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“The complex nexus between global innovation and international trade - is there more than just a correlation?”

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I want to dedicate this page to giving my thanks to the teaching personnel of the course International Economics, including Professor Cecilia Susanna Jona-Lasinio and Teaching Assistant Amin Zokaei Ashtiani, for helping me acquire the foundation knowledge that underlies this thesis.

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Abstract

It is generally believed that innovation is the key driver of growth - partly thanks to Joseph Schumpeter. As international trade is known to be crucial to firms’ profitability and probably survival, it is natural to expect that trade provides incentives for innovation. On the other hand, international trade theories have long highlighted the role of technology and innovation in explaining countries' international competitiveness. This thesis aims at exploring the two-way effect between global innovation and technology and international trade. To achieve the aforementioned goal, this paper is divided into four main parts. The first part is the overview of the context in which the relationship between innovation and trade is of interest. The second part is dedicated to presenting the effect of technology on international trade encompassing international trade models, addressing the most traditional to the most recent ones. Within the third and final part, we will talk about the effect of international trade on innovation, which is currently under debate and has less far consensus than the other way around. We will do that by first discussing the four mechanisms through which trade can affect innovation and we will end the thesis with Chapter 4 by considering the case of China's mercantilist trade policy and how it imposed a negative impact on global innovation.

Introduction

In the modern world we are living in, where globalization is growing in relevance and technological development is constant and disruptive, international trade and innovation are becoming more intertwined. It is undeniable that every day, trade is made easier by new innovations that drastically reduce the costs of doing business abroad (i.e. communication costs, and logistics). However, the interrelation and interaction between trade and innovation are far more complex such that not only does technology facilitate trade but also trade is strongly believed to drive innovations. This thesis will unwrap the complex nexus of the relationship between trade and innovation.

The thesis will start by giving the context through which the question of causality between trade and innovation arises in Chapter 1. The chapter will give an overview and the linkages of the two variables.

Bearing in mind that the effect of technology and innovation on international trade has been of interest since David Ricardo's trade model. The following models also encompass the role of technology and innovation in trade, such as the Heckscher-Ohlin model, the Technology Gap, and the Product Cycle Model. Those models will be the "stars" of Chapter 2. The chapter would also be dedicated to exploring the role of innovation in the modern context as well as the role it would play in the future of international trade.

Chapter 3 will shine a light on the effects international trade has on innovations. Although this is less supported by trade models, such an interaction is the consensus of economists and researchers. We will deep dive into the channels through which trade might have an effect on innovation and each proposed channel will be followed by reviews of relevant literature that provided empirical support.

In the final chapter, we will consider the paradox of China's participation in the global market as it seems at first that it goes against our predictions. Apparently, along with

China’s increasing competition globally comes the “drag” on the innovation of the developed countries.

Chapter 1: International Trade and Innovation: the undeniable correlation

1.1. Trade and Innovation - an overview

The idea that there is an indispensable link between cross-country differences in technology and trade patterns has been dated back to Ricardo (1817). Ricardo highlighted the principle of comparative advantage and that the differences in relative productivity, which is the determinant of the pattern of trade, stemmed from the discrepancies in skills or technology. Nowadays, technological capabilities are emphasized more than ever as the driving force behind comparative advantages.

Fast forward to the present day, the “New Trade Theory” developed in 1980 has shed light on other aspects of technology such as economies of scale and product differentiation, the key role in explaining intra-industry trade (Helpman and Krugman, 1985; Krugman, 1995; Krugman, 2009).

Furthermore, technological innovation is playing an increasingly important role as an infrastructure of trade. Particularly, studies have shown that Information and Communications Technology (ICT) has strongly facilitated international trade by significantly reducing costs associated with trade, offshoring, and other multinational corporate activities like research and development costs, transaction costs, coordination and monitoring costs (ICT report, Part 2; Baldwin, 2010; Ariu and Mion, 2010; Abramovsky and Griffith, 2006; Feenstra, 1998).

Even though nowadays there is a consensus that the integrated world economy plays a central role in dictating the pace and direction of technological changes, formal trade theories have been focusing explicitly on the effects of technological differences without diving into the causes.

This thesis will not only address the correlation between innovation and trade, but it will also illustrate the possible directions of causality between those two variables, together with empirical evidence supporting the propositions.

1.2. Trade and Innovation - the linkages

The link between international trade and innovation has long remained an interesting subject. In this chapter, we will focus on reviewing the empirical evidence that makes the association between global innovation and trade liberalisation undeniable. Although the evidence does not necessarily suggest causality, we will go on to explore mechanisms through which trade liberalisation affects global innovation.

At the aggregate level, there have been several studies that showed the effect of trade openness on technological progress and innovation. Recently, more interest has been put in both theoretical and empirical literature on international trade and many have revived the study of the link between trade and innovation. Using US data, a large body of evidence has been developed for a number of developed and emerging economies, leading to the broad consensus that exporting firms are larger, more innovative, and more productive compared to non-exporters (Bernard and Jensen, 1995).

Figure 1 below depicts the growth of global pattern applications - an innovation proxy - and world exports - an international trade proxy - from the period of 1985 to 2017. It is clear that both variables have been moving up steadily together. Over the examined period, there is a noticeable correlation between the two variables. Even without indicating causality, it is challenging to assert that international trade hardly has any effect on innovation.

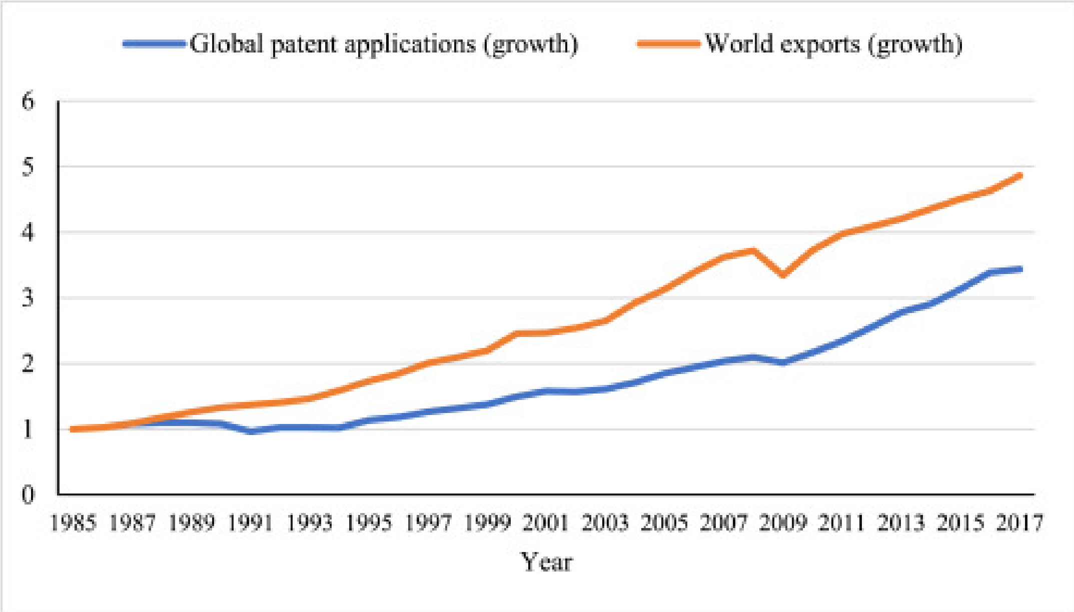

Figure 1: Global patent applications and world exports: 1985-2017 (Source: Difei Geng, Raja Kali)

Additionally, in light of the investigation of the relationship between international trade and innovation, an empirical study was conducted to examine the effect of tariff cuts during the 1990s on global innovation data among firms across 65 countries (F. Coelli, A.Moxnes, K.H. Ulltveit-Moe, 2022). Trade liberalisation is represented by tariff cuts and innovation is measured by patent data. Partly as a result of the GATT Uruguay Round in 1994, there were significant tariff cuts over the period of 1995-2000. Overall, the tariff cuts were about 6% to 3% in developed economies while the number was 20% to 13% in developing countries. This period is also referred to by leading researchers as the Great Liberalisation (Estevadeordal & Taylor, 2013). The result concluded that the Great Liberalisation indeed had a positive net impact on global innovation, showing that 1 percentage point of tariff cut in export markets led to an increase of 2% to 3% in firms' knowledge stock. The findings suggested that trade liberalisation played a non-trivial role in driving global innovation in the 1990s.

