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EMPIRICAL INVESTIGATION OF TECHNOLOGY-INDUSTRY 4.0 RELATION OF THE EFFECT ON TRADE: AN ANALYSIS ON TURKEY

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ABSTRACT

The concept of Industry 4.0 has an important role in the change and efficiency of the foreign trade structure of developing countries. This term, which is based on technological development, will help countries to have a say in the economic conjuncture. It is necessary to develop high value-added products in order to have a say in the economy and gain commercial superiority. In this context, increasing the importance and spending of countries on technological infrastructure will contribute to the realization of economic development. The term Industry 4.0 has also emerged as a result of the economic order. Providing technological development with innovative policies provides cost advantage to companies in the production process. Products and services with high quality and functional features provide advantages for both consumers and manufacturers. Taking into consideration the environmental factors in production and low energy use rates lead to the production of products with an environmentalist approach. The fourth industrial revolution has an important place in increasing competition between countries and exiting the race for commercial superiority. At the micro level, technological developments need to be realized for consumers who care about and follow the changes in the markets, for producer who want to buy quality products at low prices and those who want to provide cost advantages. In this study where the effects of Industry 4.0 on foreign trade were analyzed, data between 1990 and 2018 were used. In this study, it has been determined that technology and Industry 4.0 will have

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positive effects on the development of foreign trade structure. There was a positive interaction between the variables used in the study.

STRUCTURED ABSTRACT

Today, Industry 4.0 is the result of focusing on how to integrate new technologies and digitize to get the manufacturing advantage. This system aims to improve the product quality, to fully adapt to the existing system and to develop a fully automated production system with minimum environmental impact, as well as to change the foreign trade structure. Exports and imports started not only as a trade of goods but also with data trade. As a result of the advantages provided by the Industrial Revolution, the amount of production increased with the smart factories supported by the concepts of cyber physical systems and the internet of objects, which affected the trade between countries. The effective use of Industry 4.0 applications has a positive impact on the export performance of countries. Increasing export figures provide surplus value in the foreign trade balance of the countries, which increases the GDP and employment of the country. In this context the aim of the study the impact of the industry 4.0 on foreign trade is to examine with the example of Turkey's.

The concept of Industry 4.0 has been studied with different components in the literature. Since the term Industry 4.0 is used together with factors such as innovation, human capital, R & D and patents, the literature is searched based on these variables.

In the study, patent applications (Ptnt), advanced technology export (Hıgt) and trade (TMrk) variables were used to represent Technology-Industry 4.0. The ratio of total exports of goods and services to GDP was taken as foreign trade data. Data for 1990-2018 were used annually. Data were compiled from World Bank, TURKSTAT and Ministry of Development. Firstly, unit root tests were applied to the variables and non-stationary variables were taken to be stationary by taking the first differences. Cointegration test was applied to the variables at the same level. Then the coefficients of the variables were interpreted with FMOLS and DOLS tests. Finally, the causality test was used to determine the direction of the relationship between the variables.

As a result of unit root tests, it was observed that the variables belonging to the series were not stationary at the level value. The first differences of the variables were taken to ensure stability. In order to prevent false causality, Johansen Co-integration test was performed with the series showing the same degree of stasis as the differences of I (1). This test was used to determine whether there was a long-term relationship between the variables and the results of the analysis were determined by the probability and co-integration values between the variables. After applying the cointegration tests, two different methods, DOLS method and FMOLS method developed by Pedroni (2000, 2001) were used to test the consistency of the estimators within our expectations in order to estimate the final deviation coefficients of this relationship. According to FMOLS and DOLS test results; There is a positive and long-term relationship between the variables. For FMOLS results, advanced technology exports has the most effect on foreign trade.

According to DOLS results, patent variable has the most effect on foreign trade. As a result of the series being equally stable, co-integration between the series is sought and in case of co-integration, the causality relationship between the series can be sought. Therefore, the causality relationship was examined by Toda Yamamoto analysis. As a result of causality analysis, it is seen that there is a causality from 1% meaning level to foreign trade to high technology export. The right causality has been found in the patent from foreign trade at the 5% level of meaning. Finally, there is a causality from advanced technology exports to patents and patents to trade marks at the 10% level of meaning.

Innovative policies introduced with the globalization process have forced sectors to keep up with the new process. Industry 4.0 is a concept that has been put forward with the developments in technology. The new process has many developments for both manufacturers and consumers. The cost and time advantage created by innovations in the production process, the fact that they take environmental factors into consideration provides advantages for companies. At the same time, the convenience of the production process helps consumers to provide easier and more optional access to the desired materials.

