UNIVERSITI PUTRA MALAYSIA

IMPACT OF INNOVATION AND HIGH-TECH TRADE ON NATIONAL COMPETITIVENESS AND EMPLOYMENT STRUCTURE

ZERA ZURYANA BINTI IDRIS

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By

ZERA ZURYANA BINTI IDRIS

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Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Doctor of Philosophy

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ZERA ZURYANA BINTI IDRIS

July 2021

Chairman : Professor Normaz Wana binti Ismail, PhD
Faculty : School of Business and Economics

According to the present trend, developing countries are progressively becoming the leading high-tech exporters. Growing high-tech exports from emerging countries has prompted concerns about their participation in the lowest fragment of the global value chain. Participating in the lowest segment may delay the catch-up process for developing countries and prolonging the income convergence between economies. As argued by the literature, innovation activities are not extensive at this stage. Hence, it may not be a requirement for high-tech export. Furthermore, statistics demonstrate a decrease in high-tech exports from developed countries, despite significant innovative investment. Hence, this leads to the questioning of the role of innovation in high-tech exports. Despite the anticipated gains of high-tech trade, the competitiveness of high-tech exporters remains low. Also, the reduction in employment is noticeable along with the increase in high-tech trade. Drawing upon this scenario, this research aims to study the role of innovation on high-tech trade and the implication of high-tech trade. This research is using a sample of 20 major high-tech exporting countries. The time span for this study is from 2007 to 2016. This research has three specific objectives.

The first objective of this research is to analyse the impact of innovation on the high-tech trade. Departing from the existing literature, this study also examines the impact of innovation on the extensive margin of high-tech trade. The empirical analysis is conducted based on the gravity model of trade. Empirically, an increase in domestic research and expenditure (R&D) expenditure by one percent will induce high-tech exports value to grow by 0.34 percent and numbers of exported products by about 0.08 percent, respectively.

The second objective of this study is to examine the impact of high-tech trade on national competitiveness. The empirical analysis was done using panel data estimation technique including the Bias-corrected Least Square Dummy Variable (LSDVC). An increase in high-tech trade by one percent increases national competitiveness by 0.09 index point.

The third objective of this research is to study the impact of high-tech trade on employment structure. The LSDVC estimation technique was employed to estimate this impact. A one percent increase in high-tech trade increases the share of employment for the high-skill worker by 0.05 percent and reduces the share of employment for the middle-skill worker by 0.03 percent.

The positive impact of R&D expenditure on high-tech export suggests that the domestic investment in innovative activities is crucial to support the development of the high-tech industry. Tax incentives and other policies to encourage innovation such as research collaboration are needed to enhance high-tech exports. High-tech trade also boosts national competitiveness. High competitiveness enhances economic growth, income levels, and people's standard of living. Hence, policy should be formulated in a way that can promote high-tech trade. However, the expansion of high-tech trade may harm certain segments of the labour market. It reduces the demand for the middle skilled worker. The shrinking of demand may suppress their wages and widen the inequality in the society. This will harm the process of achieving sustainable development. The policy to develop the high-tech industry must be accompanied by an appropriate labour policy such as an upskilling program. Even though high-tech trade may enhance the living standard of the people, the unintended effect of its expansion must be taken into consideration.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Doktor Falsafah

KESAN INOVASI DAN PERDAGANGAN BERTEKNOLOGI TINGGI TERHADAP DAYA SAING NEGARA DAN STRUKTUR PEKERJAAN

Oleh

ZERA ZURYANA BINTI IDRIS

Julai 2021

Pengerusi : Profesor Normaz Wana binti Ismail, PhD
Fakulti : Sekolah Perniagaan dan Ekonomi

Menurut tren sekarang, negara-negara membangun secara progresif menjadi pengeksport teknologi tinggi. Peningkatan eksport berteknologi tinggi dari negara-negara membangun telah menimbulkan kebimbangan mengenai penyertaan mereka pada bahagian terendah dalam rantaian nilai global. Penyertaan dalam segmen terendah akan memperlahankan proses *catch-up* negara-negara membangun dan memanjangkan penumpuan pendapatan antara ekonomi. Seperti yang dibahaskan oleh literatur, kegiatan inovasi tidak begitu luas pada tahap ini. Oleh itu, ia mungkin bukan syarat untuk eksport berteknologi tinggi. Tambahan pula, statistik menunjukkan penurunan eksport berteknologi tinggi dari negara maju, walaupun terdapat pelaburan inovatif yang signifikan. Hal ini membawa kepada persoalan mengenai peranan inovasi dalam eksport berteknologi tinggi. Di sebalik jangkaan kesan positif perdagangan teknologi tinggi, daya saing pengeksport berteknologi tinggi tetap rendah. Pengurangan pekerjaan juga dapat dilihat dengan peningkatan perdagangan berteknologi tinggi. Hal ini dikaitkan dengan kesan teknologi terhadap pekerjaan. Berdasarkan senario ini, penyelidikan ini bertujuan untuk mengkaji peranan inovasi dalam perdagangan berteknologi tinggi dan juga implikasi perdagangan berteknologi tinggi. Penyelidikan ini menggunakan sampel 20 negara pengeksport berteknologi tinggi utama. Jangka masa untuk kajian ini adalah dari tahun 2007 hingga 2016. Penyelidikan ini mempunyai tiga objektif khusus.

Objektif pertama penyelidikan ini adalah untuk menganalisis kesan inovasi terhadap perdagangan berteknologi tinggi. Berbeza dengan literatur, kajian ini juga meneliti kesan inovasi pada *extensive margin* perdagangan berteknologi tinggi. Analisis empirikal dilakukan menggunakan model graviti. Peningkatan perbelanjaan penyelidikan dan pengeluaran (R&D) domestik sebanyak satu peratus akan mendorong nilai eksport berteknologi tinggi meningkat 0.34

peratus dan jumlah produk berteknologi tinggi yang dieksport masing-masing sekitar 0.08 peratus.

Objektif kedua kajian ini adalah untuk mengkaji kesan perdagangan berteknologi tinggi terhadap daya saing negara. Analisis empirikal dilakukan dengan menggunakan teknik data panel termasuk *Biased-corrected Least Square Dummy Variable* (LSDVC). Peningkatan perdagangan berteknologi tinggi sebanyak satu peratus meningkatkan daya saing negara sebanyak 0.09 mata indeks. Kedua-dua eksport dan import berteknologi tinggi memberikan sumbangan positif kepada tahap daya saing negara.

Objektif ketiga penyelidikan ini adalah untuk mengkaji kesan perdagangan berteknologi tinggi terhadap struktur pekerjaan. Teknik LSDVC digunakan untuk mengira kesan ini. Peningkatan satu peratus dalam perdagangan berteknologi tinggi meningkatkan bahagian pekerjaan untuk pekerja berkemahiran tinggi sebanyak 0.05 peratus dan mengurangkan bahagian pekerjaan untuk pekerja berkemahiran pertengahan sebanyak 0.03 peratus.

Kesan positif perbelanjaan R&D terhadap eksport teknologi tinggi menunjukkan bahawa pelaburan domestik dalam aktiviti inovatif sangat penting untuk menyokong perkembangan industri teknologi tinggi. Insentif cukai dan dasar lain untuk mendorong inovasi perlu bagu meningkatkan eksport berteknologi tinggi. Perdagangan berteknologi tinggi juga meningkatkan daya saing negara. Daya saing yang tinggi meningkatkan pertumbuhan ekonomi, tahap pendapatan, dan taraf hidup masyarakat. Oleh itu, dasar harus digubal dengan cara yang dapat mempromosikan perdagangan berteknologi tinggi. Namun, pengembangan perdagangan berteknologi tinggi dapat membahayakan segmen tertentu dalam pasaran buruh. Ia mengurangkan permintaan pekerja mahir pertengahan. Pengurangan permintaan boleh menekan gaji mereka dan meluaskan ketidaksamaan dalam masyarakat. Ini akan membahayakan proses mencapai pembangunan lestari. Oleh itu, dasar untuk mengembangkan industri berteknologi tinggi mesti disertakan dengan kebijakan pekerja yang sesuai seperti program peningkatan kemahiran. Kesimpulannya, walaupun perdagangan berteknologi tinggi dapat meningkatkan taraf hidup masyarakat, kesan pengembangannya harus diambilkira.

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This thesis was submitted to the Senate of the Universiti Putra Malaysia and has been accepted as fulfilment of the requirement for the degree of Doctor of Philosophy. The members of the Supervisory Committee were as follows:

Normaz Wana binti Ismail, PhD
Professor
School of Business and Economics
Universiti Putra Malaysia
(Chairman)

Saifuzzaman bin Ibrahim, PhD
Associate Professor
School of Business and Economics
Universiti Putra Malaysia
(Member)

Hanny Zurina binti Hamzah, PhD
Senior Lecturer
School of Business and Economics
Universiti Putra Malaysia
(Member)

ZALILAH MOHD SHARIFF, PhD
Professor and Dean
School of Graduate Studies
Universiti Putra Malaysia

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Name and Matric No: Zera Zuryana binti Idris, GS48094

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This is to confirm that:

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- supervision responsibilities as stated in the Universiti Putra Malaysia (Graduate Studies) Rules 2003 (Revision 2012-2013) were adhered to.

Signature:	
Name of Chairman of Supervisory Committee:	Professor Dr. Normaz Wana binti Ismail
Signature:	
Name of Member of Supervisory Committee:	Associate Professor Dr. Saifuzzaman bin Ibrahim
Signature:	
Name of Member of Supervisory Committee:	Dr. Hanny Zurina binti Hamzah

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CHAPTER 1

INTRODUCTION

1.1 Background of the study

The Industrial Revolution contributed to the emergence of technological goods. The value of technology in supporting economic progress was demonstrated throughout the Industrial Revolution. Many technical breakthroughs and advances were introduced in the economic sectors throughout the phases of the Industrial Revolution. Generally, there are four phases of the Industrial Revolution (Veza, Mladineo & Peko, 2015) through which the usage of technology has expanded. The first phase is mechanisation, where machines were powered by water and steam. This is followed by the second phase, which is electrification, where mass production using assembly lines were introduced in the manufacturing process. The third phase of the Industrial Revolution is the automation and computerization of the manufacturing process. The fourth Industrial Revolution is about digitalisation, which is the integration of cyber and physical systems.

The expansion of the Industrial Revolutions has contributed to the emergence of high-technology (high-tech) trade. The term high-tech trade refers to the exports and imports of high-tech products (Eurostat, 2006). A high-tech product can be defined as a product that is highly embedded with technology intensity which is measured by the sum of direct (production of technology) and indirect (use of technology) research and development (R&D) intensity. A detailed definition of high-tech products is presented in Appendix A. Following the definition, the Organization for Economic Co-operation and Development (OECD) lists high-tech goods that meet the criteria (Table A3).

Fostered by the expansion of technology, the global high-tech trade is on the rise (Figure 1.1). From 2000 to 2017, global high-tech exports showed an increasing trend. In the year 2000, global high-tech exports totalled 1.16 trillion USD. This value increased by 132% to 2.69 trillion USD in 2017. The pattern holds consistent for both developed and developing countries. Throughout the 18 years, both developed and developing countries have exhibited an increasing trend in high-tech exports. The developed countries recorded 969.10 billion USD of high-tech exports in the year 2000. In 2017, the value of high-tech exports in the developed countries had reached 1.67 trillion USD. As for the developing countries, the high-tech exports value in 2017 was amounted to 1.01 trillion USD as compared to 188.97 billion USD in the year 2000.

Although both exhibit an upward trend in terms of high-tech exports, it is worth noting that developing-country high-tech exports are increasing at a faster pace than the developed countries' high-tech exports. From 2000 to 2017, the high-tech exports of the developing countries increased by 436 percent, while the high-tech exports of the developed countries increased by only 72 percent. The developing countries' share of high-tech exports increased from 16 percent in 2000 to almost 40 percent in 2017.

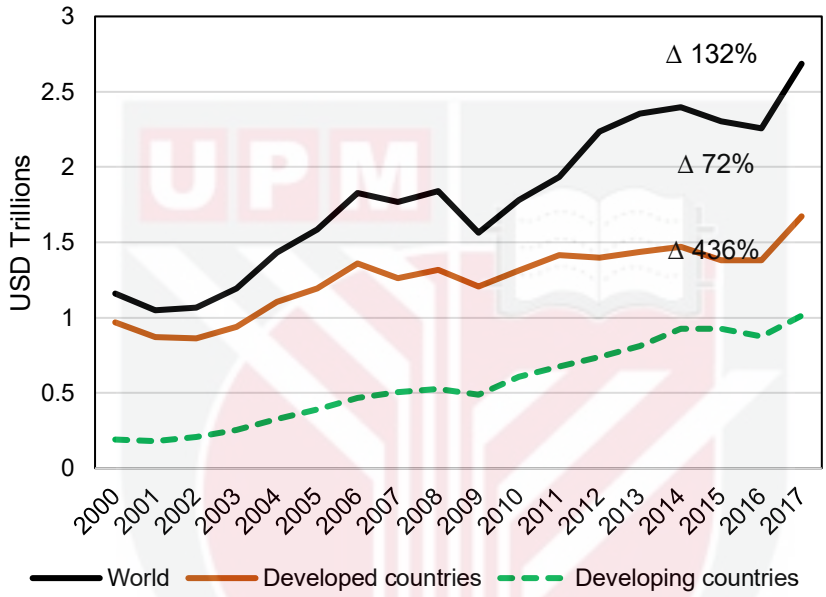

Figure 1.1 : Global High-tech Exports, 2000-2017
(Source: World Development Indicator)

As of 2017, developing-country high-tech exports accounted for roughly 40 percent of overall worldwide high-tech exports (Figure 1.2). This scenario runs counter to established trade assumptions. The theory of comparative advantage (Ricardo, 1817) states that a country should specialize and produce goods in which they have a comparative advantage. In a similar vein, factor-endowment theory predicts that countries will specialize and exports goods in which they have abundant factors to produce. High-tech goods are capital-intensive in nature. Therefore, it is expected that capital-abundant countries like the developed countries to be the leading exporters of high-tech goods while the labour-abundant countries will be exporting less capital-intensive goods.

