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Impact of corruption, through institutional quality and offshoring, in the comparative advantage, income inequality and economic growth

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Abstract

The present research aims to analyze if, due to an effect on corruption, the institutional quality and offshoring will significantly impact the comparative advantage, the income inequality and the economic growth between different countries. The literature on these effects is not yet very developed. Therefore, we sum up the main contributions of the previous literature and develop a general equilibrium endogenous R&D growth model for an integrated area with two representative countries that differ in economic dimension and level of development. Then, we estimated an econometric, linear and logarithm, model for 14 different combination of countries, between 2000 and 2017, using panel data.

Our findings suggest that an improvement of offshoring will lead to an improvement of the comparative advantage for South countries and a decrease on the wage gap between North and South countries. On the other hand, an improvement in the institutional quality will lead to an improvement of the comparative advantage for North countries and an increase in the wage disparity between more developed countries and less developed countries. In our sample, these movements are higher mainly for the combination of countries involving China and India. Lastly, an improvement on the offshoring level and an improvement on the quality of institutions will result in a higher economic development for both regions. In our sample, the combination of countries with a higher increase in their economic performance are Japan *vs* Malaysia and the United States *vs* Mexico.

As a result, North and South countries may improve their position in international trade, in the wage market and in their economic level, by creating policies that decrease corruption and respectively increase the quality of institutions and attractiveness for offshoring.

Keywords: Integrated area; Inter-country technological-knowledge gap; Inter-country wage inequality; Comparative advantage; Corruption; Offshoring; Foreign investments

JEL Classification: O31, O33, O38, F13, E62, C63, C23, D22, O52, D73

Resumo

A presente pesquisa tem como objetivos analisar se, devido a um efeito na corrupção, a qualidade das instituições e o offshoring irão ter um impacto significativo na vantagem comparativa, na desigualdade salarial e o crescimento económico entre diferentes países. A literatura relacionada com estes efeitos não se encontra ainda muito desenvolvida. Por isso, nós resumimos as principais contribuições da literatura existente e desenvolvemos um modelo geral de crescimento endógeno de pesquisa e desenvolvimento para uma área integrada com dois países representativos que diferem em dimensão económica e em nível de desenvolvimento. Depois, estimamos um modelo, linear e logarítmico, econométrico para 14 combinações diferentes de países, entre 2000 e 2017, usando dados em painel.

Os nossos resultados sugerem que uma melhoria do offshoring, levará a um crescimento da vantagem comparativa para os países do Sul e a uma descida da desigualdade salarial entre os países do Norte e do Sul. Por outro lado, uma melhoria na qualidade das instituições levará a um crescimento da vantagem comparativa para os países do Norte e a um aumento da desigualdade salarial entre países mais desenvolvidos e menos desenvolvidos. Na nossa amostra, estes efeitos são maiores principalmente para a combinação de países que envolvem a China e a India. Por fim, uma melhoria no nível do offshoring e na qualidade das instituições irá resultar num crescimento económico para as duas regiões. Na nossa amostra, a combinação de países com um maior crescimento na performance económica são, o Japão *vs* Malásia e os Estados Unidos *vs* México.

Como resultado, os países do Norte e do Sul podem melhorar a sua posição no comércio internacional, no mercado dos salários e no seu nível económico, através da criação de medidas que diminuam a corrupção e que respetivamente aumentem a qualidade institucional e a atratividade para o offshoring.

Palavras-Chave: Área Integrada; Mudança Tecnológico entre países; Desigualdade Salarial entre países; Vantagem Comparativa; Corrupção; Offshoring; Investimentos Estrangeiros

Códigos JEL: O31, O33, O38, F13, E62, C63, C23, D22, O52, D73

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1 Introduction

There is corruption when an illegal sum is paid to a public agent with the expectation of receiving a benefit in return or when there is the abuse of the power delegated for personal gain (Li et al. 2000, Blanc et al. 2019). Corruption is a key feature that differentiates countries since various countries present distinct levels of corruption. At the same time, the quality of institutions is also an important characteristic that differentiates countries since institutions define the atmosphere where firms perform (White et al. 2019). Countries have different institutions because societies have different features. Similarly, offshoring is as well an important feature that consists in the re-allocation of the production of an activity or task in a foreign unit (Kartapy and Tingvall, 2015). A change in the level of corruption it is often translated with a shift in the level of the quality of institutions that a country possess. Commonly, an increase of corruption decreases the positive features that institutions have, reducing the trust of society and its quality levels. (Sumanjeet, 2015). Furthermore, corruption also affects the performance of the offshoring activity. According to Karpaty and Tingvall study (2015), regions with higher degree of corruption are avoid when choosing the countries for the re-allocation and often a higher intensity of corruption is associated with lower levels of practiced offshoring.

As we noticed previously, a variation in the corruption levels has considerable repercussions both on the quality of organizations and on their chances of relocating production. That said, it becomes relevant to analyze how these changes affect other important characteristics of the country, such as its comparative advantage in international trade, inter-country income differences and economic development. In other words, we pretend to explore how a variation in the quality level of institutions and offshoring may contribute to a development of a country's ability in their productivity and exporting capacity, their equality features and their economic performance compared with other international countries.

With the intention to study these effects, described below we will shortly present what the previous literature already analyzed regarding these topics and detail the hypotheses that we considered important to explore: if an improvement on the quality of a country institutions and if an improvement on their level of offshoring may be crucial to increase economically and productively a country's performance and also, create more equal wages for that country.

Institutions affect economic activity, so they also influence comparative advantages and, in sequence, international trade (Rodet 2017). The theories that try to explain trade and countries specialization always focus on the production endowments and productivity. However, what most previous studies on the topic do not cover is that institutions may affect the competitiveness of an industry and may be the reason why countries have different performances even when they present the same technological level (Rodet 2017, Belloc 2006). Also, a higher level of offshoring due to a lower level of corruption will impact productivity (Castellani and Pieri 2013), which will, consequently, affect the comparative advantage. However, there is a significant gap on the literature on how a change in the offshoring level will directly impact the country's comparative advantage. Based on this, our study will first analyze the following hypothesis:

Hypothesis 1: Following a decrease on the corruption level, an increase in the quality of institutions or in the level of offshoring of a country will positively impact the comparative advantage of that country.

People receive different incomes, usually due to the different skills that they possess, but also due to the characteristics within the country where they perform professional activity. Given the fact that the quality of institutions is a key feature to define a society, if this quality is good or weak may have a direct impact and explain income disparity, not only intra-country (domestically), but also inter-country (across countries). Most studies on income disparity do not take into consideration the importance of institutional features in the level of inequality on wages (Mandal and Marjit, 2010), existing a significant gap in econometric studies on the topic. Also, as mention above, corruption has negative effect on offshoring (Karpaty and Tingvall 2015), but in previous studies there is not a consensus on the impact of offshoring in the disparity of income between countries, due to the unemployment that may be created over it (Bogliacino et al. 2018). Taking this into consideration, our analysis will proceed with following possibility to be tested:

Hypothesis 2: Following a decrease on the corruption level, an increase in the quality of institutions or in the level of offshoring of a country will decrease the income inequality between different countries.

According to Aidt (2003) and Acemoglu et al. (2014), there are two main aspects that institu-

tions, political or economic, influence: (i) the economic evolution; (ii) corrupt practices and how institutions can practice that influence. In the previous literature, there are contradictory results on the direct and indirect impacts of the quality of institutions in the countries' performance as well as a lacuna in realizing why institutions vary across countries and how they change (Acemoglu et al. 2014). Additionally, firms from several countries often invest in redirecting their production for the international markets and they usually have four main motivations to do it: (i) Are looking for bigger and more attractive markets; (ii) aim to acquired resources that are scarce in their home country; (iii) seek higher levels of efficiency; (iv) intend to create strategic assets (Dunning and Lundan 2008). Firms often offshore their productions bearing in mind the level of corruption that the international country offers, existing a negative relationship between the level of corruption on the receiving country and the amount of offshoring received (Brada et al. 2012). However, in the previous literature there is not linear conclusion about the impact of offshoring on the economic development of a country (Davis and Naghavi 2011). Finishing with our last hypothesis to study:

Hypothesis 3: Following a decrease on the corruption level, an increase in the quality of institutions or in the level of offshoring of a country will create economic growth for a country.

To perform this analysis, we considered a standard economic structure in endogenous R&D-growth theory for two countries/regions. In this case, feedback effects may occur, affecting the dynamics of the inter-country technological-knowledge gap. In each country, the production of perfectly competitive final goods uses institutions and labor together with a continuum set of country specific quality-adjusted intermediate goods. Intermediate goods, in turn, use designs (resulting from R&D activities) under monopolistic competition. The production function, in which the complementary of inputs, in each country, is coupled with substitute between countries, is adapted from the horizontal R&D growth models developed by Acemoglu and Zilibotti (2001) as well as from the vertical R&D growth model presented by Afonso (2006). This model will be studied in the short-run and in the long-run. From this model will result three econometric specifications to be tested. These specifications will be studied by a linear model and by a logarithm model.

From these models, we expect to obtain that an improvement of offshoring and in the institutional quality will lead to an improvement of the comparative advantage, to an increase

in the economic performance of countries and to a decrease on the wage gap between North and South countries. In other words, we expect that our three hypothesis will not be rejected.

The paper is structured as follows. Section 2 will contain the literature review. Section 3 describes the model. Section 4 determines the equilibrium conditions. Section 5 analyses the effects of institutional quality and offshoring in the three theoretical hypothesis. Section 6 presents the econometric specification and analysis. Finally, section 7 offers the concluding remarks.

2 Literature Review

2.1 Corruption in previous literature

Corruption is when public officials, business individuals or organizations, use and abuse of their power with the aim of gaining individual or personal benefits. This abuse can be done when there are conflicts of interest, throughout money laundering, tax evasion, fraud or the solicitation, acceptance or offering of a bribery (Stevens and Newenham-Kahindi 2018, Amir et al. 2019, Blanc et al. 2019, Zyglidopoulos et al. 2019). Given the fact that corruption is illegal and not seen by society as legitimate, is often measured by the perception that population have of the corruption installed.

Often, firms choose locations knowing already that they will have to offer a bribe in order to install itself there, seeing it has a tax that the firm must pay if it wants to operate in that market (Sumanjeet 2015). It is believed that firms do it, because they do not think that they will be discovered and if they do, the consequences will be almost unseen (Zyglidopoulos et al. 2019).

Corruption is justified by who performs it, as something necessary to respond to weak institutions and as a possible way to enter easily in the markets. Corruption can be efficient and can accelerate some processes, that are usually bureaucratic and slow. Furthermore, it can be a way to avoid multifaceted and expensive protocols. (Aidt 2003; Stevens and Newenham-Kahindi 2018). In developed countries, individuals with businesses based on powerful competitive markets defend and support the corruption activity in order to save their enterprise (Amir et al. 2019). However, the argument of the efficient corruption may lose its significance, since individuals that perform and cooperate with this activity want to maximize their profitability. In this sense, they will ask for higher bribes instead of the efficient ones and they may prolong the time of bureaucracy, in order to request more briberies during a longer period of time (Li et al. 2000). Also, the search for other corrupt allies and the maintenance of everything undisclosed demands a high level of resources, what means that these resources are not being invested in an efficient way. Lastly, if something goes wrong between the corrupt parts, they cannot fight it legally (Aidt 2003). It is, also, necessary to assume that there are limitations in defining the precise level of corruption that which country faces. For example, in countries where corruption is relatively high, it is harder to control the number of

individuals and organizations practicing corruption (Aidt 2003).

Besides the reasons that lead to corruption, is widely accepted that this activity has a negative impact in countries and firms. Corruption may lead to less trust from society in organizations, especially when the resources that are supposed to be invested in important sectors, such as education and health, are being shifted to support this illegal activity (Blanc et al. 2019). It may also lead to lower levels of economic growth, distortions in competition, raises of economic costs, put at risk democracy, generate weaker institutions and make the country less attractive to foreign direct investment (Stevens and Newenham-Kahindi 2018; Sumanjeet 2015).

In this sense, there are several measures that can be taken with the aim of making corruption less attractive. First, it is important to increase the degree of disclosure on corruption (Blanc et al. 2019). Second, create stronger legal penalties to individuals and organizations that enrolled in corrupt activities. Third, create wages sufficiently high that officials will not have the temptation of raising rents someplace else (Aidt 2003). Democracy can, as well, reduce corruption, since politicians are elected based on the willing of the population and if a politician desires to be re-elected, it will be more careful to not be involved in corruption scandals (Aidt 2003). Surprisingly, higher levels of corruption are normally associated with greater values of the child mortality rate and superior levels of basic education dropout (Policardo et al. 2019). When discovered, firms and government officials tend to spend an abundant quantity of resources to gain again the respect of society; nevertheless, this trust is very hard to conquer back and sometimes all these efforts are in vein (Sumanjeet 2015).