The technologies that Industry 4.0 needs while transforming production are; cyber-physical systems, internet of things, big data, cloud system, smart factories, three-dimensional printers, autonomous robots, augmented reality, artificial intelligence. Technological development R & D, patents, human capital and high technological products are provided by the realization of production. If the digitization current best assessment in the industry, which already produce in Turkey by medium high and medium low technology level can arrange a splash switch to more high-tech manufacturing. Both the Turkey and developed or developing countries all over the world at a time more effectively, pushing to become more efficient and more environmentally friendly 4.0 Industrial output current is an important way to reduce Turkey's foreign trade deficit.

In this study, the concepts of Technology and Industry 4.0 are discussed together and the effect of these variables on foreign trade is examined. In the summer of used time series analysis has been conducted on the basis of Turkey. After the unit root tests, cointegration analysis was performed for the variables that were stationary at the same level. In order to determine the interaction on the variables, causality analysis was performed and the results were found to be suitable for the theory. In the development process of countries like Turkey to become outstanding in foreign trade should adopt the concept of Industry 4.0. In order to create high value added products, necessary support must be given to the technological infrastructure. In order to achieve a comparative advantage in foreign trade, the development of human capital and technology terms together should be ensured.

Keywords: Industry 4.0, Technology, Trade

TEKNOLOJİ-ENDÜSTRİ 4.0 İLİŞKİSİNİN DIŞ TİCARET ÜZERİNDEKİ ETKİSİNİN AMPİRİK OLARAK İNCELENMESİ: TÜRKİYE ÜZERİNE BİR ANALİZ

ÖZ

Endüstri 4.0 kavramı gelişmekte olan ülkelerin dış ticaret yapısının değişmesinde ve etkin bir hale gelmesinde önemli bir yere sahiptir. Teknolojik gelişimin sağlanması temeline dayalı olan bu terim ülkelerin ekonomik konjonktürde söz sahibi olmasına yardımcı olacaktır. Ekonomide söz sahibi olmada ve ticari anlamda üstünlük kazanmada katma değeri yüksek ürünler geliştirmek gerekmektedir. Bu bağlamda ülkelerin teknolojik alt yapıya verdikleri önemin ve harcamaların arttırılması ekonomik gelişimin gerçekleşmesine katkı sağlayacaktır. Endüstri 4.0 terimi de, ekonomide gelişen düzen sonucu ortaya çıkmıştır. Yenilikçi politikalarla teknolojik gelişimin sağlanması üretim sürecinde firmalara da maliyet avantajı sağlamaktadır. Kaliteli ve işlevsel özelliklere sahip mal ve hizmetler hem tüketiciler hem de üreticiler açısından avantaj sağlamaktadır. Üretimde çevresel faktörleri göz önünde bulundurarak gerçekleştirilmesi ve enerji kullanım oranlarının düşük olması çevreci bir yaklaşımla ürün üretiminin gerçekleşmesine neden olmaktadır. Ülkeler arasında artan rekabet ve ticari üstünlük yarışından çıkışta dördüncü sanayi devrimi önemli bir yerde bulunmaktadır. Mikro düzeyde piyasalar üzerindeki değişiklikleri önemseyen ve takip eden, kaliteli ürünleri düşük fiyatlarla almak isteyen tüketiciler ile maliyet avantajı sağlamak isteyen üreticiler için teknolojik gelişimin gerçekleştirilmesi gerekmektedir. Endüstri 4.0'nın dış ticaret üzerindeki etkisinin incelendiği çalışmada 1990-2018 yılları arasındaki veriler kullanılmıştır. Türkiye baz alınarak yapılan çalışmada dış ticaret yapısının gelişmesinde teknolojinin ve Endüstri 4.0'nın olumlu etkiler oluşturacağı yapılan analizlerle saptanmıştır. Çalışmada kullanılan değişkenler arasında pozitif yönlü bir etkileşimin olduğu görülmüştür.

Anahtar Kelimeler: Endüstri 4.0, Dış Ticaret, Teknoloji

1. Introduction

Industry 4.0 term was first used in the 2011 German industrial fair Hannover Messe. This term, also known as the fourth industrial revolution, focused on how to integrate new technologies and digitize them to achieve production advantages. While improving product quality with this system, it is aimed to develop a fully automated production system with full adaptability to the current system and minimum environmental impact.