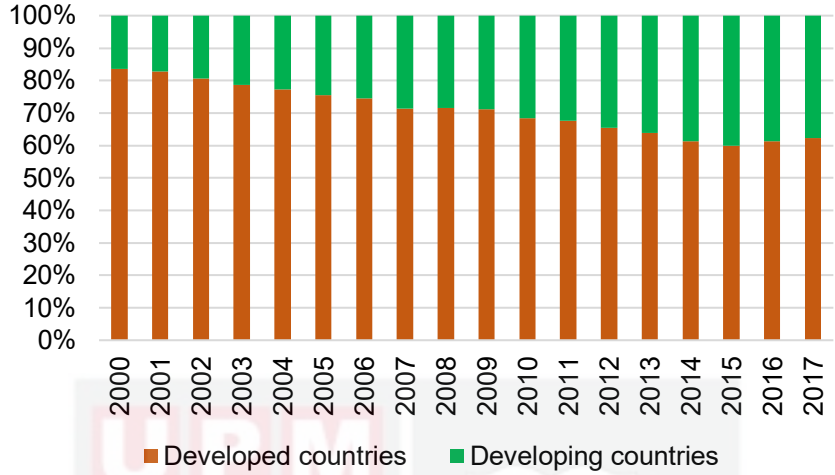

Figure 1.2 : Share of Global High-Tech Exports Based on Income Groups, 2000-2017
(Source: World Development Indicator)

When a country is able to manufacture and export high-tech items, it demonstrates that it is capable of producing higher-value products with a more significant profit margin. Countries that are more technology-intensive are able to innovate more, generate larger market share, use resources more efficiently and generally offer high-wage employment (Roberts & Wolf, 2018; Hatzichronoglou, 1997). Gani (2009) suggested that countries need to focus on product development with higher technological content to be competitive and enhance their growth and development. Furthermore, having the competency to export high-tech goods is one of the driving forces of economic development (Gokmen & Turen, 2013). Also, the ability to create new technology suggests an increase in countries' technological capabilities (UNDP, 2001; Archibugi & Coco, 2004; Gani, 2009), i.e., the capability to deploy, develop and utilise technological resources to create a comparative advantage.

While increasing high-tech exports from developing nations are viewed positively as an indication that they are climbing the global value chain ladder, they also spark controversy among experts. Srholec (2007) associated the high-tech exports from the developing countries as the statistical illusion. Xing (2014) looked at high-tech exports from developing countries like China as a myth. The increase in high-tech exports from the developing countries is associated with their participation in the lowest fragment of the global value chain. The global value chain breaks the production process into various stages in which each stage is allowed to be carried out in different countries. Developing countries are said to participate in the lowest fragment, which is the assembly process of high-tech goods. It is then recorded as high-tech exports from the developing countries despite the minimal value-added given to the product. Participating in

the lowest segment of the global value chain contributes less to a country's development. It has the potential to impede the catch-up process and delay the process of income convergence between economies.

1.1.1 Innovation and High-tech Trade

The debate has highlighted concerns about the role of innovation in the development of high-tech exports. As previously discussed, the manufacturing process of high-tech products can be divided into several stages. The manufacturing process for high-tech products under the framework of the global value chain is depicted in Figure 1.3. Mudambi (2008) emphasised the fact that activities at both ends of the value chain are more knowledge and creativity-intensive than activities at other stages of the chain. As such, participation in the lower fragment of the global value chain may not require as many innovation efforts as participation in the higher segment.

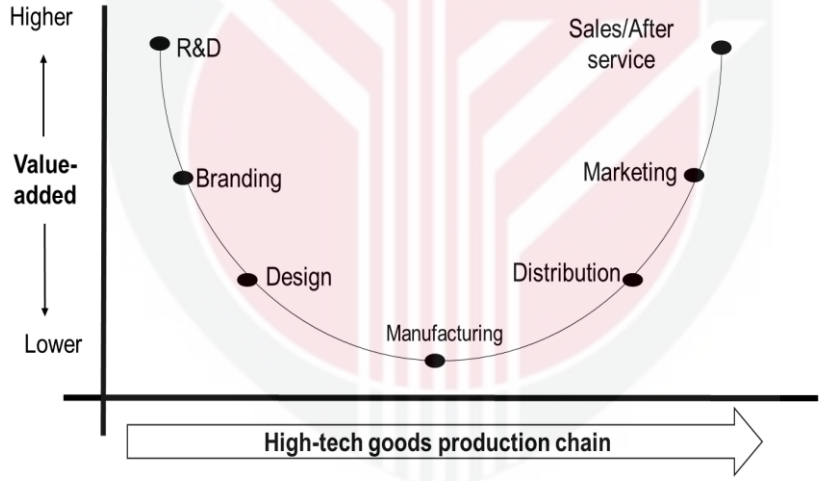

Figure 1.3 : Production Process of the High-Tech Goods in the Context of Global Value Chain
(Source: from Mudambi 2008)

Innovation activities refer to activities that improve a product, process or service. Kalanje (2006) refers to the term innovation activities as the process of bringing new ideas into the market. It denotes the process of transforming new ideas into valuable products that could meet the demand in the market. In the high-tech sector, the innovation process is normally founded on research and development (R&D) activities. Current data shows that the leading high-tech exporter from the developed countries group spends more on R&D as compared

to the high-tech exporter from the developing countries (Figure 1.4). The R&D expenditure of the largest global high-tech exporter, China, is very much lesser than developed countries like Korea, Switzerland, Japan, Germany, the USA, and Belgium. Despite a larger amount of innovative investment, Switzerland's high-tech exports are less than Malaysia's. Additionally, Germany and the USA outperform Korea in terms of high-tech exports despite lower R&D expenditure. This brings up the question of whether innovation contributes to high-tech exports.

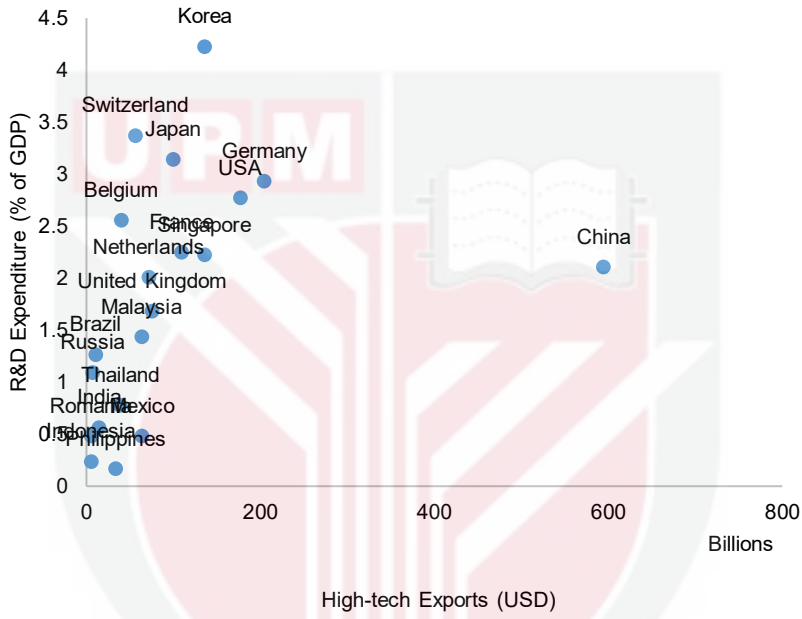

Figure 1.4 : Research & Development Expenditure and High-tech Exports, Major High-tech Exporter, 2016
(Source: World Development Indicator)

Reviewing R&D expenditure based on income groups reveals that the R&D expenditures of the developing countries are increasing. In fact, it grows at a faster rate as compared to those of developed countries (Figure 1.5). However, their average R&D expenditures as a whole are still lower than the developed countries and the world's average. This suggests the possibility that developing countries could be the major high-tech exporters even with a low level of innovative investment.

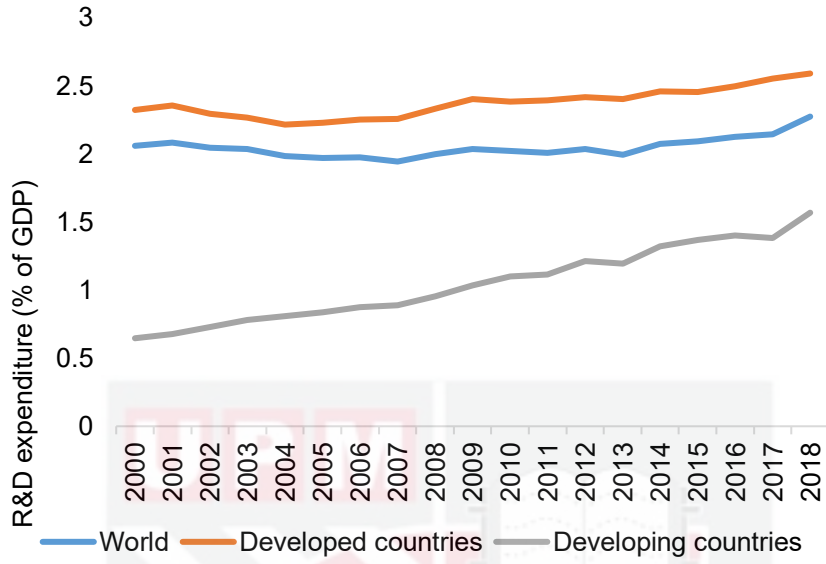

Figure 1.5 : Trend in R&D Expenditure by Income Groups, 2000-2018
(Source: World Development Indicator)

The most-traded high-tech products are coming from the electronics telecommunication sector (Figure 1.6). The products under this sector include electronic integrated circuits, optical fibre cables, microwave tubes and many others. The electronic sector is highly attributed to the fragmented global production network (Srholec, 2007). Given this, it is worth to study whether high-tech exports are depending on innovation activities or merely resulting from assembly works of high-tech products.

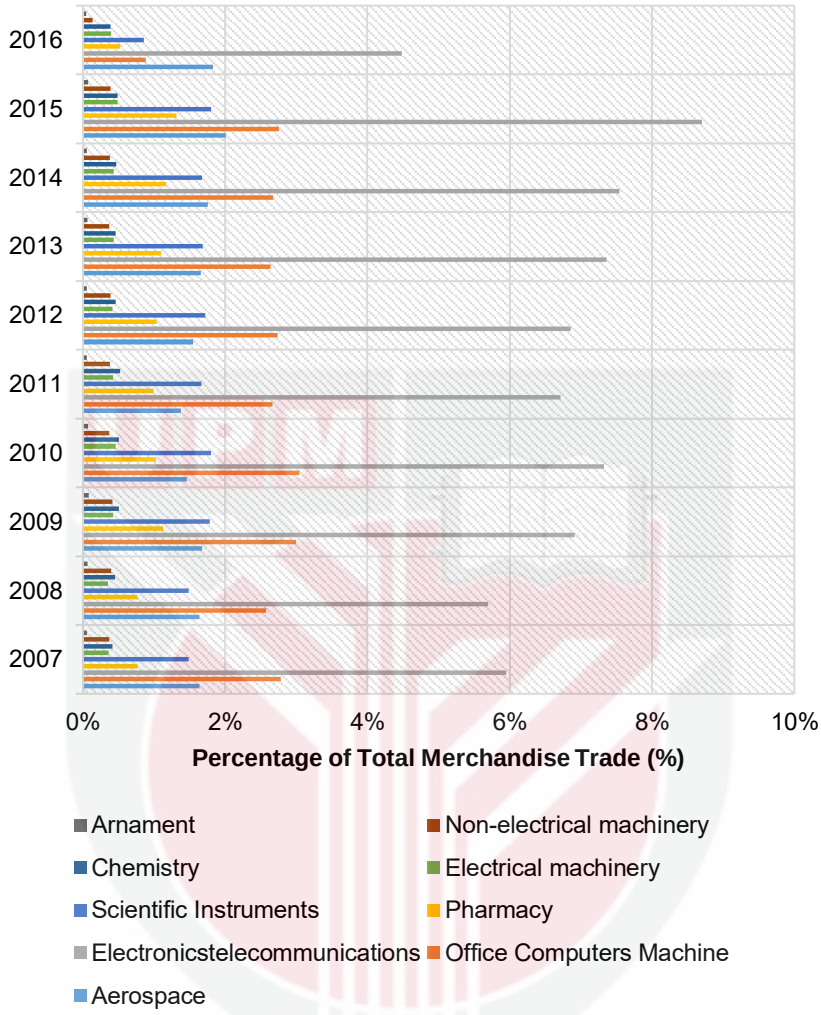

Figure 1.6 : High-tech Trade (% of Merchandise Trade), 2007-2016
(Source: COMTRADE, World Bank and author's calculation)

Apart from R&D investments, innovation can also be measured in terms of output. The patent application is one of the proxies for innovation (Singh, 2008). A patent application appears as a product of innovative activities. A patent is an exclusive right granted to the owner of innovation that excludes other parties from using, imitating or selling the innovation without the consent of the owner for a certain period of time. Patent rights act as the motivating factor to innovate since it allows the owner to enjoy some monopoly power for a period of time. Having the exclusive rights over scientific and technical knowledge facilitate a country to develop a comparative advantage over other countries and allow them to enter new markets easily and capture a larger market size.

The total patent applications both in the developed and the developing countries are presented in Figure 1.7. The applications are filed through the Patent Cooperation Treaty (PCT) or national patent offices. While the patent application in the developed countries is quite stagnant, the patent applications in the developing countries are increasing expressively from 2000 to 2016. In 2016, the patent applications from developing countries exceeded those from developed countries. Much of the increase in the patent applications coming from its residents i.e., domestic firm applications and not from non-residents i.e., foreign firm applications.