Furthermore, we look at the link between innovation and trade with a study using evidence from Italian manufacturing firms (A. Accetturo, M. Bugamelli, A.R. Lamorgese, and A.Linarello, 2014). The study aimed at testing the hypothesis that firms exposed to higher foreign demand have more incentives to innovate. Innovation is measured by the number of patterns submitted to the European Patent Office. The findings are coherent with the proposed hypothesis: the increase in exports has a positive effect on the probability of individual firms applying to the European Patent Office by showing that firms passing from the 25th percentile to the 75th percentile of the export distribution increases the probability of filing for a patent by 15%.

Chapter 2: The effect of innovation on trade

For a very long time, it is the “rule of the game” that only the biggest, most efficient players enter the international market. It is also the case that multinational companies outsource or offshore their production to developing economies to take advantage of the low cost of labor while remaining in-house for the production of goods or services that require a high-skilled workforce and an abundance of capital. All of those have been well-studied by classical and neoclassical international trade models and theories.

In today’s era of increasing globalization, the part that technology and innovation play in fostering, facilitating, or even determining international trade cannot be sufficiently described, thanks to the rapid rate at which innovation is happening and its profound potential to transform International Trade.

However, the interest taken in studying the role of technology in defining trade patterns has been around for a very long time. Since the publication of Principles of Political Economy by David Ricardo, economists have been featuring the prominence of technological differences across countries as a tool to explain the international trade pattern (Grossman, 1995). Since Ricardo, a number of models have emerged, linking the effects of technology on trade, using different underlying assumptions such as Heckscher-Ohlin, Technology (Imitation) Gap, or Product Cycle Model.

In this chapter, we will investigate the effect that technology and innovation have on international trade. This chapter will be divided into three sections. Section 1 will be dedicated to the review of different trade models, from the most classical to the most recent, in order to highlight the development of the (theoretical) role of technology and innovation in trade. Section 2 will present empirical evidence supporting those above-mentioned models. Finally, Section 3 will talk about how technology and innovation are shaping modern-day’s trade affairs by discussing the scenario in which future innovations further boost international trade and the one in which innovations may reduce trade.

2.1. The role of technology featured in different trade models following a progressing timeline

The Ricardian Model

To understand the idea behind the Ricardian model of international trade, one must first be familiar with the idea of comparative advantage. To achieve this, we must think in terms of opportunity costs. Opportunity cost is the cost of producing one good measured by the cost of not being able to produce something else with the resources used. In a simplified two-country model, the country with the comparative advantage in producing one good is the country with a lower opportunity cost in producing that good. The Ricardian model basically suggests that countries can benefit from trade if they each specialize in producing goods in which they possess a comparative advantage and then trade with one another.

To illustrate, let's consider an example featuring 2 countries - Brazil and Costa Rica - and 2 goods - coffee and sugar. The labour required to produce each unit of the good in each country is as follows:

	Brazil	Costa Rica
Coffee	100	120
Sugar	75	150

We observe that Brazil has lower higher labour productivity in the production of both goods (lower labour requirements in both sectors). This indicates that Brazil possesses an absolute advantage in producing Sugar and Coffee. The opportunity cost of producing Sugar in terms of the forgone production of Coffee in Brazil is 75/100 = 0.75 while this number is 150/120 = 1.25 in Costa Rica, meaning that in order to produce 1 unit of Sugar, Brazil forgoes 0.75 unit of Coffee and Costa Rica forgoes 1.25 unit of Coffee. Similarly, the opportunity cost of producing Coffee in terms of the forgone production of Sugar in Brazil is 100/75 = 1.33 while in Costa

Rica this number is 120/150 = 0.8, indicating that during the production of 1 unit of Coffee, Brazil forgoes 1.33 unit of Sugar and Costa Rica gives up only 0.8 unit of Sugar.

This means that Brazil has a lower opportunity cost in the production of Sugar and Costa Rica has a lower opportunity cost in the production of Coffee. The Ricardian model suggests that Brazil focuses all of its labour resources on producing Sugar, Costa Rica specializes in producing Coffee and then exporting. Consequently, Brazil can consume 100 units of Coffee using 75 units of labor instead of 100 units of labor if produced domestically and Costa Rica can consume 100 units of Sugar using 120 units of labor instead of 150 units of labor if produced domestically.

Not only does the Ricardian model suggest that by specializing in the production of the good in which the country has a comparative advantage, the total final production, and consumption of both goods increase, it only suggests that there is an advantage in the relative price of both goods after opening to trade. Applying to our current example, the relative price of Sugar is

$$\frac{aBS}{aBC} < \frac{PS}{PC} < \frac{aCS}{aCC}$$

where:

$\frac{PS}{PC}$: the relative price of Sugar after trade

$\frac{aBS}{cBC}$: the opportunity cost of producing Sugar in Brazil

$\frac{aCS}{aCC}$: the opportunity cost of producing Sugar in Costa Rica

Equivalently, the relative price of Sugar is:

$$0.75 < \frac{PS}{PC} < 1.25$$

Similarly, the relative price of Coffee is:

$$0.8 < \frac{PC}{PS} < 1.33$$

For Brazil, which has a comparative advantage in producing Sugar, the people in the country can enjoy the lowered price of Coffee. The increase in the price of Sugar also means that the domestic workers earn higher income from Sugar production.

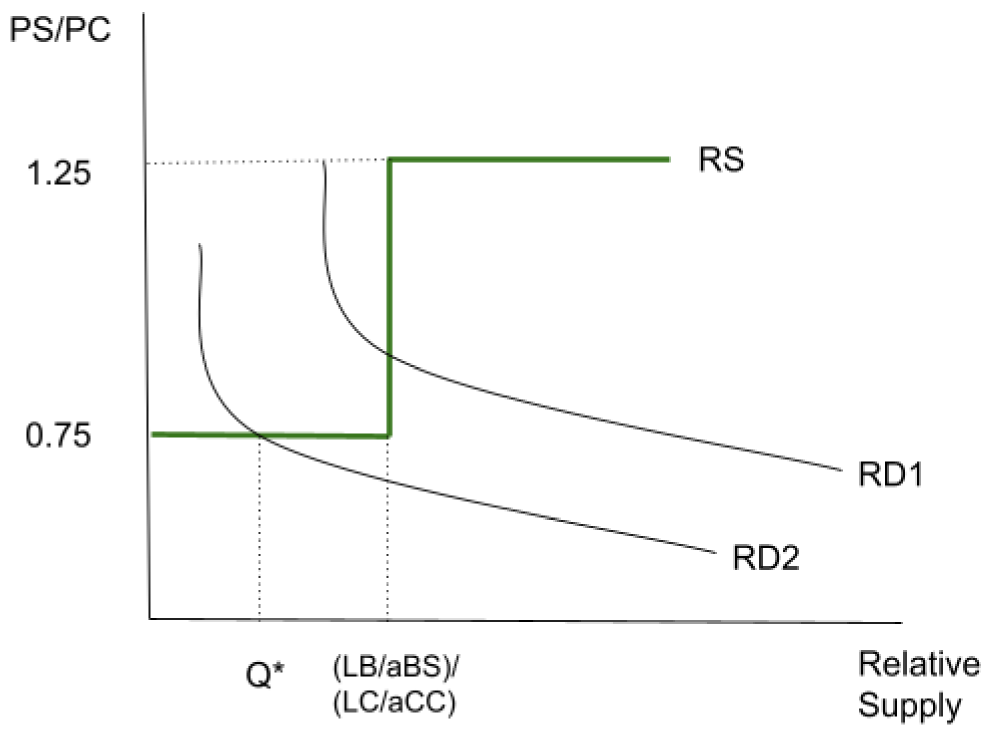

Figure 2a: World Relative Supply and Demand (1)

For Costa Rica - which has a comparative advantage in the production of coffee, the people in the country can afford Sugar more cheaply after opening to trade and domestic workers earn a higher income from Coffee production.