The concept of industry has often created the perfect environment to try and use new technology. Technology can be used in many areas from automation to security in economic and social life. Technology with this feature; it has enabled industries to become more effective, safe and profitable. In order for any major company to effectively meet the needs of all its customers, they need to offer a longer range of products that can be attractive for all industrial plant sizes. Innovation and entrepreneurship, which are the determinants of Industry 4.0, will contribute to the future prosperity increase and economic diversity for both enterprises and institutions within the economic structure. Developing technological infrastructure will enable future workers and people to develop their skills to adapt to new jobs. Thus, it will make more contribution to the development of entrepreneurial skills for the employees who need to become more efficient.

The industry has a significant role in the development of sections of traditional area. Innovations in the production stage provide companies with many advantages, especially cost advantages. In the production process of any commodity, the orientation towards consistent and stable production reduces the cost of production and creates a positive impact on the economy of scale. The concept of Industry 4.0, which was at the early stages of technological development, has seen a broad debate on the definition of the basic principles and innovation in the last few years. This process, which will be developed with an effective infrastructure, has been seen that many stakeholders should include different guidelines and definitions that are first based on the 2011 German plan, but later on to provide technology and complementary products.

Together with Industry 4.0, the foreign trade structure is changing. Along with the developments, exports and imports are realized not only with the trade of goods but also with the data trade. These data include concepts such as e-books, movies and music, computer games, technical drawings and IT services (Kazdağlı, 2015: 31). The advantages of the 4th IR and the making of the products in a more innovative way affects countries which have been done trade with each other. The overall production costs increase due to the investments made in order to use the Industry 4.0 applications. However, the use of advanced machines and automation in production is more common, eliminates labor costs as refer to in the previous section. In addition, the amount of production is increased by smart factories which are supported by the concepts of cyber physical systems and internet of objects. Even though the high investment costs are reflected on the production costs at the beginning, it leads to a decrease in costs with specialization and mass production. The effective use of Industry 4.0 applications positively affects the export performance of the countries. These countries are becoming more competitive in global markets with their high-tech products and thus increase export figures. The increase in export figures provides added value in the foreign trade balance of countries. This situation leads to an increase in the macro level GDP of the countries. Moreover, a increase in exports, is a factor which increases the total expenditures in the country and increases the employment (Seyidoğlu, 2013: 337).

The goal of the study is to examine Industry 4.0 and to examine whether this concept has an effect on foreign trade. In the first chapter, the term Industry 4.0 and its elemets are explained and the second chapter includes related the literature. In the last section, information the data of the econometric analysis related to the study were included and the results were interpreted.

2. Meaning of Industry 4.0 and Development Process

Industry 4.0 which is focusing on the machines and production systems in autonomous activities by eliminating the need for manpower, represents the convergence between information technologies and operational technologies (Öztuna, 2017: 51-53).

Industry 4.0, which will lead to the reorganization of production and consumption relations, aims to construct production systems that provide instant answers to the changing needs of consumers. In this context, Industry 4.0 makes it possible for machines and all other means of production to be connected to each other and to the products. In this respect, the Fourth Industrial Revolution transforms highly personalized and cross-linked production processes into practice (Alçın, 2014: 27).

Industry 4.0 is defined as follows according to McKinsey. Industry 4.0 is a four-stage process in the digitization of the manufacturing area. The surprising increase in data volumes, computing power and connectivity, the emergence of analytical and business intelligence skills; new forms of human-machine interactions, such as touch augmented reality systems and interfaces; advancement in the transfer of digital instructions such as advanced robotic and 3D printing to the physical world (McKinsey, 2016: 58).

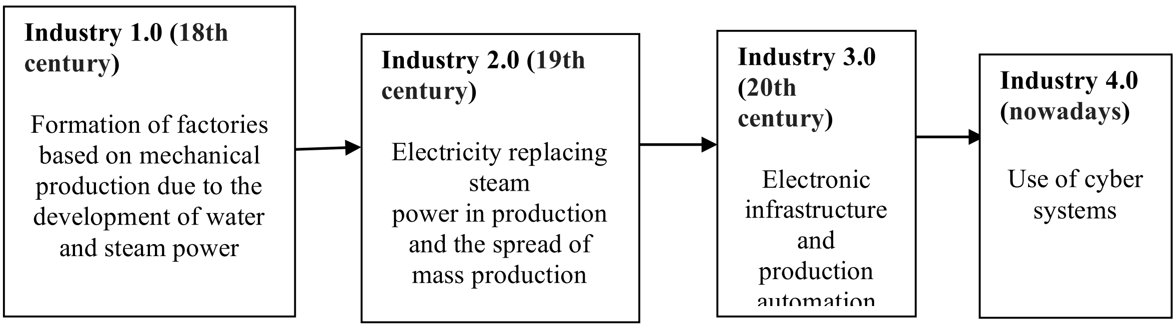
Industry 4.0 and the 4th IR is planned to cooperate with each other directly or indirectly in relation to the production, and foresees the integration of the software and information technologies of digital data (Schuh, Potente, Wesch Potente, Weber and Prote, 2014: 1).