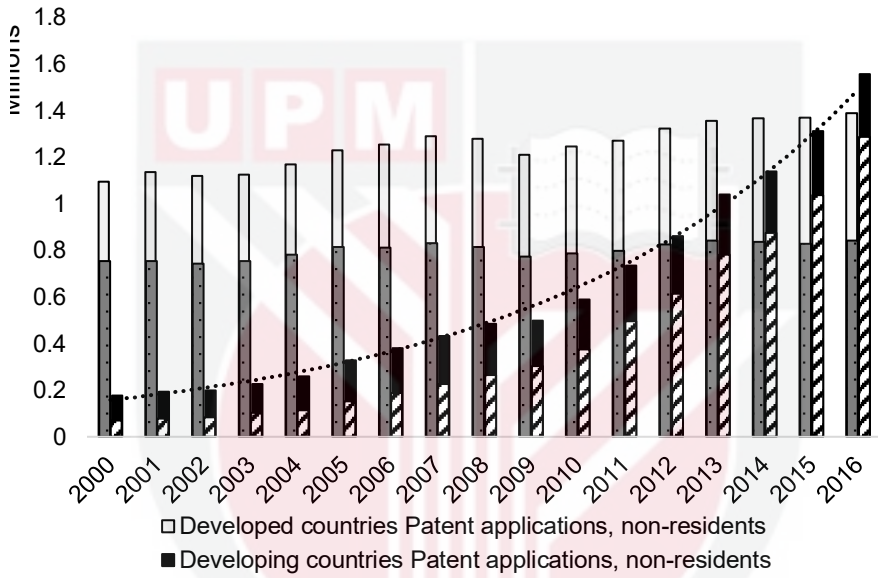

Figure 1.7 : Total Patent Applications Based on Income Groups, 2000-2016
(Source: World Intellectual Property Organization (WIPO))

According to the literature, innovation can have an impact on trade in a variety of ways. Besides increasing productivity (Eaton & Kortum, 2001; 2002), it can also improve product variety (Eaton & Kortum, 2001; 2002). (Krugman, 1979; Grossman & Helpman, 1989). It is, therefore,, possible to assess the impact of innovation on high-tech exports in terms of the intensive and extensive margins. While the intensive margin relates to the exports of already-existing products, the extensive margin is used to refer to the exports of new products (Rashidi, 2018). It has been observed that the number of high-tech products originating from developing countries has expanded between 2010 and 2016 (Table 1.1), where all countries a showing a positive percentage change. However, in terms of the number of high-tech products exported from developed countries, some countries exhibit a shrinking pattern.

Table 1.1 : Number of High-Tech Products Exported (Count), 2010-2016

Country	2010	2016	% change
Developed Countries			
Germany	3474	3422	-1.50
USA	3443	3416	-0.78
France	2939	3037	3.33
United Kingdom	2943	2972	0.99
Switzerland	2803	2875	2.57
Japan	2701	2632	-2.55
Belgium	2615	2613	-0.08
Netherlands	2681	3133	16.86
Korea	2477	2593	4.68
Singapore	2406	2587	7.52
Developing Countries			
China	2984	3132	4.96
India	2375	2485	4.63
Thailand	2012	2131	5.91
Malaysia	1896	1935	2.06
Mexico	1486	1663	11.91
Brazil	1406	1606	14.22
Indonesia	1345	1429	6.25
Russia	1172	1311	11.86
Romania	1038	1242	19.65

(Source: Author's calculation based on UN COMTRADE 2019)

Innovation may increase the product varieties through the creation of new products. It may also reduce the numbers of exported high-tech products due to radical innovation. An increase in the number of exported high-tech products reflects export diversification which is good to support the development of a country (Hesse, 2008). It is essential to understand how innovation will impact the amount of high-tech products exported.

1.1.2 High-tech trade and National Competitiveness

Discussions about high-tech trade in the literature mostly centred on the factors contributing to the growth of this industry, while the impact of this growing industry received less attention. Thus far, engaging in high-tech trade is said to boost economic growth and productivity. However, empirical evidence remains limited. Falk (2009) and Demir (2018) demonstrated that the export of high-tech is positively related to economic growth. Similarly, Seung-Hoo (2008) shows that the exports of high-tech are positively associated with economic output.

Several authors claimed that innovation enhances countries' competitiveness (Gani, 2009; Chen, 2013). By that, engaging in the high-tech industry, which is said to be highly correlated with innovation activities, should have increased a country's competitiveness. The idea of competitiveness goes beyond the concept of economic growth. While economic growth is perceived to be the end

in itself or the goal, competitiveness should be viewed as the mean to that end. National competitiveness refers to the national conditions that reflect the potential of a nation to achieve higher productivity, increase prosperity, achieve a high standard of living and generate a higher rate of employment (Porter, 1990; Tomas; 2011). The World Economic Forum (WEF) viewed competitiveness as "a set of institutions, policies and factors that determine the level of productivity of a country" (Schwab, 2018, p.11). A country that has the ability to compete should have a good set of institutions, policies and several other factors to make it favourable in the world market. A more competitive economy is likely to grow faster over time. A more detailed discussion on the concept of national competitiveness is presented in Appendix II.

One of the most widely accepted measures of national competitiveness is the Global Competitiveness Index (GCI) produced by the World Economic Forum (WEF). It assesses the ability of countries to achieve growth and provide high living standards to their citizens. Following GCI, the competitiveness of a country comprises elements such as institutions, infrastructure, macroeconomic environment, health and primary education, higher education and training, goods market efficiency, financial market development, technological readiness, market size, business sophistication and R&D innovation.

Engaging in high-tech trade could contribute to enhancing the competitiveness of a country in many ways. International trade forces countries to improve institutional quality after opening through 'race to the top' (Levchenko, 2011). For example, countries must improve contract enforcement, property rights and investors protection to remain competitive in the world market. To produce and export high-tech goods which are highly embedded with research, innovation and technology, firms or countries must have involved in continuous innovative activities. As Romer (1990) pointed out, governments must continue to innovate in order to attain sustainable long-term growth. On the same notion of 'race to the top', other pillars of competitiveness such as infrastructure, quality and skilled workforces, conducive trading environment and business sophistication should have improved.

Apart from producing and exporting, imports also can influence a country's competitiveness. Imports allow countries to minimize production costs and acquire high-quality inputs from other countries. As a result, they can specialize in their field of expertise and enhance productivity and competitiveness. Moreover, imports serve as the major channel for technology transfer. The technology embodied in the imported goods may increase the productivity of the importing country, and there may be import-related learning effects (Acharya & Keller, 2007).

Given that fact, both exporting and importing high-tech trade should have increased a country's competitiveness level. Figure 1.8 shows the relationship between countries competitiveness and their high-tech exports plotted for main high-tech exporters from both income groups. One obvious fact is that the competitiveness of high-tech exporters from the developing countries is lower than those of developed countries. An extreme case is China. Even though it is the largest exporter of high-tech goods, its competitiveness score remains below the 5.00 index point. According to Chen et al. (2017), China's high-tech industry's technical innovation efficiency is low. This demonstrates that China performs poorly in terms of technical innovation when compared to its high-tech export volume. A lack of technological innovation efficiency may have a negative impact on its national competitiveness. Furthermore, China's high-tech exports also include assembled products (Xing, 2012) which are no different than labour-intensive products.

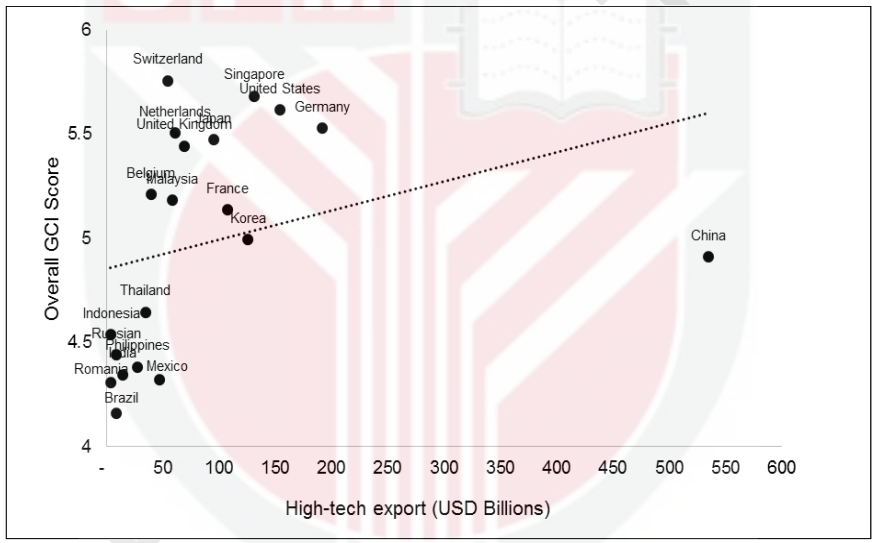

Figure 1.8 : GCI Score and High-Tech Exports, Average 2014-2016
(Source: Global Competitiveness Report and World Development Indicator
Note: GCI scores range from 1 to 7)

Table 1.2 highlights the 20 most competitive economies in the world by 2017-2018. One obvious fact is that all of the top 20 countries are developed countries. Although the developing countries are increasingly exporting high-tech goods, the only developing country that is listed closely to those developed countries is Malaysia that is the 23rd rank. The largest global high-tech exporters, i.e., China, ranked far below Malaysia that is at the 27th rank.

This situation pointed out that the ability to grow in developing countries are still weak. This poses a question of whether their high-tech exports mean an increase in their technological capability or as a result of their participation in the fragmented global production network of high-tech products. If they are concentrating at the lower end of such production network, such as assembling of the high-tech products, then exporting high-tech products with minimal domestic value-added means less to their ability to grow in the long run.

Table 1.2 : Global Competitiveness Index Ranking, 2017

Rank	Country	Income Group	Score
1	Switzerland	Developed	5.86
2	United States	Developed	5.85
3	Singapore	Developed	5.71
4	Netherlands	Developed	5.66
5	Germany	Developed	5.65
6	Hong Kong	Developed	5.53
7	Sweden	Developed	5.52
8	United Kingdom	Developed	5.51
9	Japan	Developed	5.49
10	Finland	Developed	5.49
11	Norway	Developed	5.4
12	Denmark	Developed	5.39
13	New Zealand	Developed	5.37
14	Canada	Developed	5.35
15	Taiwan	Developed	5.33
16	Israel	Developed	5.31
17	United Arab Emirates	Developed	5.3
18	Austria	Developed	5.25
19	Luxembourg	Developed	5.23
20	Belgium	Developed	5.23
23	**Malaysia**	**Developing**	**5.17**
27	**China**	**Developing**	**5.00**

(Source: Global Competitiveness Report, 2017)

1.1.3 High-tech trade and Employment Structure

Apart from the impact as discussed above, the expansion of the high-tech industry is also associated with the expansion of the usage of technology. In contrast to normal trade, the expansion of high-tech trade is directly associated with the rapid advancement of technology. Robots, artificial intelligence, additive manufacturing, and a host of other advanced technologies including robotics have been integrated into the production process in recent years (Hallward-Driemeier & Nayyar, 2017). The introduction of such technologies has the potential to introduce labor-saving techniques that may improve efficiency and production, but at the expense of increasing the demand for labour workers. Concerns have been raised about the likelihood that technology would displace

roles that people used to perform, resulting in what is known as 'technological unemployment' (Acemoglu, & Restrepo, 2018; Piva & Vivarelli, 2018; Marchant, Stevens, & Hennessy, 2014).

As the world is moving towards high-tech trade, the share of an employed person decreases (Figure 1.9). As high-tech exports increase from 1,158. 32 billion USD in 2000 to 1,842.17 billion USD in 2008, the total global employment to population ration reduces from 60.78 percent to 60.02 percent. After 2009, when high-tech trade increases further to reach 1,988.63 billion USD in 2016, the total global employment decreases further to 58.67 percent. This situation poses a question of whether exposure to high-tech trade will affect employment negatively.

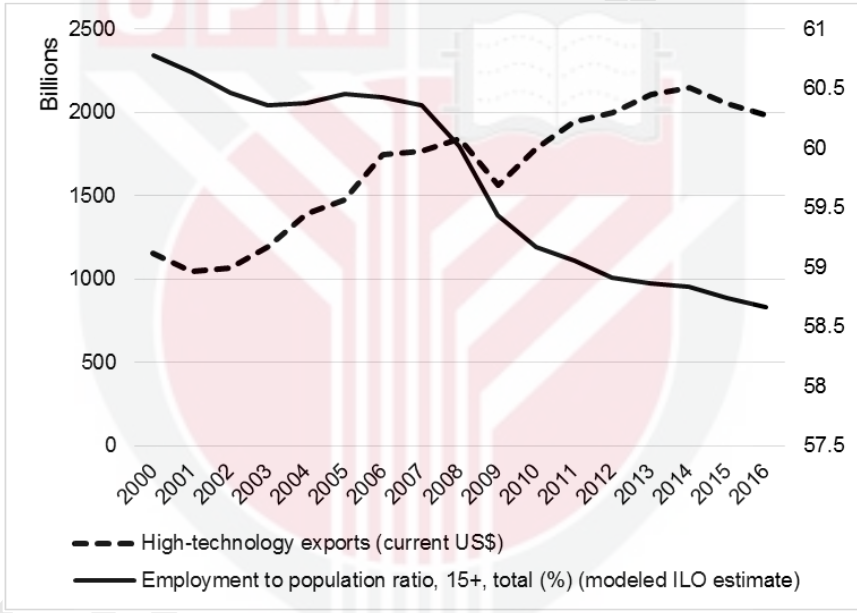

Figure 1.9 : Global Employment to Population Ratio and High-Tech Exports, 2000-2016
(Source: World Development Indicator, the World Bank)

Some analysts believe that technological advancements would result in bleak employment prospects for many sorts of jobs, particularly those that are replaceable by robots, resulting in sluggish employment growth (Rothman, 2013). In recent literature relating to the impact of technology on the labour market, a phenomenon known as job polarisation has been highlighted (Harrigan, Reshef & Toubal, 2020; Echeverri-Carroll et al., 2018; Goos, Manning & Salomons, 2009; 2014).

Job polarisation refers to a condition where middle-skilled employment is hollowed out compared to high and low-skilled employment. Mainly, two hypotheses are used to describe job polarisation. The first is called Skilled-Beneficiated Technical Change (SBTC) (Berman, Bound & Machin, 1998). The second is referred to as Routine-biased Technical Change (RBTC) (Goos, Manning & Salomons, 2014).The second is referred to as Routine-biased Technical Change (RBTC) (Goos, Manning & Salomons, 2014). According to the SBTC hypothesis, technical change resulting from the introduction of new technology is biassed in favour of the demand for highly skilled labour. The RBTC hypothesis, on the other hand, suggests that technological change will result in a reduction in the number of routine jobs. These examples demonstrate that technology may have the potential to benefit one segment of the labour market at the expense of another segment of the labour market.

