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The Evolution of International Hazelnut Trade and Determinants of Export Impact

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Abstract

Purpose: It is aimed to examine the determinants of export impact of countries which trade hazelnuts, especially Turkey.
Design/Methodology/Approach: In this study, the evolution of the dynamics of international hazelnut trade is examined from 1990 to 2018 via complex network analysis. Then, we analyzed the determinants of international hazelnut trade by using panel data analysis for the same period. After revealing complex system features with network approach, a high-degree indicator of export impact (hub centrality), which is the findings obtained from network analysis, has been used as the dependent variable in panel data analysis.
Findings: In the panel approach, we examined the long-run relationship between hub centralities of the top five countries (Turkey, Italy, Georgia, Chile, and Azerbaijan) and area harvested for the period 1996-2018. Within this scope; the complex network approach showed that Turkey is always the leader of the international hazelnut trade network while Italy, Georgia, Chile, and Azerbaijan are the countries on the rise. Panel cointegration results revealed that the area harvested has a positive impact on hub centralities of hazelnut producer countries (Turkey, Azerbaijan, Georgia, and Chile), except Italy. This impact is the highest in Azerbaijan, and Georgia and Chile follow this country. Area harvested has the lowest impact on hub centrality of Turkey.
Originality/Value: The study makes an important contribution to the literature in terms of revealing the importance of hazelnut area harvested in hazelnut export with the findings obtained by using two different methods.
Key words: Agricultural Economics, Hazelnut, Foreign Trade, Complex Network Analysis.

Uluslararası Fındık Ticaretinin Gelişimi ve İhracat Etkisinin Belirleyicileri

Özet

Amaç: Başta Türkiye olmak üzere fındık ticareti yapan ülkelerin, ihracat performansının belirleyicilerinin tespit edilmesi amaçlanmıştır.
Tasarım/Metodoloji /Yaklaşım: Bu çalışmada, uluslararası fındık ticareti dinamiklerinin 1990-2018 yılları arasındaki evrimi öncelikle karmaşık ağ analizi ile incelenmektedir. Daha sonra aynı dönem için panel veri analizi kullanılarak uluslararası fındık ticaretinin belirlenmesi analiz edilmiştir. Ağ yaklaşımı ile karmaşık sistem özellikleri ortaya çıkarıldıktan sonra, bir panel veri analizinde bağımlı değişken olarak ağ analizinden elde edilen bulgular olan ihracat etkisinin yüksek dereceli bir göstergesi (odak merkeziliği) kullanılmıştır.
Bulgular: Panel yaklaşımında, uluslararası pazardaki ilk beş ülkenin (Türkiye, İtalya, Gürcistan, Şili ve Azerbaycan) odak merkezilikleri ile 1996-2018 dönemi için hasat edilen alan arasındaki uzun vadeli ilişkiyi inceledik. Bu kapsamda; karmaşık ağ yaklaşımı, Türkiye'nin her zaman uluslararası fındık ticaret ağının lideri olduğunu ve ayrıca İtalya, Gürcistan, Şili ve Azerbaycan'ın yükselişte olduğunu göstermiştir. Panel eşbütünleşme sonuçları, hasat edilen alanın, İtalya dışındaki fındık üreticisi ülkelerin (Türkiye, Azerbaycan, Gürcistan ve Şili) odak merkeziklikleri üzerinde olumlu bir etkisi olduğunu ortaya koymuştur. Bu etki en yüksek Azerbaycan'dadır ve Azerbaycan'ı Gürcistan ve Şili izlemektedir. Hasat edilen alan, Türkiye'de odak merkeziliği üzerinde en düşük etkiye sahiptir.
Özgünlük/Değer: İki farklı yöntem kullanılarak elde edilen bulgularla fındık ihracatında, fındık ekili alanının önemini ortaya koyması açısından çalışma literatüre önemli bir katkı sağlamaktadır.
Anahtar kelimeler: Tarımsal Ekonomi, Fındık, Dış Ticaret, Kompleks Ağ Analizi.

1.INTRODUCTION

Global tree nut production kept growing at a steady pace over the last decade, reaching around 4.6 million metric tons in season 2019/2020. Almond and walnut were the top produced crops, accounting for 31% and 21% of the world share followed by cashews (17%), pistachios (14%) and hazelnuts (12%) (INC, 2020; An et al., 2020). Hazelnut is the most widely cultivated hard shell fruit in the world, after almond on the other hand the low rate of hazelnut production in the world compared to the other nuts is due to difficulty of finding suitable ecological conditions. In this study, it is exhibited the economic importance of hazelnut production and the evidence of how the area harvested affects the yield of countries'.

