notable that the authors do not distinguish between developed and developing nations.

The authors Chen and Puttinanun (2005) analysing a panel of 64 developing economies find that IPR has a positive effect on innovation and that the relation between IPR and economic development follows a U-shaped curve. As a proxy for innovation the authors use the number of patent applications made from each developing country to the U.S. Patent Office. As a measure of IPR the authors use the Ginarte Park Index. The authors conclude, “While lower IPRs facilitate imitations of foreign technologies, which reduces the market power of foreign firms and benefits domestic consumers, a developing country may also need to increase IPRs in order to encourage innovations by domestic firms. We show that innovation in a developing country increases with the protection of IPRs, and it is possible that a country’s optimal IPRs depend on its level of development (technological ability) in a non-monotonic way, first decreasing and then increasing.” (Chen & Puttitanun, 2005, p. 489)

Acknowledging the U-shaped relation between IPR and initial development, Hudson and Minea (2013) conduct a study exploring the joint effect of IPR and initial development level. Again, the Ginarte Park Index is used as a measure of IPR protection and GDP per capita to determine the initial development level. Innovation is measured by U.S. patents given to applicants of each country. The authors state, "We showed that strengthened IPR exert a complex effect on innovation, both in sign and magnitude, which depends on both the initial level of IPR and per capita GDP. These results thus help reconcile the differing results noted earlier on the different impact of IPR on innovation in developing and developed countries" (Hudson & Minea, 2013, p. 73) The authors also find that transition along this U-shaped curve happens gradually, therefore they conclude that optimal IPR protection should strengthen gradually and not uniformly for all countries, thus arguing against the uniform strengthening imposed be TRIPS.

In his approach Di Vita (2013) argues that there is a positive effect of TRIPS on innovation, as measured by domestic patent applications and by the number of scientific and technological journal articles. The author states that the greatest effect from TRIPS on welfare is the spill-over effect, as measured by the increase in FDI and international trade. This work is a good example of treating knowledge spill-over as simply exogenous to the production process. The sole existence of knowledge in the form of patent applications and scientific journals is taken as evidence of a change in productive capabilities, which are measured in an oversimplifying manner by GDP.

Regarding the effect of IPR on knowledge spill-overs Samaniego (2013) starts from the hypothesis that in a weak IPR environment knowledge spillovers occur more easily, therefore research in innovation, as measured by innovation spending, should drop. By the same logic he expects that if innovation spending is increased this would mean that spill-overs discourage innovations. He concludes that "…strong IPR enforcement is associated with disproportionately greater innovation spending, entry and exit in industries that have higher "desired" R&D intensity" (Samaniego, 2013, p. 61) he also states that "..weak IPRs and weak court systems may constitute a drag not only on innovation but also on entrepreneurship" (Samaniego, 2013, p. 61) The work of Samaniego relies heavily on the identification of innovative behavior with R&D and innovation spending.

Sometimes scholars acknowledge that tightening of IPR regulations in the "South" leads to a shrinking of domestic sector innovation but argue that "northern" firms have now an incentive to produce innovative products for the markets of the "South". Therefore, scholars very often conduct research on the effect of "southern" IPR strengthening on "northern" innovation. The findings are partly contradictory, some find no significant effect on "northern" innovation (Grossman & Helpman, 1991)

or (Park, 2012), others argue that the effect on "northern" innovation depends on various parameters such as the mode of technology transfer (Lai E. , 1997) or the type of the technological innovation (Wu, 2010).

A different approach, by which the present work is inspired, is followed by Sweet and Maggio (2015). The authors use the Economic Complexity Index (ECI) in order to capture knowledge stored in an economy and thus innovative activity and technology transfer. The authors compare the results of stronger IPR on 94 countries and find an overall significantly positive effect on economic complexity. The authors then go further and break up the countries according to different metrics. Once between countries with high per capita income and countries with low per capita income, using the mean per capita income level as a threshold. And once between countries with high initial ECI and lower initial ECI, using the mean ECI as a cut-off.

They report that, "..the impact of intellectual property rights on economic complexity remains positive and highly significant for above mean income countries and for above mean ECI countries. Second, the positive relationship between IPR and ECI breaks down for below mean income countries and for below mean ECI countries. For these countries one can say that IPR has at best a non-significant effect on economic complexity and might even have a negative effect on these countries' ECI" (Sweet & Maggio, 2015, p. 671). The authors also find that human capital levels are highly relevant for innovation stating that "Poorer countries, with lower levels of sophistication and low levels of human capital are not able to overcome the negative effects of IPRs." (Sweet & Maggio, 2015, p. 674)

It should be noted that this work builds on the approach of these authors, using a similar model. Instead on human capital I will account for the possibility of forming networks, as measured by urbanization rates and business freedom which are lowering transaction costs and allow the formation of networks.