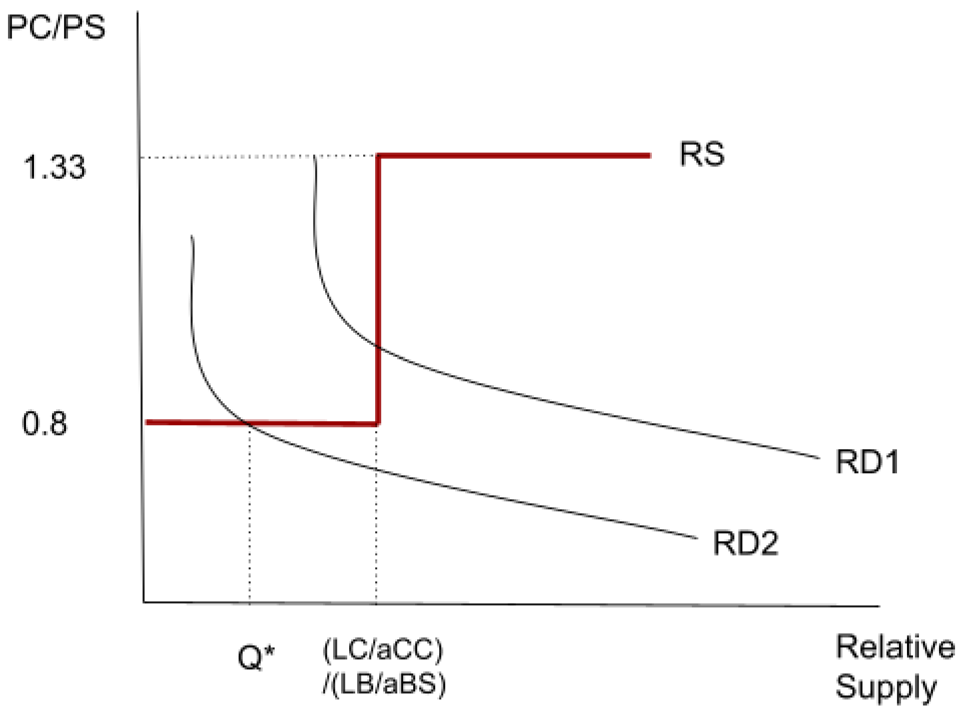

Figure 2b: World Relative Supply and Demand (2)

To summarise, the Ricardian Model focuses on technological discrepancies as the source of international trade. In our example, the reason why Brazil and Costa Rica trade with each other is because their technologies for producing Coffee and Sugar are different. Brazil has an absolute advantage in producing both goods but has a comparative advantage only in producing Sugar. Based on this comparative advantage, the price without trade for Sugar is lower in Brazil than in Costa Rica. When the countries are open to trade, the Sugar producers from Brazil export to Costa Rica, where they can charge a higher price, and Coffee producers from Costa Rica can enjoy higher prices when exporting to Brazil. From there, the pattern of trade is determined.

The model also explains how a country's level of technological progression affects the labor's wages, such that countries that possess better technology also have higher wages compared to those that are less technologically advanced. The

Ricardian model is simplified to only one single factor of production—labor. Following lessons from microeconomics, wages are presented as the marginal product of labor times the prices of each good. Because of the dependence on the marginal product of labor, it is natural to conclude that a country with better technology will pay higher wages.

Heckscher-Ohlin Model

“in a sense, the Heckscher-and-Ohlin model represents a step backward from the earlier Ricardian tradition” (Jones, 1970)

The Ricardian model, emphasized that international differences in technology together with the discrepancies among real wage levels are sources of comparative advantage, dominated trade theory until the introduction of Heckscher-Ohlin Model, which highlighted that differences in resource endowments are the drivers behind international trade patterns.

Heckscher-Ohlin's theory argues that trade happens thanks to the differences in resources across countries. Those resources include labor, labor skills, capital, and other factors of production. The theory assumes that countries are endowed with a relative abundance of different factors of production and production processes use factors of production with different relative intensity.

To simplify, we propose the following assumptions:
2 countries (Home and Foreign)
2 goods (Computers and Shoes)
2 factors of production (Capital and Labour)
Foreign has an abundance of labor, Home has an abundance of Capital
Shoe production is labor- and Computer production is capital intensive
Factors of production can move across sectors in the long run but they do not move across countries

Figure 3a below illustrates the No-Trade Equilibrium in Home country and Figure 3b illustrates the No-Trade Equilibrium in Foreign Country

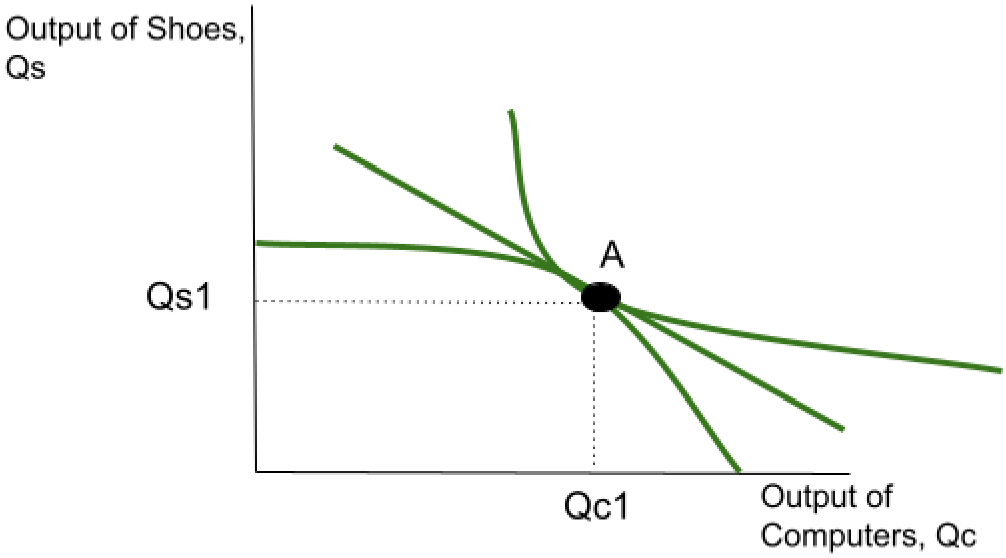

Figure 3a

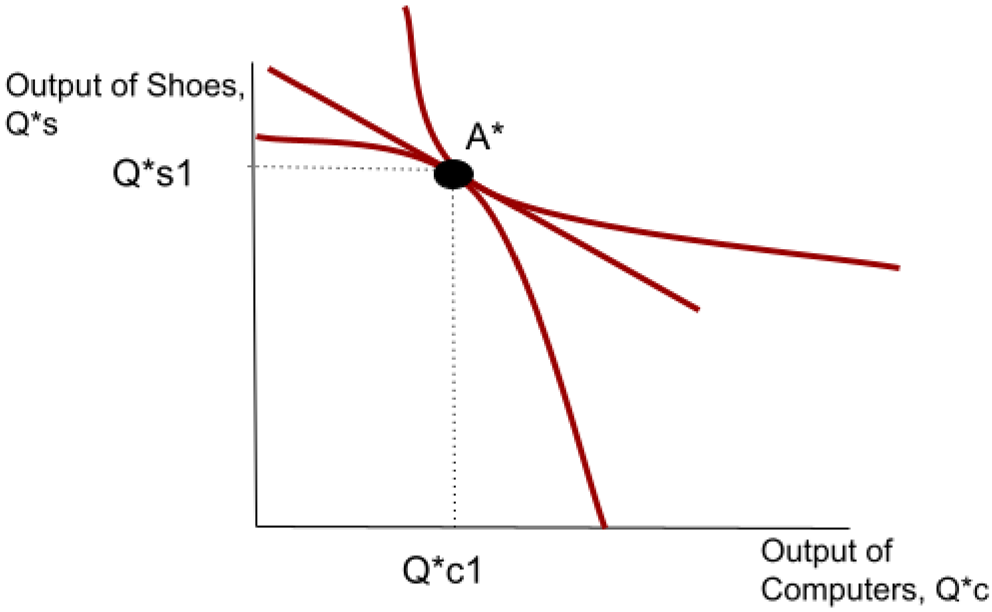

Figure 3b

We observe that as Home is more relatively abundant in the capital, its Production Possibility Frontier is skewed towards the production of computers, which is a capital-intensive sector. The flatter slope compared to the one in the Foreign country

indicates that the relative price of computers is low in the Home country. Similarly, we observe a Production Possibility Frontier that is more skewed towards the production of shoes in a Foreign country, where labor is relatively abundant. The steeper slope implies that the relative price of computers in the Foreign country is high.
Two countries are also assumed to have identical technology. Under this assumption, the Heckscher-Ohlin theorem indicates that each country has the comparative advantage in producing the good that uses relatively intensively the factor of production with which the country is more endowed. In our example, this means that Home will have a comparative advantage in producing computers and Foreign will have a comparative advantage in producing shoes. Another assumption is that both countries have the same taste, which effectively means that when faced with the same relative price, both countries will consume computers and shoes in the same ratio.

