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Does High Technology Product Exports Increase Welfare or Countries with High Welfare Levels Innovate Better? A Causality Analysis

Yüksek Teknolojili Ürün İhracatları mı Refah Düzeyini Artırıyor yoksa Refah Düzeyi Yüksek Ülkeler mi Inovasyonda Daha İyi? Bir Nedensellik Analizi

Video Link: https://youtu.be/OFk7q3tJEu4

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Öz

İkinci Dünya Savaşı'ndan, özellikle de 1980'lerden sonra, dünyanın önde gelen ülkeleri tarafından desteklenen küreselleşme olgusu, gittikçe önem ve hız kazanmıştır. 1980 yılında dünya ticareti içerisindeki payı % 18,8 olan ihracat, 2019 yılına gelindiğinde % 30,6'ya ulaşmıştır. Balassa, Chow ve Heller'in çalışmalarında da görüldüğü gibi ülkelerin Kabul edilebilir büyüme düzeylerine ulaşabilmeleri adına ihracat önem kazanmıştır. Bununla birlikte ülkelerin bazıları ihracat stratejilerini, yüksek katma değer yaratan yüksek teknolojili ürünlerin ihracatına ağırlık vermek yönünde farklılaştırdılar. Bu noktada, çalışmada Yüksek Teknolojili Ürün İhracatları mı Refah Düzeyini Artırıyor yoksa Refah Düzeyi Yüksek Ülkeler mi İnovasyonda Daha İyi? sorusuna Dimutriscue and Hurlin nedensellik testi kullanılarak ve dünyadaki en yüksek ve en düşük 10 yüksek teknolojili ürün ihracatçısı ülke grupları karşılaştırılmak suretiyle cevap aranmıştır. Elde edilen sonuçlara göre en düşük yüksek teknolojili ürün ihracatçısı ülke grubu için refah ve yüksek teknolojili ürün ihracatı arasında çift yönlü bir ilişki olduğu, en yüksek, yüksek teknolojili ürün ihracatçısı ülke grubu için ise refahtan yüksek teknolojili ürün yönlü bir nedensellik ilişkisi tespit edilmiştir. Çalışma, refah ve yüksek teknolojili ürün ihracat düzeyleri arasındaki ilişkiyi en yüksek ve en düşük yüksek teknolojili ürün ihracatçılarını karşılaştırmak yoluyla inceleyen literatürdeki ilk çalışmadır.

Anahtar Kelimeler: Yüksek Teknolojili Ürün İhracatı, Refah, Dimutriscue and Hurlin Nedensellik Testi, İnovasyon, Kişi Başına Milli Gelir

Does High Technology Product Exports Increase Welfare or Countries with High Welfare Levels Innovate Better? A Causality Analysis

Abstract

After the Second World War, globalization has been promoted and supported by the leading countries, especially after the 1980s, globalization has accelerated. 18.8% percent of exports within total world trade as of 1980 has become 30.6% by 2019. Export became important, especially for reaching acceptable growth rates for countries, as manifested in the studies of Balassa, Chow and Heller. However, some countries changed their strategies toward exporting the products that create higher values to their trade level, which means exporting the more profitable high-technology products. By this new government strategy, it is aimed to find the answer to the question '**Does High Technology Product Exports Increase Welfare or Countries with High Welfare Levels Innovate Better?'** using the causality test of Dimutriscue and Hurlin for 20 countries of the top10 and bottom 10 high-tech exporters of the world with the time span of 2007-2018. It is concluded that for bottom high-technology exporters, there is two-way causality between welfare and high technology exports, but for top ten high technology exporters, there is one-way causality from welfare to high technology exports. This may be the sign of after a certain saturation level of welfare; high-tech product exports do not create any value on welfare. To our knowledge, this research paper is the first study that makes a comparison between top high-tech exporters and bottom high-tech exports in terms of analysing the effects of high-tech exports on welfare. Moreover, this is the first paper on two-way impact analysis; the impacts of welfare on high-tech export and the impacts of high-tech export on welfare.

Keywords: High-Technology Product Exports, Welfare, Dumitrescu and Hurlin Causality Test, Causality, Innovation, GDP Per Capita