4. The Economic Complexity Index and Evolutionary Concepts of the Economy

The following Chapter is crucial in order to understand the motivation behind the use of the Economic Complexity Index in this work.
It is more of theoretical nature, but in my opinion crucial to the discussion of innovation and technology transfer.

4.1 Knowledge and Routines

I will briefly describe the relation between the Economic Complexity Index and innovation, knowledge, information and technology and layout the theory which is used to justify the construction of the Economic Complexity Index.

The complex relation between knowledge and information is described by Fischer (1999, pp. 12-13) as follows; information is factual, and its value is context dependent, while knowledge is correlational, it creates a link between established knowledge and new information, which when incorporated to established knowledge forms the new knowledge base. Knowledge is also path dependent since the ability to incorporate new information builds on the previous knowledge base. Knowledge becomes codified, but new knowledge is more likely of tacit nature, that means it is stored in the mind of the new practitioners or researchers and is therefore hard to transfer in its early stages.

Qc

Technology is defined by Mansfield (Fischer, 1999, p. 12) as a consisting set of knowledge that can be translated in procedures. In each technology set arrangements and re-arrangements of codified and tacit knowledge lead to new products, the result of this procedure is called innovation. The diffusion of innovation across a network is technological change.

Therefore, the question of technological change is closely related to the question of the diffusion of knowledge. This makes the distinction between tacit and explicit knowledge highly relevant. The notions of tacit and explicit knowledge are more recognizable in the widely used distinction between knowledge and knowhow.

The difference between knowledge and knowhow is a highly discussed theme in philosophy that goes back to distinction in Ancient Greek philosophy between ëpistemë and technë. In modern epistemology it can be traced back to Gilbert Ryle's (1949) distinction between “knowledge-how” and “knowledge-that.”

“Knowledge-hat” is implicit knowledge, it is codifiable. Once articulated it can be stored and transmitted almost without cost.

“Knowledge-how” can be characterized as tacit knowledge. It is context related and must be experienced, it is embodied in individuals but cannot be codified very precisely.

In everyday life we accept the fact that having knowledge of how a procedure is done, is not equivalent with having the knowhow to conduct this procedure. The accumulation of this kind of tacit knowledge is hard to achieve in personal as well in societal level and derives from practice and repetition.

Both tacit and explicit knowledge are embodied in repeating procedures, or else routines. The notion of routines is a paradigm used heavily in evolutionary economics. Routines as a fundamental level of economic analysis where introduced by Nelson and Winter (Nelson & Winter, 1982) and are since then a fundamental part of evolutionary economics. Nelson and Winter defined routines as a set of rules and instructions which are to be applied in the economic process.

These routines rely on tacit knowledge, since part of routines is evolving inside the firm due to continuous positive feedback loops, therefore firms will differ from another persistently and can copy each other only with great difficulties. In such a setting competition between firms is driven by the discovering of new routines, which will result in new products and technologies, in a procedure closely mirroring a "schumpetarian" innovation process of creative destruction.

Especially evolutionary approaches to the economy use very often this notion of routines. In order to understand better the motivation behind the construction of the complexity index, a small theoretical detour is needed.

4.2 Evolutionary Economics and Uneven Development

Economic geography is a field of economics which investigates uneven economic development and its causes. In is in other words, it is answering the question of why some regions developed and others don't, the answers vary according to the economic school of thought. Various economic schools of thought and different approaches explain the phenomenon differently and prescribe different solutions. There exist neoclassical approaches along with marxist, and institutional approaches to explain the divergence of different economies.

One of the most prominent attempts of the neoclassical line of thought to describe regional imbalances in growth is Krugman's "New Economic Geography". Krugman's model explains regional agglomeration, specialization in production and trade while relaxing the assumptions of perfect competition and constant returns to scale. As Boschma and Frenken summarize, "It basically is a micro-economic theory that explains the existence and persistence of agglomerations in terms of rational decision of economic agents" (Boschma & Frenken, 2006, p. 275) What Krugman is essentially showing is that regional agglomeration does not have to rely on regional differences or external economies and can be caused by endogenous factors.

Although it has been argued that “institutional economics” is not a coherent and systematic approach (Hodgson, 1998), we can say that all institutional approaches share many of their core concepts.