Figure 4 below shows the equalization of price after both countries are open to trade:

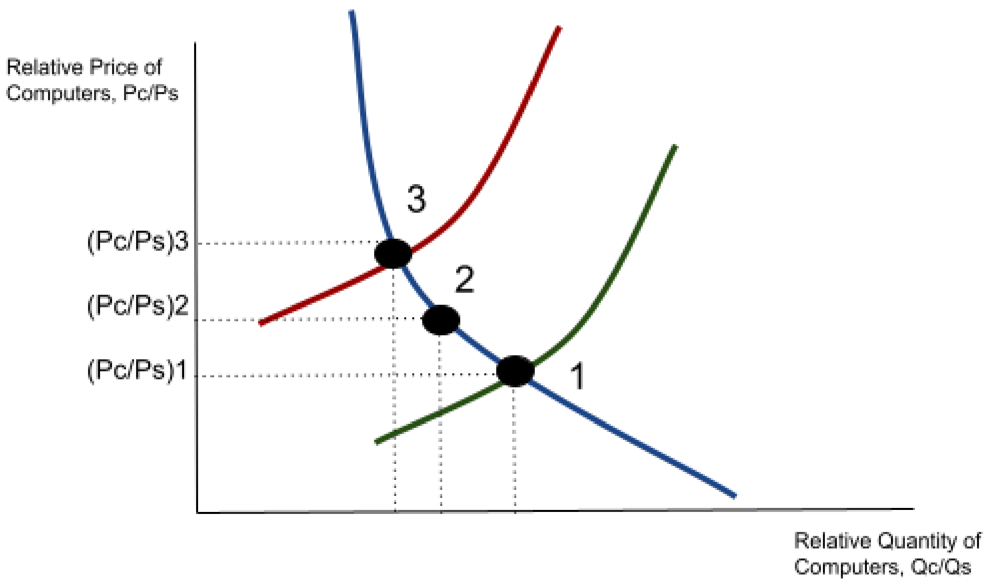

Figure 4

Point 1 is the relative price of computers in the Home country before opening to trade. Point 3 is the relative price of computers in Foreign country before opening to trade. Trade leads to a world relative price which lies between the prices in the two countries before opening to trade.

To sum up, unlike the work of David Ricardo, the Heckscher-Ohlin model predicts the trade pattern under the assumption that all countries possess identical technologies. Following the Heckscher-Ohlin model, we can infer that since the abundant resource in most developing countries is labor and in most developed countries is the capital, the two groups making trades provide the developing economies an opportunity to learn about the more advanced technologies and catch up more rapidly.

Technology gaps

In the general Ricardian model as well as Heckscher-Ohlin theory, the relative technological capabilities of each country are absolutely arbitrary as they were assumed to be fixed and given. These models, therefore, are only useful in a static system. In reality, which is more dynamic, those assumptions can no longer hold true. Technological changes have a large significant effect on production and trade. In this model as well as in the Product Cycle Model that we will discuss later, it is important to keep in mind that technological innovation can either be a new method of producing existing goods or producing new varieties of goods.

The Technology Gap model was developed in 1961 by M.V. Posner. One emphasis of this model is the assumption that technological change is a continuous process. According to Posner, such a continuous process of innovations and inventions gives rise to trade even if countries possess identical factor proportions and tastes.

Before delving into this model, we first look at an overview. According to the model, when a firm develops a new product, it will release it in its home market. If success is observed after a period of time, it will then proceed with an effort to enter the product into foreign markets. As a ‘reward’ for its innovation, the firm will see itself in a temporary monopoly position as it enters the world market. This monopoly status is protected by patents and copyrights. The exporting country will then go on to enjoy a comparative advantage over others until foreign producers are able to imitate the new product or process of production.

A few assumptions surrounding this model to keep in mind are presented below:

1) There are 2 countries, Country A and Country B
2) Factor endowments in both countries are identical
3) The demand condition between the 2 countries is similar
4) The factor price ratios in both country before trade are identical
5) Both countries possess different techniques of production

The technology gap, also called imitation gap, refers to the lag between the introduction of new innovations (such as a new product) and the appearance of their substitutes by foreign manufacturers. Posner had broken this gap down into three distinct components - the foreigner reaction lag, the domestic reaction lag, and the demand lag.

The foreigner reaction lag is the time the first foreign producer needs before they produce a new variety of products. The domestic reaction lag indicates the time taken by domestic producers to produce a newer variety of products in order to sustain their shares in the domestic market as well as in the foreign market. Finally, the demand lag is the time that domestic consumers take to acquire the taste for the new product.

“Dynamism” is a term coined by Posner to refer to the incorporation of innovation and technology gap. He also indicated that a dynamic country in international trade is one that innovates at a greater rate and imitates foreign innovations at a greater speed. In the case of trade between Country A and Country B and Country A has a greater degree of dynamism, it follows that Country B will find the erosion of its market and trade deficit.

If both countries are identical, whether or not technological innovation will generate trade between them depends on the net effect of imitation and demand lags. If the demand lag is longer than the imitation lag, which means that foreign producers can already produce “imitated” products before domestic consumers start to demand such products, no trade will be generated between the two countries. On the other hand, if the imitation lag is longer than the demand lag, technological innovation will likely result in trade. The pattern of trade then will depend on the relative duration of the two lags.

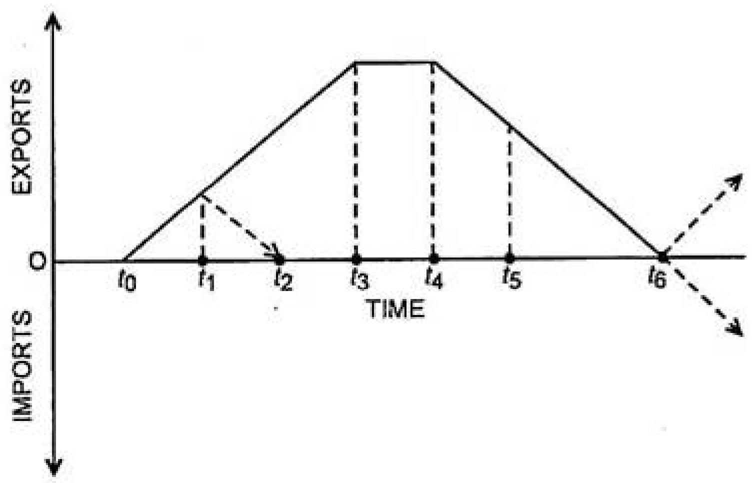

Figure 5 (Source: Wikipedia)

The figure above shows the relative trade balance of the innovating country - Country A - throughout different time horizons. At point t0, Country A introduces the new product. At this point, no trade has occurred. At t1, consumers in Country B start to be aware and demand the new product. Country A, therefore, starts exporting it. If producers in Country B are still not able to imitate the production of such products, the trade balance of Country A continues to go up until the maximum level is reached at t3.

The time horizon between t0 and t3 is in fact the demand lag. If at t1 the producers from country B could adopt the technology, the export from Country A could be eroded as illustrated at t2. If the imitation lag is longer than the demand lag, Country A's export is still going to be at the maximum level until t4.

As country B will start to adopt the technology to imitate the new product, exports from Country A will drop to zero in t6. At this point, two different scenarios can be considered. If Country A does not introduce new innovations while Country B goes on to innovate further, Country B's products will start to be demanded by consumers in Country A, and subsequently, Country A imports from Country B. Otherwise, if Country A introduces new innovation then its exports to Country B will increase.

Product Cycle Model

Following the Technology Gap theory, the Product Cycle Model was developed (Vernon and Hirsch). The theory explains how a product is first introduced and exported by the innovating country but the same country ends up importing the same product or the same differentiated variety of that product.

The model applies to labor-saving and capital-intensive products. The model also helps demonstrate the concept of dynamic comparative advantage in the sense that the comparative advantage of producing the new product shifts from economically advanced (innovating) country to developing economies.

Product Cycle Model was developed under a few assumptions:

1) Producers initially introduce new products are those in capital-abundant countries
2) The innovating firms have some monopolistic advantages
3) The innovation of a new product is stimulated by the domestic market's needs and opportunities
4) The innovating firms have little knowledge about the conditions in foreign markets
5) The environment in the advanced country that initially introduce the new product is different than the environment in other advanced countries

This theory categorises the product into three distinct stages based on the stage it is at in the product life cycle as well as the way they behave in the international market: new product, maturing product and standardised product. The trade balance of different economies (innovating country, other developed countries and developing countries) over the time horizon is illustrated below.