Corruption is strongly related with the institutional quality level and the level of offshoring. Institutions are restraints made by humankind that define how political, social and economic aspects will interact with each other (White el al. 2019). They are formed by formal codes, such as norms and property rights, and by informal rules, usually unperceived to the eye, but perceived when interacting within the country, such as cultural attributes and codes of behaviour (White et al. 2019). An institution is considered weak if is very bureaucratic and if takes too much time to give a response, if it has weak laws, where property rights may not be protected and if engages in corrupt activities (Mahmood 2019). Weak institutions are characterized by institutional voids and high levels of corruption. The high levels of corruption in institutions may decrease the quality of life of the population, since they may affect

the quality of a country facilities and their human resources (Mahmood 2019). In particular, when institutions are corrupt, tax revenue may decrease and the trust that society have in these organizations shrinks (Sumanjeet 2015). Moreover, the resources are used in an inefficient way and benefits, as subsidies, are redirected (Sumanjeet 2015).

But how corruption affects offshoring? Offshoring consists in outsource a task or production to a foreign location (Karpaty and Tingvall, 2015). Most studies present a negative impact between the offshoring and the degree of corruption (Karpaty and Tingvall, 2015) and exhibit a harmful relationship between corruption and foreign direct investment (FDI). On the one hand, Brada et al. (2012), for example, concludes that corruption affects the location choice of production, but once the production fragmentation is installed, an increase or decrease on the level of corruption does not affect FDI. On the other hand, Egger and Winner (2006) shows that a high level of corruption significantly decreases the foreign direct investment. Brada et al (2012) affirm that firms decision of the location of their FDI will strongly depend on the levels of home and host countries corruption. Usually, countries with higher levels of corruption will receive lower inflows of FDI and normally the countries that contribute for more outward FDI are countries that present intermediate levels of corruption (Brada et al. 2012). Based on Nunn (2007), North (1991) and Massini et al. (2010), offshoring is based on a contract between several agents. If this contract has more complex information involved, due to the higher levels of corruption that the receiving country possess, this will lead to a higher cost of the international offshoring contract (Karpaty and Tingvall, 2015). As most previous studies on the topic and based on Márquez-Ramos et al. (2012) and Hakkala et al. (2008), corruption often represents lower levels of investments and lower levels of trade. This indicates that decrease in corruption, usually, represents an increasing of offshoring, in the poorest countries.

2.2 Institutions and offshoring on the comparative advantage

Diverse countries are characterized by different institutions (Belloc 2006). Usually, markets with weaker and more corrupt institutions tend to have bigger illegal markets, while countries with stronger and less corrupt institutions tend to have more investment and, thus, a higher development in technology (Rodet 2017). But can strong institutions give a comparative advantage to countries and define their performance on trade? For a country to be successful

on trade in the domestic or international market, it has to spend a lot of resources in analyzing where are the best opportunities and in establishing close relationships with possible partners, what represents high costs that probably will never be recovered (Rodet 2017).

In the recent previous years, the world's production in goods and services, has been trade internationally in higher quantities and in the last decades Asia is the continent that has been having the most active role in the international trade (Krugman et al. 2012). Besides tangible goods, it is also possible to trade labor, practice international borrowing or lending and trade more risky assets, as bonds and stocks (Krugman et al. 2012). When we analyze the global trade, we note that countries tend to transact with geographically and culturally closer regions and with nations that have low trade barriers (Krugman et al. 2012). However, lately the patterns of trade are more indiscriminate, what suggests that other variables may be influencing how international trade is behaving (Krugman et al. 2012). What previous literature seems to forget is that the economic results that a country presents are strongly affected as well by the quality of institutions and subsequently, countries that present different institutional characteristics usually perform different volumes of trade (Levchenko 2007).

In the presence of a country where legal and governmental institutions lack efficiency, firms may try to reduce the costs associated by practicing corruption and ultimately can affect their performance in the international trade. On the one hand, there is a tendency for high-income countries to trade more with more capital-intensive countries[1] than with labor-intensive countries [2], giving to the firsts a comparative advantage and the seconds loose competitiveness due to this insecurity (Rodet 2017). On the other hand, countries with weak institutions may also present a comparative advantage when analyzing illegal markets, as the drugs market, since in these markets the probability of being discovered is significantly lower (Belloc 2006).

It is important to note that there are some production sectors that rely more on institutions than others. This may determine the impact that the quality of institutions may have to give those different sectors a comparative advantage or disadvantage. Sectors that have difficulties in acquiring inputs in the market rely more on institutions than the sectors that can easily access inputs in the market (Levchenko 2007). This raises concerns about the neces-

[1]Capital-intensive countries are usually the developed countries
[2]Labor-intensive countries are usually the least developed countries

sity that there is in developing institutions. When a country invests more on his institutions, this will allow it to produce at lower costs and to produce new goods for brand-new markets, transforming the country in a market leader (Rodet 2017). Besides that, also allows the country to be more efficient in detecting and forbite activities in the illegal market (Belloc 2006).

Institutions in the north and in the south present different characteristics. On the one hand, institutions in the north are classified as institutions with good quality, where contracts are more complete. On the other hand, in the South tends to exist greater market distortions, where contracts are more incomplete. In this regard, institutions tend to be characterized as poor-quality (Levchenko 2007). Based on this, it is predictable to think that the north, given the quality of its institutions, has a comparative advantage and it will specialize in sectors that depend more on institutions. This means that the north will gain from trade, but what happens to south?

On a Ricardian point of view, the south will also gain from trade, since it will only produce in sectors that are not dependent on institutions and it will not suffer the impact of the weak quality characteristics of its institutions. Overall, every type of country has gains from trade, since a development of the institutions in the north will represent positive outcomes for the north, but also for south (Levchenko 2007). However, it is important to note that when South opens to trade the sectors where wages were higher, disappeared. Is the advantage of opening to trade higher than the disadvantage? (Levchenko 2007). Although internationally trade is usually beneficial, sometimes small groups inside which country may suffer a negative impact from trade and do not resist to the intense and worldwide competition (Krugman et al. 2012).

An openness of trade will lead to higher levels of offshoring (Davis and Naghavi 2011) and offshoring has been increasing in the last years, mainly because of a significant reduction on communicative and transaction costs (Thede 2018). A company can re-allocate their production through investing in a subsidiary in a foreign country, known as in-house offshoring, or by buying the intermediate goods to an exterior company in another country, known as outsourced offshoring (Butter and Hayat 2013). The relocation of production means that a large part of the process of producing a good is not only produced by one country, but it is acquired from other countries (Butter and Hayat 2013).

A country will possess comparative advantage in producing a good if they possess the

factors that represent the smallest economic cost to produce that commodity (Autor 2013). This economic cost is highly influenced by the country's technological level and the opportunity cost between producing in one country or in another (Autor 2013). Countries consider participating in trade and exchange goods between them with the expectation to receive mutual benefits. They consider that are benefits in opening a country to trade, specially if they possess key features that allows them to have an advantage in the production of a commodity or task (Krugman et al. 2012). However, some countries, particularly, a few developing regions may have some doubts if they can be competitive against industries characterized by high levels of technology. With trade, a country that has an abundant quantity of resources needed to produce certain goods and services can sell these internationally and, in exchange, buy goods and services constituted by scarce resources in the country. With trade, countries tend to import goods and services in which they are less efficient and tend to export goods and services in which they are more efficient (Krugman et al. 2012).

When offshoring occurs from industrialized regions to less industrialized ones, part of the technology originated in developed nations migrates to developing countries (Autor 2013). With the fragmentation on the production through several parts of the world, the countries may specialize not only in products, but also in specific tasks. Nowadays, the specialization in tasks has significantly increased (Butter and Hayat 2013). With this higher segmentation, firms will have the opportunity to specialize in the parts of production in which they possess an advantage (Butter and Hayat 2013). With higher levels of offshoring for South countries, the probability of the South in having a comparative advantage will increase, while North countries will have a comparative advantage in outward offshoring. South countries will also start possessing higher levels of technology, will start having better work conditions, what will create a pressure over their advantaged wages, making them increase in the long run (Butter and Hayat 2013) and becoming less attractive for international re-allocation of production in the future.

2.3 Institutions and offshoring on income inequality

OECD defines income as the available revenue that a household possess in each year[3]. It can be received when working for others or in case of self-employment. When receiving this income, households should spend part of it in social security contributions and taxes. Each person of the household receives an income that can be different from person to person, representing income inequality.

As mention above, it is believed that corruption may lead to lower levels of economic growth and create an inefficient allocation of the primary resources. However, this activity can also intentionally model the tax system to improve the life conditions of the population that present higher levels of income, what contributes to a higher dispersion of the salary distribution (Policardo et al. 2019).

It is important to note that there are two main types of corruption, (i) business corruption and (ii) government corruption. However, countries with higher levels of business corruption are not necessarily the ones that have the higher levels of government corruption and vice-versa (Amir et al. 2019). On the one hand, business corruption is when the fraud and other illegal activities are performed by corporate individuals or organizations and it is more perceived by population in developed countries as, for example, East Europe (Sumanjeet 2015; Zyglidopoulos et al. 2019). On the other hand, government corruption is when the corrupt activities are performed by government officials and it is more noticed in the least developed countries (Amir et al. 2019).

It is possible to measure income inequality based on the wages of labor and capital or based on the market income after taxes and social subsidies (Sánchez and Goda 2018). Associated with the last method there is the median voter theorem that affirms that more unequal income countries will present higher levels of redistribution since most population receives wages that are below the mean and will demand for bigger ones. However, when literature tries to prove this theorem with real data, there is not a significant support for it, and it is observable the contrary. Most of the countries with higher income inequality present a lower redistribution. This is known as the paradox of redistribution (Sánchez and Goda 2018). Previous literature believes that weak political institutions and corruption can be the main

[3]Information retrieved from https://www.oecd-ilibrary.org/social-issues-migration-health/income-inequality/indicator/english_459aa7f1-en, accessed on 16.11.2019

cause for this paradox. When there is a higher level of corruption, population has less faith in government officials and institutions, so they do not demand more redistribution. Also, when there are higher levels of corruption, resources that should be invested in social contributions are being invested to support corrupt practices. Lastly, re-distributive measures can be distorted by corrupt practices. Overall, poor institution quality has a negative impact on redistribution and countries with higher levels of redistribution, this is countries that are constituted by institutions with high quality, present significantly lower levels of corruption (Sánchez and Goda 2018).

But are the results the same when income inequality is measured through the wages of labour and capital?

Based on a theoretical model, Mandal and Marjit (2010) found two major conclusions. First, is it clear that when the level of corruption of a country decreases the corrupt sector becomes smaller. Second, the effect of corruption can increase or decrease the inequality in wages, depending on which sector loses when the cost of capital increases, what means that a country with a lower level of corruption can present higher or lower levels of redistribution. But does this hold when comparing with data from countries?

Besides that, it is usually assumed that higher levels of bad institution quality significantly reduce the population well-being, but higher levels of income disparity can also lead to a decrease of the social welfare of a country's population (Yan and Wen 2019). It is important to note that income inequality can itself increase the level of corrupt activities, since people often look at income disparity as unfair and frequently engage in corruption to respond to the disparity in income (Policardo et al. 2019). Usually, countries with higher levels of corruption are countries where children have few years of mandatory schooling attainment, have a huge black market, present lower levels of urbanization and lower levels of international trade, with significant increases in population, where governments spend more and where growth per capita is lower. As main examples, the majority countries of Latin America and Kenya (Li et al. 2000).

It is also important to take into consideration that in the past few years, the value chains are becoming more complicated and there has been a strong increase in the internationally exchange of intermediate goods (Luck, 2019). Bogliacino et al. (2018) that focused their analysis in a restrained sample of few European countries, concludes that wages tend to increase

when new products are developed in high technological sectors and that wages decrease when produced in the lower ones.

Some researches, approached for example by Grossman and Rossi-Hanberg (2008) and Feenstra and Hanson (1999), that analyze the impacts of offshoring on the wage inequality have been growing (Impullitti 2016). Nevertheless, there is no universal conclusion (Bogliacino et al. 2018). Through offshoring enterprises are able to transfer their productions to countries that present lower factor prices, what may lead to a more equal factor price (Impullitti 2016). Furthermore, studies as, for example, Feenstra and Gordon (1997) defend that offshoring may increase unemployment of low-skilled and increase wage inequality (Bogliacino et al. 2018).