We can distinguish between to branches within institutional economics, between those who put the primacy to social institutions who regulate individual behavior and those who put the primacy on individuals whose actions result in institutions, these two approach can be called “old” and “new institutional” economics respectively (Boschma & Frenken, 2006).

Between “New Economic Geography” and institutional economics many points of disagreement exist. While the former starts from the neutrality of space in order to explain agglomerations the latter is interested only in “real” historic space. Thus, the former relies mostly on modeling while the later works preferably with case studies.

Furthermore “New Economic Geography” sticks to the neoclassical assumptions on the behavior of individuals, that is to utility-maximizing actions, while institutionalists prefer to work under the concept of bounded rationality.

Boschma and Frenken argue that Evolutionary Economic Geography is a third approach in the economic geography research program. Every evolutionary account of phenomena needs an “population” which is observed to be evolving. Evolutionary Economic Geography analyzes the behavior of firms in terms of organizational routines, a routine following the definition of Nelson and Winter (Nelson & Winter, 1982) , is a set of rules and instructions which are to be applied in the economic process.

Evolutionary Economic Geography wants to explain the distribution of different routines (or rules) over time and space. Therefore “the emergence of spatial agglomerations is to be analysed neither in terms of rational decisions, as in neoclassical theory, nor in terms of the set-up of specific institutions, as in institutional theory, but in terms of the historically grown spatial concentration of knowledge residing in organizational routines.” (Boschma & Frenken 2006, p.278-279)

As Metcalfe (1998) notices, the market mechanism itself does not select between routines directly rather on the product characteristics and the factor utilization, which themselves are influenced by a bundle of routines, that in all determine the design of a firm. Therefore, “it is the activity of the business unit which is selected indirectly” (Metcalfe, 1998, p. 28)

Following this line of thought spatial concertation of firms and thus inequality of economic development arise due the following mechanisms.

Events of chance within a firm that get magnified by a positive feedback loop. (Arthur, 1990) This leads to creation of regional industry leaders which establish regional daughter firms. In that manner, due

to path dependency, an industrial spatial dynamic is introduced which lead to regional industry concertation. Once this path has been paved it is very difficult to be reverted. (Klepper, 2002).

Another way that leads to spatial concentration is increasing returns in regional levels. New knowledge may spill-over to other firms, as "tacit" knowledge does not transmit "ethereally", the spill-over is based on inter-firm collaboration, workers mobility, and professional networks, all of them being more present in regional networks than globally. (Jaffe, Trajtenberg, & Henderson, 1993), (Capello, 1999), (Giulani & Bell, 2005).

4.3 Economic Complexity Index

Hausman and Hidalgo (2011) build on this concepts of routines and evolutionary economics to construct the ECI. I will very briefly present their theoretical approach as it will crucial to justify my decision of using the Economic Complexity Index as a proxy for innovation.

Hidalgo (Hidalgo, 2015) defines the maximum amount of what an individual can store in knowledge and knowhow as the *personbyte*. As a neologism the term helps to introduce a fundamental idea. In order for a society to grow more complex, networks of individuals have to be formed that transgress the limit of the personbyte. The same thinking can be mirrored in the term *firmbyte.* A firm can transgress the limits of knowledge and knowhow only cooperating with other firms, who are specializing in different tasks.

Hidalgo is using his interpretation of the transaction cost theory of Coase[20], and the work of Coase's student Williamson, to explain the formations of a networks (the firm) based on transaction cost theory. He claims that when the internal transaction costs are higher than the external transaction costs a network stops growing. Therefore, as Hidalgo notes, "there are fundamental forces that limit the size of the networks we know as firms, and hence that there is a limit to the knowledge and knowhow these networks can accumulate. Moreover, it also tells us that there is a fundamental relationship between the cost of the links and the size of these networks: the cheaper the link, the larger the network." (Hidalgo 2015, p.91)

When faced with their limit these firms form networks of firms. In all these networks transaction costs govern and decide the size each network can reach. Williamson studied the costs of interactions between firms and the institutions that were developed to manage these transactions. He showed that as transaction becomes reoccurring, additional costs can arise, namely the costs of institutionalizing

[20] See the seminal paper of Coase „The Nature of the Firm" (Coase, 1937)

the transaction (Williamson, 1979). These costs limit the size of the network that firms can use, as Hidalgo argues. He mentions also social and cultural constrains that can limit the size of networks, such as trust building on the study on networks from the famous sociologist Granovetter (2005). [21]

Hausman and Hidalgo use the all the above theoretical considerations in constructing the ECI. How the ECI is exactly derived is discussed in the Appendix of this work. What is important to know is that the ECI is essentially measuring the degree of specialization present in the export matrix of tradeable goods. The more complex the export matrix of a country is the more specialized knowledge is stored in the economy, thus the higher the score on the ECI for this country.