High-tech trade is possible to change the demand for labour and employment structure in at least three ways. First, the production of high-tech goods increases the demand for high-skilled workers, thus creates job opportunities for this group of workers. Works of the literature suggest that exporting firms are more productive, efficient and produce high-quality goods. Exports create opportunities for firms to sell to buyers from the high-income market who are willing to pay more for quality (Atkin, Khandelwal & Osmen, 2014). To become a high-tech exporter, firms need to engage in vigorous competition to capture global market share. Firms need to continuously perform R&D activity and invest in advanced technology, which is typically conducted by high-skilled workers such as science and engineering professionals. In addition, an exporting firm also must have an excellent corporate strategy to compete globally. As a result, there is an increased demand for highly qualified managers and administrative officials.

Secondly, as countries increase their high-tech exports, it is expected that they will increase their technological investment. Several of which may be labor-saving in nature. If their technology investment includes these characteristics, demand for middle-skilled labour is expected to decline. Thirdly, rapid technological advancements may be incapable of displacing non-routine low-skilled workers. Specific low-skilled jobs, such as cleaning, are best performed by humans. As a result, the demand for low-skilled labour is expected to grow relatively quickly.

Besides exports, imports of high-tech may also alter the demand for labour. Imports of final high-tech goods such as computer office machines for domestic use can replace humans to perform routine tasks customarily handled by medium-skilled workers like clerical support workers, causing lower demand for such workers. Meanwhile, imports of intermediate high-tech products as the production inputs may reduce the domestic production of the same products, resulting in a reduction in employment. In some cases, imports of intermediate

high-tech goods may result in an increase in demand for medium-skilled workers if the countries are involved in the assembly process.

The International Labour Organization (ILO) publishes employment statistics by occupation, which are classified into three broad skill levels: high, medium, and low. Appendix C contains a detailed explanation of the various types of employment based on these three skill groupings. Figure 1.10 depicts the breakdown of employment growth by skill for twenty leading high-tech exporters from developed and developing countries from 2010 to 2022. Employment growth is generally increasing in the most significant global high-tech exporters. In general, the number of employed person is expected to increase by 7.25 percent between 2010 and 2022. However, growth in employment is not evenly distributed among the three broad skill categories (Figure 1.11). High-skilled workers experience the fastest employment growth (17.29 percent), followed by low-skilled workers (3.18 percent). Middle-skilled workers experience the slowest employment growth. This situation raises the question of whether exposure to high-tech trade has an effect on the labour market.

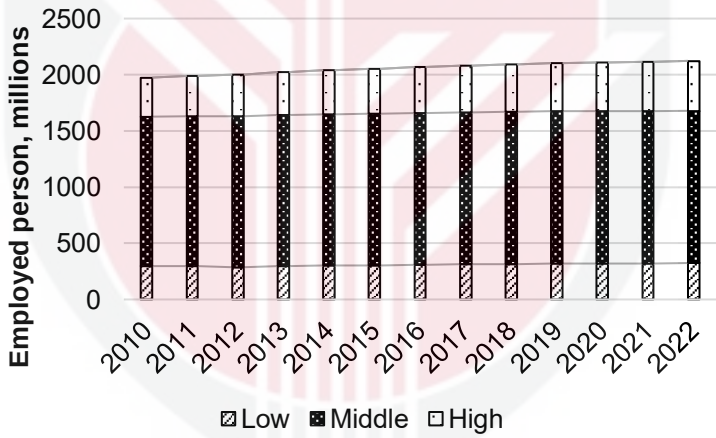

Figure 1.10 : Employment by Skill, Main High-tech Exporter, 2010-2022
(Source: ILOStat)

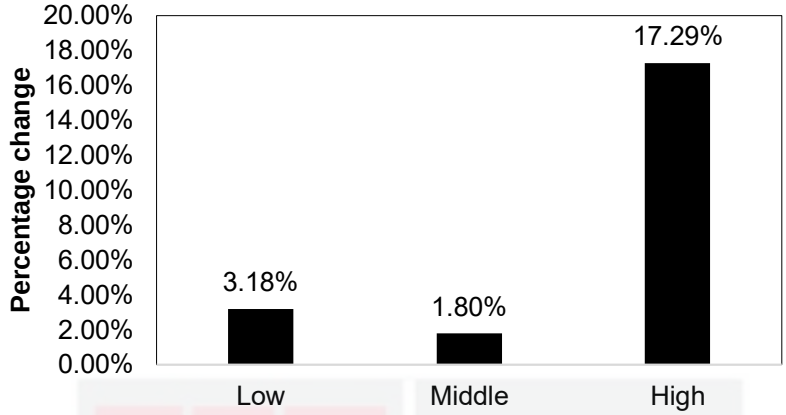

Figure 1.11 : Employment Growth Based on Skills Category, Main High-tech Exporter, 2010-2022
(Source: ILOStat and author's calculation)

1.2 Problem Statement

Following the phases of the Industrial Revolution, the global high-tech trade is seeing an upsurge. Taking into account the advancements in technology, countries are now able to manufacture and trade high-tech products. Trade theory predicts that capital-abundant countries will produce and export capital-intensive goods while labour-abundant countries will produce and export labour-intensive goods. Based on this prediction, the developed country is expected to be the leading exporter of high-tech goods while the developing country will produce and exports relatively low-technology goods. However, the current trend of high-tech trade is exhibiting a contradictory scenario to the theoretical prediction. The data shows a decline in high-tech exports from developed countries despite their large amount of innovative investment. Developing countries, on the other hand, are increasingly becoming high-tech exporters. Despite the fact that this scenario could be interpreted as a positive sign that developing countries are moving up the global value chain ladder and improving their technological capabilities, experts argued that high-tech exports from developing countries are a statistical mirage. The increase in high-tech exports is related to their participation in the lowest-value-added segments of the global value chain, such as the assembly of high-tech items. Participating in the lowest segment has the unintended consequence of delaying the process of catching up and extending the period of income convergence between economies.

The argument raises a concern about the role of innovation in the expansion of high-tech exports. Innovation may not be as important if a country participates in the lowest fragment of the global value chain as compared to countries that participate in the highest fragment. The trend of R&D expenditures indicates that

the developing countries' expenditure on innovation activities is increasing. However, their average R&D expenditures as a whole remain lower than the high-income countries' as well as the world's average. As innovation is deemed an important variable to explain high-tech trade, it is crucial to examine how innovation would impact the high-tech trade closely. According to the literature, there are two ways in which innovation might impact high-tech exports. Innovation may influence the intensive margin (exports of existing goods) as well as the extensive margin (exports of new goods). Data shows that there are changes in terms of the numbers of exported high-tech products. Some countries demonstrate an increasing number of exported high-tech products while some others experienced a shrinking number of exported high-tech products. Innovation has the potential to increase the extensive margin, allowing the exporter to diversify its export and gain a larger market share, which in turn will then improve its well-being. It is, therefore, useful to examine how innovation will influence the extensive margin of high-tech exports.

Most of the previous pieces of literature on high-tech trade focus on exploring the factors influencing high-tech trade. Little emphasis has been given to the impact of high-tech trade. Theoretically, innovation and technology are the important components of economic growth and thus increases national competitiveness, i.e., the ability of a nation to grow further. While exporting high-tech products forces countries to improve their economic environment to remain attractive globally, importing high-tech products increases a nation's competitiveness by increasing productivity, reducing manufacturing costs, enhanced specialization, and import-related learning effects. Despite this, the high-tech exporters' competitiveness level, particularly those coming from the developing countries, is not satisfactory. For example, China, who overtakes other high-income countries such as Germany, the USA, and Singapore to be the major high-tech exporter globally, is ranked at 27 with just a 5.00 GCI score in 2017. Most of the other high-tech exporters from developing countries are not positioned in the top ranks. In addition, although the position of the high-tech exporters coming from the developed countries is better than those of the developing countries, they are also overtaken by those who are not the major high-tech exporters such as Switzerland. Thus, it poses a question of whether engaging in high-tech trade could positively affect a country's competitiveness.

The expansion of high-tech trade also is often associated with rapid technological change. Similar to the normal trade, engaging in high-tech trade also has employment effects. As the high-tech trade is expanding over time, the employment to population ratio decreases. Concerns have been raised about the possibility of technology displacing humans in performing tasks. Exporting and importing high-tech products may alter the demand for labour because of the technology embedded in high-tech products as well as technology innovations introduced in the production process. The breakdown of employment by skill level yields that employment growth is very much less for the middle-skilled workers as compared to the low and high-skilled workers. As the high-tech exporters marching towards technological advancement, medium-

skilled jobs seem to hollow out relative to low and high-skilled jobs. Thus, even though technology enhances efficiency in the production process, it might harm some segments of the labour market. Changes in the employment structure need to be accompanied by an appropriate policy to meet future skill needs. Achieving higher economic growth through high-tech trade might defeat the efforts towards achieving inclusive and sustainable growth if its effect on the employment structure is ignored.

1.3 Research Objectives

Generally, the purpose of this research is to investigate the factors driving high-tech trade as well as the implications of engaging in high-tech trade among the major high-tech exporter from 2007-2016. Following the general objective, the specific objectives are outlined as follows:

i. To analyse the impact of innovation on high-tech trade;
ii. To examine the impact of high-tech trade on national competitiveness; and
iii. To study the impact of high-tech trade on employment structure.

1.4 Significance of the study

The primary purpose of this research is to conduct a comprehensive analysis comprising the cause and impact of high-tech trade. The focus has been centered towards the emerging high-tech. However, discussion on high-tech trade is not pervasive. The expansion of high-tech trade is relatively new as compared to other industries. As such, the empirical study of this industry are quite limited. Conducting this research is therefore, contributes to the expansion of literature pertaining to high-tech trade.

Most of the previous literature focused on understanding the factor influencing this industry (Liu & Shu; 2003; Bhaduri & Ray, 2004; Braunerhjelm & Thulin, 2008; Sara, Jackson & Upchurch, 2012; Ismail, 2013; Sandu & Ciocanel, 2014; Kabaklarli, Duran & Ucler, 2017; Mehrara, Seijani & Rezazadeh, 2017). The most highlighted factor is innovation activities. Thus far, existing literature in this area focuses on the impact of innovation on high-tech exports at the aggregate level. Estimating the impact of innovation on the aggregate level of high-tech trade may result in aggregation bias, which will result in the generalisation of findings. Extending the existing literature, this study disaggregates high-tech exports into 9 categories: aerospace, computers-office machines, electronics-telecommunications, pharmacy, scientific instruments, electrical machinery, chemistry, non-electrical machinery, and armament. Estimating the impact of innovation on each high-tech product group may address aggregation bias. The impact of innovation may differ from one product group to another. For example, innovation may have a different impact on the electronics-telecommunications

industry than it does on the pharmaceutical industry. By categorising high-tech products into nine categories, we can determine whether trends observed in aggregated data also apply to each group of high-tech products and avert the generalization of findings with regards to the impact of innovation on high-tech trade.

Furthermore, this study expands the literature by looking at the impact of innovation on the extensive margin of high-tech trade. According to the literature, innovation boosts exports in various ways, including product variety (Krugman, 1979; Grossman & Helpman, 1989). Hence, the influence of innovation on high-tech trade can also be studied in terms of the extensive margin. Existing studies like Ismail (2013) examine the impact of innovation on high-tech trade values. This study also takes a step further to understand how innovation may affect the number of exported high-tech products. More trade of existing products is expected if the innovation activities are much more focused on the process. Process innovation improves productivity and hence boosts exports.

On the other hand, product innovation has the tendency to influence high-tech trade. It may add the numbers of product variety by creating new products, or it may reduce the number of product variations through radical innovation. Estimating the impact of innovation on the extensive margin of high-tech trade is crucial to understanding whether innovation has promoted the creation of new products. A positive impact of innovation on the extensive margin of high-tech exports implies that innovation improves products variety. An increase in exports at the extensive margins brings different welfare implications than the increase in the trade of existing products. If innovations increase the extensive margins, the welfare effect is positive on the innovator (Chen, 2013). It improves the export diversification of the exporting countries, which is crucial for sustainability. On the other hand, increasing the exports volume of existing products will result in price reduction, reducing the welfare effect on the innovator. Therefore, capturing the impact of innovation on the extensive margin of high-tech trade is crucial for policy formulation.

Most of the available literature in the context of high-tech trade focuses on exploring the factors influencing high-tech trade. Less attention has been given towards the impact of engaging in high-tech trade. Unlike normal trade, high-tech trade brings together a more significant technological effect. Taking this as a starting point, this study attempts to examine the implication of engaging in high-tech trade.

Firstly, this study examines the impact of engaging in high-tech trade on national competitiveness to understand whether participating in high-tech trade has helped countries improve their position in the Global Competitiveness Ranking. Although the role of international trade and technology in enhancing national competitiveness has been widely discussed theoretically, previous studies have

yet to examine the impact of technology arising from international trade activities such as high-tech trade on the overall competitiveness of a country. This might be due to the fact that there is no common agreement among the exports with regard to the definition of national competitiveness. By conducting this research, we contribute to the expansion of empirical literature on national competitiveness. Nevertheless, there are few studies that empirically examine the determinant of national competitiveness (Marčeta & Bojnec, 2020; Rusu & Roman, 2018; Helga, 2017; Zoroja & Bach, 2016; Ganna & Olga, 2013). Regardless, previous studies have yet to highlight the role of high-tech trade on national competitiveness. As mentioned in Krishna Krishna (1988), we argue that high-tech trade is different from normal trade. Hence, it should be handled differently. High-tech trade brings together the impact of technology. By theory, it should facilitate countries to improves their position in the Global Competitiveness Ranking.

It is observed that several studies have attempted to examine the impact of high-tech exports on economic growth (Demir, 2018; Falk, 2009; Seung-Hoo, 2008) and innovative capability (Wu, Ma & Zuo, 2017). Despite their outstanding efforts, these studies only looked at one element of competitiveness. National competitiveness is a multidimensional concept. Therefore, a single measure cannot represent overall national competitiveness. This study attempts to look at a bigger picture of the impact engaging in high-tech trade might have on an economy. Conducting this research allows us to understand the role of high-tech trade in improving national competitiveness. Achieving the status of a competitive economy matters for many reasons. First, a high-level of competitiveness create prosperity, better living standards, and more satisfaction among the economic units. Second, competitive countries offer greater returns on investment and economic stability. Competitive economies are more likely to be able to grow in a more sustainable and inclusive manner. Hence, it is important to capture the role of high-tech trade on national competitiveness. The positive influence of high-tech trade on national competitiveness calls for more proactive innovative investment and policies, while negative influence demands a revisit of development strategy.