Hazelnut is the most widely cultivated hard shell fruit in the world, after almond on the other hand the low rate of hazelnut production in the world compared to the other nuts is due to difficulty of finding suitable ecological conditions. Hazelnut is a plant that can grow at latitudes of 36-41 and needs its own climate. It is grown within 30 km inland at most from the coasts and in places not exceeding 750 - 1800 m in height (RTMCT, 2019) Black Sea Region is one of the few hazelnuts have a favorable ecological conditions for production and is grown in almost every province in the Black Sea coast in Turkey. For Turkey, which is a world leader in hazelnut products, it is one of the most exported agricultural products. Turkish hazelnuts importers are consisting of chocolate producers abroad, mainly in Europe. In addition to the consumption of hazelnuts as food, the use of hazelnut shell as a biofuel in energy production increases the demand for this product all over the world (Dogru et al., 2002; Franchi and Boubaker, 2014)

Hazelnut cultivation is mainly carried out on steep lands in the Black Sea region of Turkey. The largest producing and exporting country is Turkey in the world, which exports 84% of its production, representing approximately 20% of Turkey's total agricultural exports. Hazelnut is such an important product for Turkey that there is a large number of publications researching the agricultural and economic situation of Turkish hazelnuts. Yavuz et al., (2005), Tanrıvermiş (2008, Bayramoğlu et al., (2010), Akal (2009), Bozoğlu (2005), Bozoğlu et al. (2019) provided Turkey's hazelnut industry to make inferences about current policies by using econometric modeling. They concluded that the most important implication of the model is that the high price support policy applied for years caused the expansion of the areas planted with hazelnuts and the surplus supply of hazelnuts. The results obtained from the model are not consistent with the belief that rising world hazelnut prices will cause competing hazelnut producing countries to increase their share of the world market to the detriment of Turkey and adversely affect hazelnut exports. foreign chocolate companies used almonds instead of hazelnuts. The most important activity to consider is the expansion of the world hazelnut market by increasing world consumption of hazelnuts. Furthermore, the request for export funds, which negatively affects hazelnut exports, should be terminated. Turkey's hazelnut areas and export amount of Turkey have been increasing, while hazelnut yield and production decreasing since 2001 (Marongiu, 2005; Candemir et al., 2011; Gonenç et al., 2006; Kayalak and Özçelik, 2012; Şişman , 2020).

2.MATERIALS and METHODS

The first step to understand a complex system is the decomposition of this system into its parts (Reichardt, 2009: 2). Economics is defined as a complex system, contrary to standard approaches, within the scope of complexity science. Hence, complex system methodology has started being used in the field of economics. Network analysis is one of these methodologies as a proper tool to decompose the economic system into its parts. Network representation of economic relations enables one to see the parts of the system and the relations among them. Therefore, the network analysis has drawn attention of policymakers, recently (OECD 2009: 9). In the present study, we first analyzed international trade of hazelnut via network approach. We built the adjacency matrices based on weighted-directed network structure. A weighted network refers to a network in which each link has a distinct weight. *G= (V, W, f)* is the mathematical notation of a weighted network, where *W*= $\{w_1, w_2, \dots, w_m\}$ shows the set of weights. In the examination of network topology, there are some major properties to analyze. Connectedness is one of them and is analyzed both in node-level and in network level. Connectedness is calculated in network level by 'density coefficient', which refers to ratio of actual links to possible maximum count of links. In a directed network, which does not involve self-loops and multilinks, density coefficient is formulized as;

$\rho = \frac{m}{n(n-1)}$ (Newman 2010: 134), where m corresponds to count of links and n corresponds to count of nodes. Another important property of a network is reciprocity that can be related with a lot of important phenomena. Reciprocity, as another property, indicates the tendency of node pairs to be connected by mutual links pointing in opposite directions (Ruzzenenti, 2010: 1716). It is the proportion of mutual connections in a directed graph (Igraph, 2020: 331). Degree distribution is another important topological feature of a network. A large number of studies based on real-world networks have proved that there are a lot of nodes with weak links and there are a few nodes with strong links. It means that degree distribution follows power-law. Power-law distribution is indicated as $P(k) \propto k^{-\alpha}$ in mathematical notation. In network analysis, power-law degree distribution means that link formation in network is not random. In other words, it implies that network system is managed by some hubs with high degree/strength. These hubs are major determinants on system behavior even if their number is not so high (Newman 2008: 34). In network theory, a network that follows power-law distribution is called scale-free network since the same functional form exists when the variable is rescaled (Boccaletti et al., 2006: 188). Fitness to power-law distribution is analyzed statistically with Kolmogorov-Smirnov test. If the p-value is lower than 0.05, then the null hypothesis that represents fitness to power-law distribution is rejected (R igraph manual pages). Fitness to power-law distribution is an indication of complexity in generating process of the structure examined (Clauset, 2011). Assortative/disassortative mixing is another important property of networks to investigate. Assortativity implies that nodes with high degree/strength have tendency to have links with the nodes with high degree/strength. Contrarily, disassortativity means that nodes with high degree/strength have tendency to have links with the nodes with low degree/strength (Reichardt, 2009: 6-7).