Industry 4.0 refers to the planning of manufacturing processes based on devices and technologies that communicate autonomously with each other throughout the value chain. This organization describes a structure that is defined as the, smart factory of the future, which can take autonomous decisions based on self-organizing mechanisms, where computer-guided systems follow physical processes, create a physical virtual copy (Industry 4.0, 2016: 20).

Industry 4.0 will provide more flexibility and durability in the engineering, manufacturing, planning, logistics and operational processes along with the highest quality standards. It also means the creation of dynamic, real-time optimized, self-organizing value chains that can be optimized based on various criteria such as cost, availability and resource consumption (Acatech, 2013: 20).

Industry 4.0 is based on the achievements of the three previous revolutions in the fields of mechanical, electrical and information technologies. First Industrial Revolution, physical systems benefiting from water and steam power; The 2nd IR, the use of electricity and the systems that activate mass production; The 3th IR was the result of systems that automate production with the difference created by information and communication technologies (Öztuna, 2017: 51).

Figure 1. Development Process of Industrial Revolution



Resource: Tika, 2018: 11

The First Industrial Revolution refers to the process of industrialization, which has been enabled the transition from muscle to mechanical force in production since 1750. The First Industrial Revolution, which continued until the second half of the 19th century, pioneered the spread of railway networks and steam engines (Schwab, 2016: 15-16). The first success of the 1st IR was the fundamental change of cotton textile production. A significant increase was observed in labor productivity in other areas after textile by changing production method (Acemoğlu and Robinson, 2014: 17). The First Industrial Revolution is the first step of globalization which is the most important phenomenon of our age. Industry 1.0, which is the source of all the innovations and discoveries realized in the Second Industrial Revolution with its results, has been a process affecting the whole world (Görçün, 2017: 34-35).

The 2nd IR, which can be described as the second stage of globalization, began with the discovery that oil could be used in industry since the 1870s. In the process described as Industry 2.0, the energy source of industrial production was oil instead of coal used in Industry 1.0. The difficulties caused by the supply, transportation and storage of coal have become unable to meet the increasing needs of the industry due to the cost it creates. Accordingly, in the industrial activities, the search for a new source of energy, which would reduce the costs and increase the efficiency, was replaced by the replacement of coal. The oil, which offers incredible opportunities and benefits compared to coal, has been created the energy source of the industry in the new period. This situation led to the start of studies to produce new machines (Görçün, 2017: 52). With the 2nd IR, the mass production period began. One of the most characteristic features of the period is the studies on the inclusion of scientific methods to the production process. The Second Industrial Revolution can be summarized as the realization of new applications that support the serial and continuous production of engineering activities in industry (Jevons, 1931: 2).

Industry 3.0 differs in terms of the points it focuses on when compared to previous periods. The large consumer community that emerged after the demolition of the bipolar order and whose habits were quite different made it one of the most important factors of the 3rd IR. Consumers have become the most important actors of the market while production which is the main focus of the previous periods has left the place to consumption, and accordingly industries have had to develop new paradigms. As a result, industries have reassessed their role in all stages of the procurement process from consumption to consumption, and have adopted outsourcing improving a new strategy (Görçün, 2017: 100-104).

With Industry 4.0, everything is done automatically, from machine to machine and from system to system without any human intervention. Hence, data from a sensor can be immediately improved in several production lines anywhere in the world. Industry 4.0; IT, communication, sensor (data collection), internet, automation, artificial intelligence and robotics is a new technology emerged by changing the production process. With this technology called Industry 4.0, the entire production and value chain from the first supplier to the end user will be fully integrated using the most advanced digital technologies (Eldem, 2017: 2).

2.1. Determinants of Industry 4.0

2.1.1. Cloud Sites

The cloud system is now widely used to define large data sets, where global data is rapidly increasing. Compared to traditional data sets, large data appears to contain unstructured data that need to be analyzed in real time. And big data allows new values to be discovered and hidden values to be understood. With the recognition of the high potential of big data by industrial enterprises, governments have accelerated their research and implementation efforts (Chen, Mao and Lu, 2014: 171).