Based on the model developed by Bergin et al. (2011), focusing on the home and foreign price of labor, when there is a positive shock on demand, the wages domestically will be high, so firms will have a higher incentive to offshore to countries to where the wages are lower. The opposite happens with a negative shock (Foster-McGregor and Pöschl 2015).

With the reallocation of production, occurs a phenomenon known as wage-stealing, where in the receiving country the skill premium will increase, workers will gain new skills and their education level will increase and since the wages are hand-in-hand with the workers' skills, their wages will also increase (Impullitti 2016). Overall, the raise in offshoring will result in more equal prices for the production factors between different countries (Impullitti 2016).

2.4 Institutions and offshoring on the economic growth

Countries around the world present different levels of economic growth. There are two main reasons for these differences: (i) the "proximate cause", involving human and physical capital and (ii) the "fundamental cause", involving institutions (Nugroho at al. 2019). Institutions dictate the rules of each society and they decide how economic individuals behave (Mahmood 2019). Additionally, these organizations decree what are the next steps that each country will pursue and how that steps will be played. Since institutions are different across countries, because societies across countries are diverse, their economic growth will be also different (Nugroho et al. 2019). The civic rules that constitute the market are based in the institutions of the country. If a country has high quality institutions, more skills it will possess to face the common challenges of the world as, for example, poverty (Bilan et al. 2019). Institutions

may increase or decrease growth in the way that, for example, if there is a country that have institutions where technology rights are very well protected, this will stimulate firms and governments to invest more in innovation and that will create growth and vice-versa (Sumanjeet 2015).

There are several types of institutions. On the one hand, according to Nugroho et al. (2019), economic institutions are organizations responsible to allocate capital and goods, creating inducements or barriers for agents to contribute for the productivity of the economy. On the other hand, political institutions are organizations inside a government that make sure that the laws are enforced.

Institution quality may indirectly influence economic growth. Multinational firms usually have the capacity to influence prices and sometimes they are able to fully control the markets where they are installed and in countries that lack strong institutions, other firms will invest a high quantity of resources in protecting themselves instead of investing in resources that will create value added to the firm, what represents a lower level of productivity and ultimately, a lower economic growth (Sumanjeet 2015).

Foreign direct investment (FDI) is crucial to create economic growth. However, when it comes to analyzing if the quality of institutions is vital to attract FDI, literature does not arrive to a consensus. In one hand, Kurul (2017) considers in his study only the least developed countries and finds a positive connection between the quality of institutions and the attractiveness for FDI. Buchnan et al. (2012) also found a positive relationship between the two, but made the study based on developed and developing countries. Based on Globerman and Shapiro (1999) good institutional quality translate more FDI and according with Brunetti and Weder (1998) weaker institutional quality, frequently related with corrupt practices, discourages FDI (Mahmood 2019).

On the other hand, Jun and Singh (1996) found that the impact of institutional quality on FDI is not significant. Wheeler and Mody (1992) do not found any connection on how the fact that a country has strong or weaker institutions affects the country's attractiveness to FDI (Mahmood 2019). Lin et al. (2019) found that corruption negatively affects growth; however, the impact is not significant. Some believe that if one country decides to invest in developing its institutions, that will contribute, in the future, for a development in the country itself and to increase its growth (Mahmood 2019).

It is believed that good institutions contribute to stimulate innovation progress and accommodate knowledge. All developed countries have good institutions running (Nugroho et al. 2019). Frequently, bad institutional quality represents to the business sector, political instability, low levels of education for worker's, low levels of innovation, unethical behaviors, poor quality of materials and infrastructures, high level of corrupt activities and less healthy environments (Bilan et al. 2019). But having weak institutions is not always a disadvantage. Usually, firms that already come from countries where these institutional voids are more persistent, have better skills to deal with the institutional voids of other countries than firms that come from countries with few institutional voids (White et al. 2019). Clearly, firms that come from the least developed countries are quickly approaching the levels of internationalization practiced by firms from the developed countries (Cuervo-Cazurra and Genc 2008). Some believe that this growth comes from choosing the host countries that have a more similar environment compared with their home country.

Based on Bilan et al. (2019) one important factor that may determine the effect of the quality of institutions on economic growth is if institutions were formed in an evolutionary way or in a revolutionary way. The quality of institutions has a higher impact on the economic growth if institutions were created in an evolutionary way than what it has when institutions were created in a revolutionary manner (Tamilina and Tamilina 2014).

One of the best ways to discourage corruption is to increase transparency at an institutional level and make sure who practices corruption is accounted for it. When there is more transparency, information is clearer to population and citizens can use this advantage to make firms and public officials accountable (Sumanjeet 2015). But what means transparency? Transparency is when organizations have clear activities and have procedures that are accessible to everyone who wants to consult them. Based on Suk et al. (2005) a transparent governance is an open structure of processes, used by government officials to govern, that are easily to access by society and that ensure that public officials are accountable for their actions. When institutions have low levels of transparency, they tend to destroy economic development, because they end up disrupting the allocation of resources. Some believe that one of the main reasons of the recent global economic crisis is the lack of transparency that do not allowed the banking institutions to reach holdings of good quality, what represented a smaller amount of lending. When institutions have high levels of transparency, usually,

markets function in a more efficient manner. Usually, more transparency increases fiscal outcomes, during a crisis creates more discipline and lower levels of corruption. Overall, the absence of transparency harms not only institutions itself, but also the all country (Sumanjeet 2015). Typically, there are lower levels of transparency in countries where there is a higher level of population living at risk of poverty and where there is a higher absence of respect for human rights (Sumanjeet 2015).

Following the line of thinking of Antràs (2005), usually firms reallocate their productions through FDI and when the project is stable normally move for an outside firm. The negative impact of corruption on the level of offshoring, noted above, is higher for bigger multinationals, since they are able to avoid the more corrupt locations due to their extensive network (Karpaty and Tingvall, 2015).

When firms decide to where to reallocate their productions, they sometimes choose corrupt countries for more simple performances and choose countries with lower levels of corruption for more complex productions (Antràs and Helpman, 2006). However, several firms still engage in corrupt activities, because as mention above, it allows them to overcome processes that are often very bureaucratic and depress investment (Karpaty and Tingvall, 2015).

Offshoring is usually saw as a way that firms have to save costs. Usually, countries that reallocate their productions present higher levels of productivity, that will lead to higher profits and in the long run can be translated in a higher economic growth (Davis and Naghavi, 2011). Based on Mankiw and Swagel (2006) and Baily and Lawrence (2004), often offshoring increases the technological sector, what leads to an economic growth, not only abroad, but also nationally. Offshoring increases technological development, because, based on Lewin et al. (2009) and Youngdahl and Ramaswamy (2008), it will reduce costs, will allow them to have a more prepared and capable labor force. Firms will also be able to access to a wider scope of markets, where firms can become more competitive and innovative, leading to economic growth (Tojero-Rivero et al., 2019).

Focusing on OECD countries, the majority of their research and development knowledge came, in the past, from their own firms and countries. Nowadays, the majority of their knowledge is gain through offshoring (Tojero-Rivero et al., 2019). This happens, because nowadays there is a major need to seek for diverse aptitudes and skills abroad, this is, complementary assets. Firms main goal is to acquire the knowledge faster and at lower costs

(Castellani and Pieri, 2013). Enterprises with the new knowledge obtained due to the culture, formal and informal rules, education level and different laws of the countries where they install their productions, will be able to create new products and new procedures (Castellani and Pieri, 2013). Jones and Marjit (2001) found that offshoring usually creates changes in regulation processes that can as well improve the development of the economy. However, the impact of offshoring on the economic growth is not linear. Offshoring may also bring to the home-country workers less jobs, decrease their wages and lower their economic power (Davis and Naghavi, 2011).

3 Theoretical Setup

3.1 Overview

This Section describes the economic setup, emphasizing the interactions among economic agents.

3.2 Productive activity – technology and prices

Our model is an extension of Acemoglu and Zilibotti (2001) and Afonso (2006), retaining the same assumptions. We define the aggregate output of the union, Y, i.e., the composite final good,[4] as a composite good of an infinite number of varieties thus resulting from:

$$Y = \int_0^1 p_n Y_n dn \tag{1}$$

where $p_n = \frac{P_n}{P_Y}$ is the real price of the variety n,[5] Y_n is the output of the variety n, and $p_n Y_n$ is constant.[6] Resources of the union, Y, that are not consumed, C, are used in the production of intermediate goods, X, and in the R&D sector, R; i.e., $Y = X + R + C$. The output of n at time t, $Y_n(t)$, is then defined as:

$$Y_n = \left[\int_0^J (q^{k(j,t)} x_n(j,k,t))^{1-\alpha} dj\right][(1-n)lL_n(t)]^{\alpha} + \left[\int_J^1 (q^{k(j,t)} x_n(j,k,t))^{1-\alpha} dj\right][nhH_n(t)]^{\alpha} \tag{2}$$

where the integral terms represent the contributions of quality-adjusted intermediate goods to production. Country L uses intermediate goods $j \in [0, J]$, while country H requires other intermediate goods $j \in [J, 1]$. The size of each quality upgrade due to successful R&D is denoted by q, an exogenously constant greater than 1. The rungs of the quality ladder are

[4] In this paper when we mention "output" we are more precisely referring to the "value added" of the economy. Since output is produced with labor and capital and, in our case, as it will be made clear further ahead, the factors are labor and intermediate goods, we can interpret intermediate goods in the context of our model as replacing the role of capital in the production function.

[5] By real we mean that is the ratio of the price of the output in each sector to the price of final output. All prices and costs in this paper are to be regarded in this way.

[6] Our production function is a Cobb Douglas production function with equal shares of inputs and an infinite number of varieties indexed between 0 and 1. The production function takes this form if we analyse the discrete version of this one, in which $Y = Y_1^{1/n} \cdot Y_2^{1/n} \cdot .... \cdot Y_n^{1/n}$. Assuming perfect competition in both final goods and factor markets from the maximization problem of profits, which are given by $\Pi = Y - \sum_{i=1}^{n} p_i Y_i$, results that $p_i Y_i = \frac{Y}{n}$, which is constant. From here we can express the output as $Y = \sum_{i=1}^{n} p_i Y_i$, which becomes $Y = \int_0^1 p_n Y_n dn$ as the number of varieties tend to infinite and if they are indexed between 0 and 1.

indexed by k, with higher ks denoting higher quality. At time 0, the highest quality good in each intermediate good, j, has a quality index $k = 0$. At t the highest quality good produced by j has a quality index $k(j,t)$, which is actually used due to profit maximizing limit pricing by the monopolist producers. The quantity $x_n(j,k,t)$ is the quantity of intermediate input j used together with the m-type labor to produce $Y_n(t)$. The term $(1-\alpha)$ is the aggregate intermediate-goods input share and $\alpha \in (0,1)$ is the labor share.

In each country, the labor terms include the quantities of labor employed in the production of the n^{th} final good, L_n or H_n, as well as two types of corrective country accounting for productivity differentials. An absolute productivity advantage of:

- the H-country over the L-country is accounted for by the parameter h, assuming $h > l \geq 1$; that is, h and l are positive exogenous variable representing the level of productivity, dependent on the country's institutions, namely property rights, tax laws and government services, which we consider more advances in H;an extended analysis of available estimates suggests that due to this effect $h \in [1.1, 2]$- e.g. Acemoglu and Zilibotti (2001) and Afonso (2006);

- the L-country over the H-country due to smaller wages in terms of relocations performed by global firms, as is empirically shown (e.g., Pierce and Schott 2016), since, in general, outsourced, offshored, and filial of multinationals from H take advantage of wages in L and impose their own efficient production methods and their tacit knowledge (e.g., Antras and Yeaple 2014); an extended analysis of available estimates suggests that due to this effect $l \in [1.2, 2]$- e.g., Ciccone and Peri (2005).

A relative productivity advantage of either country is captured by the terms n and $1-n$, which transform the index n into an ordering index meaning that the H-country is relatively more productive in producing varieties indexed by larger n's, and vice-versa. Since $n \in [0,1]$, there is an equilibrium threshold final good, $\overline{n}(t)$, endogenously determined, where the switch from production in one country to another becomes advantageous, as will become clear later on. The optimal choice of the producer country is thus reflected in $\overline{n}(t)$, which results from profit maximization by perfectly competitive producers of the varieties and by intermediate-goods monopolists, and by full-employment equilibrium in factor markets, given the labor supply in each country and the current state of technological knowledge.