JEL Classification: F63, O39, O49

Introduction

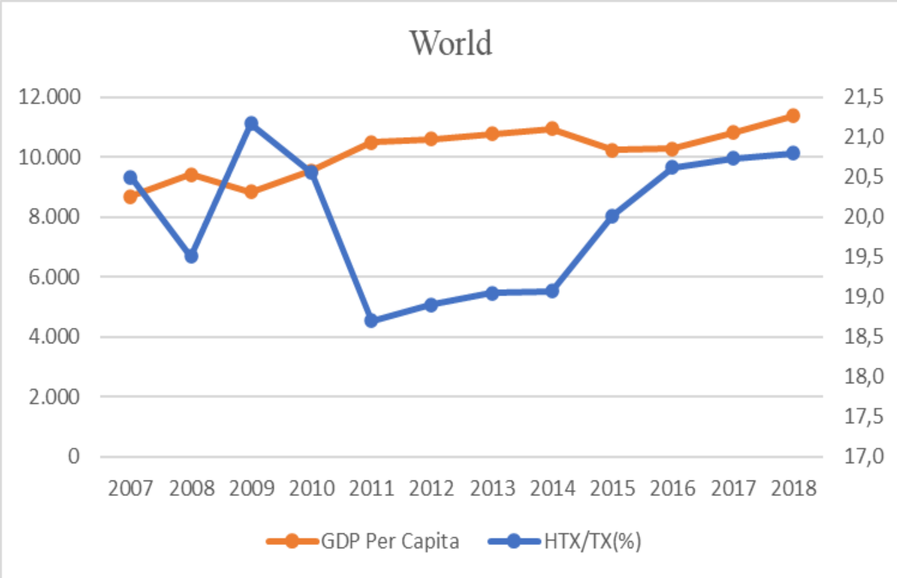
How to increase the welfare of households is one of the most critical questions in the literature in economics. Also, this is the most important concern of politicians and governments. Although there is not certain parallelism in economic growth and quality of life, per capita income is still used for measuring the welfare of households. Some indices have been developed for measuring welfare, such as the HDI-Human Development Index, ISEW-the index of sustainable economic welfare (Stockhammer et al., 1997:21). In fact, the mentioned indices measure well-being rather than welfare. According to the written explanation of IMF (2020), "*Well-being includes intangible aspects that cannot be traded in a market, such as happiness, trust, and bio-diversity. Economic welfare is the part of well-being having to do with broadly-defined current and lifetime consumption and the resources that enable the consumption (income, comprehensive wealth, and households' time endowment)*".

Thus, in this paper, per capita income is used as the indicator of economic welfare. On the other hand, the relationship between exports and growth has become very popular between politicians and also researchers. There are two main theories on the export and growth relationship: the first theory is the export-led growth hypothesis, which is based on the idea of the increase in exports leads to economic growth. The idea can easily be proved by the equation of GDP= C+I+G+(X-M). The second theory is growth-driven exports, which are based on the idea that growth itself promotes exports. New growth theories have taken innovation diffusion as the main accelerator of growth.

Some developing countries set their strategy on exporting high technology products on their way to reaching rapid and sustainable growth rates. High-technology products are accepted as computers, aerospace, scientific instruments, pharmaceuticals and electrical machinery according to the classification of World Bank (2002). As a result of the mentioned strategy, a higher growth rate which is one of the indicators of welfare increases. At this point, it is worth mentioning the aim of this paper in detail. This paper aims to understand whether high technology product exports increase the level of welfare of the countries or do countries need a certain level of welfare for being innovative to have a chance to export distinguished high-technology products. With this paper, it is the first time in the literature that is making a comparison between countries with top and bottom high technology export levels. Selected top and bottom high-technology exporter countries are mentioned. Most of the researchers have chosen a group of countries, such as OECD countries, or have conducted their research on developing or developed countries. Thus, the exact structural differences between the countries with the highest and the lowest high-technology product export levels could not be distinguished.

The selected top 10 and bottom 10 high-technology exporter countries are listed with the details of the income groups that they belong to and the ratio of the HTX/Total Export in Table 1. The world average of GDP Per Capita and HTX/Total Export ratio can be followed from Figure 1. As it is observed from Figure 1, it can be seen that in 2007, the world average of HTX/Total Export Ratio was 20.5% and it has reached 20.8% at the end of 2018. It can be observed that there are fluctuations in the ratio. On the other hand, GDP Per capita has increased from $8,695 to $11,382, and it has an increasing trend.

Figure 1: Welfare and HTX/Total Exports



Source: Established by the author using World Bank data

When the income levels of selected countries are investigated, it is observed that for the top 10 high technology exporters, 70% of the countries belong to a high-income level country group, 20% upper middle income and 10% low middle income. Moreover, for bottom 10 high-technology product exporters, 50% of the countries belong to the upper middle income level country group, 40% lower middle income and just 10% high-income country group. The only high-income country within 10 bottom high technology exporters is Saudi Arabia. GDP Per Capita of the county is $23.338 as of 2018. However, she has an exceptional situation: she has 17% of the world's fuel oil reserve and 50% of GDP and 70% of export incomes come from fuel oil (OPEC, 2020).