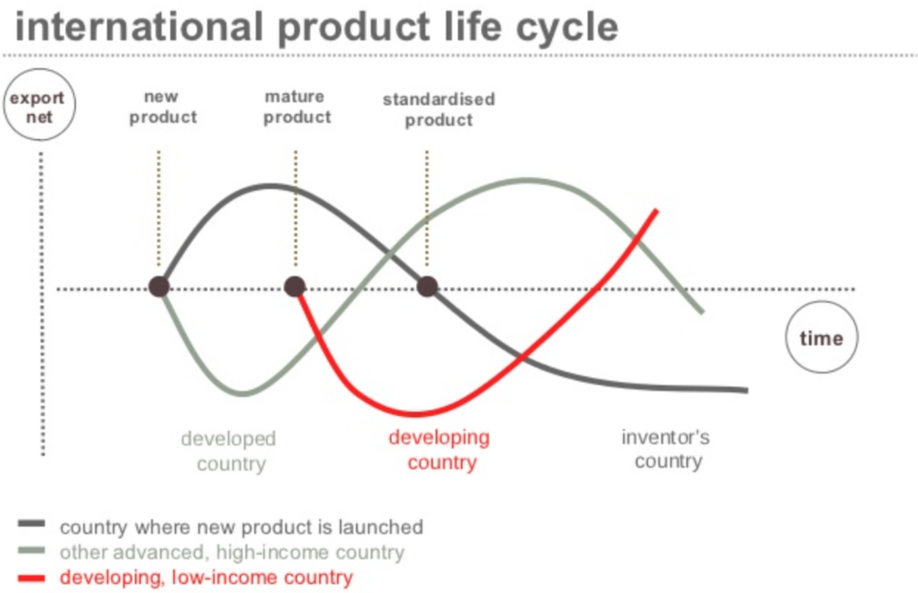

Figure 6 (Source: Wikipedia)

According to this theory, the new product goes through four stages:

Stage 1
The capital-intensive and labor-saving new product is introduced first in the innovating country (i.e. USA). After the product is accepted and consumed by domestic consumers, they are exported to other advanced economies with similar taste and level of income. The innovating firm enjoys the advantages of a monopoly for a period of time.

Stage 2
At this stage, foreign producers in other advanced economies start to produce the product or close substitutes. Consequently, exports from innovating country start to decline but they still play a large role in the supply of the product in the world market.

Stage 3
Foreign manufacturers from other advanced countries start to gain advantages over the innovating country from economies of scale and as the product now is well-known and sales growth starts to slow down, the innovating country also starts to shift production to other advanced economies. The innovating country's exports decrease as imports increase.

Stage 4
As the market demand is satisfied, the sales revenues from the product are no longer profitable to justify the continued production of it in high-income countries. Investment is also minimized. Production is shifted to developing countries and those countries will export the product to the world market.

2.2. Empirical evidence

A lot of attempts throughout the centuries have been made in order to prove the validity of international trade models and their implications for real-life situations. As far as models go, they are simplifications of trade affairs, and most often than not, they require certain given assumptions that are quite difficult to ascertain in a practical world. This is also one of the main reasons why trade models are found inapplicable or inconsistent with data. Nevertheless, it is undeniable that under certain circumstances, trade models give economists and researchers a good overview or prediction of the situation.

The underlying assumptions are different across both classical and more modern trade models. However, most of them are based on the founding idea of comparative advantage as developed in the Ricardian model. Generally, real data often supports the trade pattern predicted by the Ricardian trade model. For instance, compared to China, Bangladesh is less productive in all industries, including apparel. However, since the productivity in the apparel industry of Bangladesh is 77% of that of China (compared to Bangladesh's productivity of 28.5% of China's productivity on average), Bangladesh has a comparative advantage in apparel production and therefore it exports apparel (McKinsey&Company).

	Bangladesh - Output per worker as % of China	Bangladesh - Exports as % of China
All industries	28.5	1.0
Apparel	77	15.5

On the other hand, empirical support for the Heckscher-Ohlin model has been rather weak. The model is proved to be unsuccessful in predicting the pattern of trade. However, it is still very useful for the analysis of international trade on income distribution. Arising from this model is the so-called "Leontief Paradox". Based on US's trade data, it was found that even though the US was a capital-abundant country, its exports were less capital-intensive than its imports. One way that could explain the paradox is by drawing attention to technology-related variables (ie. labour skill and human capital).

Empirical studies surrounding the Technology Gap or Product Cycle Model have been emphasizing the discrepancies in innovativeness within each sector across countries as the source of international trade patterns. Most of the sectoral studies, for example in chemicals, plastics, process plants, semiconductors, and electronics products - call attention to the dynamic relationship between early innovation, economies of scale, learning by doing, oligopolistic advantages, and international competitiveness. In an intercountry and intersectoral study, Hufbauer (1970) found a widespread existence of country advantages or disadvantages related to technological innovation and domestic conditions. Walker (1979), though his sectoral study on product-cycle patterns of production and exports, found evidence that some product groups did conform to the “flow” from advanced to “low-wage” countries. Other product groups seemed to be in confirmation with the Technology Gap theory, in which the advantage remained in the most innovative country for a period of time.

2.3. Technology, Innovation, and Trade in the modern context - how is it reshaping the future of trade?

Having discussed international trade models developed throughout economic history, it is clear that although there are many factors that affect trade flows - a lot of which are unpredictable in the real world - technology is one crucial driver in this equation.

The path of technological innovation is reflected in the history of trade. For example, the invention of steamships and railroads during the Second Industrial Revolution alternated the tradings across borders. Similarly, the digital revolution enabled companies to interact with far-flung customers and suppliers. The emergence of the Internet has further facilitated the global value chain by significantly improving coordination and eliminating communication costs.

Today, however, the direction towards which the next generation of innovations is pushing international trade is more complex. Some innovations will further facilitate trade by means such as, but are not limited to, improving logistics and reducing transaction costs. On the contrary, some innovations may change the economics and location of production, and the content of trade and thus lead to a reduction in trade traffic. In the following subsections, we will examine possible effects and estimate the magnitude of potential changes.

An overview of how technology is reshaping trade flows in value chains can be summarised in the table below (Source: McKinsey&Company)

Reduce Transaction Costs	Internet of Things E-commerce Blockchain Automated document processing	Up to +$4.7T increase in goods trade by 2030 as transaction costs are reduced
Change Production Processes	Artificial Intelligence Automation 3D Printing	Up to -$4T reduction in goods trade by 2030 as production moves closer to consumers
New goods	Electric vehicles Renewables Digital goods	Up to -$310B less goods trade by 2030 through changes in composition and tradability of goods

2.3.1. Technology and innovation further boost international trade

Among the problems faced during international trade, transaction costs and logistics are the most common ones. For instance, domestic consumers who want to buy products abroad often face high transaction costs and uncertainty due to customs, taxes, foreign payments, the inability to “see” the products, etc. The logistics situation is also less than ideal. Frequently, the customers would like to know where their shipments are currently at and would like to be immediately aware if there is a delay, especially in B2B segments. Currently, the tracking of shipments is usually not up to expectations. High transportation costs and a shortage of drivers are also incidentally detrimental to international trade. Fortunately, some of the current and future technological developments will help reduce or eliminate these issues.

Digital platforms, which are anything from Facebook, Amazon, Quora to Uber, connect directly buyers to sellers and thus reduce the costs of searching and coordinating immediately (McAfee and Brynjolfsson 2017). Social media platforms like Facebook, Instagram, and Whatsapp have made cross-border communication very simple. E-commerce platforms like Amazon or eBay have completely transformed the way shopping is done. Other platforms like knowledge platforms, services, and media sharing platforms also have helped communication borderless. The revenue of global cross-border B2C e-commerce sales reached $793.7 million in 2021 and it is estimated to grow at a Compound Annual Growth Rate of 25.1% (Vantage Market Research). It is also estimated that e-commerce sales could achieve $1.3 trillion to $2.1 trillion in incremental trade by 2030, increasing the trade in manufactured goods by 6-10% (Lund and Bughin, 2019). This will also help small businesses by helping them get an easy reach of customers across the globe.

Technologies to improve logistics are also on the rise. The increased applications using the Internet of things can help customers obtain the “visibility” of the shipment, meaning that they can have access to the real-time whereabouts of the shipments at any time. The developments of Artificial Intelligence can help route trucks according to current road conditions, making transportation less risky. To offset the issues due to the shortage of drivers, some companies are currently developing self-driving truck fleets. Additionally, there are a number of ports around the world that have introduced automated cranes and guided vehicles that are capable of unloading, staking, and reloading containers at a faster rate and with minimal errors. Blockchain technology has the potential to further improve tracking shipments and automated payments and document processing.

Overall, the technologies mentioned above, along with some others, are significantly reducing trade costs and the reduction will even be larger as those technologies continue to improve. Studies have shown that with a 1% reduction in trade costs, trade flows increase by 0.4% (Djankov et al. 2010, Hausman et al. 2013).