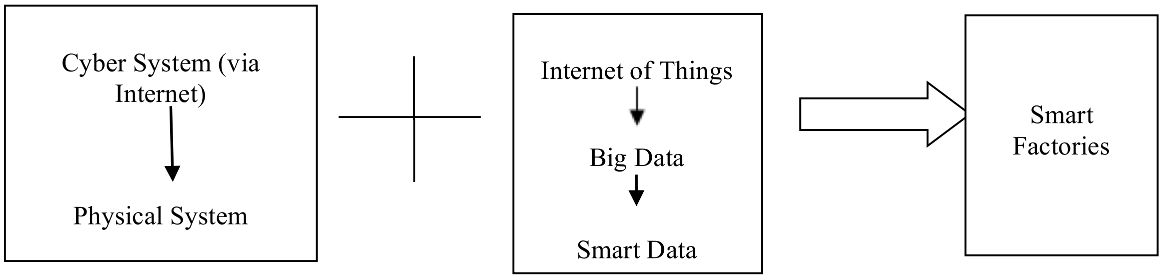
2.1.2. Cyber Physical Systems

Today, CPS is applied driverless cars, intelligent buildings, robotic surgery, intelligent electricity grid, intelligent production etc. as in many practical examples (Monostori, 2014: 9). CPS and advanced sensor networks represent the next evolutionary step of existing embedded systems; the internet, the data and services offered online, along with the embedded systems are the basic elements of CPS. For example, General Electric and Rolls Royce use common flight information in the production of the jet engine that they have developed jointly with the help of sensors and instant flight information in the production development stage (Dai, et al, 2012, transcr. Alçın, 2016: 27).

2.1.3. Smart Factories

The concept of smart factory, which is one of the most important elements of the 4th IR, consists of three components. The first of these is the vertical integration of all computers, machines, devices and tools in the factory system. Secondly, the factory is integrated with all supplier and supplier industry. The last one is the integration of systems and processes within the factory with end-to-end digital engineering systems (Öztuna, 2017: 81).

Figure 2. The Relationship between Smart Factories and Industry 4.0



Resource: Werthmann and Blunk, 2017: 647.

2.1.4. Smart Robots

The production process targeted by Industry 4.0 is possible only when production is fully automated. By using the data collected from the customers and suppliers, it is expected to produce by using robots in intelligent factories in order to make analyzes that will make production more efficient. It is known that the materials moving on the traditional production line are defined by the sensor technologies by intelligent robots and how they should be processed. Thus, it is possible to process the products with zero error in the production line. In the next stage, interconnected machines can check the quality of the product and identify possible errors in the production process more quickly. The whole process is planned to be managed by interconnected cyber-physical systems (EKOIQ, 2014: 4-5).

2.1.5. Interoperability

Cyber-physical systems enable that people and intelligent factories connect and communicate with each other. An example of this is Tractor etc. a pilot project in the Bosch Rexroth Hamburg factory where hydraulic valves for agricultural vehicles are produced. Within the scope of the project, people, machines and products are connected to each other and give an idea of how the production environment will be in the future (TOBB, 2016: 18).

2.1.6. Internet of Things

The Internet of things refers to a system that allows objects in the physical world to be connected to the Internet via wireless or wired connections of sensors embedded within them. Here sensors are data collection devices in the Internet of Things (Banger, 2016: 95). In this structure, objects should be in communication with each other and they manage the work themselves. Particularly within the scope of this platform, the integration of CNC and robotics technologies has been ensured and thanks to this integrated technology, smart products which are considered ultra modern can be obtained (EBSO, 2015: 35)

3. A Brief Review of the Literatur

The Industry 4.0 has been studied in the literature together with different components. Since the term Industry 4.0 was used in conjunction with factors such as innovation, human capital, patent and R & D the literature review was conducted on the basis of these variables.

Bayraç (2003) examined the phenomenon of new economy in his study and examined changes in the development of communication and information technologies on societies and economies.

Kök and Şimşek (2006) examined the relationship between intra-industry trade patents for 19 OECD countries. In this study, the determinants of international technological spread were investigated by FMOLS method developed by Pedroni. In the results of the analysis, two of the main determinants of the technological spread were intra-industry foreign trade and foreign patents.

Yücel (2006) tried to explain the factors affecting export supply and demand by using foreign trade theories in his study on the determinants of foreign trade. He emphasized that factors such as R & D and patent in foreign trade are important variables and their share in GDP should be increased.

Yiğit and Güner (2006) conducted a study on foreign trade and entrepreneurship. They have examined the relationship between foreign trade, technology, finance, R & D process and risk capital variables in Turkey and the World. The increase in these variables will lead to an increase in investments, innovations and thus technological development and increase in foreign trade.

In the study conducted by Özer and Çiftçi (2009), the relationship between R & D expenditures and exports of OECD countries was examined. In the 1990-2005 analysis, positive and high coefficients were found between the two variables.