In this sense, $\overline{n}(t)$ defines the structure and the comparative advantages of each country in final-goods production since the production function combines complementarity between inputs with substitutability between the two countries. That is, it consists of a weighted sum of two Cobb-Douglas production functions: if Y_n is produced in the L-country, factors are the L-labor and a specific set of quality-adjusted intermediate goods, while if Y_n is produced in the H-country factors are the H-labor and other specific set of quality-adjusted intermediate goods. Thus, we also extend Dornbusch et al. (1976) and Eaton and Kortum (2002),[7] since there is a continuum of final goods n, indexed between 0 and 1 ranked by decreasing order of comparative advantage, but produced with labor, intermediate goods and institutions.

Due to zero profit equilibrium by producers of $n \in [0, 1]$, the demand for the top-quality of j by the producer of n is

$$x_n(t) = \left[\frac{p_n(t)(1-\alpha)}{p(k,j,t)}\right]^{\frac{1}{\alpha}} q^{k(j,t)\left(\frac{1-\alpha}{\alpha}\right)}(1-n)lL_n,\ 0 < j \leq J, \tag{3}$$

$$x_n(t) = \left[\frac{p_n(t)(1-\alpha)}{p(k,j,t)}\right]^{\frac{1}{\alpha}} q^{k(j,t)\left(\frac{1-\alpha}{\alpha}\right)}nhH_n,\ J < j \leq 1, \tag{4}$$

where: $p(j) = \frac{P(j)}{P_Y}$ is the real price of the intermediate good j. A higher p_n increases the marginal revenue product of the factors, encouraging firms to rent more intermediate goods. A higher L_n or H_n implies that more labor is used with intermediate goods, raising demand. Finally, a higher $p(j)$ means lower demand, since the demand curve for intermediate goods is downward sloping. Plugging (3) and (4) into (2), i.e., considering the demand for each j by the producer of n, (2) can be written as

$$Y_n(t) = \left[\frac{p_n(t)(1-\alpha)}{p(k,j,t)}\right]^{\frac{1-\alpha}{\alpha}} \left[(1-n)lL_nQ_L(t) + nhH_nQ_H(t)\right], \tag{5}$$

where $Q_L(t) \equiv \int_0^J q^{k(j,t)(\frac{1-\alpha}{\alpha})}dj$ and $Q_H(t) \equiv \int_J^1 q^{k(j,t)(\frac{1-\alpha}{\alpha})}dj$ are aggregate quality indexes, measuring the technological knowledge in the country-specific range of intermediate goods. Let us define $G \equiv Q_H/Q_L$, which accounts for the relative technological-knowledge level of H's specific intermediate goods, giving a measure of the inter-country technological-

[7] As shown below, with our modeling strategy we broaden the range of variables of interest to inter-country wage inequality and to economic growth.

knowledge gap or, in other words, of the economic development gap. An endogenous relevant result shown later is that $G > 1$, since the L-country has less human capital and worse institutions.

Since Y is the input in the production of $j \in [0, 1]$ and final goods are produced in perfect competition, the real marginal cost of production of $j \in [0, 1]$ is 1, regardless of the country. Following Romer (1990), j embodies a costly design (created in the R&D sector), which is recovered if profits at each date are positive for a certain time in future. This is assured by a patent law, which protects each leader firm's monopoly, while at the same time, almost without costs, spreading acquired technological knowledge to other firms. The profit-maximization price of the monopolistic firms yields the constant over t, across j and for all k mark-up $p(k, j, t) = p = \frac{1}{1-\alpha}$, which is in fact a mark-up over 1. This mark-up is stable over t, across j and for all k. This symmetry is thus dictated by the way in which each j enters in (2) and by the fact that all intermediate good producers use the same input. Since the leader firm is the only one legally allowed to produce the top-quality, it will use pricing to wipe out sales of lower quality. Depending on whether $q(1–\alpha)$ is greater or lesser than the real marginal cost 1, it will respectively use the monopoly pricing $p = \frac{1}{1-\alpha}$ or the limit pricing $p(k, j, t) = p = q$ to capture all the market. As in Grossman and Helpman (1991, Ch. 4), it is assumed that limit pricing strategy is used by all firms. Since the lowest price that the closest follower can charge without negative profits is 1, the leader can capture all the market by selling at a price slightly below q – more specifically, q in L and q in H –, because q represents the quality advantage over the closest follower.

In turn, the outcomes of R&D are designs, which improve the quality of intermediate goods and the quality indexes in (5) and thus drive economic growth in L-country and H-country, while creatively destroying the profits from previous advances (e.g., Aghion and Howitt 1992), as the previous best quality loses that status. Let $I(k, j, t)$ denote the instantaneous probability at t – a Poisson arrival rate – of successful innovation in the next higher quality $k(j, t) + 1$ in j,

$$I_L(k, j, t) = y_L(k, j, t)\ \beta_L q^{k(j,t)}\ \varsigma_L^{-1} q^{k(j,t)(-\frac{1}{\alpha})}\ L^{-\delta}\ \sigma_L \tag{6}$$

$$I_H(k,j,t) = y_H(k,j,t)\ \beta_H q^{k(j,t)}\ \varsigma_H^{-1} q^{k(j,t)(-\frac{1}{\alpha})}\ H^{-\delta}\ \sigma_H \tag{7}$$

where: $y_L(k,j,t)$ and $y_H(k,j,t)$ are the flow of final-good resources devoted to R&D in j in country L and in country H; $\beta_L q^{k(j,t)}$ and $\beta_H q^{k(j,t)}$, $\beta_L > 0$ and $\beta_H > 0$, are the positive learning effect of accumulated public knowledge from past successful R&D in j in country L and in country H; $\varsigma_L^{-1} q^{k(j,t)(-\frac{1}{\alpha})}$ and $\varsigma_H^{-1} q^{k(j,t)(-\frac{1}{\alpha})}$, $\varsigma_L > 0$ and $\varsigma_H > 0$, are the adverse effect caused by the increasing complexity of quality improvements in j in country L and in country H;[8] $L^{-\delta}$ and $H^{-\delta}$ are the adverse effect of the market size in each country, L and H, related to the difficulty of introducing new quality-adjusted intermediate goods and replacing old ones, and such difficulty is proportional to the size of the market due to coordination among agents, organizational and transportation costs, processing of ideas, information and marketing (e.g., Dinopoulos and Segerstrom, 1999; Dinopoulos and Thompson, 1999); finally, σ_L and σ_H capture the absolute advantage of country H in relation to country L in R&D activity and is given by $\sigma_L = 1$ and $\sigma_H > 1$.

To sum up, R&D activities in each country result in innovative designs for the production of intermediate goods, which increase their quality. The designs are domestically patented and the leader in each j, which produces according to the latest patent, uses limit pricing to assure monopoly. The value of the leading-edge patent relies on the profit-yields accruing during each t to the monopolist, and on the monopoly-power duration. This one depends on the probability of a new innovation, which creatively destroys the current leading-edge design in the lines of the Schumpeterian models (e.g., Aghion and Howitt, 1992).

3.3 Preferences

As preferences are identical in both countries types, L and H, there is a representative household, which, at time $t = 0$, maximizes the discounted intertemporal lifetime utility subject to the flow budget constraint, having perfect foresight concerning the technological-knowledge progress overtime. The utility function is $U = \int_0^{\infty} \left(\frac{C(t)^{1-\theta}-1}{1-\theta} \right) e^{-\rho t} dt$, where $\rho > 0$ is the subjective discount rate, whereby U is bounded away from infinitely if the consumption of the ag-

[8] The positive learning effect, (ii), is thus modelled in such a way that, together with the adverse effect, (iii), it totally offsets the positive influence of the quality rung on the profits of each intermediate good leader firm, as we can see below.

gregate good, $[C(t)]_{t\geq 0}$, were stable over time, and $\theta > 0$ is the inverse of the inter-temporal elasticity of substitution. The economy is populated by a fixed number of infinity-lived households who consume and collect income from investments in financial assets, and from labor supply. The flow budget constraint is $\dot{a}(t) = r(t) \cdot a(t) + w_L(t) \cdot L + w_H(t) \cdot H - C(t)$, where $a(t) = \sum_{i=L,H} a_i(t)$ is the household's real financial assets/wealth holdings in the form of public debt owned by individuals and in the form of ownership of the firms that produce intermediate goods in monopolistic competition: [9] r is the union real interest rate; $w_L$and $w_H$are the wages paid in country L and in country H, and households inelastically supply labor, L or H. From standard dynamic optimization, we derive a no-arbitrage condition between real money balances and real financial assets (this amounts to the well-known Fisher equation) and the optimal path of consumption (the households' Euler equation):

$$\dot{C}(t) = \frac{1}{\theta} \cdot [r(t) - \rho] \cdot C(t) \tag{8}$$

where $\frac{\dot{C}}{C}$ is the growth rate of C,and the transversality condition is $\lim_{t\to+\infty} e^{-\rho t} \cdot C(t)^{-\theta} \cdot a(t) = 0$.

[9]The value of these firms, in turn, corresponds to the value of patents in use

4 Equilibrium

We proceed by analyzing the dynamic general equilibrium resulting from optimal decentralized behavior, which is described by the equilibrium dynamics of the aggregate quality indexes that drive economic growth. The interaction effects between L- and H-countries, arising from the union, play thus a crucial role in the dynamic general equilibrium.

4.1 Equilibrium for given technological knowledge

The competitive advantage of either country on the production of the n, the final good, relies on the relative productivity related with the quality of national institutions, $\frac{h}{l}$, and on the price of the country-specific labor, as well as on the relative productivity and prices of the intermediate goods, because of complementarity in production. The prices of labor depend on the quantities, L and H. In relative terms, the productivity-adjusted quantity of H in production is $\left(\frac{h\,H}{l\,L}\right)$. As for the productivity and prices of intermediate goods, they depend on complementarity with either labor, on the technological knowledge in the country-specific range of intermediate goods and on the mark-up. These determinants are summed up in Q_L and Q_H in (5). The endogenous threshold final good $\overline{n}(t)$ follows from equilibrium in the inputs markets and relies on the determinants of the competitive advantage in final goods:

$$\overline{n}(t) = \left\{1 + \left[G(t)\frac{h\,H}{l\,L}\right]^{\frac{1}{2}}\right\}^{-1}, \tag{9}$$

In other words, since the production function (2) combines complementarity between inputs with substitutability between the two countries, the optimal choice of technology is reflected in the equilibrium threshold final good, $\overline{n}(t)$, which results from profit maximization (by perfectly competitive final-goods producers and by intermediate-goods monopolists) and full-employment equilibrium in factor markets, given the supply of labor and the current state of technological knowledge, are aggregate quality indexes of the stocks of technological knowledge. Thus, H-country produces final goods $n > \overline{n}$ and L-country produces final goods $n \leq \overline{n}$. The threshold can be related to prices noting that it is indifferent to produce it in H or L. This yields the ratio of index prices of final goods produced in each country,

The threshold $\overline{n}(t)$ can be implicitly expressed in terms of price indexes. This is achieved by taking into account that in the production of the threshold $n = \overline{n}(t)$ both a firm that uses

L-technology and a firm that uses H-technology should break even. This turns out to yield, at each moment in time, the following ratio of index prices of goods produced with H and L technologies:

$$\frac{p_H(t)}{p_L(t)} = \left(\frac{\overline{n}(t)}{1-\overline{n}(t)}\right)^{\alpha}. \tag{10}$$

Moreover, taking into consideration that the aggregate (or composite) final good (1) is obtained by integration over final goods, and (9) and (10), the price-indexes of L and H final goods are, respectively,

$$\begin{aligned} p_L(t) &= p_n{\cdot}(1-n)^{\alpha} = \exp(-\alpha){\cdot}\overline{n}(t)^{-\alpha} \\ p_H(t) &= p_n{\cdot}n^{\alpha} = \exp(-\alpha)\cdot[1-\overline{n}(t)]^{-\alpha} \end{aligned}. \tag{11}$$

Equation (9) shows that a higher countries' economic development gap, G, a larger H-country relative supply of labour, $\frac{H}{L}$, and/or a higher H-country relative productivity concerning the quality of national institutions, $\frac{h}{l}$, results in a higher fraction of final goods produced in the H-country, thus in a small $\overline{n}$; i.e., comparative advantage in more final goods. By (10), small implies a low relative price of final goods produced by H. In this case, the demand for H specific intermediate goods is relatively low, which discourages R&D activities aimed at improving their quality.