2.3.2. Technology and innovation may reduce goods trade

There are two ways in which technology and innovation may reduce the volume and value of traded goods. There are technologies that are changing the way production processes are taking place, making the initial global value chain strategies of companies shift completely. In addition, the emergence and increasing presence of new products are making the trading of goods seem obsolete.

For a long time, companies in developed economies outsource or offshore some or all production activities to developing nations in order to take advantage of lower labor costs. However, the emergence of Artificial Intelligence and Automation has made labor costs a trivial variable in the equation compared to other factors such as workforce skills, infrastructure quality, proximity to consumers and markets, etc. Consequently, a trend of moving production closer to end consumers is observed. Today, only 18% of traded goods are from low-wage to high-wage countries, and this number is shrinking further in labor-intensive sectors such as apparel. Both Adidas and Nike have designed a new line of shoes that can go through full automation of the production process.

Furthermore, process automation will also reduce the trade in service. Currently, some companies who offshore or outsource their customer service are shifting it in-house using ‘virtual agents’. This trend, if more widely adopted, could lead to a decrease in the $160 billion global business process sourcing.

3D printing (additive printing) in theory has the potential to change the trade flow as it can be produced on-demand, near point-of-use which eliminates the need for international shipping, however, due to its current cost, speed and quality, it is not expected to make any significant changes to trade in the near future.

The increasing demand for new products, such as electric vehicles, renewables, and digital goods can make some unpredictable changes to trade flows. For instance, renewable energy is less tradable than its carbon-based counterpart, thus the higher demand for renewables as a substitution for carbon-based energy may lead to a reduction in international trade.

The use of electric vehicles might also play a role in the reduction of trade. Compared to internal combustion engines, electric vehicles' drivetrains only have about 15% of the moving parts. The higher adoption of electric vehicles therefore could lead to less trading while also reducing the demand for oil imports.

As digital goods play an increasingly important role, the composition of trade is inevitably affected. Millennials or Gen Z barely "remember" the existence of CDs or DVDs as streaming now plays a crucial part in the movies and music industries. Cloud computing allows the subscription model pay-as-you-go, making it no longer necessary for users to put upfront a heavy investment for their IT infrastructure.

Chapter 3: The global innovation effect of international trade - unraveling the mechanisms and empirical evidence

3.1. Introduction

As demonstrated in the previous chapter, the relationship technology has with international trade is well-defined throughout different trade models in the history of economic theories, starting with David Ricardo's trade model. However, researchers and economists have predominantly agreed upon the consensus that such a relationship is a two-way causality. Nevertheless, the claim that international trade affects global innovation is "less rock-solid" than its counterpart in the sense that it is less supported by trade models and theories, mainly traditional, static theories.

Nowadays, as we live in a world where technology has received almost unanimous recognition, innovation is the key to growth. There are various factors contributing to the constant change and development of innovations, and the expansion of international trade is one of them. Studies have been done to provide empirical evidence for this perspective and will be further elaborated.

This chapter will be divided into four parts, enlightening four mechanisms through which international trade may affect innovation. Specifically, we will examine how incentives and capabilities for innovation of domestic firms are influenced by trade liberalization (such as lowering trade barriers).

Section 1 will look into the increase in market size as the driver for innovation through international trade. Such an incentive is induced by increased export opportunities. Essentially, exporting gives domestic firms access to a bigger overall market, which has the potential for higher profitability and, thus, incentives for innovation.

Section 2 will investigate the second channel through which trade affects innovation - competition, which can either be negative or positive. According to an industrial organization's trade-off theory, increased competition can drop profits and reduce innovating incentives. However, the Schumpeterian approach can raise the incentives to innovate.

Finally, Section 3 will show that trade can affect innovation through the diffusion of technology and knowledge spillovers, which pave the way for ideas to spread and countries to catch up with technology. Knowledge spillovers can happen intentionally through investments in knowledge acquisition, serendipitously, or as a result of the product cycle.

<u>3.2. Trade affects Innovation through Market Expansion</u>

"As it is the power of exchanging that gives occasion to the division of labor, so the extent of this division must always be limited by the extent of that power, or, in other words, by the extent of the market." - Adam Smith, Wealth of Nations.

The idea that market size plays a crucial role in economic development can be traced back to at least Adam Smith. In examining the effect of market expansion on innovation, it is vital to keep in mind that an increase in market size, as addressed throughout this section, does not refer to a rise in aggregate demand but rather to the market for individual firms. Moreover, we consider the consumers as individual end-users and intermediaries that purchase the products. We also differentiate between product and process innovation.

3.2.1. Theory

Theoretically, an expansion of market size leads to higher profitability. Consequently, more R&D projects are funded or invested in as they usually incur high fixed costs that make them worthy only if the potential return on investments is high enough. In other words, exposure to a larger market encourages firms to innovate because they help justify the upfront costs. Such a mechanism can play out well in applying it to both product and process innovation. Product innovations become more desirable as a more extensive market makes the value of a new product line or an improved existing product higher. Additionally, it also offers firms higher returns for process innovation.

According to some static models of international trade formalized by Paul Krugman, market size plays a vital role in specialization and labor division. Under the New Trade Theory, international trade increases the number of varieties available to consumers. It also forces less efficient firms to exit, and the remaining firms can enjoy economies of scale.

While static trade models highlight that fixed costs are incurred during the production of new varieties, dynamic models - such as Romer (1990) - feature that the offers of varieties grow over time through R&D investments. These investments, once again, bear a fixed cost feature: after the new variety’s blueprint has been in place, it is to be used at no marginal cost, leaving only production costs. Consequently, a powerful scale effect is implied, such that larger economies enjoy higher rates of innovation.

The increased market size has effects on both product and process innovation but to a different extent. Flach & Irlacher (2018) developed a model that demonstrates this distinction. For instance, while improved export opportunities increase both product and process innovations, product innovation increases relatively more in sectors that have higher product differentiation and vice versa for process innovation. This pattern emerges from industry-level demand and cost linkages. The former refers to the cannibalization effect, in which a new variety destroys the demand for existing varieties, and this effect is relatively more fragile in more differentiated industries. The latter concerns how effectively a process innovation can be applied to produce different varieties. Such effectiveness is lower in sectors where products are more differentiated as they often require the use of different technologies. Accordingly, different firms across industries undertake different innovation strategies as a response to improved export opportunities.

The incentives to innovate may also be affected by the difference or similarity in income levels of the exporting and foreign countries, following the logic that wealthier consumers are willing to pay a premium in exchange for higher quality. Verhoogen (2008) demonstrated this mechanism in a model of trade between the North (high-income) and the South (low-income). Better opportunities to export to the North incentivize firms in the South to innovate to sell high-quality products in the North than in the domestic market.

Non-technological innovations are often expected when entering a new market. For instance, when a pharmaceutical company based in a developed country penetrates the market in developing economies, it usually has to adapt an innovative marketing strategy specifically addressed to locals. On the other hand, when a pharmaceutical company in a developing country enters a developed market, it usually faces higher regulatory standards. Therefore the company has to upgrade its practice.

3.2.2. Empirical evidence

Early studies showed a robust correlation between firm size and innovation using firm size as a proxy for market size faced by domestic firms. Schmookler (1966) argued that higher sales had a causal effect on innovation efforts as data showed that firms with higher sales do more R&D activities. Pakes & Schankerman (1984) documented that higher R&D intensity is associated with output growth. In industries where R&D is vital - specifically the pharmaceutical industry - there is a high correlation between expected future revenues and the introduction of new drugs (Morton, 1999; Reiffen & Ward, 2005; Acemoglu & Linn, 2004).

Recent studies show a positive correlation between export-induced market expansion and innovation. Bustos (2011) designed a study to investigate the innovation reaction of Argentinian firms following a reduction in import tariffs from 1992 to 1996. The study shows that more product and process innovations are carried out in industries where tariff cuts are more significant. Lileeva & Trefler (2010) carried out a similar study on Canadian firms after the enforcement of the US-Canada Free Trade Agreement. The result found that Canadian firms that, under the FTA, started exporting or exporting more also increased investments in product innovation and manufacturing technologies.

There is also empirical evidence supporting the proposition, as mentioned earlier, that market size affects different types of innovations to a different extent (Flach &

Irlacher, 2018). The study, using data from Brazillian firms, showed that increased foreign market access increased firms' profits, which incentivized them to invest more in product and process innovations. They also found that firms in differentiation sectors are more likely to carry out product innovation, whereas those in homogenous sectors are relatively more interested in process innovation.