The drawback of the ECI is that it is not measuring sophistication in products that are non-tradable and are sold just in the domestic market, and that it is not measuring innovation in the service sector as exports in of this sector are typically not included in export statistics.

What is interesting, in the context of this present work, is to recognize that the ECI accounts for the "tacitness" of knowledge and therefore can serve as good methodology when studying matters related to innovation.

The use of the ECI as a proxy for knowledge can be understood also in the context of the evolutionary approach of reasoning. An evolving economy is producing new routines in local networks, this new knowledge is reflected in a higher ECI ranking, following the assumption that there is international demand for innovative manufactured goods, and therefore this new knowledge accumulation can be read from the export matrix.

According the evolutionary economics, from which concepts the ECI is derived, we would expect that stronger IPR can have a positive effect on innovation which is strictly endogenous.

While on the other hand technology transfer could very difficult to happen from developed to developing economies because economically useful knowledge is born in regional networks.

[21] On how trust shapes economies and societies in general see for example the seminal work of Fukuyma (Fukuyama, 1995)

5. Empirical Testing

5.1 Model and Hypothesis

In this chapter I will lay out the hypothesis that the empirical part is testing, as well as the econometric model which will be used.

The Null Hypothesis is formulated as follows:

H0: An increase in Intellectual Property Rights protection, as measured by the variable ipp, has a significant positive effect on economic complexity

Vs.

H1:H0 is rejected

The Null Hypothesis is formulated in a way to reflect the majority position on that subject, assuming that stronger IPR protection has a positive influence on innovation.

Based on conclusions from evolutionary economics and institutional economics, we would expect to see a greater influence of the other control variables that will determine the possible size of "knowledge networks" as defined in previous chapters.

The empirical model that is used can be written as follows:

$$\boldsymbol{ECI}_{i,t} = \delta_1 \boldsymbol{ECI}_{i,t-1} + \alpha_i + n_t + \beta_1 \boldsymbol{IPR}_{i,t} + \gamma \mathbf{X}_{i,t} + \varepsilon_{i,t}$$

Where $\boldsymbol{ECI}_{i,t}$ stands for the level of economic complexity of each country on a given year t, α_i and n_t represent the country and time effects respectively, $\boldsymbol{IPR}_{i,t}$ is the level of perceived intellectual property right protection in each country on a given year, and the vector $\mathbf{X}_{i,t}$ represents economic, institutional and demographic control variables.

It is expected that the previous level of economic complexity influences the current level, so we have to include some lags of the depended variable into the explanatory variables. This renders OLS and inefficient due to "dynamic panel bias". The potential endogeneity of the regressors renders also Fixed Effects (FE) approaches such as Least Square Dummy Variable (LSDV) regressions inefficient (Nickell , 1981).

Nevertheless, as Roodman suggests it is beneficial to perform "naïve" OLS and LSDV to find the range in which the true coefficients should lie. (Roodman 2009, p. 103).

After performing these two regressions, and establishing a realistic range for results, I will use two instrumental variable estimators that has been constructed to work around concerns of endogeneity and dynamic panel bias, as well as issues due to fixed effects.

Many scholars use the „System GMM" estimator following Blundell and Bond (1998). Assuming orthogonality conditions based on assumptions of quasi-stationarity of the dependent variable, in that case $ECI_{i,t}$, one can then use a system GMM estimator to use lagged differences of the dependent variable as instruments in levels and lagged levels of the dependent variable as instruments for equations in in fist differences. (Arellano & Bover, 1995). This estimator reduces the small sample bias, from which the differencing approach suffers heavily, and improves precision. (Baltagi 2005, p.148)[22]

Nevertheless, as Hsiao (2003, p. 90) and Roodman (2009) are warning, the use of too many instruments increases the probability of the potential of Type I errors because it leads to results that appear valid but are not, because coefficient standard errors are heavily downwards biased. Additionally, the typical tests on validity such as the Hansen J and the difference-in-Sargan/Hansen test are weakened and cannot be used to justify the use of System-GMM when the instrument count grows too big in relation to the observations available. (Roodman, 2009). To overcome this drawback the Windmeijer correction is used (Windmeijer, 2005).