Table 1: Top and Bottom 10 High-Tech Product Exporter Countries

Top 10 High Technology Exporters

Country Name	**Income Group**	**High-tech product exports/Total Exp. (%)-2018**
Hong Kong SAR, China	High income	64.6
Malaysia	Upper middle income	52.8

Singapore	High income	51.7
Vietnam	Lower middle income	40.2
Korea, Rep.	High income	36.3
Malta	High income	32.2
China	Upper middle income	31.4
France	High income	25.9
Ireland	High income	24.7
Iceland	High income	23.5
World		**20.8**

Bottom 10 High Technology Exporters

Country Name	**Income Group**	**High-tech product exports/Total Exp. (%)-2018**
Georgia	Upper middle income	3.3
Montenegro	Upper middle income	3.2
Jordan	Upper middle income	2.9
Moldova	Lower middle income	2.5
Lebanon	Upper middle income	2.4

Turkey	Upper middle income	2.3
Pakistan	Lower middle income	2.2
Nigeria	Lower middle income	1.9
Egypt, Arab Rep.	Lower middle income	0.9
Saudi Arabia	High income	0.6

Source: Established by the author using World Bank data

Under shed of light of this picture concerning the composition of income group shares of the selected countries, a further detailed analysis was made with 174 countries which have HTX/Total Export ratio greater than zero. Sixty-five high-income group countries have the highest HTX/Total export ratio; 13.74%. The consequence between the HTX/Total Export ratio and income level for the mentioned 174 countries is not proper just for the low income group countries. When it is researched in detail, it is noticed that number of low income group countries; 18, are low compared to other income groups, so the possibility of concentration is high. If we exclude the top four countries (Niger-22.7%, Rwanda-13.6, Mozambique-10.6%, Central African Republic-10.2%) with the highest HXT/Total X rate out of the low-income group, the group average drops to 3.60. With this point of view, the country groups with higher HTX ratio also have higher income levels.

Table 2: HTX/Total Export Ratio of Countries concerning Income Groups

Income Group	**Number of Countries**	**HTX/Total X (%) (2007-2018 average)**
High income	65	13.76
Upper middle income	44	8.61
Lower middle income	47	4.33
Low income	18	5,.70

Source: Established by the author using World Bank data

According to descriptive statistic results (Table 5) the mean of HTX/Total Exports is 33.4%, and GDP Per Capita is USD 31,381 for the selected top 10 high technology exporters. The same data are 18.5% and $ 18,451 for the bottom 10 HT Exporters (Table 6). It can easily be observed that the average of HTX/Total Exports is 81% and per capita income is 70% above for top HT Exporters compared to bottom HTX Exportes. This may be a pre-indicator of the causality between welfare and high-technology products.

Table 3: Income Group Based Welfare-HTX Distribution of Selected 20 Countries

Income Group	HTX/Total X (%)	Number of Countries	GDP Per Capita $
High income	32.5	8	48,542
Upper middle income	14.0	7	8,080
Lower middle income	9.5	5	2,573

Source: Established by the author using World Bank data

In Table 3, selected 20 countries that were grouped concerning their income group and the average of the model variables were calculated according to their income groups. It is concluded that high-income group countries have the highest HTX/Total Exports ratio; 32.5%, upper-middle-income countries have the average; 14% and the lower-middle-income group countries have the lowest; 9.5%.

With all basic analysis summarized in Tables 2, 3, 4 and 5, it can be easily observed a relationship between income level and high technology exports of countries. For the next steps after literature review and data analysis, a proper econometric model will be chosen and applied.

Literature

Most of the researchers have investigated the contribution of exports on growth in years 1980s and 1990s. The general output of the mentioned studies is although imitation of technology is the important factor for the growth of low-income countries in the 1980s, with the years beginning with 1990, generating their own innovation systems have changed place with imitation of technology for growth (Fagerberg & Verspagen, 2007: 24-27).

Dorado, critisized the previous studies that are focused on a limited number of countries, and in his paper, he has taken 86 of the poorest countries of the world and investigated the causality between growth and exports for the years between 1967-1986. He concluded that the relationship between exports and growth is not as strong as it was found out in previous studies for developing countries (Dorado (1993: 227:231).

With technology gradually becoming an integral part of daily life, from the beginning of the last half of the 1990s till today, the studies mostly focused on the relationship between high-technology exports and growth, instead of exports and growth.

Fagerberg has taken resources, education and investment for GDP Per capita as a proxy in his paper to measure the gap in productivity, which is measured by per capita income Fagerberg (1994:24-27).

Gani classified 45 countries into three as ‘technological leaders’, ‘potential leaders’ and ‘dynamic adopters’ concerning their high technology exports and per capita economic growth relationship for the years between 1996-2004. It is concluded that for technological leader countries, there is a positive and statistically significant relationship between HTX, and growth and there is not a significant relationship between the mentioned variables for potential leaders. Gani applied a separate regression equation for each county (Gani, 2004: 31).

Braunerhjelm and Thulin analysed the impact of research and development expenditure and country size on high-tech exports by working on 19 OECD countries and with a time span of 1981-1999. It is concluded that country size does not any impact on HTX, but R&D expenses have a statistically significant impact on HTX (Braunerhjelm and Thulin, 2008:95).

Seung-Hoo Yoo worked with 91 countries for the years between 1988-2000 and concluded that HTX significantly impacts economic output (Seung-Hoo Yoo 2008:523-525).

Falk concluded that change in high technology exports has a significant impact on economic growth. He used a GMM panel estimator for 22 OECD countries with the time span of 1980-2004 (Falk, 2009:1025).