Overall, empirical evidence from recent studies has exerted a positive role that market size has on innovation. Improve market access through better export opportunities encourage domestic firms' product and process innovations. The extent of the effect market size has on each type of innovation depends on the characteristic of the industries in which the firms are.

3.3. Trade affects Innovation through the Competition Effect

We have discussed the role of market expansion - which immediately ensues the opening of international trade - on firms' innovation efforts. Looking at another perspective, international trade also gives rise to intensified competition through imports, exports, FDI, technology licensing, etc.

This section will explore the effects of trade on innovation through competition. Depending on the circumstances and theoretical views, competition can either damage or facilitate innovation efforts. This section begins by discussing the negative consequences of innovation caused by competition. Then, it will deal with how competition can nurture innovation. Finally, the section ends by reviewing some empirical studies that support the propositions.

3.3.1 Theory

There are two sources of increased competition from international trade. For instance, export opportunities encourage the entry of domestic firms and thus strengthen competition. Import or FDI opportunities also boost competition by encouraging the entrance of foreign firms. The theory in this section will deal with competition as it is, regardless of what the source is.

In conventional Industrial Organization theories, there is a classic trade-off between static and dynamic efficiency under monopoly, indicating that greater competition depresses incentives to innovate as it reduces expected future profits. Competition also diminishes innovation by firm size restriction, as smaller firms have a disadvantage in organizing innovative activities and weak economies of scale from R&D (Schumpeter, Aghion & Howitt).

On the contrary, in the case of a monopolist, limited competition undermines the intention to innovate due to high pre-innovation rents (Arrow, 1962). This proposition, however, was pointed out by Gilbert (2006) as a better fit to process innovation as a monopolist can also benefit from product innovation in order to expand its product portfolio and exploit higher profits through price discrimination. Gilbert also proposed a hypothesis regarding the two conditions in order for competition to have a positive impact on product innovation: (i) competition for the old (existing) product is intense and (ii) innovation is drastic as it makes the old product obsolete.

Furthermore, industry structure has the potential to determine the effect competition has on innovation. This is explained using Schumpeterian models of step-by-step innovation (Anghion, Bloom, Blundell, Griffith & Howitt, 2005). The idea is that “technological laggards”, in order to fight for future technological leadership, must first catch up with the leading-edge technology. Differentiation is made between two industry types: neck-to-neck and leader-and-laggard. Neck-to-neck industries are characterized by tight competition between incumbents. Leader-and-laggard industries in which there is a significant technological gap between firms. When firms are neck-to-neck, they have the incentive to innovate in order to escape competition. In contrast, a leader-and-laggard situation creates a “discouragement” effect.

Dhingra (2013) contributed to another theory that competition effects on innovation can be shaped by demand characteristics. Taking into consideration the case of an open economy and firms developing their own brands and each brand consisting of a number of product varieties, product innovation effectively expands the product lines. The theory states that if consumers’ preferences for brand size. If there is little preference, competition escalates cannibalization within the brand and, thus, forces the firm to maintain fewer product lines and reduce product innovation. If the preferences are significant, the benefits of expanding the brand's size outweigh the negative consequences of cannibalization and thus encourage product innovation.

Another source of increased innovation through competition is the reallocation of resources. Holmes et al. (2001) showed that heightened pressure from competition pushed incumbents to switch from unproductive activities, such as blocking new technologies' entry, to R&D. Aghion et al. (1999) developed a model of agency concerns. The separation of ownership and control often creates the principal-agent dilemma. Managers may take actions that favor their personal benefits rather than those that maximize profits. In such cases, the increased competition encourages managers to invest more in R&D activities. Bloom et al. (2019) argued that competition reduces the returns on certain “trapped” factors and thus reducing the opportunity cost of using them as inputs for innovative activities.

The extent to which competition affects innovation varies across firms with different productivity levels. It also affects product and process innovation differently. Boone (2000) developed an oligopoly model with heterogeneous firms and consequently showed that as competition rises, product innovation rises for firms with high productivity but declines for those with low productivity. Interestingly, process innovation falls within the most and least productive firms but increases within the intermediate ones. He also showed that in the industry as a whole, competition only increases with product or process innovation, not both. Another study also shows the difference in innovation activities when faced with increased import competition between high-productivity and low-productivity exporting firms. High-productivity exporters reduce product innovations when confronting tough competition from foreign firms. In contrast, low-productivity firms increase product innovation when facing a similar circumstance (Dhingra, 2013). This is because the least productive exporters exit the market. Nevertheless, process innovations are reduced by all domestic exporters.

3.3.2. Empirical evidence

Overall, studies and research on the causal relationship between competition and innovation have been inconclusive. More recent studies can be useful to gain some insights into the relationship between the two variables. For example, Hashmi (2013) and Goettler & Gordon (2011) analyzed US data in public firms and the computer microprocessor industry, respectively. The result showed that there is a negative correlation between competition and innovation activities of domestic firms. However, the relationship between those two yielded a different result when analyzing UK data. Studies found an inverted U-shaped relationship (Aghion, Bloom, Blundell, Griffith & Howitt, 2005). In Europe, studies have shown a positive reaction of firms' innovation to increased competition from import penetration. Using data from firms listed on the London International Stock Exchange, Blundell et al. (1999) showed that increased import competition positively correlated to the increased number of patents granted - a proxy for innovation. Bloom et al. (2016) conducted a study using data from twelve European countries and Chinese imports. The study shows that firms that are more exposed to Chinese imports have a higher number of patents granted. It can be understood that the effect that competition has on innovation differs across countries.

Similar to the situation in developed countries, studies found inconsistent results concerning the effect of competition on innovation across developing economies. Teshima (2009) conducted a study using data on Mexican plants between 2002 and 2004. The study shows that increased import competition pushes Mexican plants to increase their spending on R&D activities. Gorodnichenko et al. (2010) show that firms in twenty-seven transition economies have a tendency to carry out more R&D if they face foreign competition. Studies on Peruvian and Chilean firms show that they tend to upgrade quality when there is bigger import competition. There are also studies that do not imply a positive correlation. For instance, there is no evidence that rising imports from China have an impact on technology adoption by Vietnamese firms over the period between 2011 and 2015 (Dang, 2017). Moreover, Lim et al. (2018) show a decrease in R&D and patenting by Chinese firms pursuant to stronger import competition.

On the contrary, studies in North America show that stronger competition weakly damages domestic innovation. Kueng et al. (2017) show decreased product and process innovations by Canadian firms following increased import competition from China. Autor et al. (2019) find that increased Chinese imports lead US firms to reduce spending on R&D and diminish the number of patents. Along with those consequences, permanence indicators of US firms, including revenues, stock, etc., dropped. Another study by Xu and Gong (2017) found no significant impact of import competition on R&D investments by US firms.

The mixed empirical findings above raise a question as to why competition affects innovation inconsistently across countries. Several theories as proposed earlier can be used to explain the inconsistency. First, it could be attributed to the difference in industry structures across countries. For example, the industries in the US can be characterized as leader-and-laggard while those in Europe and several developing economies are neck-to-neck. Additionally, firms in developing economies are more likely to have less managerial efficiency and more issues with trapped factors as market frictions are higher.

In summary, although the relationship between competition and innovation is not confirmed due to inconsistent study results, a pattern does emerge. It suggests that the relationship between the two variables differs across regions, possibly due to distinctive industry structures, such that competition shows a weak negative correlation with innovation in the US and a largely positive correlation with innovation in Europe and some developing economies.

3.4. Trade affects Innovation through the Diffusion of technology and knowledge spillovers

Improved access to foreign technology and knowledge contributes does not only contribute to domestic growth but also to innovation (Grossman and Helpman, 1991). Studies have shown that 25% of income per capita differences can be accounted for by the variation of technology adoption and another 40% by the extent of technology adoption (Comin, Hobijn, and Mestieri, 2010).

There are a number of channels through which the diffusion of technology and spillovers of knowledge can occur: imports of intermediate and capital goods, foreign direct investment, and trade in technology. The diffusion can result between competitors, within a supply chain or an enterprise, from government or university research groups.

3.4.1. Theory

First, technology diffusion affects innovation through the imports of intermediate or capital goods. As pointed out by Grossman and Helpman (1995), the trade of tangible goods can result in the exchange of intangible ideas. Contacts between trading partners can lead to innovative ideas, Moreover, the imports of intermediates that are not produced or available locally can give the importing firms new insights while using such goods. Imports of capital goods can also involve technology diffusion. For instance, in the case of the entrance into the semiconductor industry by South Korean firms, vendors were willing to teach new users how to properly use the manufacturing equipment since they require advanced knowledge.