Ultimately for the validity of the instruments the lagged change in the depended variable should be uncorrelated with the current unexplained change, that means uncorrelated with the fixed effects (Roodman, 2009, p. 146). This is a strong assumption since, it is theoretically not far-fetched to assume that there is a strong relationship between a countries fixed effect and its deviation from its long run mean. But what is ultimately required is that there is no correlation between ECI and country specific fixed effects without conditioning this correlation on other variables. (Bond, Hoeffler, & Temple, 2001).

Bun and Sarafidis (2013) discuss especially the assumption of mean stationarity on which the use of the system GMM estimator hinges. They review the use of different GMM estimators which are used typically for inference in dynamic panels and list possible problems that arise in finite panels. They identify problems with the asymptotics of the standard errors, the overidentification of the modes due to the use of too many instruments, the heavy dependence on nuisance parameters (as for example on the ratio of the variance of the errors of the individual effects to the variance of the errors of the idiosyncratic errors), and the bias that results from the use of weak instruments.

All these possible problems in the use of system GMM are well documented and Bun and Sarafidis give a good summary of the related literature. What the authors stress more importantly is the underlying

[22] See (Hsiao, 2003) or (Harris, Matyas, & Sevestre, 2008) for a detailed analysis of the System-GMM approach

assumption which is made when the system GMM estimator is used, which is systematically underreported by scholars using the system GMM estimator, namely the assumption of mean stationarity on all variables of the model.

Bund and Sarafidis show that the "constant correlated effects" (cce) condition, is necessary and sufficient for the use of the system GMM estimator. The cce states that "the first-differenced variables are free from the individual effects" (Bun and Sarafides 2013, p.13), which means that the correlation between the dependent variable, and the explanatory variables, as well as the unobserved time-invariant heterogeneity are constant over time, respectively. If this condition is ruled out, the authors claim that the most efficient estimator is the GMM estimator proposed by Ahn and Schmidt (1995), henceforth AS estimator. After running simulations and ranking the different GMM estimators the authors conclude:

"A straightforward advise for practitioners regarding which method to prefer in small samples does not emerge, but the non-linear AS GMM estimator seems a relatively safe choice. It is robust to deviations from cce, and more efficient than first-differenced linear GMM." (Bun and Sarafidis, 2014, p.27)

For these reasons, and to get more robust conclusions, in this work both the System-GMM estimator and the AS-estimator are used, and their results are compared.

5.2 Data

Since I wanted to measure the impact of IPR on the innovation process in the developing economies I had to choose a definition for developing economies that suits this scope. I used the World Bank definition for a developing economy which uses an absolute threshold of US$6,000 GNI per capita in 1987-prices for the distinction between developed and developing countries.

To use a more nuanced definition which could even split developing countries in developing and least-developing countries could be also possible, but the data on least-developed economies are often missing or not reported.

I will examine the timespan from 1996-2013. For that timeline data on the Economic Complexity Index (ECI) is freely available, 1996 coincides also to be the year that most countries signed TRIPS, so unfortunately, one cannot analyze whether the signing of TRIPS had an effect in the form of a structure break.

I will use indicators that traditionally have been used as proxies for innovation and technology transfer, such as R&D spending, patents, and foreign direct investment, to test the hypothesis that they play a significant role in shaping the economic complexity of an economy.

List of Control Variables:

6. Foreign Direct Investment

   Foreign Direct Investment Data are taken from the World Bank, the construction is explained as follows: "Foreign direct investment refers to direct investment equity flows in the reporting economy. It is the sum of equity capital, reinvestment of earnings, and other capital….. Ownership of 10 percent or more of the ordinary shares of voting stock is the criterion for determining the existence of a direct investment relationship"[23]

7. Intellectual Property Protection

   To measure the enforcement of IPR laws I will use as data from the Index of Intellectual Property Protection measured each year in the Global Competitiveness Report and published by the World Economic Forum. To construct this Index the World Economic Forum is using data from different international organizations as well a data from the Executive Opinion Survey which is answered each year by leading executives and business people from each country.

8. Urbanization Rate

   Measure percentage of a population in a country that lives in an urban area as defined by national statistical authorities. Source of the data is The United Nations Population Division's World Urbanization Prospects. I will use the urbanization rate of the country, since a tighter geographical agglomeration decreases the transaction costs in a network and can have positive effects on its size.