Lee (2011) has categorized export into four groups: high-technology export, medium-high technology export, medium-low technology and low technology and has searched impact on the openness of these four groups on economic growth and the empirical results have confirmed that high-technology export has caused more rapid growth (Lee, 2011: 45).

Tebaldi aimed to investigate the indicators of high technology exports, with 95 countries and time span of 1980-2008. He concluded that openness concerning international trade, inflows of foreign direct investments, human capital impact high-technology imports. Moreover, it is concluded that savings, gross capital formation and macroeconomic volatility have no statistically significant impact on high technology exports (Tebaldi, 2011: 343-346.

Yunus & Turen have researched the determinants of HTX using the Granger causality method for 15 European Union Countries for the time span of 1995-2010. They concluded that there is a long-run causality relationship from 'Human Development Level-HDL', 'Foreign Direct Investments-FDI' and 'Economic Freedom Level-EFL' towards HTX and also from HTX, FDI, EFL and towards HDL (Yunus&Turen, 2013: 217).

Ekananda & Parlinggoman have investigated the effects of high-technology exports, non-high technology exports and foreign direct investments on GDP for 50 countries with the time span of 1992-2014 and have concluded that both high-tech and non-high-tech exports have a significant and positive effect on GDP, but high-tech exports also have better productivity (Ekananda & Parlinggoman 2017: 194).

Usman has analysed the effects of high-tech exports on growth for Pakistan using the data between 1995-2014 with the help of ordinary least square method and has concluded that for long-run growth, high-tech export has an important role Usman, 2017: 91-105).

Satrovic has conducted the Granger causality test for 70 countries for the years between 1995 and 2015 to test the relationship between high-technology exports and economic output. The results have indicated that there is a bidirectional relationship between two variables (Satrovic, 2018: 55).

Şahin has aimed to investigate the impacts of high technology exports on economic growth using Granger Causality Method for Turkey with a time span of 1989-2017 and the findings have revealed that high-technology export has a positive impact on economic growth. (Şahin, 2019: 165)

In conclusion, researchers mostly found out positive impacts of high-technology exports on economic growth; however, to our knowledge, this research paper is the first study, which makes a comparison between top high-tech exporters and bottom high-tech exports in terms of analysing the effects of high-tech exports on welfare. And also, it is the first paper on two way impact analysis; the impacts of welfare on high-tech export and the impacts of high-tech export on welfare.

Data and Methodology

The data set comprises yearly measures on 20 countries which are the 10 top high-technology product exporters; Hong-Kong, Malaysia, Singapore, Vietnam, Korea Republic, Malta, China, France, Ireland, Iceland, Thailand, Israel, Netherlands, United Kingdom, Norway and 10 which are the bottom high-tech product exporters; Saudi Arabia, Egypt, µµNigeria, Pakistan, Turkey, Lebanon, Moldova, Jordan, Montenegro, Georgia, Azerbaijan, Bolivia, Portugal, South Africa, Argentina for the years between 2007-2018.

The bottom ten countries are chosen other than the ones with zero-high technology product exports. Both the share of high-technology product exports in total exports and also per capita income as the indicator of welfare were gathered from World Bank Databank. Logarithmic form of per capita income was used in the analysis. The comparative trend analysis of HTX and welfare for the selected 20 countries has been graphicized in Figure 2.

Specified empirical model is as follows:

$$Welfareit = \theta i + \alpha 1HTXit + \mathcal{E}1it \tag{1}$$

$$HTXit = \mu i + \beta 1Welfareit + \mathcal{E}2it \tag{2}$$

Where i denotes the number of panel units, t-time period, θ *and* μ unobserved country-specific effect, $\mathcal{E}1it$ *and* $\mathcal{E}2it$ error terms and β and α coefficients.

To determine the method to be used for unit root test and panel causality analysis, Pesaran's CD (2004) test was applied first to test the presence of cross-section dependence. Since cross-section dependency was determined, unit root and panel causality tests were selected from the second generation groups; Pesaran's (2007) Cross-Section Expanded Dickey-Fuller (CADF) test, which can be used in cases of both N <T (N-cross section size, T-period)) or N> T (Pesaran, 2007: 266-267), has been determined as the relevant method. The CIPS statistics (Tatoğlu, 2018: 86) obtained from the t-statistics of the lagged variables were also included in the analysis. After determining the stationary level of variables, it is decided to apply Dumitrescu and Hurlin Panel Causality test after getting the result of Swammy S Test, which resulted as the parameters are heterogenous and also there is cross section dependency for both of the variables. Dumitrescu and Hurlin test has mainly four advantages; the test can be applied for both small and large cross section sizes (N). Second, it can be applied under both circumstances of there is cointegration between variables or not. Third, it can be applied for unbalanced panels, and the fourth it can be used for the cases both periods (T) are greater than the number of cross section (N); T>N or N>T.