Şimşek and Kadılar (2010) examined the relationship between foreign trade and human capital by using the number of students enrolled in real exports and higher education. ARDL analysis was made of 54 years for Turkey and a long-term relationship was determined between variables.

Genç, Değer and Berber (2010) examined the effect of exports on human capital. As a result Toda-Yamamoto causality analysis used in the study, parallel to the structural changes observed in the exports of Turkey have reached the conclusion that the economy needed more in human capital.

In his study, Göçer (2013) tried to examine the effect of communication technology exports, high technology exports and total exports on R & D expenditures. On 11 Asian countries, the data set between 1996 and 2012 was used in the study. As a result of the analysis, it was observed that 1% increase in R & D expenditures increased the high technology product exports by 6.5% and information and communication technologies exports by 0.6%.

Sungur et al. (2016) examined the impact of technological development on export and economic growth in Turkey. In the study, the time series analysis was conducted using the annual data of 1990-2013 period. As a result of the analysis, it was found that there is a positive and two-way relationship between exports and R & D.

Şen and Pehlivan (2018) have examined the effectiveness in the economy of technology and human capital developments occurred in BRICS countries and Turkey. As a result of the panel regression analysis, technology and human capital have positive effects on economy.

Rosenving and Olanders (2018) examined the impact of Industry 4.0 on firms. As a result of the study, it is concluded that companies should be able to make sure that they apply Industry 4.0 concepts to their businesses and how an enterprise can generate value.

Özkan, Al and Yavuz (2018) examined the possible effects of Industry 4.0 of what happens in the Turkey economic structure. They argued that Turkey aims to become the world's top ten largest economies and it has become a necessity to adapt the Fourth Industrial Revolution era to realize this goal.

Aydin (2018) has examined effectiveness of the economy of technological development in Turkey in the context of industrial 4.0. In this study, ARDL analysis was performed by using R & D expenditures and data of information communication technology. As a result of the analysis, technological development will contribute positively to the economy.

3.1. Methodology and Data Set

In this study, the effect of technology and Industry 4.0 relationship on foreign trade is examined. Patent applications (Ptnt), high technology export (Hıgt) and trademark (TMrk) variables were used to represent Technology-Industry 4.0. As a foreign trade data, the ratio of total exports of goods and services to GDP was taken. The data for 1990-2018 are used annually. The data have been compiled from the World Bank, TUIK and Ministry of Development. Firstly, unit root tests were applied to variables and non-stationary variables were stabilized by taking first differences. The co-integration test was applied to the variables which were stabilized at the same level. Then, the coefficients of variables were interpreted by FMOLS and DOLS tests. Finally, it is tried to determine the direction of the relationship between variables with causality test.

The Dickey Fuller test is used to test whether the time series contains unit roots in the statistics. This test is the first time Dickey D.A. and W.A. Fuller, published in 1979 by the Journal of American Statistical Association. The test was used in many ways from the first period to the present. In the applications performed on the series, it is absolutely necessary to perform the ADF test to determine whether the series carries the root of the unit.

In the Phillips Perron Test claims that the Dickey Fuller test error terms are not autocorrelated. In other words, they are independent of each other and argue that their variances are constant. However, many time series contradict these assumptions and show both a more or less dependent and non-homogeneous structure. Phillips and Perron have developed the PP test. For this purpose, they have used nonparametric statistical test methods without considering the delayed difference values (Gujarati and Porter, 2012: 740).

Table 1: Unit Root Results of Variables

		ADF								
		Intercept		Intercept+Trend			Intercept		Intercept+Trend	
LEVEL VALUE	Variables	ADF Value	Prob	ADF Value	Prob	FIRST	ADF Value	Prob	ADF Value	Prob
	Trade	-1.929	0.314	-3.426	0.478		-4.755	0.000***	-4.746	0.004***
	lnPtnt	1.411	0.998	-2.615	0.276		-4.412	0.001***	-4.586	0.005***
	TMrk	0.316	0.975	-2.221	0.461		-4.666	0.001***	-4.813	0.003***
	lnHıgt	-1.918	0.319	-2.058	0.545		-4.812	0.000***	-4.718	0.004***
		Phillips-Perron (PP)								
		Intercept		Intercept+Trend			Intercept		Intercept+Trend	
LEVEL VALUE	Variables	PP Value	Prob	PP Value	Prob	FIRST	PP Value	Prob	PP Value	Prob
	Trade	-1.512	0.513	-2.503	0.324		-5.726	0.000***	-6.132	0.000***
	lnPtnt	0.956	0.994	-2.544	0.307		-4.406	0.001***	-4.586	0.005***
	TMrk	0.567	0.986	-2.16	0.491		-4.572	0.001***	-4.799	0.003***
	lnHıgt	-1.918	0.319	-2.206	0.467		-4.812	0.000***	-4.711	0.004***

Note: The *** in the table indicates the meaning level % 1.