9. Business Freedom

   To quantify business freedom, I will use the Business Freedom Index taken from the Heritage Foundations Index of Economic Freedom. The quantitative score is derived from an array of measurements of the difficulty of starting, operating, and closing a business. The business freedom score for each country is a number between 0 and 100, with 100 equalling the freest business environment. Since the personbyte restricts the amount of knowledge and knowhow that is stored in a network of individuals, it is crucial that these individuals can form larger

[23] Taken from data description on http://data.worldbank.org/indicator/BX.KLT.DINV.CD.WD (accessed 24.05.2017)

networks (firms) to increase shared knowledge. If the legislative environment in a country is not business friendly we can imagine that there is a constraint in this evolutionary process of network building.

10. Research & Development

    Measures private and public expenditures in R&D as a percentage of GDP, taken from the UNESCO, Institute for Statistics.

11. Patents

    Counts the total applications, from residents and non-residents, filled in each country's patent office. Therefore, it captures domestic innovation as well as trust of non-residents in the protection of IPR. The data is taken from the WIPO Statistics Database.

12. Charges for Intellectual Property

    Captures the payments made by residents and non-residents for the use of intellectual property rights, including patents, licencing agreements, trademarks, copyrights, franchises and a range of other related rights. These figures are highly relevant because the capture directly the use of intellectual property rights. The data are taken from the International Monetary Fund, Balance of Payments Statistics Yearbook and data files. A drawback of this figures is that they are available from 2005 onwards, nevertheless they are included because of their high relevance.

It must be stated which variables are instrumented as purely exogenous and which ones are considered endogenous.

The only purely exogenous instrumental variable in this model is FDI inflow. All other variables are treated also as endogenous.

5.3 Results

A proposed by Bond (2002) and Roodman (2006) I first performed a simple "naïve" OLS regression and a simple LSDV-Regression in order to establish a range in which the consistent estimate of the lagged depended variable should lie. That is because the "dynamic panel bias" inflates the OLS coefficient while the LSDV coefficient on the lagged variable is most of the time biased downwards (Bond S. J., 2002, p. 144) So, we would expect good results for the coefficient of the lagged variable to lie in between or at least not far away between the coefficient of those two regressions. I found that a good

estimate for the coefficient of the lagged depended variable should lie between 0.43988 and 0.95873, as can be seen in in the first and second column of Table 2.

Having established that, I used the System GMM approach, as proposed by Blundell and Bond (1998) bypassing the problematic of a possible violation of the constant correlating effects condition. As suggested by Roodman (2009) I collapsed the instruments, and I restricted the lags of the endogenous variables including only up to the 3rd lag to reduce the instrument count. The results can be seen in the 3rd column of Table 2. The only significant coefficients, at 95% confidence level, belong to the IPR variable. The coefficient of the lagged dependent variable lies way below the desired range and is not significant. After testing for autocorrelation in the idiosyncratic error term, the test rejects the null hypothesis of "no autocorrelation of order 1", and does not reject the null of "no autocorrelation of order 2".

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The Hansen J tests for overidentifying restrictions has a P-value of 0.233, therefore we reject the Null of overidentifying restrictions. We have to keep in mind that in general the power of the test might be reduced if the instrument count is too high (Roodman, 2009). In this case however the resulting P-Value is not so high, so there is no worry that the result is inflated by to many instruments.

The Difference-in- Hansen/Sargan test, checks for the joint validity of a subset of instruments. The Null Hypothesis is that instruments are valid. The Difference-in- Hansen/Sargan test is returning a P-Value is 0.335, so we do not reject the validity of the instruments.

Since we cannot assume for sure that cce hold, I perform also a GMM estimation using the Ahn-Schmidt estimator (AS GMM). Bun and Serafidis show that the AS GMM performs well without needing the assumption of cce to hold. Again, I collapsed the instruments and I used only up to 3 lags of the endogenous variables. The coefficients of FDI and IPP are significant on a 95% significance level. The coefficient of the lagged dependent variable lies outside the desired range and is not significant.
As with the System GMM approach all the other variables seem not significant.

Again, testing for autocorrelation in the idiosyncratic error term, the test rejects the null hypothesis of "no autocorrelation of order 1", and does not reject the null of "no autocorrelation of order 2".

The Hansen J-Test has a very high P-Value of 0.9026 which leads to the suspicion that it over performs maybe because of too many instruments.

To account for this possibility, I reduced the instrument count, using only 1st and 2nd lags of the endogenous variables as instruments, and repeated the regression in order to compare results.