Dumitrescu and Hurlin (2012) enhanced the panel version of Grange. They developed four types of causality relationship between variables under the condition of heterogeneity: "Homogeneous Non-Causality (HNC)", "Homogenous Causality (HC)", "Heterogeneous causality (HEC)" and "Heterogeneous Non-Causality (HENC)".

Causalityrelationship equation using the panel vector autoregression model is:

$$Y_{i,}=\alpha_i+\sum_{k=1}^{K} Yi^{(k)}\, Y_{\text{it-k}}+\sum_{k=1}^{K} \beta_i^{(k)} X_{it-k}+\varepsilon_{it} \qquad (3)$$

In the model, X and Y are the variables that do not consist of a unit root. It is assumed that lag length (K) is identical for all panel units, but the coefficients slope βi varies according to the panel units but constant concerning time.

The null hypothesis for Homogenous non-Causality (HNC) is;

$H0{:}\beta i=0 \qquad \forall i=1,\ldots,$

Alternative hypothesis is;

$H1{:}\beta i=0 \qquad \forall i=1,\ldots,1$

$H1{:}\beta i\neq 0 \qquad \forall i= N1+1,1+2,\ldots,N$

$$W_{N,T}^{HNC}=\frac{1}{N}\sum_{i=1}^{N} W_{it} \qquad (4)$$

W_{it} is the Wald statistics for testing the null hypothesis H_0: $\beta_i=0$ of i.

$$Z_{N,T}^{HNC}=\frac{N}{2K}\left(W_{N,T}^{HTC}-K\right) \qquad (5)$$

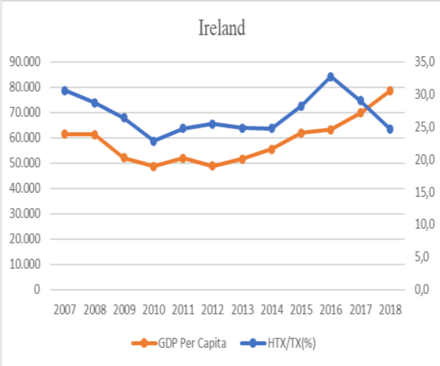
$Z_{N,T}^{HNC}$ demonstrated by equation 5 is used in the case of N-number of panel units are less than T-number of periods

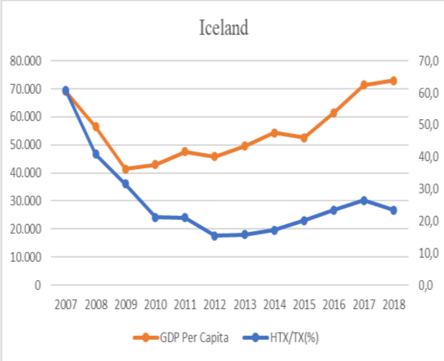
$$Z_{N}^{HNC}=\frac{\sqrt{(W_{N,T}^{HNC}}-N^{-1}\sum_{i=1}^{N} E(W_{it}))}{\sqrt{N^{-1}\sum_{i=1}^{N} Var(W_{it})}} \qquad (6)$$

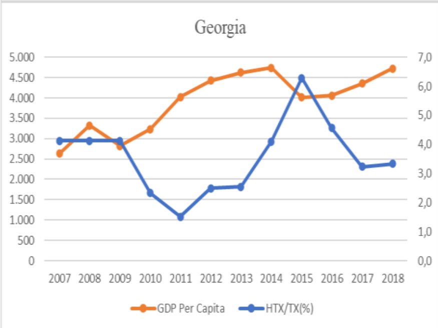
In Eq. 6 $E(W_{i,T})$ denotes mean and $Var(W_{i,T})$ denotes the variance of the $W_{i,T}$. Z_{N}^{HNC} is used in the case of N-number of panel units are greater than the T-number of periods.

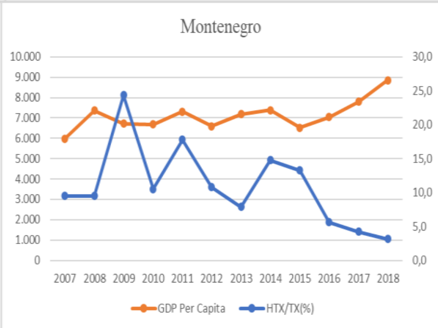
All procedures mentioned above via Eviews, applied for; A) Both bottom and top 20 HT Exporters B) Bottom 10 HT Exporters C) Top 10 HT Exporters.