The second implication of engagement in high-tech trade that this study attempts to pursue is in terms of employment structure. This objective is motivated by the claims that technology might replace humans in performing tasks. This study aims to examine the employment-effect of technology that arises through international trade activities. Previous studies have examined the impact of international trade on employment (Greenaway, Hine and Wright 1999; Fu and Balasubramanyam 2005; Chinembiri 2010; Sousa, Arto and Andreoni 2012; Tuhin 2015; Feenstra and Sasahara 2018). These studies, however, did not segregate high-tech trade from the normal trade. Based on our afore-mentioned argument, the impact of high-tech trade needs to be specifically examined. The technology embedded in or adopted for the production of high-tech products may alter the demand for labour differently than the normal trade will do. While exporting normal products may result in the creation of jobs as a result of the

increased market size, exporting high-tech products may result in a decrease in labour demand due to the technology used in the manufacturing process. Imports of high-tech, on the other hand, may create or destroy jobs. High-tech imports may result in a decline in labour demand as the import-competing industry contracts. However, it may also generate employment through assembly work. Given the possibility, it is worth studying how the employment structure will be affected by the engagement of high-tech trade. The expansion of high-tech trade is likely to favour high-skilled labour as compared to middle and low-skilled labour. If this is determined, consideration should be given to developing labour policies such as upskilling programmes. Failing to observe this unintended consequence of high-tech trade may harm the economic stability through widening income gap among different segments in the labour market.

1.5 Scope of study

The study will be undertaken within the setting of the panel dataset. The cross-sectional dimension will include a list of high-tech exporters. The high-tech exporters are initially ranked according to their trade value in 2016, the most recent year for which data are available at the time the sample countries are chosen. Then, the high-tech exporters are divided into two categories based on the income group's classification, i.e., the developed and developing countries. In this study, the developed countries refer to the high-income countries with GDP per capita exceeding 12,056 USD. On the other hand, the developing countries refer to the low and middle-income countries with a GDP per capita of fewer than 995 USD to 12,055 USD.

The ten largest exporters are selected from the developed countries group. The ten developed countries under consideration are Germany, the United States of America (USA), Singapore, Korea, France, Japan, United Kingdom, Switzerland, Netherlands, and Belgium. Another ten largest exporters are selected from the developing countries list. The selected developing countries are China, Malaysia, Mexico, Thailand, Philippines, India, Brazil, Russian Federation, Romania, and Indonesia. All of the selected developing countries are middle-income countries, and none are from low-income countries. In total, this study included a total of 20 sample countries. The details of sample selection are presented in Appendix E.

The selection of sample countries which consists of the largest high-tech exporters from the developed and developing countries, will allow for a richer analysis. Combining the two income groups in the sample provides a heterogeneous sample. This enables a more robust conclusion regarding the impact of innovation on high-tech trade, national competitiveness, and employment structure.

As for the time dimension, the study will involve ten years of annual data from 2007-2016. The selection of the time dimension follows the availability of the high-tech trade data extracted from COMTRADE. The data on high-tech trade is available from 2007 onwards.

1.6 Organization of the study

This research consists of five chapters. This chapter serves as the introduction chapter, constitutes the first chapter. The chapter provides an overview of the research background and issues. In this phase, the research foundation is built. It contributes to a fundamental understanding of the overall study. The second chapter is devoted to a review of the literature. It includes a review of existing literature that is relevant to the context of the study. This part included a review of theoretical and empirical literature relevant to the issues under consideration. From the review, the research gap was identified. It is critical to identify the research gap in order to understand where this research fits into the existing literature and to emphasise the contribution of this research. This chapter is also particularly important to develop the framework of the technical analysis.

The third chapter is the research and methodology. The theoretical analysis that underpins the concept of this research was discussed in further detail in this chapter. In addition, a complete description of the methodology, model formulation, estimating approach, and data collection procedure was all described in length. Specifically, the modelling technique used for the first objective was based on the gravity model of international trade. This is the model that is most frequently employed in empirical international trade studies. The second and third objectives were estimated based on the dynamic panel data.

The findings and conclusions of this study are presented in the fourth chapter of this research. Specifically, it shows the results of data analysis and empirical estimation. In this chapter, the main findings based on the technical analysis were discussed based on the economic theory and previous works of literature. The final chapter is the conclusion and policy recommendations. This chapter contains a summary of the study work, policy recommendations, and ideas for the future research agenda.

REFERENCES

Abramovitz, M. (1986). Catching up, forging ahead, and falling behind. *Journal of Economic History*, *46*(2), 385-406.

Acemoglu, D., & Autor, D. (2011). *Skills, tasks and technologies: Implications for employment and earnings*. NBER Working Paper No. 16082. National Bureau of Economic Research.

Acemoglu, D., & Restrepo, P. (2018). *Artificial intelligence, automation and work*. NBER Working Paper Series No. 24196. National Bureau of Economic Research. https://www.nber.org/papers/w24196

Acharya, R. C., & Keller, W. (2009). Technology transfer through imports. *Canadian Journal of Economics/Revue Canadienne D'économique*, *42*(4), 1411-1448.

Aiginger, K. (1998). A framework for evaluating the dynamic competitiveness of countries. *Structural Change and Economic Dynamics*, *9*(2), 159-188.

Aiginger, K. (2006). Competitiveness: from a dangerous obsession to a welfare creating ability with positive externalities. *Journal of Industry, Competition and Trade*, *6*(2), 161-177.

Almeida, R., Leite Corseuil, C. H., & Poole, J. (2017). *The impact of digital technologies on routine tasks: do labor policies matter?*. World Bank Policy Research Working Paper No. 8187. World Bank, Washington, DC.

Alvarez, I., & Marin, R. (2013). FDI and technology as levering factors of competitiveness in developing countries. *Journal of International Management*, *19*(3), 232-246.

Amin, R. M., Hamid, Z., & Saad, N. M. (2005). Economic integration among the members of the League of Arab States: an empirical evidence. *Journal of Economic Cooperation*, *26*(3), 77-102.

Amurgo-Pacheco, A. (2007). *Patterns of export diversification in developing countries*. World Bank Policy Research Working Paper No 4473. World Bank. and an application to employment equations. *The Review of Economic Studies*, *58*(2), 277-297.

Anderson, J. E. (1979). A theoretical foundation for the gravity equation. *The American Economic Review*, *69*(1), 106-116.

Anderson, J. E., & Van Wincoop, E. (2003). Gravity with gravitas: a solution to the border puzzle. *American Economic Review*, *93*(1), 170-192.

Archibugi, D., & Coco, A. (2004). A new indicator of technological capabilities for developed and developing countries (ArCo). *World Development*, *32*(4), 629-654.

Arellano, M., & Bond, S. (1991). Some tests of specification for panel data: Monte Carlo evidence and an application to employment equations. The review of economic studies, 58(2), 277-297.

Arrow, K. J. (1962). The economic implications of learning by doing. *The Review of Economic Studies*, 29, 155-123.

Artto, E. W. (1987). Relative total costs: an approach to competitiveness measurement of industries. *Management International Review*, *27*, 47-58.

Aswicahyono, H. H., Brooks, D., & Manning, C. (2011). *Exports and employment in Indonesia: The decline in labor-intensive manufacturing and the rise of services*. Asian Development Bank Economics Working Paper Series No. 279. Asian Development Bank (ADB), Manila, http://hdl.handle.net/11540/1997

Atalay, E., Phongthiengtham, P., Sotelo, S., & Tannenbaum, D. (2018). New technologies and the labor market. *Journal of Monetary Economics*, *97*, 48-67.

Atkin, D., Khandelwal, A. K., & Osman, A. (2017). Exporting and firm performance: Evidence from a randomized experiment. *The Quarterly Journal of Economics*, *132*(2), 551-615.

Autor, D. H., Levy, F., & Murnane, R. J. (2003). The skill content of recent technological change: An empirical exploration. *The Quarterly Journal of Economics*, *118*(4), 1279-1333.

Baier, S. L., & Bergstrand, J. H. (2007). Do free trade agreements actually increase members' international trade?. *Journal of International Economics*, *71*(1), 72-95.

Baier, S. L., & Bergstrand, J. H. (2009). Bonus vetus OLS: A simple method for approximating international trade-cost effects using the gravity equation. *Journal of International Economics*, *77*(1), 77-85.

Baier, S. L., Bergstrand, J. H., & Feng, M. (2014). Economic integration agreements and the margins of international trade. *Journal of International Economics*, *93*(2), 339-350.

Baier, Scott L.; Kerr, Amanda; Yotov, Yoto V. (2017) : Gravity, Distance, and International Trade, CESifo Working Paper, No. 6357, Center for Economic Studies and ifo Institute (CESifo), Munich

Balassa, B. (1967). Trade creation and trade diversion in the European Common Market. *The Economic Journal*, *77*(305), 1-21.

Baldwin, R., & Taglioni, D. (2006). *Gravity for dummies and dummies for gravity equations*. NBER Working Paper Series No. 12516. National Bureau of Economic Research. https://www.nber.org/papers/w12516

Baldwin, R., Gonzalez, A., Jackson, S., Murphy, K., Sally, R., & Singh, V. H. (2015). *The Case for Trade and Competitiveness*. World Economic Forum. Retrieved from http://www3.weforum.org/docs/WEF_GAC_Competitiveness_2105.pdf

Barro, R. J. (2003). Determinants of economic growth in a panel of countries. *Annals Of Economics and Finance*, *4*, 231-274.

Batra, A. (2006). India's global trade potential: The gravity model approach. *Global Economic Review*, *35*(3), 327-361.

Baumol, W. J. (1967). Macroeconomics of unbalanced growth: the anatomy of urban crisis. *The American Economic Review*, *57*(3), 415-426.

Belitz, H., & Mölders, F. (2016). International knowledge spillovers through high-tech imports and R&D of foreign-owned firms. *The Journal of International Trade & Economic Development*, *25*(4), 590-613.

Bergstrand, J. H. (1985). The gravity equation in international trade: some microeconomic foundations and empirical evidence. *The Review of Economics and Statistics*, *67*(3), 474-481.

Bergstrand, J. H., Egger, P., & Larch, M. (2013). Gravity Redux: Estimation of gravity- equation coefficients, elasticities of substitution, and general equilibrium comparative statics under asymmetric bilateral trade costs. *Journal of International Economics*, *89*(1), 110-121.

Berman, E., Bound, J., & Machin, S. (1998). Implications of skill-biased technological change: international evidence. *The Quarterly Journal of Economics*, *113*(4), 1245-1279.

Beverelli, C., Neumueller, S., & Teh, R. (2015). Export diversification effects of the WTO trade facilitation agreement. *World Development*, *76*, 293-310.

Bhaduri, S., & Ray, A. S. (2004). Exporting through technological capability: Econometric evidence from India's pharmaceutical and electrical/electronics firms. *Oxford Development Studies*, *32*(1), 87-100.

Biscourp, P., & Kramarz, F. (2007). Employment, skill structure and international trade: Firm-level evidence for France. *Journal of International Economics*, *72*(1), 22-51.

Bisztray, M., Koren, M., & Szeidl, A. (2018). Learning to import from your peers. *Journal of International Economics*, *115*, 242-258.

Blundell, R., & Bond, S. (1998). Initial conditions and moment restrictions in dynamic panel data models. *Journal of Econometrics*, *87*(1), 115-143.

Bogliacino, F., Piva, M., & Vivarelli, M. (2012). R&D and employment: An application of the LSDVC estimator using European microdata. *Economics Letters*, *116*(1), 56-59.

Braunerhjelm, P., & Thulin, P. (2008). Can countries create comparative advantages? R&D expenditures, high-tech exports and country size in 19 OECD countries, 1981–1999. *International Economic Journal*, *22*(1), 95-111.

Breene, K. (2016). *What is 'networked readiness' and why does it matter*. World Economic Forum. Retrieved from https://www.weforum.org/agenda/2016/07/what-is-networked-readiness-and-why-does-it-matter/

Bresson, G., Kramarz, F., & Sevestre, P. (1992). Dynamic labour demand models. In Mátyás L. & Sevestre P. (Eds.) *The Econometrics of Panel Data. Advanced Studies in Theoretical and Applied Econometrics* (Vol. 33., pp. 660-684). Springer, Dordrecht.

Bruno, G. S. (2005a). Approximating the bias of the LSDV estimator for dynamic unbalanced panel data models. *Economics Letters*, *87*(3), 361-366.

Bruno, G. S. (2005b). Estimation and inference in dynamic unbalanced panel-data models with a small number of individuals. *The Stata Journal*, *5*(4), 473-500.

Buckley, P. J., Pass, C. L., & Prescott, K. (1988). Measures of international competitiveness: a critical survey. *Journal of Marketing Management*, *4*(2), 175-200.

Bun, M. J., & Kiviet, J. F. (2003). On the diminishing returns of higher-order terms in asymptotic expansions of bias. *Economics Letters*, *79*(2), 145-152.

Burger, M., Van Oort, F., & Linders, G. J. (2009). On the specification of the gravity model of trade: zeros, excess zeros and zero-inflated estimation. *Spatial Economic Analysis*, *4*(2), 167-190.

Busse, M., & Groizard, J. L. (2008). Technology trade in economic development. *World Economy*, *31*(4), 569-592.

Chang, C. L., Chen, S. P., & McAleer, M. (2013). Globalization and knowledge spillover: international direct investment, exports and patents. *Economics of Innovation and New Technology*, *22*(4), 329-352.

Chang, Y. T., Jo, A., Choi, K. S., & Lee, S. (2020). Port efficiency and international trade in China. *Transportmetrica A: Transport Science*, 1-23.

Charrass, A. (2017). New Criticism on the Competitiveness Concept: A Critical Review of the Concept at the Macroeconomic Level. *International Journal of Economics and Finance*, *9*(1), 190-193.