As seen in the 4th column of Table 2, the Hansen P-Value is now 0.7715, which is a less exaggerated result. The Difference-in- Hansen/Sargan has a P-Value of 0.8948, which speaks for the validity of the instruments.

The P-Value for the autocorrelation test rejects the Null with a value of 0.0022, it cannot be tested for second order autocorrelation since the second regression uses only up to the second lag of the instruments.

The coefficients on the variables show that again IPP and FDI stay significant on a 95% confidence level, with values of 0.1937235 and 0.1776988 respectively.

Variable	OLS	LSDV	System GMM	Ahn-Schmidt GMM (1-3) lags	Ahn-Schmidt GMM (1-2) lags
l.eci	**.95873**	**.43988**	.0557176	.253862	.2330185
	(.0192498)	(.0491955)	(.1791099)	(.1931771)	(.1569876)
ipp	-.0024583	.0145643	**.2555104**	**.1879303**	**.1937235**
	(.0158062)	(.0218954)	(.0737323)*	(.0584778)*	(.0616481)*
fdi_log	-.0496304	.0108258	.1065709	**.1322238**	**.1776988**
	(.0208099)	(.0241841)	(0.239)	(.0471801)*	(.0673405)*
urb_rate	-.0567381	1.461099	4.032291	1.874853	2.007485
	(.0574678)	(.6070316)	(3.492693)	(4.256995)	(3.574139)
biz	.000596	.0003833	.0035579	.0042052	.0048025
	(.0009467)	(.0010093)	(.0049552)	(.0054767)	(.0071958)
rd	.0307208	.1691965	.1889406	.404981	.7440461
	(.0396082)	(.0776751)	(.5825937)	(.5771682)	(.5728792)
pat	-1.99e-06	-7.41e-06	-.0000169	-7.26e-06	-.0000153
	(1.81e-06)	(2.50e-06)	(.000022)	(.0000396)	(.0000339)
charg	.0649508	-.0060402	-.053262	.0016915	-.1172212
	(.016957)	(.0278984)	(.0918474)	(.0820528)	(.1451889)
Observations:			39	39	39
Instruments:			23	35	28
Hansen J P-Value:			0.233	0.9026	0.7715
Difference-in-Hansen P-Values(all GMM Instruments):			0.335	0.9994	0.8948
AR(1) P-Values:			0.049	0.0122	0.0022
AR(2) P-Values:			0.915	0.5875	.

Table 2

5.4 Discussion of Results and Research Suggestions

Since the IPP variable has a significant positive coefficient we do **not reject the Null** that **IPR have a positive effect on the complexity index of an economy**. Since the ECI is closely related to GDP growth (Hausmann, Hidalgo, & et al., 2011) and it approximates the knowledge used in an economy, it is very likely that stricter enforcement of IPR leads to economic growth as well as to domestic innovation and technology transfer.

The results should be viewed with caution. Due to the overall econometric difficulty of evaluating dynamic panels combined with the difficulty of working with short panels it is possible that the results are not correctly capturing the systematic relationship between the variables.

A drawback is that many of the variables, such as patents for example, were lacking in completeness especially since developing countries are often not reporting all variables for a long enough timeline.

A research implication from these results is to research further on how IPR effects the economy, possibly microeconomic data, for example on industry specific level, would give more insights.

The model that was used had as controls the variables urbanization rate and business freedom, which should capture the cost of forming networks. For these additional control variables no systematic relationship could be established. Business freedom and urbanization rate seem to be very abstract generalizations. Future research should use variables that capture transaction costs and costs of forming networks (and firms) more directly.

Another issue that can be a possible drawback is that the ECI, by its construction, is not capturing innovation in the service sector and also by construction is only capturing the export of innovative products and thus is neglecting products and services which are innovative but are only consumed in the domestic economy. It can be argued that innovation is strongly local since firms are answering mostly problems of the local market. A variable that could capture domestic innovation more directly would be an improvement for the evaluation of this model.

Conclusion

The purpose of this work was to try to capture directly the impact of the tightening of IPR protection, on innovation process in developing countries. This work used to Economic Complexity Index as a proxy variable for the amount of knowledge that is stored in an economy, and thus by extension as proxy for the amount of innovation that takes place in an economy.

The aim for its use was to overcome methodological problems that arise using other proxies for innovation. The ECI should simultaneously account for theoretical considerations about the tacit nature of knowledge and constrains on networks which limit the dispersion of knowledge. The empirical analysis confirmed the importance of intellectual property rights protection for the economic complexity of an economy. The hypothesized constrains of networks were not be replicated in the empirical results.