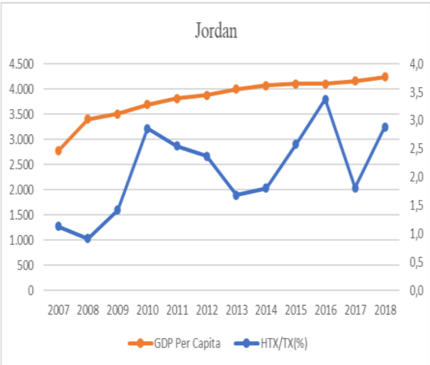
Figure 2: Trend Analysis of Welfare and High-Tech Product Export Ratio for Selected Countries

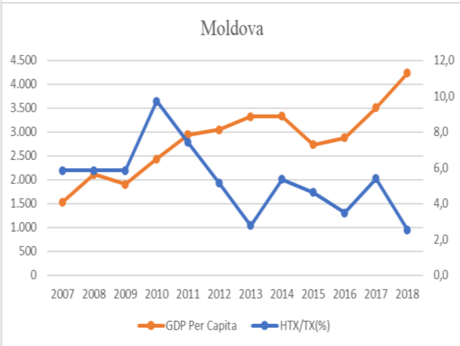

Ireland
90.000 80.000 70.000 60.000 50.000 40.000 30.000 20.000 10.000 0
35,0 30,0 25,0 20,0 15,0 10,0 5,0 0,0
2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018
GDP Per Capita HTX/TX(%)

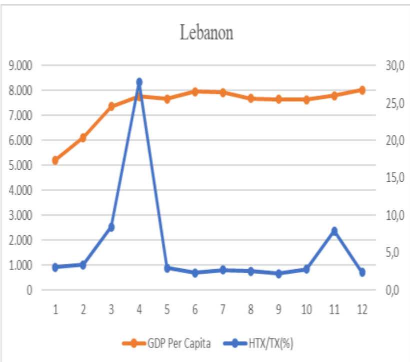

Iceland
80.000 70.000 60.000 50.000 40.000 30.000 20.000 10.000 0
70,0 60,0 50,0 40,0 30,0 20,0 10,0 0,0
2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018
GDP Per Capita HTX/TX(%)


Georgia
5.000 4.500 4.000 3.500 3.000 2.500 2.000 1.500 1.000 500 0
7,0 6,0 5,0 4,0 3,0 2,0 1,0 0,0
2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018
GDP Per Capita HTX/TX(%)


Montenegro
10.000 9.000 8.000 7.000 6.000 5.000 4.000 3.000 2.000 1.000 0
30,0 25,0 20,0 15,0 10,0 5,0 0,0
2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018
GDP Per Capita HTX/TX(%)


Jordan
4.500 4.000 3.500 3.000 2.500 2.000 1.500 1.000 500 0
4,0 3,5 3,0 2,5 2,0 1,5 1,0 0,5 0,0
2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018
GDP Per Capita HTX/TX(%)


Moldova
4.500 4.000 3.500 3.000 2.500 2.000 1.500 1.000 500 0
12,0 10,0 8,0 6,0 4,0 2,0 0,0
2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018
GDP Per Capita HTX/TX(%)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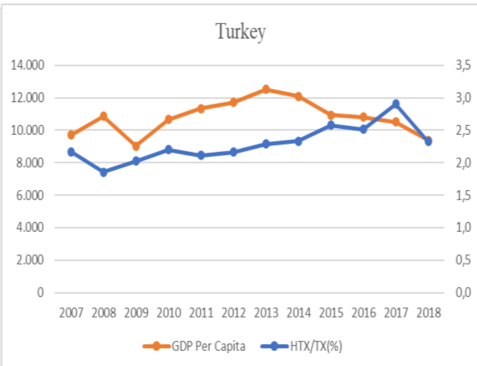
GDP Per Capita HTX/TX(%)


Turkey
14.000 12.000 10.000 8.000 6.000 4.000 2.000 0
3,5 3,0 2,5 2,0 1,5 1,0 0,5 0,0
2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018
GDP Per Capita HTX/TX(%)

Source: Established by the author using World Bank data

Empirical Results

In this section, primarily descriptive statistics for three different targeted group countries are given in Tables 4, 5 and 6. Then, Pesaran CD, Cross Section Augmented Dickey-Fuller" (CADF), Swammy S Test for homogeneity, respectively.

Table 4: Descriptive Statistics-Selected Top 10 and Bottom 10 HTX Countries

Variable	**Observation #**	**Mean**	**Std. Dev.**	**Min.**	**Max**
Countries	252	11	6.06	1	21
Periods	252	6.5	3.46	1	12
HTX/TX	252	18.57	17.27	0.51	64.65
GDPPerCap	252	18,451	19,362	906	78,621

Source: Established by the author using Stata output

Table 5: Descriptive Statistics-Selected Top 10 HTX Countries

Variable	Observation #	Mean	Std. Dev.	Min.	Max
Countries	120	5.5	2.88	1	10
Periods	120	6.5	3.46	1	12
HTX/TX	120	33.45	12.69	8.76	64.65
GDPPerCap	120	31,381	20,824	906	78,621

Source: Established by the author using Stata output

Table 6: Descriptive Statistics-Bottom 10 HTX Countries

Variable	Observation #	Mean	Std. Dev.	Min.	Max
Countries	120	5.5	2.88	1	10
Periods	120	6.5	3.47	1	12
HTX/TX	120	3.56	4.19	0.51	27.80
GDPPerCap	120	6,349	5,818	908	25,243

Source: Established by author using Stata output

Pesaran CD Test Results:

Before determining a method for unit root and causality, it is necessary to investigate whether there is cross section dependency between units of the panel. In the globalizing world, the potential of a possible economic shock to be experienced in a country with a large volume of trade spread to other countries has increased significantly due to the intensive transfer of goods and services between countries. Pesaran's CD (2004) test has been applied to determine the existence of cross-sectional dependence.