In the analysis, ADF and PP unit root tests were applied for the variables. It was determined that the variables of the series were not stable at the level value, ie I (0). The first differences were taken to ensure the stability of the variables. The hypothesis H_1, which assumes that there is no unit root in the series, is accepted, while the hypothesis Ho is assumed to be the unit root. The delay length of the variables was determined as 2. The selected delay length was used in Johansen cointegration test. In econometric models, two or more non-stationary series are analyzed using the cointegration test to see if they act together in the long run. The relationship between the variables is made by taking the differences of the non-stationary series in the long term. After the series are stabilized at the same level, Engle-Granger or Johansen-Juselius (JJ) techniques are tested (Barışık and Demircioğlu, 2006: 74).

As a result of the same degree of stability of series I (1) in order to prevent the false causality relation, Johansen cointegration test was performed. With this test it has been determined whether there is a long-term relationship between these variables.

Table 2: Johansen Cointegration Test Results

Hypotheses	Model 1	Model 2	Model 3	Model 4	Model 5
H_0: none H_1: at most 1	52.785 (0.001)	77.658 (0.000)	70.260 (0.000)	104.226 (0.000)	102.853 (0.000)
H_0: at most 1 H_1: at most 2	26.057 (0.029)	48.260 (0.001)	41.022 (0.001)	60.455 (0.000)	59.397 (0.000)
H_0: at most 2 H_1: at most 3	7.069 (0.318)	23.371 (0.018)	17.915 (0.021)	37.201 (0.001)	36.299 (0.000)
H_0: at most 3 H_1: at most 4	0.023 (0.900)	5.795 (0.207)	0.427 (0.513)	15.513 (0.015)	15.237 (0.120)

Note: Values in parentheses refer to the probability values. Other values are trace values.

As a result of the models in Table 2, a long-term relationship between variables is determined by the probability and co-integration values. In our analyzes, Error Correction Model was estimated after co-integration between variables. There is a long-term balance assumption among the variables. However, there are deviations from this long-term equilibrium in the short term. In addition, the values of series have been deferred by taking the differences of the series. Since these losses could have negative effects on the results, ECM was applied to determine how long these deviations would be lost in the long term.

Table 3: Error Correction Factor and Model Results

Error Correction	D(Trade)	D(Ptnt)	D(TMrk)	D(Hıgt)
Coint	***-0.636***	0.016	827.689	0.004
Std. Error	0.333	0.009	505.708	0.013
t-Statistic	-1.909	1.708	1.636	0.337

Table 3 presents the error correction model results. With this data, the long term deviations in the short term will be re-equilibrated within a period of 1 / ECM. For the coefficient to be significant, the coefficient should be between 0 and -1. At the same time, t Calculated Value should be more than 2 (Tarı, 2012: 435). The closer the ECM value is to 1, the sooner the long-term balance is captured. In Table 3, the coefficient of correction according to the error results was -0.636. The error correction parameter is statistically significant and negative (- 0.636). The error correction coefficient shows that approximately 63 percent of the difference between the observed value of the GDP and the long-term value disappears every year and that the improvement is achieved and the long-term equilibrium value can be reached.

Short term model;

$$\Delta TRADE = \beta_0 + \sum_{i=1}^{p} \beta_{1i}\Delta PTNT_{t-i} + \sum_{i=1}^{q} \alpha_{1i}\Delta TMRK_{t-i} + \sum_{i=1}^{q} \Delta_{1i}\Delta HIGT_{t-i} + \sum_{i=1}^{r} \dot{I}_{1i}\Delta TRADE_{t-i} + \psi_1 + \mu_{1t} \quad (1)$$

is expressed as.

Two methods were used to test the consistency of the estimators to our expectations in order to estimate the ultimate indeterminate coefficients of this relationship after the co-integration tests, namely the DOLS method and the FMOLS method developed by Pedroni (2000, 2001). FMOLS method corrects the deviations in standard fixed-effect estimators bur the DOLS method is a method that can eliminate the deviations in the static regression by including dynamic elements in the model (Root et al., 2010: 8).