The use of the Economic Complexity Index in research concerning the knowledge-based transformation of economies seems promising. The shortcomings of this work are mainly due to the poor data availability for most of the developing countries, which constraint the choice of control variables and the quality of data.

This work also could also not address directly the question if the Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS), as a uniformly intellectual property protection regime, is justified. To answer this question the grouping of the countries according to different levels of economic and technological development would be necessary. Again, this was not possible because of the lag of uniformly available data for all countries and thus the difficulty of clustering in different groups.

The literature regarding the econometric techniques I used, suggests that results should interpreted always with caution. The opinion of this work is that future research on technology spillovers should be rely on case studies of similar countries or comparable industries. This way the interpretation of the data would be more valid.

Appendix I

To arrive at the Economic Complexity Index Hausmann and Hidalgo look at the export data of each country as it expressed in standardized classifications. They then observe the ubiquity and diversity of its exports.

The ubiquity reflects how many countries produce the same product, if many countries produced it then the ubiquity is high. If it is low it can be the case that knowledge to produce that certain product is not located everywhere.

Diversity shows that a country produces a large variety of products and therefore must accumulated knowledge about a large variety of production techniques.

However, the ubiquity of product may be a product of a rare natural resource and not of complex knowledge, similarly the diversity of products may be the product of a very large and diverse country. To rule out this possibilities Hausmann and Hidalgo correct ubiquity with diversity. If a country that produces a product low in ubiquity but not many other products with low ubiquity than this must reflect the rareness of this product and not the complexity of the knowledge that is involved.

The same is true for diversity, if diversity is attributed only to high ubiquous products then it cannot be assumed that the diversity was caused by complex knowledge.

Therefore, the authors use ubiquity to correct diversity and diversity to correct ubiquity, until the process converges and results in to the Economic Complexity Index.

In a technical sense this process looks as follows[24]:

Constructing a matrix with exported products for each country *c* where the value 1 is assigned if the country produces a product *p* and 0 otherwise, $M_{cp.}$

Formally:

$$Diversity = k_{c,0} = \sum_{p} M_{cp}$$

and,

[24] The explanation is taken from „ https://atlas.media.mit.edu/en/resources/methodology/" (01.03.2018)

$$Ubiquity = k_{p,0} = \sum_{c} M_{cp}$$

Correcting diversity and ubiquity with each other, by calculating the average ubiquity of the products that a country exports and the average diversity of the countries that make those products for countries. And for the products by calculating the average diversity of the countries that produce the products and the average ubiquity of the other products that they produce:

$$k_{c,N} = \frac{1}{k_{c,0}} \sum_{p} M_{cp} * k_{p,N-1}$$

And,

$$k_{p,N} = \frac{1}{k_{p,0}} \sum_{p} M_{cp} * k_{c,N-1}$$

Then, by inserting one to the other, we get:

$$k_{c,N} = \frac{1}{k_{c,0}} \sum_{p} M_{cp} \frac{1}{k_{p,0}} M_{c',p} * k_{c',N-2}$$

$$k_{c,N} = \sum_{c'} k_{c',N-2} \sum \frac{M_{cp}}{k_{c,p}} \frac{M_{c'p}}{k_{p,0}}$$

If we define $\sum \frac{M_{cp}}{k_{c,p}} \frac{M_{c'p}}{k_{p,0}}$ as $M_{cc'}$, we obtain:

$$k_{c,N} = \sum_{c'} M_{cc'} k_{c',N-2}$$

Which is true if $k_{c,N} = k_{c,N-2} = 1$. Which is the largest eigenvalue of $M_{cc'}$ and is a vector of ones. To construct the ECI the authors take the second largest eigenvalue which stands for the variance in the system. Therefore defining,

$$K^* = eigenvector\ of\ M_{cc'}\ representing\ the\ second\ largest\ eigenvalue$$

The ECI derives from:

$$ECI = \frac{K^* - [K^*]}{s.d.(K^*)}$$

Where $[K^*]$ is the average deviation and $s.d.(K^*)$ the standard deviation.

As Hausmann and Hidalgo note there are serious limitations in using export data, because they may be other products that are produced but not exported. But as they claim "The fact that they do not export them, however, suggests that they may not be very good at them" (Hausmann & Hidalgo 2011, p.23)

Exports of services are also not included since countries have not yet started yet to gather data on the export of services, this is also a serious limitation, and especially if we consider that the service industry is highly depended on knowledge.

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