Table 7: Pesaran CD Test Result for both Top and Bottom High-Tech Product Exporters

Test	Statistics	P-Value
Lgdp	26.61	0.000
HTX	2.22	0.027

Source: Established by the author using Stata output

Table 8: Pesaran CD Test Result for both Bottom High-Tech Product Exporters

Test	Statistics	P-Value
Lgdp	14.29	0.000
HTX	-1.01	0.310

Source: Established by the author using Stata output

Table 9: Pesaran CD Test Result for both Top High-Tech Product Exporters

Test	Statistics	P-Value
Lgdp	12.64	0.000
HTX	1.73	0.083

Source: Established by the author using Stata output

According to the Pesaran CD test, as shown from Tables 7, 8 and 9, there is cross-section dependency for lgdp and HTX of 20 selected bottom and top HTX countries and top HTX countries. Since it is unconvincing to deny the existence of cross sectional dependency in such a high level of globalization period and with the results of the Pesaran CD test, the second-generation unit root test has decided to be applied for the next step of the procedure.

Unit Root Test Results

Because it is concluded that there is cross-section dependency, it became a necessity of choosing the panel cointegration and the unit root tests from the second generation groups. The first generation tests work with the assumption of no correlation between the units. The second generation tests work with the assumption of the correlation between the series (Tatoğlu, 2018: 22). Pesaran (2007), which is named as "Cross Section Augmented Dickey-Fuller" (CADF), which is one of the second-generation unit root tests, can also be used in cases where it is N >T or N<T (Pesaran, 2007: 266–267). CADF test includes the delayed cross-section averages of the model used in the ADF-Augmented Dickey-Fuller test.

CADF test repeated for three different targeted groups of countries and results are summarized in Tables 10, 11 and 12.

Table 10: CADF Unit Root Test Results for both Top and Bottom High-Tech Product Exporters

	Level	
Variable	**t-bar**	**P-Value**
Lgdp	-2.334	0.005
HTX	-2.244	0.014

Source: Established by the author using Stata output

As it can be followed from Table 10, both welfare indicator lgdp and HTX are stagnant at the level since the t-bar value at the level for HTX is greater than the critical value determined at the 5% confidence level in all units of the panel.

Table 11: CADF Unit Root Test Results for Bottom High-Tech Product Exporters

	Level		1st Difference	
Variable	**t-bar**	**P-Value**	**t-bar**	**P-Value**
Lgdp	-2.521	0.009	-2.346	0.033
HTX	-1.769	0.432	-2.766	0.001

Source: Established by the author using Stata output

As it can be followed from Table 11, although welfare indicator lgdp is stagnant, HTX is not stationary at the level since the t-bar value at the level for HTX is smaller than the critical value determined at the 5% confidence level in all units of the panel. As a result of the test repeated with the first-degree differences, it is seen that all variables become stagnant.

Table 12: CADF Unit Root Test Results for Top High-Tech Product Exporters

	Level		1st Difference	
Variable	**t-bar**	**P-Value**	**t-bar**	**P-Value**
Lgdp	-1.727	0.480	-2.745	0.007
HTX	-2.050	0.162	-2.299	0.044

Source: Established by the author using Stata output

As it can be followed from Table 12, both welfare indicator lgdp and HTX are not stationary at the level since the t-bar value at the level for HTX and lgdp are smaller than the critical value determined at the 5% confidence level in all units of the panel for the mentioned two variables. Hence, the test repeated with the first-degree differences and it is concluded that all variables are stagnant for the first-degree difference.

Homogeneity Test Result:

After concluding on the stationary status of the variables, before choosing the proper Causality test, one more step is needed, which is homogeneity tests. There are many homogeneity tests, such as F, Wald (Zellner, 1962) and Hausman (Pesaran, Smith and Im, 1995). In the literature, there are studies on comparing the homogeneity test. Mostly, it is concluded that Swammy S

and Pesaran Yamagata Δ test results are better than the others (Tatoğlu, 2018).
To define the proper causality test, the Swammy S Homogeneity Test was applied. The result of the test is as follows:

Swammy S Test for Homogeneity for both Top and Bottom High-Tech Product Exporters

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Test of parameter constancy: chi2(60) = 15504.91 Prob > chi2 = 0.0> 000

Swammy S Test for Homogeneity for Bottom High-Tech Product Exporters

Test of parameter constancy: chi2(27) = 127.80 Prob > chi2 = 0.0000

Swammy S Test for Homogeneity for Top High-Tech Product Exporters

Test of parameter constancy: chi2(27) = 52.82 Prob > chi2 = 0.0021-

The p-value is smaller than 0.05 for all country groups, both top and bottom high technology exporters, top HT exporters and bottom HT exporters, so the null hypothesis is rejected and heterogeneity was accepted and it was decided to apply a causality test which is suitable for the case of heterogeneity.