Table 4: FMOLS and DOLS Results

	FMOLS			**DOLS**		
Variables	Coefficient	t-Statistic	Prob	Coefficient	t-Statistic	Prob
lnPtnt	1.522	0.288	0.077*	11.942	0.72	0.048**
TMrk	0.001	0.819	0.042**	0.001	0.87	0.004***
lnHıgt	6.286	1.763	0.090*	1.777	0.27	0.079*

Note: The *** sign in the table indicates% 1, **% 5, * sign% 10 meaning level.

According to FMOLS and DOLS test results, there is a positive and long-term relationship between the variables. High technology export has the biggest impact on foreign trade exports according to the results of FMOLS. This variable is followed by patent (1.522) and trademark variable (0.001). According to the results of DOLS, while patent variable has the biggest impact on foreign trade exports, this variable is followed by high technology exports.

In order to conduct a causality survey between the series, there is a need for stationary knowledge. If the series are stationary in the same order, the relationship between kointegration can be searched. If there is no correlation between the co-integration and causality, the causality relationship can be investigated (Büyükakın, Bozkurt and Cengiz, 2009: 110). As a result of the series being equally stable, it is searched for co-integration between the series and in the case of co-integration, the causality relationship between the series can be searched. Causality relation was examined with Toda-Yamamoto analysis in this study. The Wald test is applied for the Toda-Yamamoto causality analysis. The VAR model is created at the level values of the variables. The distribution of the Wald test is determined by the number of delays (k) in the VAR model and the degree of stability (dmax) of the series. Toda-Yamamoto causality test is applied to (k + dmax) by determining two values (Toda and Yamamoto, 1995: 225).

Table 5: Causality Results

Hypotheses	**Optimal Delay Length (k+ dmax)**	**Wald χ^2**	**Possibility**
lnhıgt ò>lnptnt	2	0.076	0.962

lnptnt ȯ> lnhıgt	2	0.683	0.71
lnhıgt ȯ> Tmrk	2	0.561	0.755
tmrk ȯ> lnhıgt	2	0.521	0.77
lnhıgt ȯ>Trade	2	0.328	0.846
Trade≠> lnhıgh	**2**	**15.02**	**0.000*****
lnptnt ȯ>lnhıgt	2	0.683	0.71
lnhıgt≠>lnptnt	**2**	**0.076**	**0.092***
lnptntȯ> Trade	2	0.281	0.868
Trade≠>lnptnt	**2**	**0.118**	**0.058****
lnptnt≠>Tmrk	**2**	**4.486**	**0.096***
Tmrkȯ>lnptnt	2	0.86	0.65
Tmrkȯ>Trade	2	1.102	0.576
Tradeȯ>Tmrk	2	0.33	0.847

Note: The *** sign in the table indicates% 1, **% 5, * sign% 10 meaning level.

As a result of the causality analysis, it is seen that there is a causality from the foreign trade to the high technology export at the level of 1%. From the foreign trade to the patents at the level of 5% meaning causality was found. Finally, it is found that there is a causality from high technology export to patent and from patents and to trademarks at 10% level.

4. Conclusion

Innovative policies introduced with the globalization process have forced sectors to keep up with the new process. Industry4.0 concept emerges as a concept put forward with the developments in technology. The new process has many developments for both manufacturers and consumers. The cost and time advantage created by innovations in the production process and the fact that they take environmental factors into consideration provides advantages for companies. At the same time, the convenience of the production process helps consumers to provide easier and more optional access to the desired materials.

The technologies that Industry 4.0 needs in transforming production can be realized with the development of factor such as CPS, big data, internet of things, cloud system, smart factories, three-dimensional printers, autonomous robots, augmented reality and artificial intelligence. Technological development R & D, patents, human capital and high technological products are provided by the realization of production. If the digitization current best assessment in the industry, which already produce in Turkey by medium high and medium low technology level can arrange a splash switch to more high-tech manufacturing. Both the Turkey and developed or developing countries all over the world at a time more effectively, pushing to become more efficient and more environmentally friendly 4.0 Industrial output current is an important way to reduce Turkey's foreign trade deficit.

In this study, the concepts of technology and Industry 4.0 are discussed together and the effect of these variables on foreign trade is examined. In studies using time series analysis it has been conducted on the basis of Turkey. After the unit root tests, cointegration analysis was performed for the variables that were stationary at the same level. In order to determine the interaction on the variables, causality analysis was performed and the results were found to be suitable for the theory. In the development process of countries like Turkey to become outstanding in foreign trade should adopt the concept of Industry 4.0. In order to create high value added products, necessary support must be given to the technological infrastructure. In order to obtain a comparative advantage in foreign trade, technology terms and the development of human capital together should be ensured.

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