Chen, H., He, P., Zhang, C. X., & Liu, Q. (2017). Efficiency of technological innovation in China's high-tech industry based on DEA method. *Journal of Interdisciplinary Mathematics*, *20*(6-7), 1493-1496.

Chen, W. C. (2012). Innovation and duration of exports. *Economics Letters*, *115*(2), 305-308.

Chen, W. C. (2013). The extensive and intensive margins of exports: The role of innovation. *The World Economy*, *36*(5), 607-635.

Cheong, J., Kwak, D. W., & Tang, K. K. (2014). The WTO puzzle, multilateral resistance terms and multicollinearity. *Applied Economics Letters*, *21*(13), 928-933.

Cirera, X., Marin, A., & Markwald, R. (2015). Explaining export diversification through firm innovation decisions: The case of Brazil. *Research Policy*, *44*(10), 1962-1973.

Cirillo, V. (2017). Technology, employment and skills. *Economics of Innovation and New Technology*, *26*(8), 734-754.

Clark, T. (1991). The Competitive Advantage of Nations [Review of the Competitive Advantage of Nations, by M. E. Porter]. *Journal of Marketing*, 118–20.

Coe, D. T., Helpman, E., & Hoffmaister, A. W. (1997). North-south R & D spillovers. *The Economic Journal*, *107*(440), 134-149.

Csath, M. (2007). The competitiveness of economies: Different views and arguments. *Society and Economy*, *29*(1), 87-102.

Czaika, M., & Parsons, C. R. (2017). The gravity of high-skilled migration policies. *Demography*, *54*(2), 603-630.

Dalton, J. T. (2014). The new goods margin in Japanese–Chinese trade. *Japan and The World Economy*, *31*, 8-13.

Dang, V. A., Kim, M., & Shin, Y. (2015). In search of robust methods for dynamic panel data models in empirical corporate finance. *Journal of Banking & Finance*, *53*, 84-98.

David, H., Katz, L. F., & Kearney, M. S. (2006). The polarization of the US labor market. *American Economic Review*, *96*(2), 189-194.

Davidson, C., Martin, L., & Matusz, S. (1999). Trade and search generated unemployment. *Journal of International Economics*, *48*(2), 271-299.

Davies, H., & Ellis, P. (2000). Porter's competitive advantage of nations: time for the final judgement?. *Journal of Management Studies*, *37*(8), 1189-1214.

Dayasindhu, N. (2002). Embeddedness, knowledge transfer, industry clusters and global competitiveness: a case study of the Indian software industry. *Technovation*, *22*(9), 551-560.

De Benedictis, L. D., & Taglioni, D. (2011). The gravity model in international trade. In De Benedictis, L., Salvatici, L. (Eds.) *The Trade Impact of European Union Preferential Policies: An Analysis Through Gravity Models* (pp. 55-89). Springer, Berlin, Heidelberg.

Deardorff, A. V. (1998). Determinants of bilateral trade: does gravity work in a neoclassical world?. In J.A Frankel (Ed.), *The Regionalization of The World Economy* (pp.7-32). Chicago, Il: University of Chicago Press.

Debaere, P., & Mostashari, S. (2010). Do tariffs matter for the extensive margin of international trade? An empirical analysis. *Journal of International Economics*, *81*(2), 163-169.

Delgado, M., Ketels, C., Porter, M. E., & Stern, S. (2012). *The determinants of national competitiveness.* NBER Working Paper No. 16082. National Bureau of Economic Research. https://www.nber.org/papers/w18249

Demir, O. (2018). Does High Tech Exports Really Matter for Economic Growth A Panel Approach for Upper Middle-Income Economies. *AJIT-e:Online Academic Journal of Information Technology*, *9*(30), 43.

Dennis, A., & Shepherd, B. (2007). Barriers to entry, trade costs, and export diversification in developing countries. *The World Bank Policy Research Working Paper*, *4*(368), 1-40.

Dion, M. E., & Parlinggoman, J. (2017). The Role of High-Tech Exports and of Foreign Direct Investments (FDI) on Economic Growth. *European Research Studies*, *20*(4A), 194-212.

Dohse, D., & Niebuhr, A. (2018). How different kinds of innovation affect exporting. *Economics Letters*, *163*, 182-185.

Dollar, D. (1986). Technological innovation, capital mobility, and the product cycle in North-South trade. *The American Economic Review*, *76*(1), 177-190.

Dutt, P., Mihov, I., & Van Zandt, T. (2013). The effect of WTO on the extensive and the intensive margins of trade. *Journal of International Economics*, *91*(2), 204-219.

Eaton, J., & Kortum, S. (1999). International technology diffusion: Theory and measurement. *International Economic Review*, *40*(3), 537-570.

Eaton, J., & Kortum, S. (2001). Technology, trade, and growth: A unified framework. *European Economic Review*, *45*(4-6), 742-755.

Eaton, J., & Kortum, S. (2002). Technology, geography, and trade. *Econometrica*, *70*(5), 1741-1779.

Eaton, J., Kortum, S., & Kramarz, F. (2004). Dissecting trade: Firms, industries, and export destinations. *American Economic Review*, *94*(2), 150-154.

Echeverri-Carroll, E. L., Oden, M. D., Gibson, D. V., & Johnston, E. A. (2018). Unintended consequences on gender diversity of high-tech growth and labor market polarization. *Research Policy*, *47*(1), 209-217.

Edwards, S. M. (2001). The Technology Paradox: Efficiency Versus Creativity. *Creativity Research Journal*, 13(2), 221–228

Egger, P. (2000). A note on the proper econometric specification of the gravity equation. *Economics Letters*, *66*(1), 25-31.

Egger, P., & Pfaffermayr, M. (2003). The proper panel econometric specification of the gravity equation: A three-way model with bilateral interaction effects. *Empirical Economics*, *28*(3), 571-580.

Eurostat. (2006). *Eurostat indicators on High-tech industry and Knowledge – intensive services: Annex 4 – High-tech aggregation by SITC Rev.3*. European Statistical Office Retrieved from: https://ec.europa.eu/eurostat/cache/metadata/Annexes/htec_esms_an4.pdf

Fagerberg, J. (1988). International competitiveness. *The Economic Journal*, *98*(391), 355-374.

Fagerberg, J. (1996). Technology and competitiveness. *Oxford Review of Economic Policy*, *12*(3), 39-51.

Fagerberg, J., Srholec, M., & Knell, M. (2007). The competitiveness of nations: Why some countries prosper while others fall behind. *World Development*, *35*(10), 1595-1620.

Falk, M. (2009). High-tech exports and economic growth in industrialized countries. *Applied Economics Letters*, *16*(10), 1025-1028.

Falvey, R., Foster, N., & Greenaway, D. (2009). Trade, imitative ability and intellectual property rights. *Review of World Economics*, *145*(3), 373-404.

Feenstra, R. C. (2016). *Advanced International Trade: Theory and Evidence (Second Edition)*. Princeton University Press.

Feenstra, R. C., & Sasahara, A. (2018). The 'China shock,'exports and US employment: A global input–output analysis. *Review of International Economics*, *26*(5), 1053-1083.

Feenstra, R. C., Ma, H., & Xu, Y. (2019). US exports and employment. *Journal of International Economics*, *120*, 46-58.

Feenstra, R.C. (2004). *Advanced International Trade: Theory and Evidence*. Princeton University Press, Princeton, NJ.

Fidrmuc, J., Fidrmuc, J. Foreign languages and trade: evidence from a natural experiment. Empir Econ 50, 31–49.

Filippini, C., & Molini, V. (2003). The determinants of East Asian trade flows: a gravity equation approach. *Journal of Asian Economics*, *14*(5), 695-711.

Flam, H., & Helpman, E. (1987). Vertical product differentiation and North-South trade. *The American Economic Review*, 810-822.

Fonseca, T., Lima, F., & Pereira, S. C. (2018). Job polarization, technological change and routinization: Evidence for Portugal. *Labour Economics*, *51*, 317-339.

Foster, N. (2012). Preferential trade agreements and the margins of imports. *Open Economies Review*, *23*(5), 869-889.

Foster, N., Poeschl, J., & Stehrer, R. (2011). The impact of preferential trade agreements on the margins of international trade. *Economic Systems*, *35*(1), 84-97.

Frankel, M. (1962). The production function in allocation and growth: a synthesis. *The American Economic Review*, *52*(5), 996-1022.

Freeman, C. (2004). Technological infrastructure and international competitiveness. *Industrial and Corporate Change*, *13*(3), 541-569.

Fu, D., Wu, Y., & Tang, Y. (2012). Does innovation matter for Chinese high-tech exports? A firm-level analysis. *Frontiers of Economics in China*, *7*(2), 218-245.

Fu, X., & Balasubramanyam, V. N. (2005). Exports, foreign direct investment and employment: The case of China. *World Economy*, *28*(4), 607-625.

Gani, A. (2009). Technological achievement, high technology exports and growth. *Journal of Comparative International Management*, *12*(2), 31-47.

Gao, S. (2009). *The predictive capacity of gravity model of trade and foreign direct investment*. Nationalekonomiska Institutionen, Uppsala Universitet, Uppsala, HT 2008.

Gökmen, Y., & Turen, U. (2013). The determinants of high technology exports volume: A panel data analysis of EU-15 countries. *International Journal of Management, Economics and Social Sciences*, *2*(3), 217-232.

Goldar, B. (2013). R&D intensity and exports: a study of Indian pharmaceutical firms. *Innovation and Development*, *3*(2), 151-167.

Goos, M., & Manning, A. (2007). Lousy and lovely jobs: The rising polarization of work in Britain. *The Review of Economics and Statistics*, *89*(1), 118-133.

Goos, M., Manning, A., & Salomons, A. (2009). Job polarization in Europe. *American Economic Review*, *99*(2), 58-63.

Goos, M., Manning, A., & Salomons, A. (2014). Explaining job polarization: Routine-biased technological change and offshoring. *American Economic Review*, *104*(8), 2509-26.

Green, A. (2019). *What is happening to middle skill workers?.* OECD Social, Employment and Migration Working Papers No. 230. OECD Publishing, Paris.

Greenaway, D., Hine, R. C., & Wright, P. (1999). An empirical assessment of the impact of trade on employment in the United Kingdom. *European Journal of Political Economy*, *15*(3), 485-500.

Greene, W. (2013). *Export Potential for US Advanced Technology Goods to India Using a Gravity Model Approach*. US International Trade Commission, Working Paper No. 2013-03B), 1-43.

Grossman, G. M., & Helpman, E. (1989). Product development and international trade. *Journal of Political Economy*, *97*(6), 1261-1283.

Grossman, G. M., & Helpman, E. (1991). Quality ladders in the theory of growth. *The Review of Economic Studies*, *58*(1), 43-61.

Ha, H. V., & Tran, T. Q. (2017). International trade and employment: A quantile regression approach. *Journal of Economic Integration*, *32*(3), 531-557.

Haakonsson, S. J. (2009). 'Learning by importing'in global value chains: upgrading and South–South strategies in the Ugandan pharmaceutical industry. *Development Southern Africa*, *26*(3), 499-516.

Hair, J. F., Black, W. C., Babin, B. J., & Anderson, R. E. (2009). *Multivariate Data Analysis*. Upper Saddle River, NJ: Prentice Hall.

Hale, G., & Hobijn, B. (2011). *The US content of "Made in China".* FRBSF Economic Letter: A Pacific Basin Note.

Hallward-Driemeier, M., & Nayyar, G. (2017). *Trouble in the making?: The future of manufacturing-led development*. World Bank Publications.

Harrigan, J., Reshef, A., & Toubal, F. (2020). The march of the techies: Job polarization within and between firms. *Research Policy*, 104008, 1-13.

Haskel, J., & Heden, Y. (1999). Computers and the demand for skilled labour: industry-and establishment-level panel evidence for the UK. *The Economic Journal*, *109*(454), 68-79.

Hatzichronoglou, T. (1997). *Revision of the high-technology sector and product classification*. OECD Science, Technology and Industry Working Papers No. 1997/02. OECD Publishing, Paris.

Hausman, J. A & Pinkovskiy, M. L. (2017). Estimating dynamic panel models: Backing out the Nickell Bias, cemmap working paper, No. CWP53/17, Centre for Microdata Methods and Practice, London.

Head, K. and Mayer, T. (2014). Gravity equations: Workhorse, toolkit, and cookbook. Chapter 3 in the Handbook of International Economics Vol. 4, eds. Gita Gopinath, Elhanan Helpman, and Kenneth S. Rogoff, Elsevier Ltd., Oxford.

Head, K., & Mayer, T. (2014). Gravity equations: Workhorse, toolkit, and cookbook. In *Handbook of International Economics* (Vol. 4, pp. 131-195). Elsevier.

Helga, K. (2017). Country Competitiveness: An Empirical Study, *Baltic Region*, 9(2), 31-44.

Helpman, E., & Krugman, P. R. (1985). *Market structure and foreign trade: Increasing returns, imperfect competition, and the international economy*. MIT Press.

Helpman, E., Melitz, M., and Rubinstein, Y. (2008). Estimatng Trade Flows: Trading Partners and Trading Volumes. *Quarterly Journal of Economics*, 123(2), 441–487.

Herath, H. M. S. P. (2014). The Impact of International Trade on Employment Generation: A Sri Lankan Experience. *International Journal of Economics, Commerce and Management*, *2*(7), 1-8.

Hesse, H. (2008). *Export Diversification and Economic Growth*. Commission on Growth and Development Working Paper; No. 21. World Bank, Washington, DC. © World Bank.

Hoekman, B., & Winters, L. A. (2005). *Trade and Employment: Stylized Facts and Research Findings*. World Bank Policy Research Working Paper No. 3676). 1-36.

Hummels, D. (1999). *Toward a Geography of Trade Costs*. GTAP Working Paper No. 17. Global Trade Analysis Project. http://www.krannert.purdue.edu/faculty/hummelsd/research/toward/tgtc.pdf .

Hummels, D., & Klenow, P. J. (2005). The variety and quality of a nation's exports. *American Economic Review*, *95*(3), 704-723.

Idris, Z. Z., Ismail, N. W., Ibrahim, S., & Hamzah, H. Z. (2020). The impact of high-technology trade on employment. *The Journal of International Trade & Economic Development*, 1-18.

ILO. (2014). *Skilled Labour: A determining factor for sustainable growth of the nation*. Policy Brief No.1. International Labour Organization.