Causality Test Results

Panel causality tests are mainly divided into two as homogenous and heterogenous tests according homogeneity of the parameters. It is decided to apply Dumitrescu and Hurlin Panel Causality test, after getting the result of Swammy S Test. Another reason for choosing the Dumitrescu and Hurlin Panel Test is also the existence of cross section dependency. Besides these, Dumitrescu and Hurlin test has mainly four advantages; the test can be applied for both small and large cross section sizes (N). Second, it can be applied under both circumstances of there is cointegration between variables or not. Third, it can be applied for unbalanced panels, and the fourth, it can be used for the cases both periods (T) are greater than the number of cross section (N); T>N or N>T (Dumitrescu & Hurlin, 2012).

Table 13: Dumitrescu and Hurlin Causality Test Results for both Top and Bottom High-Tech Product Exporters

	$W_{N,T}^{NHC}$	$Z_{N,T}^{NHC}$	Z_{N}^{NHC}
Welfare- HTX	10.7800	20.1174	4.5783
		(0.0000)	(0.000)
HTX-Welfare	3.5364	3.5204	0.1249
		(0.0004)	0.9006)

Resource: Established by the author using Stata output

According to causality test results for 20 countries plus world average, although there is a causality relationship from welfare to high technology product exports, there is not a causality relationship from high technology product exports to welfare. We use the Z_{N}^{NHC} statistics in the case of N-number of panels are greater than T-periods.

Table 14: Dumitrescu and Hurlin Causality Test Results for Bottom High-Tech Product Exporters

	$W_{N,T}^{NHC}$	$Z_{N,T}^{NHC}$	Z_{N}^{NHC}
Welfare- HTX	2.5724	3.5160	1.3241
		(0.0004)	(0.1855)
HTX-Welfare	1.9793	2.1898	0.6543
		(0.0285)	(0.5129)

Resource: Established by the author using Stata output

According to causality test results for the bottom 10 high technology exporters, there is a two-way causality relationship between welfare and high technology product exports. We use the statistics $Z_{N,T}^{NHC}$ since the number of T-periods is greater than N-number of panels.

Table 15: Dumitrescu and Hurlin Causality Test Results for Top High-Tech Product Exporters

	$W_{N,T}^{NHC}$	$Z_{N,T}^{NHC}$	Z_{N}^{NHC}
Welfare- HTX	2.2422	2.7777	0.9512
		(0.0055)	(0.3415)
HTX-Welfare	1.2942	0.6579	-0.1195
		(0.5106)	(0.9049)

Resource: Established by the author using Stata output

According to causality test results, which can be followed from Table 15 (We use the statistics $Z_{N,T}^{NHC}$ since the number of T-periods is greater than N-number of panels) for top 10 high technology exporters. Although there is a causality relationship from welfare to high technology product exports, there is not a causality relationship from high technology product exports to welfare.

Concluding Remarks

After technology became an integral part of daily life, the focus of scientists researching international trade and economics has shifted to the relationship between high technology product growth from the relationship between exports and growth. The motivation of the paper was shedding light on the relationship between high-technology product exports and welfare with the idea of the increasing importance of technology and also the essential governmental target property of the welfare of households. With the mentioned motivation, the causality relationship between welfare and high-technology product export share in total exports was searched using heterogenous Dumitrescu and Hurlin panel causality test by making a comparison between top 10 and bottom 10 high technology product exporters of the world.

To our knowledge, although there is not any study focusing on welfare and high-technology product exporting levels of countries in the literature, several researchers who concluded that high-technology product exports have a significant effect on GDP growth. In this paper, working separately on the top ten and bottom ten high-technology product exporters of the world at first in the literature, for the years between 2007-2018, it is concluded that for bottom high-technology exporters, there is two-way causality between welfare and high technology exports. However, for the top ten high technology exporters, there is one-way causality from welfare to high technology exports. This may be the sign of after a certain level of welfare; high-tech product exports do not create any value on welfare.

When the ratio of high-tech product exports to total exports is analyzed by income groups of all countries in the world, it is observed that, the ratio of high technology product exports of 65 high-income group countries is 13.76%, 8.61% of the average of 44 countries in the high-middle income group is 8.61%, the average of 47 countries in the middle income group is 4.33% and the average of 18 countries in the low income group is 5.70%.

Both descriptive statistics and empirical results show that during economic development phase of countries, higher high-tech product export ratio, creates positive and statistically significant effect on GDP Per capita. It is recommended to especially low income and middle-income countries, to make changes on their foreign trade policies for increasing high-technology product export share.

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