Full-employment in the labor market, implicit in $\overline{n}$, yields the following equilibrium inter-country wage inequality:

$$\frac{w_H(t)}{w_L(t)} = \left(G(t)\frac{h}{l}\frac{L}{H}\right)^{\frac{1}{2}}, \tag{12}$$

where $w_H(t)$ and $w_L(t)$ are, respectively, wages per unit of H and L.

4.2 Equilibrium R&D

Given the functional form (6) of the probability of success in R&D in each country, free-entry equilibrium is defined by the equality between expected revenue and resources spent:

$$I_S(k,j,t)\cdot V_S(k,j,t) = y_S(k,j,t), \text{ where: } S = L, H \tag{13}$$

i.e., the present value of all the profit flows that a single innovator will receive for the discovery of a new quality intermediate good during the time s/he enjoys the projection of a patent in country S, V_S, times the probability of a new successful discovery, $I_S(k,j,t)$, must be equal to the effective R&D expenditures, $y_S(k,j,t)$. Hence, V_S is the expected current value of the flow of profits to the monopolist producer of j or, in other words, the market value of the patent in country S. The expected flow of profits depends on the amount at each t, Π_S, on the interest rate, and on the expected duration of the flow, which is the expected duration of technological-knowledge leadership. Such duration, in turn, depends on the probability of a successful innovation in m. The expression for V_S, $s = L, H$, is $V_S(j,t) = \int_t^\infty \Pi_S(j,t) \exp\left[-\int_t^s (r(\nu) + I_S(j,\nu))\, d\nu\right] ds$, which can be differentiated using Leibniz's rule, resulting the following dynamic arbitrage equation:

$$r(\nu) + I_S(j,\nu) = \frac{\dot{V}_S(j,t)}{V_S(j,t)} + \frac{\Pi_S(j,t)}{V_S(j,t)} - \dot{k}(j,t)\left(\frac{1-\alpha}{\alpha}\right)\ln q. \tag{14}$$

The equilibrium (13) can be translated into the equilibrium path of the technological-knowledge; in the case of country L results:

$$\frac{\dot{Q}_L}{Q_L} = \left\{\frac{\beta_L \cdot \sigma_L}{\varsigma_L}\left(\frac{q-1}{q}\right) \cdot l \cdot L^{1-\delta}\left[p_L(1-\alpha)\right]^{\frac{1}{\alpha}} - r\right\}\left(q^{\frac{1-\alpha}{\alpha}} - 1\right) \tag{15}$$

In (15), the term in large brackets is the equilibrium country-specific probability of successful R&D, I_L, given r and p_L, which turns out to be independent of j and k, due to the removal of scale of technological-knowledge effects: the positive influence of the quality rung on profits and on the learning effect in (6) is exactly offset by its influence on the complexity cost also in (6). Additional scale/market effects could arise through market size, as has been intensely discussed in the R&D endogenous growth literature since Jones' (1995) critique. Due to the technological complementarity in the production function (2), the size of the market for L-specific intermediate goods in our model is the the level of labor L. Then, the scale effect is apparent in the size of the profits. Since we also aim at understanding the effects other than market size, the removal of scale is in order. The adverse effect of market size due to the scale-proportional difficulty of introducing new quality intermediate goods in (6) is designed to offset the scale effect on profits. With $\delta = 1$, the offsetting is such that the influence of market size is null.

4.3 Steady state

In each county and thus in the union, the aggregate final good, Y, is used for consumption, C, and savings, which, in turn, are allocated between production of intermediate goods, X, and R&D, R. Since both countries have access to the state-of-the-art intermediate goods and they have the same technology of production of final goods, in steady state they have differences in the levels but not in the growth rates. The common and stable steady-state growth rate is thus equal to growth rate of the technological knowledge, because Y, X, R and C are all constant multiples of Q_H and Q_L. Through the Euler equation (8), the steady-state interest rates, $r^*(= r_H^* = r_L^*)$, are also equalized between countries. The common and stable steady state growth rate, designed by $g^*(= g_H^* = g_L^*)$ is thus:

$$g^* = \left(\frac{\dot{Q}_S}{Q_S}\right)^* = \left(\frac{\dot{Y}}{Y}\right)^* = \left(\frac{\dot{X}}{X}\right)^* = \left(\frac{\dot{R}}{R}\right)^* = \left(\frac{\dot{C}}{C}\right)^* = \left(\frac{\dot{c}}{c}\right)^* = \frac{r^* - \rho}{\theta}, \quad (16)$$

implying constant steady-state levels of G^*. Thus, r^* is obtained by setting the growth rate of consumption in (8) equal to the growth rate of technological knowledge in (15), and using the equilibrium levels of p_H and p_L. Clearly, R&D drives steady-state endogenous growth. If $G(0) = \frac{Q_H(0)}{Q_L(0)}$ is such that $\frac{\dot{G}(0)}{G(0)} > 0$, $\overline{n}$ will decrease overtime, which implies that $\frac{\dot{p_H}}{p_H} < 0$ and $\frac{\dot{p_L}}{p_L} > 0$. In turn, a lower p_H and a higher p_L over time induce lower incentives to perform R&D directed to the H-country in relation to the L-country, which implies a lower $\frac{\dot{G}}{G}$. These dynamics continue until $\frac{\dot{G}}{G} = 0$. If $G(0)$ is such that $\frac{\dot{G}(0)}{G(0)} < 0$, the opposite dynamics will occur.

From (15) and (10), Q_L and Q_H rise at the same rate when:

$$\overline{n}^* = \left[1 + \frac{\beta_H}{\beta_L} \cdot \frac{\varsigma_H}{\varsigma_L} \cdot \frac{\sigma_H}{\sigma_L} \cdot \frac{h}{l} \cdot \left(\frac{H}{L}\right)^{1-\delta}\right]^{-1}. \quad (17)$$

Then, bearing in mind (9) and (17), the steady-state inter-country technological-knowledge gap is:

$$G^* = \left(\frac{\beta_H}{\beta_L} \cdot \frac{\varsigma_H}{\varsigma_L} \cdot \frac{\sigma_H}{\sigma_L}\right)^2 \cdot \frac{h}{l} \cdot \left(\frac{H}{L}\right)^{1-2\delta}. \quad (18)$$

In turn, from (12) and (18), the steady-state inter-country wage inequality is:

$$\left(\frac{w_H}{w_L}\right)^* = \frac{\beta_H}{\beta_L} \cdot \frac{\varsigma_H}{\varsigma_L} \cdot \frac{\sigma_H}{\sigma_L} \cdot \frac{h}{l} \cdot \left(\frac{H}{L}\right)^{-\delta}. \tag{19}$$

Finally, choosing the case of the L-country and bearing in mind (15) and (16), we first determine the stable and unique steady-state interest rate and then we insert that expression in (16) to determine the steady-state economic growth rate:

$$g^* = \frac{\frac{\beta_L \cdot \sigma_L}{\varsigma_L}\left(\frac{q-1}{q}\right) \cdot l \cdot L^{1-\delta}\left[p_L^*\left(1-\alpha\right)\right]^{\frac{1}{\alpha}} + \rho}{\left(q^{\frac{1-\alpha}{\alpha}} - 1\right)^{-1} + \theta}, \tag{20}$$

where p_L^* can be determined by the expressions (11) and (17), $p_L^* = \exp(-\alpha) \cdot \overline{n}^{*-\alpha} = \exp(-\alpha) \cdot \left[\left[1 + \frac{\beta_H}{\beta_L} \cdot \frac{\varsigma_H}{\varsigma_L} \cdot \frac{\sigma_H}{\sigma_L} \cdot \frac{h}{l} \cdot \left(\frac{H}{L}\right)^{1-\delta}\right]^{-1}\right]^{-\alpha}$.

5 Economic effects of institutions and offshoring

As related before, the advantage of the Northern countries is given by the quality level of their institutions, while the Southern countries can achieve an advantage throughout offshoring. In this Section, we will analyze how institutions and offshoring: (i) contribute to the optimal choice of the country that produce the final good n, which we interpret as the country that will have a comparative advantage on production; (ii) affect the technological-knowledge level between countries; i.e., the technological-knowledge gap between some combination of two countries; (iii) contribute for wages, which we interpret as wage inequality; (iv) affect the growth of a country in economic terms.

5.1 Data and calibration

For testing our theoretical model, we present fourteen different combinations of countries. To measure the production capacity of H-countries and L-countries, we retrieved from the World Bank the total labor force for these countries for the time period 2000-2017. We considered as country H, the United States, Germany and Japan, because they are classified as developed by the literature and they present a CPI (Corruption Perception Index) higher than 6 between 2000 and 2011 and higher than 60 between 2012 and 2017. The data were acquired from the Transparency International. For L-countries, we considered countries that presented a CPI lower than 6 between 2000 and 2011, and lower than 60 between 2012 and 2017. When choosing the L-countries for our sample, we took into consideration countries with who the United States, Germany and Japan tend highly offshore with. The L-countries chosen were China, Mexico, India, Republic of Korea, Italy, Czech Republic, Brazil, Hungary, Indonesia, Thailand and Malaysia.

We calibrated the theoretical model, bearing in mind the baseline parameter values and labor endowments. This way, the transitional dynamics are displayed, bearing in mind the initial condition $G(0) = 60$ and the following set of baseline parameter values and labor endowments: $h = 1.80$, $l = 1.00$, $\alpha = 0.60$, $q = \frac{1}{1-\alpha}$, $\beta_H = 1.60$, $\beta_L = 1.20$, $\varsigma_H = 5.00$, $\varsigma_L = 4.00$,$\theta = 1.05$, $\rho = 0.015$, $\sigma_H = 1.20$,$\sigma_L = 1.00$,$\delta = 0.50$ - see Table 6- Appendix A. The values of h and l respect our assumption used in (2) that $h > l \geq 1$ and that $h \, \epsilon [1.1, 2]$ – e.g., Acemoglu and Zilibotti (2001) and Afonso (2006). Since $p = q$ and $q = \frac{1}{1-\alpha}$, with

$\alpha = 0.60$, $q = 2.5$ which is in accordance with the average estimation of mark-up made by Kwan and Lai (2003).

Since β represents the positive effect of the previous effective R&D, we know that $\beta > 0$ due to innovation experience that countries start gaining (Connolly 2003). Northern countries possess an advantage over the South regarding R&D, because the South has less human capital and lower institution quality. In this sense, we consider that $\beta_H = 1.60$ and $\beta_L = 1.20$ (Connolly 2003). Based on Kortum (1997), all countries suffer from negative effects due to the increasing complexity that intermediate goods quality require, which means that $\varsigma_H > 0$ and $\varsigma_L > 0$. These effects will be higher in H than in L, so we assume $\varsigma_H = 5.00$ and $\varsigma_L = 4.00$.

For the inverse of the elasticity of substitution we consider $\theta = 1.05$, because $\theta \in [1, 2]$ – e.g., Attanasio and Weber (1993) –, and for the discount rate we take $\rho = 0.015$ in line with Afonso (2006) and Dinopoulos and Segerstrom (1999). The innovator North has an R&D absolute advantage over the South, which is represented by $\sigma_H = 1.20$ and $\sigma_L = 1.00$. Lastly, δ must be higher than 0, because it is harder to replace old products and successfully integrate new and more developed ones (Dinopoulos and Segerstrom 1999).

5.2 Offshoring and corruption effects on comparative advantage

Bearing in mind (2), the Northern countries have a comparative advantage in producing the final good if the n is higher than $\overline{n}$, while the Southern countries will have a comparative advantage on the production of the final good if the n is lower than $\overline{n}$. On the one hand, characteristics as a lower level of corruption found in countries such as, the United States, Japan and Germany will improve their institutional quality. On the other hand, a lower corrupt activity in regions as China, Brazil and Thailand, will conduct to a higher levels of offshoring.

When countries experience an increase on the re-allocations levels received, they suffered, immediately, a shock that will affect their comparative advantage. In the short-run, when offshoring increases to $l = 1.20$, for example, in comparison with the US, China will produce 40% of the final goods; in contrast with the Germany, Brazil will produce, approximately, 31%; and in comparison with Japan, Thailand will produce 19% of the final goods, approximately. This short-run effect is possible to measure in equation (9). The fact that countries present higher or lower levels of corruption and consequently present lower or higher insti-

tutional quality and lower or higher re-allocations of production will in the long run affect the optimal choice of the producer of the final good n.