ILO. (2015). Employment by occupation. International Labour Organization. Retrieved from https://www.ilo.org/global/statistics-and-databases/research-and-databases/kilm/WCMS_422410/lang--en/index.htm

Inotai, A. (1988). International Competitiveness and Imports. *Acta Oeconomica, 39(1-2), 45–60.*

Ismail, N. W. (2009). *The determinant of foreign direct investment in ASEAN: a semi-gravity approach. Transition Studies Review*, 16 (3), 710-722.

Ismail, N. W. (2013). Innovation and high-tech trade in Asian countries. In *Proceedings from International Conference on Recent Developments in Asian Trade Policy and Integration* (pp. 1-19).

Ivus, O. (2010). Do stronger patent rights raise high-tech exports to the developing world?. *Journal of International Economics*, *81*(1), 38-47.

Jarreau, J., & Poncet, S. (2012). Export sophistication and economic growth: Evidence from China. *Journal of Development Economics*, *97*(2), 281-292.

Jayasinghe, S., Beghin, J. C., & Moschini, G. (2017). Determinants of world demand for US corn seeds: the role of trade costs. In Beghin, J. C. (Eds). *Nontariff Measures and International Trade* (pp. 309-320). World Scientific Publishing Company.

Jin, C., Lee, S., & Hwang, J. (2019). The impact of import and export on unemployment: a cross-national analysis. *International Journal of Sustainable Economy*, *11*(4), 347-363.

Judson, R. A., & Owen, A. L. (1999). Estimating dynamic panel data models: a guide for macroeconomists. *Economics Letters*, *65*(1), 9-15.

Kabaklarli, E., Duran, M. S., & Üçler, Y. T. (2017). The Determinants Of High-Technology Exports: A Panel Data Approach for Selected OECD Countries. *Dubrovnik International Economic Meeting 3*(1), 888-900.

Kahouli, B., & Maktouf, S. (2015). The determinants of FDI and the impact of the economic crisis on the implementation of RTAs: A static and dynamic gravity model. *International Business Review*, *24*(3), 518-529.

Kaiser, U. (2000). New technologies and the demand for heterogeneous labor: firm-level evidence for the German business-related service sector. *Economics of Innovation and New Technology*, *9*(5), 465-486.

Kalanje, C. M. (2006). *Role of intellectual property in innovation and new product development*. World Intellectual Property Organization. http://www.wipo.int/sme /en/documents/ip_innovation _development_fulltext.html

Kaldor, N. (1978). The effect of devaluations on trade in manufactures. In *Further Essays on Applied Economics* (pp. 99-118). London: Duckworth.

Kale, D., & Little, S. (2007). From imitation to innovation: The evolution of R&D capabilities and learning processes in the Indian pharmaceutical industry. *Technology Analysis & Strategic Management*, *19*(5), 589-609.

Kareem, F. O., Martinez-Zarzoso, I., & Brümmer, B. (2016). *Fitting the gravity model when zero trade flows are frequent: A comparison of estimation techniques using Africa's trade data*. Global Food Discussion Papers No. 858-2016-60260. Georg-August-University of Göttingen.

Karemera, D., Oguledo, V. I., & Davis, B. (2000). A gravity model analysis of international migration to North America. *Applied Economics*, *32*(13), 1745-1755.

Katila, R. (2000). Using patent data to measure innovation performance. *International Journal of Business Performance Management*, *2*(1-3), 180-193.

Keele, L., & Kelly, N. J. (2006). Dynamic models for dynamic theories: The ins and outs of lagged dependent variables. *Political Analysis*, *14*(2), 186-205.

Kehoe, T. J., & Ruhl, K. J. (2013). How important is the new goods margin in international trade?. *Journal of Political Economy*, *121*(2), 358-392.

Kehoe, T. J., Rossbach, J., & Ruhl, K. J. (2015). Using the new products margin to predict the industry-level impact of trade reform. *Journal of International Economics*, *96*(2), 289-297.

Keller, W., & Utar, H. (2016). *International trade and job polarization: Evidence at the worker-level*. NBER Working Paper No. 22315. National Bureau of Economic Research.

Khadaroo, J., & Seetanah, B. (2008). The role of transport infrastructure in international tourism development: A gravity model approach. *Tourism Management*, *29*(5), 831-840.

Khayat, S. H. (2019). A gravity model analysis for trade between the GCC and developed countries. *Cogent Economics & Finance*, *7*(1), 1703440.

Kinoshita, Y. (2000). *R&D and technology spillovers via FDI: Innovation and absorptive capacity*. CERGE-EI Working Papers No.163. The Center for Economic Research and Graduate Education - Economics Institute, Prague.

Kis-Katos, K., & Sparrow, R. (2015). Poverty, labor markets and trade liberalization in Indonesia. *Journal of Development Economics*, *117*, 94-106.

Kiviet, J. F. (1995). On bias, inconsistency, and efficiency of various estimators in dynamic panel data models. *Journal of Econometrics*, *68*(1), 53-78.

Kiyota, K. 2016. Exports and Employment in China, Indonesia, Japan, and Korea. *Asian Economic Papers*, *13*(3), 30-58.

Kline, R. B. (1998). *Principles and practice of structural equation modeling*. New York, NY: The Guilford Press

Kohl, T., Brakman, S., & Garretsen, H. (2016). Do trade agreements stimulate international trade differently? Evidence from 296 trade agreements. *The World Economy*, *39*(1), 97-131.

Krüger, J. 2013. *The Role of International Trade in Employment Growth in Micro- and Small Enterprises: Evidence from Developing Asia*. ADB Working Paper Series on Regional Economic Integration No. 115. Asian Development Bank (ADB), Manila.

Krugman, P. (1979). A model of innovation, technology transfer, and the world distribution of income. *Journal of Political Economy*, *87*(2), 253-266.

Krugman, P. (1980). Scale economies, product differentiation, and the pattern of trade. *The American Economic Review*, *70*(5), 950-959.

Krugman, P. (1983). New theories of trade among industrial countries. *The American Economic Review*, *73*(2), 343-347.

Krugman, P. (1994). Competitiveness: a dangerous obsession. *Foreign Affairs, 73*, 28-44.

Krugman, P., Melitz, M., & Obstfeld, M. (2012). *International Economics: Theory and Policy, Global Edition*. Pearson Addison-Wesley.

Lachenmaier, S., & Wößmann, L. (2006). Does innovation cause exports? Evidence from exogenous innovation impulses and obstacles using German micro data. *Oxford Economic Papers*, *58*(2), 317-350.

Lawless, M. (2010). Deconstructing gravity: trade costs and extensive and intensive margins. *Canadian Journal of Economics/Revue Canadienne D'économique*, *43*(4), 1149-1172.

Leamer, E. E. (1980). The Leontief paradox, reconsidered. *Journal of Political Economy*, *88*(3), 495-503.

Leamer, E. E., & Levinsohn, J. (1995). International trade theory: the evidence. *Handbook of International Economics*, *3*, 1339-1394.

Lee, N., & Clarke, S. (2019). Do low-skilled workers gain from high-tech employment growth? High-technology multipliers, employment and wages in Britain. *Research Policy*, *48* (103803), 1-11.

Lei, L. (2007). The Dynamic Connection between Technology Imports and R&D: Firm Level Evidence from Industrial Large and Medium-sized Enterprises in Shanghai. *Nankai Business Review*, *3*.

Lemoine, F., & Ünal-Kesenci, D. (2004). Assembly trade and technology transfer: the case of China. *World Development*, *32*(5), 829-850.

Leontief, W. (1953). Domestic production and foreign trade; the American capital position re-examined. *Proceedings of the American Philosophical Society*, *97*(4), 332-349.

Levchenko, A. A. (2012). International trade and institutional change. *The Journal of Law, Economics, & Organization*, *29*(5), 1145-1181.

Lewer, J. J., & Van den Berg, H. (2008). A gravity model of immigration. *Economics Letters*, *99*(1), 164-167.

Linder, S. B. (1961). *An essay on trade and transformation* (pp. 82-109). Stockholm: Almqvist & Wiksell.

Linders, G. J., & De Groot, H. L. (2006). *Estimation of the gravity equation in the presence of zero flows*. Tinbergen Institute Discussion Paper, No. 06-072/3. Tinbergen Institute, Amsterdam and Rotterdam.

Linneman, H. (1969) Trade Flows and Geographical Distance, or the Importance of Being Neighbors. In H. C. Bos (Ed.) *Towards Balanced International Growth*, North Holland, Amsterdam.

Liu, W. H., & Lin, Y. C. (2005). Foreign patent rights and high-tech exports: evidence from Taiwan. *Applied Economics*, *37*(13), 1543-1555.

Liu, X. (2009). GATT/WTO promotes trade strongly: Sample selection and model specification. *Review of International Economics*, *17*(3), 428-446.

Liu, X., & Buck, T. (2007). Innovation performance and channels for international technology spillovers: Evidence from Chinese high-tech industries. *Research Policy*, *36*(3), 355- 366.

Liu, X., & Shu, C. (2003). Determinants of export performance: evidence from Chinese industries. *Economics of Planning*, *36*(1), 45-67.

Lopez-de-Silanes, F., Markusen, J. R., & Rutherford, T. F. (1994). Complementarity and increasing returns in intermediate inputs. *Journal of Development Economics*, *45*(1), 101-119.

Lucas, R. E. (1988). On the mechanics of economic development. *Journal of Monetary Economics*, *22*(1), 3-42.

Madsen, J. B. (2008). Innovations and manufacturing export performance in the OECD countries. *Oxford Economic Papers*, *60*(1), 143-167.

Marčeta, M., & Bojnec, Š. (2020). Drivers of global competitiveness in the european union countries in 2014 and 2017. *Organizacija, 53*(1), 37-52.

Marchant, G. E., Stevens, Y. A., & Hennessy, J. M. (2014). Technology, unemployment & policy options: Navigating the transition to a better world. *Journal of Evolution and Technology*, *24*(1), 26-44.

Martínez-Zarzoso, I., & Nowak-Lehmann, F. (2003). Augmented gravity model: An empirical application to Mercosur-European Union trade flows. *Journal of Applied Economics*, *6*(2), 291-316.

Maskus, K. E., & Yang, L. (2018). Domestic patent rights, access to technologies and the structure of exports. *Canadian Journal of Economics/Revue Canadienne D'économique*, *51*(2), 483-509.

Matyas, L., Konya, L., & Harris, M. N. (2004). Modelling export activity of eleven APEC countries, 1978-1997. *Applied Econometrics and International Development*, *4*(4), 85-100.

Maxwell, N. L. (2006). Low-Skilled Jobs: The Reality Behind the Popular Perceptions. In The *Working Life: The Labor Market for Workers in Low-Skilled Jobs (*pp. 1-23). Kalamazoo, MI: W.E. Upjohn Institute for Employment Research.

McCallum, J. (1995). National borders matter: Canada-US regional trade patterns. *The American Economic Review*, *85*(3), 615-623.

McGuire, S., & Islam, N. (2015). Indigenous technological capabilities, emerging market firms and the aerospace industry. *Technology Analysis & Strategic Management*, *27*(7), 739-758.

Mehrara, M., Seijani, S., & Karsalari, A. R. (2017). Determinants of high-tech export in developing countries based on Bayesian model averaging. *Journal of Economics and Business*, *35*(1), 199-215.

Melitz, J. (2008). Language and foreign trade. *European Economic Review*, *52*(4), 667-699.

Meschi, E., & Vivarelli, M. (2009). Trade and income inequality in developing countries. *World Development*, *37*(2), 287-302.

Mishra, B., Ghosh, S., & Kanjilal, K. (2020). Evaluation of import substitution strategy in Indian telecom sector: Empirical evidence of non-linear dynamics. *Telecommunications Policy*, *44*(7), 1-20.

Moore, M. P., & Ranjan, P. (2005). Globalisation vs Skill-Biased Technological Change: Implications for Unemployment and Wage Inequality. *The Economic Journal*, *115*(503), 391-422.

Morley, C., Rosselló, J., & Santana-Gallego, M. (2014). Gravity models for tourism demand: theory and use. *Annals of Tourism Research*, *48*, 1-10.

Mudambi, R. (2008). Location, control and innovation in knowledge-intensive industries. *Journal of Economic Geography*, *8*(5), 699-725.

Muller, D., & Wei, W. W. (1997). Iterative least squares estimation and identification of the transfer function model. *Journal of Time Series Analysis*, *18*(6), 579-592.

Nguyen, X. D. (2014). Effects of Japan's Economic Partnership Agreements on the Extensive Margin of International Trade. *The International Trade Journal*, *28*(2), 169-191.

Njikam, O. (2016). Trade liberalization, labor market regulations and labor demand in Cameroon. *International Review of Economics & Finance*, *43*, 525-541.

Ocampo, J. A., & Taylor, L. (1998). Trade liberalisation in developing economies: modest benefits but problems with productivity growth, macro prices, and income distribution. *The Economic Journal*, *108*(450), 1523-1546.

OECD. (2009). *Innovation in Firms: A Microeconomic Perspective.* OECD Publishing, Paris. Retrieved from *https://doi.org/10.1787/9789264056213-en.*

Ohlin, B. (1935). *Interregional and international trade*. Harvard University Press, Cambridge.

Okun, A. M. (1962). *Potential GNP: Its Measurement and Significance*. Proceedings of the Business and Economics Section of the American Statistical Association, Washington, DC: American Statistical Association, 98-104.

Olivero, M. P., & Yotov, Y. V. (2012). Dynamic gravity: endogenous country size and asset accumulation. *Canadian Journal of Economics/Revue Canadienne D'économique*, *45*(1), 64-92.

Onsel, S., Ulengin, F., Ulusoy, G., Aktaş, E., Kabak, O., & Topcu, Y. I. (2008). A new perspective on the competitiveness of nations. *Socio-Economic Planning Sciences*, *42*(4), 221-246.

Panda, S., Sharma, R., & Park, W. G. (2020). Patent protection, technological efforts, and exports: An empirical investigation. *The Journal of Developing Areas*, *54*(2), 145-162.

Pantea, S., Sabadash, A., & Biagi, F. (2017). Are ICT displacing workers in the short run? Evidence from seven European countries. *Information Economics and Policy*, *39*, 36-44.