The second channel for the diffusion of technology is through foreign direct investment and this can happen in a number of ways. For example, a domestic firm, through inward FDI, can observe and learn from its foreign affiliate(s). Vertical backward spillovers can also happen if a multinational affiliate provides technology to the suppliers. Labor turnover can also serve as a source of diffusion from FDI. Additionally, acquisitions also help bring technology to the acquiring firm and help upgrade its technology.

Nowadays, a vital channel for technology diffusion is through trade in technology, especially through licensing of intellectual properties. Trade in technology helps improve both the quality and the efficiency of innovations. In particular, it increases the pool of ideas and stimulates the division of labor and specialization in innovation. Trade in technology can also take the form of a collaborative agreement.

3.4.2. Empirical evidence

Goldberg et al. (2010) used data from Indian manufacturing firms in the period between 1989 and 2003, during which import tariffs on intermediate inputs were substantially lowered. The study found that the reduction in tariffs accounts for 31% of the new products that were introduced by domestic firms. Achrya and Keller (2009) conducted a study, using data from 17 OECD countries from 1973 to 2002, and found that most technology transfers from the USA to the UK happened through imports. However, imports do not account for the technology transfer from Germany and Japan.

Studies on the impact of foreign direct investment have been conducted mainly in the manufacturing sectors. Keller and Yeaple (2009) find that horizontal spillovers (within the same industry) from foreign multinationals to domestic firms in the US between 1987-1996 can account for a significant part of the productivity growth. They also find that such spillovers are most substantial in high-tech industries.

Although there have not been a sizeable number of studies on the effect of trade in technology, some existing studies show a positive correlation between technology licensing and innovation. Gonçalves et al. (2007), using data in Argentina and Brazil in the late 90s, find that both product and process innovation are driven more by the acquisition of foreign technology (through outsourcing and licensing) than by in-house R&D.

Chapter 4: The Trade and Innovation Paradox - China's Innovation Drag

So far, the proposition that innovation plays a role in shaping the pattern of international trade has been made clear by several trade models as presented in Section 2. Section 3 tackled a less "solid" perspective - trade affects innovation - by extensively providing different mechanisms through which the effect of trade on innovation may take place along with empirical evidence supporting them.

Such a proposition that international trade plays a role in global innovation has been widely accepted and has conformed with numerous studies and data. However, things did get a little bit trickier ever since the "China Shock" - the big rise of Chinese exports after the country joined WTO in 2001. The early studies find information that confirms trade theories and models. However, as China recently turned its focus to more advanced industries, studies have found that overall, there is a reduction in R&D spending and investments in developed nations, especially in North America and Europe, associated with the increase in Chinese trade. This is absolutely against what Section 3 sets out to explain.

This chapter will give an overview of the situation. It will show the effects that Chinese trade has on product and process innovation distinctively. Throughout the details, it will be made clear that the paradox arises not because of China participating in global trade, but rather because of Chinese mercantilist trade policies and thus shows that this paradox does not contradict our proposition.

<u>4.1. Innovation Drag - Process Innovation</u>

When considering process innovation, it is worth talking about the "Webb" effect. It theorizes that the higher the price of labor, the higher the return from investing in labor-saving technology. For example, when companies shift their production to a low-wage country, they would be less likely to invest in automation because the labor is cheaper. The minimum wage is a good indicator of the penetration rate of robots in production across countries. For instance, Germany, which has a high minimum wage, has a higher automation rate than India.

A study on the effect of the bilateral trade agreement between the US and China shows that as US firms gained better access to Chinese cheap labor, they reduced their investments in capital goods. A similar result is found among Canadian firms. The negative associations can be explained by attributing to the low labor costs in China that prevail over the costs of maintaining machines in production. Some companies even redesigned their products so that more manual assembly can be done. Those redesigns may harm innovation and long-term consumer welfare.

At a quick glance, it could appear that the effects were a natural consequence of globalization and over time, the overall net impact would be positive. However, it was not the case. China and its mercantilist policies have consistently manipulated the value of its own currency, keeping the dollar-denominated cost of labor low than market forces would lead to. In other words, without its innovation mercantilism, Chinese labor would cost more than it has been. As a matter of fact, a study estimated that the Chinese currency was undervalued by 23% in 2003. Additionally, there were a lot of Chinese subsidiaries to incentivize Western firms to locate production in China, which leads to further market distortions.

Another example of the distortion effects that China's policies had on the market would be the Chinese government subsidiaries of the shipbuilding industry. Such subsidiaries led to a reduction in costs of production by 13-20%, which inevitably resulted in a misallocation of production across countries. For example, it was estimated that without the subsidiary, China's market shares would be cut by half while the market shares of Japan would increase by 70%.

In a nutshell, it was China's mercantilist policies that hurt more productive foreign firms - like in the case of the shipbuilding industry with Japan - or resulted in the transfer of production from developed countries which ended up being less automated. Such policies left an overall negative impact only on production processes and productivity but also on capital investment and innovation.

4.2. Innovation Drag - Product Innovation

A study was done to investigate the impact of Chinese competition on US patents during the 2010s (Autor, Dorn, Hanson, Pisano, and Shu, 2017). They find a negative impact of increased Chinese competition on the firm level as well as technology class-level patent production. Within those affected firms, innovation, global sales, profit, and R&D spending also declined. They also found that increased Chinese import competition can account for roughly 40% of the decline in patenting in the period of 1999-2007 as compared to the period of 1991-1999. A number of other studies in the US also confirmed similar results.

On the other hand, studies on the impact of Chinese competition on innovation in the EU have yielded rather mixed results. A study by Bloom, Draca, and Van Reene - a frequently cited one - found that the Chinese trade with the EU from the period 2010 to 2017 can explain roughly 15% of the increase in Patenting, Information Technology, and productivity. They also found that in response to increased Chinese competition, firms that had a lower level of patents or total factor productivity exited the market at a faster rate than high-tech firms. Among the surviving firms, there is evidence that Chinese competition increases innovation within them.

Several explanations have been given as to why trade with China was found to have a negative impact on innovations within North American firms but a positive impact on the EU counterpart. One of the most prominent ones is that the authors of the study (Bloom et al.) did not look at all the countries within the EU, but only at the twelve most innovative ones. It is possible that less innovative countries whose competition with China is more dependent on costs were hurt more severely. One study on the effect of Chinese competition on Portuguese manufacturing firms found the effect to be negative (Branstetter, Kovak, Mauro, and Venancio). A later study by Campell and Mau found that once controlled for sectoral trends, lagged level of patents, or switched to Chinese import penetration rather than Chinese share of imports, the positive effect that Chinese competition has on EU patenting disappeared. The method used was more robust and the result is consistent with that of the US.

4.3. China's Mercantilist Trade Policies and How It Harms Global Innovation

First, it is important to keep in mind that the nature of innovation industries is that they usually incur high fixed costs. After the design and development, those innovations can be used at zero or very little marginal costs. Therefore, great sales potential is needed in order to justify investments in innovation. However, Chinese policies limit the market shares of foreign companies in the domestic market,
For instance, take a look at the Solar Energy Policies of China after 2008. The Chinese government put hundreds of millions of yuan into Chinese solar energy firms to help them gain more market shares globally. As a result, the price of Chinese crystalline solar PV declined by 85 percent during the period of 2009 to 2017. It was not the case, however, that Chinese firms were more innovative than foreign firms, as they invested a much lower percentage of revenues into R&D compared to American or European firms. Consequently, some innovative solar energy firms in the US went bankrupt because of this mercantilist trade policy.

4.4. Conclusions

In short, it is not the participation of China in the global economy itself that deteriorates global innovation. The opposite actually prevails in the absence of Chinese mercantilistic policies. Such policies benefit domestic firms but harm overall global innovation.

Concluding Remarks

As illustrated throughout the thesis, it is clear that the relationship between international trade and global innovation is more than a mere correlation. Technology helps determine trade patterns, as made clear by several trade models. As innovation is happening at an incredibly fast rate, it is not unexpected that current and future innovations will transform the trade that we know. As a result, the net effect of innovation on trade in the next decades is ambiguous.

On the other hand, the role of international trade in global innovation is growing in relevance but still requires a lot more research in order to consolidate the causality. So far, it has been determined that trade can affect innovation through at least three different channels: increased market size, competition, and technology diffusion and knowledge spillovers. Empirical evidence does support those propositions but some of them still generate mixed or inconsistent results.

When it comes to the “China shock”, it is worth talking about the negative innovation effects that increased Chinese competition has on other developed economies. It is clear that, however, such negative effects have less to do with China’s participation in global trade itself but more with its mercantilist trade policies.

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