Regarding Table 1, it is noticeable that when the value of re-allocations increases from 1.00 to 1.20, the $\overline{n}$ increases for all the combinations of countries. In the long-run, when analyzing the combination of the United States and China, when offshoring is 1.00, China will produce 38% of the final goods, but when offshoring increases for 1.20, China will produce, around, 43% of the final goods. For Germany and Brazil, when the value of offshoring for Brazil is 1.00, Germany will produce 71%, but when the offshoring level in Brazil increases to 1.20, Germany will only produce, about, 67% of the final goods. Comparing Japan and Thailand, when the level of re-allocation is1.00, Thailand will produce, around, 17%, but when the value increases to 1.20, Thailand produces 20% of the final goods.

Hence, due to the higher level of offshoring in countries as China, Brazil and Thailand, the level of the optimal choice of the producer of the final good will also increase and these countries will gain advantage in the production of final goods. As a result, developed Northern countries may lose part of the advantage in producing final goods. The effects would be opposite if we analyzed the improvement of the institutional quality in the H-countries. This improvement would translate in a decrease of $\overline{n}$, so that North countries would have more possibilities to possess the comparative advantage.

Countries	$l = 1.00$	$l_{short-run} = 1.20$	$l_{long-run} = 1.20$
United States/China	0.3817	0.4034	0.4256
United States/Mexico	0.1334	0.1443	0.1559
United States/India	0.3224	0.3426	0.3634
United States/Korea Rep.	0.1007	0.1093	0.1185
Germany/Italy	0.1758	0.1894	0.2038
Germany/China	0.5438	0.5663	0.5885
Germany/Czech Republic	0.0896	0.0973	0.1056
Germany/Brazil	0.2931	0.3123	0.3323
Germany/Hungary	0.0823	0.0895	0.0972
Japan/China	0.4850	0.5078	0.5305
Japan/Korea Rep.	0.1459	0.1577	0.1701
Japan/Indonesia	0.2645	0.2826	0.3015
Japan/Thailand	0.1736	0.1871	0.2013
Japan/Malaysia	0.1059	0.1149	0.1244

Table 1: Effects on comparative advantage

5.3 Offshoring and corruption effects on the technological-knowledge gap

The technological-knowledge gap between countries is quite similar despite of the different combinations of countries. Usually, when firms of the *H*-country start to re-allocate with more intensity in the *L*-country is noticed a progressive decrease in the technological-knowledge gap between the North and the South, as shown in Figure 1. In turn, when the institutional quality of the North is improved due to a lower level of corruption, the technological-knowledge gap between the two types of countries starts increasing, as shown in Figure 2. In this case, firms in the *H*-country start trusting even more in the respective governments and will perceive that the investments are more protected so they will feel more comfortable to invest more in R&D within the *H*-country.

Figure 1: Technological-knowledge gap due to relocations

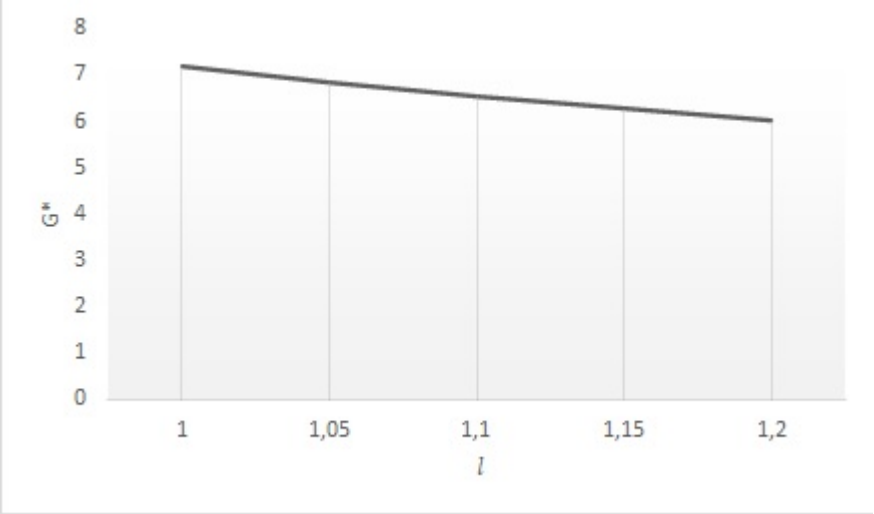
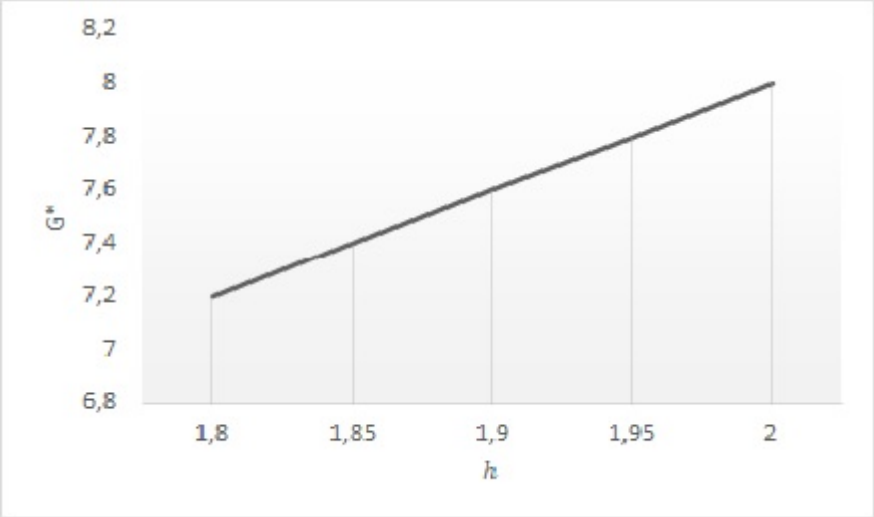


Figure 2: Technological-knowledge gap due to relocations



5.4 Offshoring and corruption effects on inter-country wage inequality

The major inter-country wage gaps between the H-country and L-country in our sample occur in the following relationships: The United States *vs* China, The United States *vs* India, Germany *vs* China, and Japan *vs* China. As expected, when countries as the United States, Germany and Japan increase the re-allocation of their productions to countries in the South, the wage inequality between the two type of countries decreases.

In the short-run, the shock felt by the increasing of the level of offshoring in the L-countries will immediately decrease the inter-country wage inequality disparity, as results from (12). As perceptible in Table 2, the wage disparity, for example, between the The United States and India when $l=$ 1.00 is about 6.17, but when the l increases to 1.20, in the short-run, the income disparity will decrease to, approximately, 5.63, between Germany and Italy the reduction goes from 2.76 to 2.52, and between Japan and Indonesia the wage differences will lower from 4.66 to 3.88. In the short-run, the increase on the offshoring level leads to a higher decrease in the income disparities between Germany and China, with a reduction of 1.35 and between Japan and China, with a decrease of, approximately, 1.06.

In the long-run, also perceptible in table 2, when the value of the offshoring increases from 1.00 to 1.20, the wage inequality, for example, between The United States and India decreases from 6.17 to 5.14, the differential of inter-country wage inequality between

Germany and Italy decreases from 2.76 to 2.30, and the wage disparity between Japan and Indonesia slowly decreases from 4.66 to 3.88.

Hence, an increase on offshoring will immediately decrease the wage disparity between the H-country and L-country. This decrease will be even higher when, in the long run, the new steady state is achieved.

In the long-run, the combination of countries that show higher differences between wages are the ones that have the highest decrease when the value of offshoring increases. For example, when offshoring increases from 1.00 to 1.20, the decrease of the wage inequality between Germany and China is around 2.58, the decrease of the wages disparity between Japan and China is of 2.03, approximately, and the reduction of the wages disparity between the United States and China is about 1.33.

The combination of countries that present a low gap on wages between them, when offshoring increases from 1.00 to 1.20, their inter-country disparity also decreases since the path of wages is close related with the path of the technological-knowledge bias. However, this decrease is lower that the ones mentioned above. For example, approximately, the gap of wages between the United States and the Republic of Korea is of 0.24, the difference of wages between Japan and Malaysia is of 0.26 and the wages disparity reduction between Germany and Hungary is of 0.19.

This means that Southern countries are able to decrease more their wage inequality when they receive more re-allocations from Northern countries, and specifically with those who they had their major gap difference in wages. The H-country decides to re-allocate productions for the L-country due to the lower wages. However, with the higher level of re-allocations, more people will be employed in the South and based in the Kuznets' Inverted U-hypothesis, the wage-inequality gap will decrease.

On the other hand, if the institutional quality of the North increases and everything remains stable in the South, the advantage on the wages that the North countries already possess over the South will be even higher, what will lead to a higher inter-country wage inequality.

Countries	$l = 1.00$	$l_{short-run} = 1.20$	$l_{long-run} = 1.20$
United States/China	8.0006	7.3036	6.6672
United States/Mexico	1.9943	1.8206	1.6619
United States/India	6.1656	5.6284	5.1380
United States/Korea Rep.	1.4516	1.3251	1.2097
Germany/Italy	2.7644	2.5235	2.3036
Germany/China	15.4468	14.1009	12.8723
Germany/Czech Republic	1.2758	1.1646	1.0631
Germany/Brazil	5.3738	4.9056	4.4781
Germany/Hungary	1.1622	1.0610	0.9685
Japan/China	12.2037	11.1404	10.1698
Japan/Korea Rep.	2.2142	2.0213	1.8452
Japan/Indonesia	4.6607	4.2546	3.8839
Japan/Thailand	2.7227	2.4854	2.2689
Japan/Malaysia	1.5351	1.4013	1.2792

Table 2: Effects on inter-country wage inequality

5.5 Offshoring and corruption effects on the economic growth

In order to see in a more accurate perspective on the effects of offshoring on growth, we used proportional measures for accounting labor (values of H and L), considering that values of labor of each country in 2000 were equal to 1. For all combination of countries, it is possible to analyze that an increase on offshoring from 1.00 to 1.20 will lead to an increase on the economic growth rate.

The increase of the re-allocations of productions to the South results in an increase of technological knowledge in these countries and this will increase the possibility of these countries in having a comparative advantage in the final goods production. Multinational firms will be tempted to re-allocated production for South due to lower wages. With an increase of the offshoring, more investment and technological knowledge the South will receive, which contributes to improve the economic growth rate – see Table 3.

For example, an increase of offshoring from 1.00 to 1.20 increases the worldwide economic growth from approximately 2.81% to 2.95%, when involved countries are the US and India. When the countries are Germany and China the economic growth increase is of, approximately, 0.13 percentage points and when the involved countries are Japan and Indonesia

the economic growth goes from approximately 3.26% to 3.40%.

This increase in the economic performance is higher for the following combination of countries: (i) Japan *vs* Malaysia, with an increase in the economic development around 0.15 percentage points; (ii) United States *vs* Mexico, with an expansion approximately of 0.14 percentage points and (iii) Germany *vs* Brazil also with a boost of 0.14 percentage points. The expansion on the economic growth is smaller for the following combination of countries: (i) Germany *vs* Czech Republic and (ii) Germany *vs* Hungary, with an increase of about 0.13 percentage points.

Countries	$l = 1.00$	$l_{long-run} = 1.20$
United States/China	0.0239	0.0252
United States/Mexico	0.0598	0.0612
United States/India	0.0281	0.0295
United States/Korea Rep.	0.0738	0.0752
Germany/Italy	0.0442	0.0455
Germany/China	0.0188	0.0201
Germany/Czech Republic	0.0790	0.0803
Germany/Brazil	0.0305	0.0319
Germany/Hungary	0.0865	0.0878
Japan/China	0.0203	0.0215
Japan/Korea Rep.	0.0530	0.0544
Japan/Indonesia	0.0326	0.0340
Japan/Thailand	0.0453	0.0466
Japan/Malaysia	0.0752	0.0767

Table 3: Effects on economic growth

6 Econometric specifications

With the intention of analyzing if an improvement in the quality of institutions or an increase of offshoring will positively impact the comparative advantage of countries and their economic development and decrease the wage gap between different countries and in order to support the findings obtained in the previous section, we decided to estimate three econometric specifications that will be described with detail in the following Subsections.

As in our theoretical model, our sample included all the fourteen different combinations of countries between the years of 2000 and 2017. Due to missing information regarding some variables for some specific years included in our regressions, the number of observations may change between the three econometric specifications. Our estimation is based on panel data, since our data sample presents time-series and cross-sectional information. The data was collected from several organizations that will be described below.