Persson, M. (2013). Trade facilitation and the extensive margin. *The Journal of International Trade & Economic Development*, *22*(5), 658-693.

Peter, L., Hajek, L., Maresova, P., Augustynek, M., & Penhaker, M. (2020). Medical devices: Regulation, risk classification, and open innovation. *Journal of Open Innovation: Technology, Market, and Complexity*, *6*(42), 1-13.

Piermartini, R., & Yotov, Y. (2016). *Estimating trade policy effects with structural gravity*. WTO Staff Working Paper No. ERSD-2016-10. World Trade Organization (WTO), Geneva.

Piva, M., & Vivarelli, M. (2018). Is innovation destroying jobs? Firm-level evidence from the EU. *Sustainability*, *10* (1279), 1-16.

Porter, M. E. (1990). The Competitive Advantage of Nations. *Harvard Business Review, 68 (2), 73-93.*

Porter, M. E., & Stern, S. (2001). National innovative capacity. In *The global competitiveness Report 2002* (pp.102-118). World Economic Forum.

Portugal-Perez, A., & Wilson, J. S. (2012). Export performance and trade facilitation reform: Hard and soft infrastructure. *World Development*, *40*(7), 1295-1307.

Pöyhönen, P. (1963). A tentative model for the volume of trade between countries. *Weltwirtschaftliches Archiv*, *16*(2), 69-78.

Rajesh, R. S. N., & Sasidharan, S. (2015). Impact of Foreign Trade on Employment and Wages in Indian Manufacturing. *South Asia Economic Journal*, *16*(2), 209–32.

Razavi, S., Mostafa, G., Rohollah, A. B., & Kashani, M. (2011). Relationship between technological readiness and innovation: A secondary analysis of countries global competitiveness. *European Journal of Scientific Research*, *59*(3), 318-328.

Revenga, A. L. (1992). Exporting jobs? The impact of import competition on employment and wages in US manufacturing. *The Quarterly Journal of Economics*, *107*(1), 255-284.

Ricardo, D. (1817). *On the Principles of Political Economy and Taxation.* London: Dent.

Roberts, B., & Wolf, M. (2018). *High-tech industries: An analysis of employment, wages, and output*. Bureau of Labor Statistics, Beyond the Numbers: Employment & Unemployment Vol. 7(7). U.S. Bureau of Labor Statistics.

Roberts, E. B. (1987). *Technological innovation and medical devices.* Symposium on New Medical Devices: Factors Influencing Invention, Development, and Use. Washington D.C.

Romer, P. M. (1990). Endogenous technological change. *Journal of Political Economy*, *98*(5), 71-102.

Rose, A. K., & Van Wincoop, E. (2001). National money as a barrier to international trade: The real case for currency union. *American Economic Review*, *91*(2), 386-390.

Rothman, D. (2013). How technology is destroying jobs. *Technology Review* 16(4), 28-35.

Rugman, A. M., & D'cruz, J. R. (1993). The" double diamond" model of international competitiveness: The Canadian experience. *Management International Review*, *33*(2-1), 17-40.

Rusu, V. D., & Roman, A. (2018). An empirical analysis of factors affecting competitiveness of CEE countries. *Economic Research-Ekonomska Istraživanja*, *31*(1), 2044-2059.

Sabadie, J. A., & Johansen, J. (2010). How do national economic competitiveness indices view human capital?. *European Journal of Education*, *45*(2), 236-258.

Sahin, B. E. (2019). Impact of High Technology Export on Economic Growth: An Analysis on Turkey. *Journal of Business Economics and Finance*, *8*(3), 165-172.

Said, R., & Ismail, N. W. (2018). The impacts of Malaysian free trade agreements on margins of trade (Impak Perjanjian Perdagangan Bebas Malaysia ke atas margin perdagangan). *Jurnal Ekonomi Malaysia*, *52*(1), 185-194.

Salvatori, A. (2018). The anatomy of job polarisation in the UK. *Journal for Labour Market Research, 52*(1), 1-15.

Sandu, S., & Ciocanel, B. (2014). Impact of R&D and Innovation on High-tech Export. *Procedia Economics and Finance*, *15*, 80-90.

Santos Silva, J. S., & Tenreyro, S. (2006). The log of gravity. *The Review of Economics and Statistics*, *88*(4), 641-658.

Sara, T. S., Jackson, F. H., & Upchurch, L. T. (2012). Role of innovation in hi-tech-exports of a nation. *International Journal of Business and Management*, *7*(7), 85-93.

Savrul, M., & Incekara, A. (2015). The effect of R&D intensity on innovation performance: A country level evaluation. *Procedia–Social and Behavioral Sciences*, *210*(1), 388- 396.

Schneider, P. H. (2005). International trade, economic growth and intellectual property rights: A panel data study of developed and developing countries. *Journal of Development Economics*, 78, 529-547.

Schneider, P. H. (2005). International trade, economic growth and intellectual property rights: A panel data study of developed and developing countries. Journal of Development Economics , 78, 529-547.

Schumpeter, J.A. (1934). *The Theory of Economic Development*. Harvard University Press: Cambridge, MA.

Schwab, K. (2018). *The Global Competitiveness Report 2017–2018*. World Economic Forum.

Schwab, K., & Porter, M. (2008). *The global competitiveness report 2008–2009*. World Economic Forum.

Šegota, A., Tomljanović, M., & Huđek, I. (2017). Contemporary approaches to measuring competitiveness–the case of EU member states. *Journal of Economics and Business*, *35*(1), 123-150.

Sen, K. (2009). International trade and manufacturing employment: Is India following the footsteps of Asia or Africa?. *Review of development economics*, *13*(4), 765-777.

Sen, K. C., & Morgan, T. (1968). Trade Liberalization among Industrial Countries: Objectives and Alternatives. *Journal of Economic Issues, 2*(000003), 349-351.

Seung-Hoo, Y. (2008). High-technology exports and economic output: an empirical investigation. *Applied Economics Letters*, *15*(7), 523-525.

Seyoum, B. (2005). Determinants of levels of high technology exports an empirical investigation. *Journal of Competitiveness Studies*, *13*(1), 64-79.

Shepherd, B. (2016). *The gravity model of international trade: A user guide (An updated version)*. Bangkok, Thailand: United Nations Economic and Social Commissions for Asia and the Pacific.

Silva, G. M., Gomes, P. J., & Lages, L. F. (2019). Does importer involvement contribute to product innovation? The role of export market factors and intra-firm coordination. *Industrial Marketing Management*, *78*, 169-182.

Singh, J. (2008). Distributed R&D, cross-regional knowledge integration and quality of innovative output. *Research Policy*, *37*(1), 77-96.

Sirine, M. (2016). Skill biased technological changes: Case of the MENA Region. *Theoretical & Applied Economics*, *23*(3), 339-350.

Siudek, T., & Zawojska, A. (2014). Competitiveness in the economic concepts, theories and empirical research. *Acta Scientiarum Polonorum. Oeconomia*, *13*(1), 91-108.

Smith, A. (1776). *The wealth of nations*. New York: The Modern Library.

Smith, D. J., & Tranfield, D. (2005). Talented suppliers? Strategic change and innovation in the UK aerospace industry. *R&D Management*, *35*(1), 37-49.

Smith, P. J. (1999). Are weak patent rights a barrier to US exports?. *Journal of International Economics*, *48*(1), 151-177.

Soete, L. (1987). The impact of technological innovation on international trade patterns: the evidence reconsidered. *Research Policy*, *16*(2-4), 101-130.

Spulber, D. F. (2008). Innovation and international trade in technology. *Journal of Economic Theory*, *138*(1), 1-20.

Srholec, M. (2007). High-tech exports from developing countries: A symptom of technology spurts or statistical illusion?. *Review of World Economics*, *143*(2), 227-255.

Srivatsan, T. S., Manigandan, K., & Sudarshan, T. S. (2016). Additive Manufacturing of Materials: Viable Techniques, Metals, Advances, Advantages, and Applications. *Additive Manufacturing: Innovations, Advances and Applications, CRC Press, Boca Raton*, 1-48.

Stolper, W. F., & Samuelson, P. A. (1941). Protection and real wages. *The Review of Economic Studies*, *9*(1), 58-73.

Svensson, R. (2015). *Measuring innovation using patent data*. IFN Working Paper, No. 1067. Research Institute of Industrial Economics (IFN), Stockholm.

Taner, B., Oncu, S., & Civi, E. (2000). The relationship between international trade and national competitiveness. In *First International Joint Symposium on Business Administration Challenges for Business Administrators in the New Millennium: Selected Papers* (pp. 371-383).

Tebaldi, E. (2011). The determinants of high-technology exports: A panel data analysis. *Atlantic Economic Journal*, *39*(4), 343-353.

Thirlwall, A. P. (1979). 'The balance of payments constraint as an explanation of international growth rate differences.' *Banca Nazionale Del Lavoro Quarterly Review,* 32(128), 45-53.

Tinbergen J (1962), *Shaping the World Economy; Suggestions for an international economic policy*. Shaping the world economy. New York, NY: The Twentieth Century Fund.

Tomáš, V. (2011). National competitiveness and expenditure on education, research and development. *Journal of Competitiveness*, *2*, 3-10.

Tuhin, R. (2015). *Impact of international trade on employment: Evidence from Australian manufacturing industries*. Research Paper No. 2/2015. Office of the Chief Economist, Department of Industry and Science, Australian Government.

Tyagi, S., Mahajan, V., & Nauriyal, D. K. (2014). Innovations in Indian drug and pharmaceutical industry: have they impacted exports?. *Journal of Intellectual Property Rights*, *19*, 243-252.

Ueshima, Y., Funaba, T., & Inoki, T. (2006). New technology and demand for educated workers: The experience of Japanese manufacturing in the era of high-speed growth. *Journal of the Japanese and International Economies*, *20*(1), 50-76.

United Nations Development Programme (UNDP). (2001). *Human Development Report*. New York: United Nations.

Uzawa, H. (1965). Optimum technical change in an aggregative model of economic growth. *International Economic Review*, *6*(1), 18-31.

Van Roy, V., Vértesy, D., & Vivarelli, M. (2018). Technology and employment: Mass unemployment or job creation? Empirical evidence from European patenting firms. *Research Policy*, *47*(9), 1762-1776.

Vandenberg, P. (2017). *Can Trade Help Achieve the Employment Targets of the Sustainable Development Goals?*. ADBI Working Paper, No. 650. Asian Development Bank Institute (ADBI).

Vernon, R. (1966). International investment and international trade in the product cycle. *The Quarterly Journal of Economics,* 80(2), 190-207.

Veza, I., Mladineo, M., & Peko, I. (2015). *Analysis of the current state of Croatian manufacturing industry with regard to industry 4.0*. 15th International Scientific Conference on Production Engineering – CIM 2015At: Croatia, Vodice.

Viner, J. (1950). *The Customs Union Issue*. New York, NY: Carnegie Endowment for International Peace.

Wabiga, P., & Nakijoba, S. (2018). High technology exports, gross capital formation and economic growth in Uganda: a vector auto regressive approach. *International Journal of Business and Economics Research*, *7*(6), 191-202.

Wakasugi, R., & Koyata, F. (1997). R&D, firm size and innovation outputs: are Japanese firms efficient in product development?. *Journal of Product Innovation Management*, *14*(5), 383-392.

Wang, J., & Du, Y. (2017). A study of China's high-tech products trade flow and export potential based on Gravity Model. In *2017 International Conference on Service Systems and Service Management*, 1-6.

Wang, T. Y., Chien, S. C., & Kao, C. (2007). The role of technology development in national competitiveness—Evidence from Southeast Asian countries. *Technological Forecasting and Social Change*, *74*(8), 1357-1373.

Watanabe, C., Hur, J. Y., & Lei, S. (2006). Converging trend of innovation efforts in high technology firms under paradigm shift—a case of Japan's electrical machinery. *Omega*, *34*(2), 178-188.

Wei, S. J. (1996). *Intra-national versus international trade: how stubborn are nations in global integration?*. NBER Working Paper No. w5531. National Bureau of Economic Research.

Westerlund, J., & Wilhelmsson, F. (2011). Estimating the gravity model without gravity using panel data. *Applied Economics*, *43*(6), 641-649.

Wood, A. (1995). How trade hurt unskilled workers. *Journal of Economic Perspectives*, *9*(3), 57-80.

World Bank. (2008). *Global economic prospects 2008: Technology diffusion in the developing world*. The World Bank.

World Peace Foundation (n.d). *Myth 4: National arms industries are technologically innovative job creators*. Retrieved from https://sites.tufts.edu/wpf/myths-of-the-global-arms-trade-myth-4/

Wu, J., Ma, Z., & Zhuo, S. (2017). Enhancing national innovative capacity: The impact of high-tech international trade and inward foreign direct investment. *International Business Review*, *26*(3), 502-514.

Wu, J., Ma, Z., & Zhuo, S. (2017). Enhancing national innovative capacity: The impact of high-tech international trade and inward foreign direct investment. *International Business Review*, *26*(3), 502-514.

Xing, Y. (2012). *The People's Republic of China's High-Tech Exports: Myth and Reality.* ADBI Working Paper Series No. 357. Asian Development Bank Institute.

Xing, Y. (2014). China's high-tech exports: The myth and reality. *Asian Economic Papers*, *13*(1), 109-123.

Yanikkaya, H. (2013). Is trade liberalization a solution to the unemployment problem?. *Portuguese Economic Journal*, *12*(1), 57-85.

Yotov, Y. V., Piermartini, R., Monteiro, J. A., & Larch, M. (2016). *An advanced guide to trade policy analysis: The structural gravity model*. Geneva: World Trade Organization.

Zhao, H. (1995). Technology imports and their impacts on the enhancement of China's indigenous technological capability. *The Journal of Development Studies*, *31*(4), 585-602.

Zhao, Y., Wang, S., Liu, Y., Zhang, Z., Zhang, Y., & Li, H. (2017). Identifying the economic and environmental impacts of China's trade in intermediates within the Asia-Pacific region. *Journal of Cleaner Production*, *149*, 164-179.

Zoroja, J., & Bach, M. P. (2016). Editorial: Impact of information and communication technology to the competitiveness of european countries - cluster analysis approach. *Journal of Theoretical and Applied Electronic Commerce Research, 11*(1), I-X.