6.1 Variables

The main aim of this dissertation is to analyze the impact of variables as offshoring and institutional quality, due to a change in the corruption level, have on the comparative advantage, inter-country wage inequality and economic growth between countries with different economic backgrounds. The dependent variables are the following:

- Comparative Advantage, assessed by the Revealed Comparative Advantage (RCA), retrieved from WITS (World Integrated Trade Solutions) [10]

- Wage Inequality, measured by the total average wages, retrieved from OCDE (Organisation for Economic Co-operation and Development), ILO (International Labour Organization) and CEIC. The data for the United States, Germany, Japan, Mexico, Republic of Korea, Italy, Czech Republic and Hungary was retrieved from OCDE. The data from China, Brazil, Indonesia, Thailand and Malaysia was retrieved from ILO. The data for India was retrieved from CEIC[11]

[10] Data available at https://wits.worldbank.org/CountryProfile/en/Country/BY-COUNTRY/StartYear/2000/EndYear/2017/TradeFlow/Export/Indicator/RCA/Partner/USA/Product/UNCTAD-SoP2#, acessed on 24.04.2020

[11] Available at https://data.oecd.org/earnwage/average-wages.htm; https://www.ilo.org/shinyapps/bulkexplorer40/? and https://www.ceicdata.com/en, acessed on 24.04.2020

- Economic Growth, assessed by the annual GDP growth (measured in %), retrieved from World Bank [12]

In turn, the main explanatory variables are (i) Labor Endowments, $Labor$, based on the total labor force available for each country. The data of the sample was retrieved from the World Bank; (ii) Institutional Quality, IQ,measured by the Rule of Law, retrieved by the World Bank; (iii) Offshoring, Off, assessed by the ration between the imported intermediate goods of the H-country from the L-country and the value added. The data for the imported intermediate goods was exported from WITS and the value added information was retrieved from the World Bank.We estimated the level of offshoring by using the inter-industry offshoring indicator. This indicator was used by Hijzen and Swain (2007), on a study on how offshoring impacts employment.; (iv) Technological-knowledge development, TD, measured by the number of patents applications of residents and non-residents. Data retrieved from the World Bank; and (v) an Anti-Corruption Measure, $A-C$,based on the government effectiveness, retrieved by the World Bank. These variables considered are listed below:

- Labor levels, $Labor$, the total labor force is measured by women and men with 15 years old or more that are capable to supply labor with aim of producing goods and services, this labor availability is measured by people that currently work, but also by people that are looking for a job. [13]

- Institutional Quality, IQ, the rule of law represents the level of trust that population has on their agents regarding the effectiveness of the laws of contracts, the protection of property rights, the quality of judicial system [14]. The more close from 2.5, the country possess a higher level of rule of law, more trust exists on public agents. The more close to -2.5, the lower the level of the rule of law that the countries possess.

- Offshoring, Off, the ration between the imported intermediate goods of the H-country from the L-country and the value added. [15]

[12] Available at https://data.worldbank.org/indicator/NY.GDP.MKTP.KD.ZG, acessed on 24.04.2020

[13] Data available at https://data.worldbank.org/indicator/SL.TLF.TOTL.IN, acessed on 06.04.2020

[14] Data retrieved from https://tcdata360.worldbank.org/indicators/had2c21ab?country=BRA&indicator=370&viz=line_chart&years=2000,2017, acessed on 26.06.2020

[15] Available at https://wits.worldbank.org/CountryProfile/en/Country/BY-COUNTRY/StartYear/2000/EndYear/2017/TradeFlow/Import/Indicator/MPRT-TRD-VL/Partner/WLD/Product/UNCTAD-SoP2, https://data.worldbank.org/indicator/NV.IND.TOTL.CD, https://data.worldbank.org/indicator/NV.SRV.TOTL.CD , acessed in 24.04.2020

- Technological Development, TD, patent applications allow the owner of an invention to have full and exclusive rights over it.[16]

- Anti-Corruption, $A - C$, government effectiveness is the perception that population have regarding the independence of their governmental officials in implementing policies [17]. The more close from 2.5, the country possess a higher level of government effectiveness. The more close to -2.5, the lower the level effectiveness of the government of the countries

6.2 Descriptive Statistics

In this subsection, it is presented the summary statistics for the dependent variables and for the independent variables, that may be the key to affect the dependent variables - see Table 4.

	Mean	Median	Standard Deviation
Comparative advantage, RCA	1.0778	1.0400	0.2764
Wage inequality, WI	9.2700	3.9692	11.4608
Economic growth, EG	1.9109	1.4606	1.8698
Labor, $Labor$	2.8912	1.7099	3.0950
Institutional quality, IQ	1.4057	1.5233	0.6091
Offshoring, Off	15.4465	10.1860	12.1131
Technologic Development, TD	29.1733	11.5040	35.3116
Anti-Corruption, $A - C$	1.1505	1.2594	0.4988

Table 4: Descriptive statistics of the key variables

Our study has about 252 observations for each variable. On average, *ceteris paribus*, the revealed comparative advantage (RCA) for the fourteen different combinations of countries reaches a value close to 1.0778, with a standard deviation of 0.2764. This show us that, on average, with everything constant, the high-income countries (the North) have a higher strength in producing good n and in exporting it over low-income countries (the South).

The wages in the United States, Germany and Japan are, on average, *ceteris paribus*, 9.2700 times higher than in countries such as China, Mexico, India, Republic of Korea, Italy, Czech

[16] Data available at https://data.worldbank.org/indicator/IP.PAT.NRES, acessed in 24.04.2020

[17] Data retrieved from https://govdata360.worldbank.org/indicators/h1c9d2797?country=BRA&indicator=388&viz=line_chart&years=2000,2017, acessed on 26.06.2020

Republic, Brazil, Hungary, Indonesia, Thailand and Malaysia. The standard deviation for the income disparity reaches about 11.4608 times. *Ceteris paribus*, the mean economic growth rate of our observations was of 1.9109 percent with a standard deviation of 1.8698 percent.

The mean of labor force available for our sample is approximately 3, *ceteris paribus*. The standard deviation regarding the labor force available is also around 3. The measure used for estimate the institutional quality between countries was the Rule of Law presented by each country. For our sample, the mean was of 1.4057, what represents that, on average, the high-income countries present a higher perception of safety regarding the level protection of property rights and respect for the laws, that in low-income countries. This variable has as standard deviation approximately 0.6091.

Ceteris paribus, on average, our combination of countries tend to offshore 15.4465 percent of their production between them with a standard deviation of 12.1131 and on average tend to create 29.1733 technological patents between them, with a standard deviation of 35.3116 patents.

Lastly, as an anti-corruption measure, our study analyzed the government effectiveness in the two types of countries. The mean of government effectiveness felt by our sample was of 1.1505 and a standard deviation of 0.4988. This result shows that, on average, the high-income countries have a higher confidence and trust in their government's independence when implementing policies than low-income countries.

6.3 Comparative advantage regression

Motivated by (9) and (17), our first regression pretends to analyze the impact of variables on the comparative advantage of the combination of countries. In line with the theoretical model, our econometric specification considers the impact of labor endowments, institutional quality, offshoring, technological-knowledge gap and anti-corruption measure on the comparative advantage.

$$RCA = \beta_0 + \beta_1 Labor + \beta_2 IQ + \beta_3 Off + \beta_4 TD + \beta_5 A - C + u \tag{21}$$

where u is the random error. For 231 observations, the independent variables as labor, institutional quality and the measure of anti-corruption will have a significant impact on the

dependent variable, the comparative advantage – see Table 5, column 1. The anti-corruption measure is significant at a 5 percent level and the remain variables are significant at 1 percent level. Taking into consideration the R^2,this regression explains the variation on the Revealed Comparative Advantage (RCA) in about 30%, and the F-test, with a p-value of 0.0000, proves that the model is global significant; i.e., we reject the null hypothesis that all coefficients are equal to zero. Also, the Wald test presents a p-value of 0.0000, what shows us that the model has some predictability and rejects the null hypothesis that all coefficients are equal to zero. The labor level presents a coefficient of -0.0505, which means that when there is an increase in labor levels, the RCA decreases 0.0505. With a p-value of 0, an increase of in the rule of law, leads to a decrease in the Comparative Advantage of 0.2355 of the South countries, what is in line with our theoretical model. With a statistic significance at 5%, the coefficient of the government effectiveness is of -0.1621. Hence, an increase of one in the independence of a country's government, *ceteris paribus*, will decrease the RCA in 0.1621. This results can be explained given the fact that in our sample, the United States, Germany and Japan have higher values of Rule of Law and Government Effectiveness than the South countries, what is in line with the work of Levchenko (2007) that concludes that the more developed countries gain more from trade than the less developed countries when there is a improvement in the institutional quality.

We also tested the equation in a logarithm model to compare the econometric model in a more efficient and accurate manner with the theoretical model.

$$\ln RCA = \beta_0 + \beta_1 \ln Labor + \beta_2 \ln IQ + \beta_3 \ln Off + B_4 \ln TD + \beta_5 \ln A - C + u \quad (22)$$

In this model, for a sample of 231 observations, variables as labor, institutional quality, offshoring and technological development are significant to explain shifts in the revealed comparative advantage of countries - see Table 5, column 4. At a significance of 5 percent, an increase of 1% in labor, will increase the comparative advantage of countries in 4.53% and an increase of 1% on offshoring, will lead to an increase of 5.95% in the comparative advantage of South countries. The same effect is observable in our theoretical model. The institutional quality and the technological variables are significant at a 10 percent level. An increase of 1%

in the confidence of population in the protection of the property rights, contract laws and justice will reduce the comparative advantage of South countries in 22.27%. On the other hand, the comparative advantage will increase 4.53%,due to an increase of 1% in the number of patents. The F-test and the Wald test with a p-value of 0.0000 and with a R^2in about 22.61%,the model is global significant, rejecting the null hypothesis that all coefficients are equal to zero. Based on the Jarque-Bera test, the null hypothesis that residuals are normally distributed is accepted.

6.4 Wage inequality regression

With our second econometric regression, we will analyze the impact of labor, institutional quality, re-allocation of productions, technological-knowledge development and of an anti-corruption measure on inter-country wage inequality, as is indicated by theoretical equation (12). The aim is to understand the impact of these variables will have on the wages discrepancies between the countries.

$$WI = \gamma_0 + \gamma_1 Labor + \gamma_2 IQ + \gamma_3 Off + \gamma_4 TD + \gamma_5 A - C + v \tag{23}$$

where v is the random error. Results are presented in Table 5, column 2. When the labor force increases in one the wages gap between our H-country and our L-country will decrease on average 2.0970. An increase of 1 percent of offshoring will decrease the income differences in 0.2112. The same effect was observed in our theoretical model. The variables of labor, offshoring and technological development significantly explain the shifts in the wages disparity at 1% level. The technological development presents an coefficient of 0.1299. Based on the R^2,this regression explains the impact on wages differences in about 52%, and the F-statistics shows that the model presents a global significance, rejecting the null-hypothesis that all the coefficients are equal to zero.

Testing the second econometric regression in a logarithm model, with a p-value of 0, all variables (Labor, Institutional Quality, Offshoring, Technological Development and Anti-Corruption) are significant to explain changes in the wages gap.

$$\ln WI = \gamma_0 + \gamma_1 \ln Labor + \gamma_2 \ln IQ + \gamma_3 \ln Off + \gamma_4 \ln TD + \gamma_5 \ln A - C + v \quad (24)$$

Results for 200 observations are presented in Table 5, column 5. It is observable, that an increase of 1% on the number of labor force will decrease the wage disparity on average in 68.14%. In line with the results obtained in the theoretical model, an increase of the institutional quality in 1 will lead to an increase on average of 63.28% in the wage differences between the two representative areas. On the other hand, an increase of 1% in the re-allocation of production will decrease on average the income gap in 50.42%. This econometric result is in accordance with our theoretical model. As mention before, to measure the anti-corruption level, we collect data for our sample regarding the government effectiveness. An increase of 1% in the effectiveness of government will decrease the wages differences in 55.99%. Lastly, an increase of 1% in the number of patents will lead to an increase of the wage differences in average of 31.15%.

Based on the R^2,this regression explains the impact on wages disparity in about 87%, and the F-statistics and the Wald test, with a p-value of 0.0000, shows that the model presents a global significance, rejecting the null-hypothesis that all the coefficients are equal to zero. In this model, the residuals are normally distributed, given the Jarque-Bera test.

6.5 Economic Growth Regression

Finally, we intend to analyze the impact of labor, institutional quality, re-allocation of production, technological-knowledge progress and an anti-corruption measure have on economic growth in line with the theoretical equation (20). In particular, it will be possible to understand how an increase on labor together with an improvement on the institutional quality and together with an improvement in the level of offshoring will have on the economic growth of countries.

$$EG = \eta_0 + \eta_1 Labor + \eta_2 IQ + \eta_3 Off + \eta_4 TD + \eta_5 A - C + \eta_6 Labor \times IQ + \eta_7 Labor \times Off + z \quad (25)$$

where z is the random error. Results are shown in Table 5, column 3. Accordingly to the R^2, this regression explains about 52% of the economic growth of the countries. From the F-statistic and the Wald test, the null hypothesis that all the coefficients are equal to zero is rejected and thus the regression possesses a high global significance. The coefficient of labor on the economic growth is of 0.6837, which means that an increase of the labor force will positively impact the economic growth. Also, the coefficients of the institutional quality and of offshoring are respectively, 2.8355 and 0.0379, which can be stated that when the level of perception regarding the rule of law increases in one the economic growth increase in approximately 3% and when the offshoring increases in 1% the economic growth increases in approximately 0.04%. This is in accordance with the the work of Bakkar and Ögcem (2019) for islamic and non-islamic countries that concludes that the rule of law together with democracy increases the economic performance of all countries. This is also in line with Agostino et al. (2020), that concludes that for European countries, an improvement in the institutional quality leads to an increase in firm's productivity and ultimately, improves the economic performance of countries. Also, Schwörer (2013) concludes that an increase on offshoring creates a improvement in productivity and lastly an expansion in the economic development of countries. An increase of the government effectiveness in one, will negatively and significantly impact the economic growth in 0.8550%. In this model, the variable of Labor, Institutional Quality, Offshoring are significant at 1% level and the variable of Anti-Corruption is significant at 5% level. When the term Labor interacts with the Rule of Law, the coefficient is -0.6657, significantly at 1% level. Which means that the impact of labor is a negative function of the institutional quality on the economic growth. Also, the interaction between Labor and Offshoring presents a negative and significant coefficient (-0.0121). This result implies that the impact of labor is a negative function of offshoring in the economic development.

Lastly, we test the above regression by the logarithm model.

$$\ln EG = \eta_0 + \eta_1 \ln Labor + \eta_2 \ln IQ + \eta_3 \ln Off + \eta_4 \ln TD + \eta_5 \ln A-C + \eta_6 \ln (Labor \times IQ) + \eta_7 \ln(Labor \times Off) + z \quad (26)$$

Results are shown in Table 5, column 6. Given the R^2, this model explains on average 47% of the economic development of the countries and the F-statistic and the Wald test with

a p-value of 0.0000 rejects the null hypothesis that all the coefficients are equal to zero and proves that this regression presents global significance.

In this regression, the coefficients of institutional quality and offshoring are, respectively, 0.0217 and 0.0184. This means that when the rule of law increases 1%, the country's economic performance will increase, on average, 2% and when the offshoring level increases 1%,the growth in the economy will be on average of 1.8%. However, in this regression, these two variables are significant when interacting with the labor variable. When the term Labor interacts with the Institutional Quality, the coefficient is -0.2451, significantly at 10% level. This result implies that the impact of labor is a negative function of the institutional quality on the economic growth. Also, the interaction between Labor and Offshoring presents a coefficient of -0.0873 and significant at 10 percent level (-0.0121), this means that, the impact of labor is a negative function of offshoring in the economic development.

	Regression number, dependent variable					
Explanatory variables:	1, RCA	2, WI	3, EG	4, ln RCA	5, ln WI	6, ln EG
Labor	-0.0505***	-2.0970***	0.6837***	-0.0453**	-0.6814***	-0.1125
	(0.0000)	(0.0000)	(0.0000)	(0.0119)	(0.0000)	(0.3997)
Institutional Quality	-0.2355***	0.0795	2.8355***	-0.2227***	0.6328***	0.0217
	(0.0000)	(0.9657)	(0.0000)	(0.0000)	(0.0000)	(0.9147)
Offshoring	-0.0025	-0.2112***	0.0379***	0.0595**	-0.5042***	0.0184
	(0.1011)	(0.0000)	(0.0005)	(0.0129)	(0.0000)	(0.8301)
Technological Development	-0.0001	0.1299***	-0.0028	0.0453***	0.3115***	0.0646
	(0.8322)	(0.0000)	(0.3785)	(0.0005)	(0.0000)	(0.1718)
Anti-Corruption	-0.1621**	3.2428	-0.8550**	-0.0307	-0.5599***	-0.0010
	(0.0114)	(0.1976)	(0.0190)	(0.4063)	(0.0000)	(0.9939)
Labor x Institution Quality			-0.6657***			-0.2451*
			(0.0000)			(0.0540)
Labor x Offshoring			-0.0121***			-0.0873*
			(0.0003)			(0.0583)
Number of observations (NO)	231	200	231	231	200	213
R^2	0.3000	0.5217	0.5152	0.2261	0.8669	0.4668
$\overline{R}^2$	0.2845	0.5093	0.5000	0.2089	0.8634	0.4486
F-statistic (p-value)	19.2871 (0.000)	42.3158 (0.000)	33.8512 (0.000)	13.1497 (0.0000)	252.7716 (0.0000)	25.6427 (0.0000)
Breusch-Godfrey test (p-value)	350.7719 (0.0000)	450.9850 (0.0000)	455.2966 (0.0000)	360.0339 (0.0000)	331.8781 (0.0000)	276.1127 (0.0000)
Jarque-Bera test (p-value)	41.3729 (0.0000)	215.6809 (0.0000)	15.1570 (0.0005)	4.8151 (0.0900)	4.4255 (0.1094)	1934.347 (0.0000)
Wald F-statistic (p-value)	19.2871 (0.0000)	42.3158 (0.0000)	33.8512 (0.0000)	13.1497 (0.0000)	252.7716 (0.0000)	25.6427 (0.0000)

Table 5: Estimation of equations (21), (23), and (25), taking into account the period 2000-2017. Notes: p-values for the tests of significance appear in brackets; the symbols ***, **, and * mean that the estimated coefficients are significant, respectively, at the level 1%, 5% and 10%.

7 Conclusion

The main goal of this research is to analyze how a variation in the corruption levels, through institutional quality and offshoring, will affect the comparative advantages, the inter-country wage inequality and the economic growth between industrialized and less industrialized countries.

First, we defined main concepts as corruption, institutional quality and offshoring. As mention before, there is corruption when individuals abuse of their power in order to obtain personal benefits (Li et al. 2000, Blanc et al. 2019). A higher or smaller level of corruption may affect how a institution is perceived (Sumanjeet 2015) and affect the attractiveness of a country for re-location of production (Brada et al. 2012). In this sense, we also analyzed, through the previous literature, how corruption affects the level of institutional quality and of offshoring and, from the literature, we conclude that:

1. a lower level of corruption results in strong institutions (e.g., Mahmood 2019, Sumanjeet 2015);

2. the level of corruption is negatively related with the level of offshoring; i.e., a lower level of corruption is related with a higher level of offshoring (e.g., Egger and Winner 2006, Karpaty and Tingvall 2015).

Our analyses is based on these two assumptions.

Secondly, from the literature review we analyze how the institutional quality of countries and the offshoring level affects the comparative advantage, the inter-country wage gap and the economic growth. Regarding the comparative advantage and institutional quality there is a significant lack of literature on the topic, since most studies focus more on aspects as, geographical and cultural distance. However, this is not enough to explain the new tendencies of trade (Krugman et al. 2012), being fundamental to study the role of institutions on it (Rodet 2017, Belloc 2006). There is also a significant lack of literature for the comparative advantage and offshoring, which makes relevant to study this relationship. Regarding the inter-country wage inequality and the institutional quality the studies are almost non-existent, while for the relationship of offshoring and the inter-country wage inequality the previous literature presents different results. For the impact of the institutional quality on the economic growth, the literature is quite abundant. However, the outcomes of the studies significantly

vary. Regarding the impact of offshoring, due to corruption, on the economic performance of countries, we were only able to find a small amount of research and also these research present contradictory results.

In third place, we constructed a theoretical model taking into consideration two types of countries, the North and the South, that are different in terms of development and estimate econometric specifications using panel data to test for the effectiveness of the institutional quality and offshoring on the comparative advantage, wage inequality and economic performance of countries. In our theoretical model, an increase of offshoring in the South leads to an improvement of their comparative advantage and a decrease in the percentage of goods produced by the North and the opposite results from an improvement of the institutional quality in the North countries. The South countries that gain more advantage in the international trade with an increase on offshoring, were China in comparison with the United States and with Japan and India in comparison with the United States. The countries that had the smaller increase in their comparative advantage were Hungary and Czech Republic when comparing with Germany. It is also observable that an increase of offshoring leads to a decrease of the wages differences between countries. On the other hand, an increase of the institutional quality will have the reverse effect. The income disparity decreased in higher amount between China and Germany, China and Japan and China and the United States. The decrease in the wage gap was smaller between Hungary and Germany and between Czech Republic and Germany. Regarding the economic growth of the countries, our theoretical model shows that an increase of offshoring will lead to an increase of the South economic performance. The combination of countries, Japan *vs* Malaysia, United States *vs* Mexico and Germany *vs* Brazil suffer the higher increase in their economic development.

Lastly, we conclude that the same effects are observable in our econometric model. An increase of 1% of the offshoring leads to an increase on the comparative advantage; i.e., the capability in producing goods decreases in the North and increases in the South and the opposite occurs with an increase of 1% in the quality of institutions. The same effects of an increase of offshoring due to a decrease of corruption results from the theoretical and econometric model for the inter-country wage inequality between the North and the South. In both, an increase of offshoring leads to a decrease of the wages differences between countries and the opposite results from an increase of the quality of institutions. Regarding

the economic growth of the countries our econometric model show us that an improvement of the offshoring level from the North to the South and an improvement in the institutional level in 1% increases South and North economic performance.

This dissertation has as main lacuna's the small combination of countries. With a larger sample, we could confirm if the results presented here are representative for a larger combination of Northern and Southern countries.

What we want the reader to take away from this research for future policy is that indirectly corruption and directly the quality of institutions and attractiveness for offshoring may affect the attractiveness of a country and their performance. By creating polices with the intention of decrease corruption and consequently improve the trust that society have on institutions, North countries, specially, can become more competitive in trade internationally, can achieve higher wages and can perform at a higher economic level. On the other hand, South countries, in particular, can gain advantages in taking part on international trade, can increase their wages and can be more attractive economically, by investing in polices that focus on the reduction of corruption and make the country more attractive to offshoring.

For further research purposes, would be interesting to analyze the impact of several and different sectors separately on the comparative advantage of different countries having as base the quality of institutions and the re-allocation of production and study the impact of institutional quality and offshoring in wages differentiating the impact of skilled and unskilled labor.

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Appendix A

Parameter	Value	Description
h	1.80	Theoretical assumption, such that $h > l \geq 1$ and that $h \in [1.1, 2]$, in accordance with Acemoglu and Zilibotti (2001) and Afonso (2006)
l	1.00	Theoretical assumption, such that $h > l \geq 1$ and that $h \in [1.1, 2]$, in accordance with Acemoglu and Zilibotti (2001) and Afonso (2006)
α	0.60	Theoretical assumption, such that $\frac{1}{\alpha} \in [1.25, 2.5]$, in accordance with Kwan and Lai (2003)
q	2.5	Assuming the particular case, $q = \frac{1}{1-\alpha}$, with $\alpha = 0.60, q = 2.5$, which is set in line with the average estimates made in Kwan and Lai (2003)
β_H	1.60	Theoretical assumption, such that $\beta > 0$, in accordance with Connolly (2003) and $\beta_H > \beta_L$ - see equations (6) and (7)
β_L	1.20	Theoretical assumption, such that $\beta > 0$, in accordance with Connolly (2003) and $\beta_H > \beta_L$ - see equations (6) and (7)
ς_H	5.00	Theoretical assumption, such that $\varsigma_H > 0$, in accordance with Kortum (1997)
ς_L	4.00	Theoretical assumption, such that $\varsigma_L > 0$, in accordance with Kortum (1997)
σ_H	1.20	Theoretical assumption, such that $\sigma_H > 1$ - see equation (6)
σ_L	1.00	Theoretical assumption, such that $\sigma_L = 1$ - see equation (7)
θ	1.05	Theoretical assumption, such that $\theta \in [1, 2]$,in accordance with Attanasio and Weber(1993)
ρ	0.015	Theoretical assumption, such that $\rho > 0$, in accordance with Dinopoulos and Segerstrom (1999) and Afonso (2006)
δ	0.50	Theoretical assumption, such that $\delta > 0$, in accordance with Dinopoulos and Segerstrom (1999)

Table 6: Baseline Parameter Values