A correlation coefficient, lying in the range of $-1<r<1$, is used to determine whether assortative or disassortative structure exists in network (Newman, n.d.: 5). If it is positive, there exists assortativity in the network, while there exists disassortativity if it is negative. Detection of assortative/disassortative structure is an important part of network analysis. Because disassortativity indicates existence of core-periphery structure in network (Fuge et al. 2013: 6; Csermely, 2013: 99). In a core-periphery structure, nodes in the core are related to each other and also to the nodes in the periphery. However, nodes in the periphery are not related to each other (Borgatti and Everett, 1999: 377, 378). Borgatti and Everett (1999) developed a correlation coefficient that measure fit of a real data network to a network that has ideal core-periphery structure. The closer to 1 the coefficient is, the closer to perfect core-periphery structure the real-data network is (Borgatti and Everett, 1999: 393). Existence of core-periphery structure in a network requires the determination of core and periphery nodes of network. In the present study, hub and authority centralities, developed by Kleinberg (1999), are used to determine these hubs.

Network analysis of international hazelnut trade covers the period from 1990 to 2018. The bilateral trade data to build matrices are obtained from the UN Comtrade database. These data correspond to bilateral export volumes. Network analysis, contrarily to the standard approach to international trade, reveals high-degree indicators by taking indirect relationships among the nodes with a holistic view (Fagiolo et al., 2013: 82). Based on this, long-term relationship via panel-data analysis between 'areas harvested' and 'hub centralities', which correspond to export impacts as high-degree indicators, has been also examined for the top 5 exporter of hazelnut. This analysis covers the period from 1996 to 2018.

When non-stationary series are used in econometric analyses, spurious regression problem could be faced. Accordingly, it is necessary to ensure stationarity of series before the analysis. Unit root tests employed to determine stationarity in panel data analysis, are classified as the first generation tests and second generation tests. The first generation tests are used in case of the non-cross sectional dependency of data set, meaning that if a shock occurs in a unit-section it does not affect the other unit-sections. However, the second generation tests are used in case of cross sectional dependency, meaning that if a shock occurs in a cross-section it affects the other cross-sections (Yerdelen Tatoglu, 2013). Therefore, unit root tests differ according to whether there is cross sectional dependency in the series and it is first necessary to test cross sectional dependency in the dataset. In panel data analysis, various tests were developed in order to examine cross sectional dependency in series. The first test was the Lagrange Multiplier (LM) test developed by Breusch and Pagan, which is employed when time dimension of panel data is greater than cross-sectional dimension (T>N). However, applicability of this test decreases when $N \to \infty$. That's why, Pesaran introduced a new test that could be applied for high values of N and T (Pesaran 2004). Afterwards, Pesaran (2007) developed another version of LM test. This test's statistic (LM_{adj}) is with corrected deviation (Pan et al. 2015). In the present study, cross-section dependency test results confirmed the cross-sectional dependency. Therefore, we employed Cross-sectionally Augmented Dickey Fuller (CADF) test which is a second-generation unit root test. CADF test is used in case of both T>N and N>T (Pesaran 2007). Monte Carlo simulations based on various models indicated that CADF test gives robust results even for small N and T (Pesaran, 2007: 266-267). H0 hypothesis of this test refers to that all cross-sections have unit root, while H1 represents stationarity. As a result of CADF test, test statistics is calculated for both cross-sections and panel overall. The test statistics for the panel overall (CIPS) is obtained with averaging the test statistics of cross-sections (Pesaran, 2007: 276). After testing stationarity of the series, cointegration analysis has been applied to the series to examine long-term relationship between the variables. Durbin-Hausman, as a second generation cointegration test which is used in case of existence cross-section dependence in the residuals of cointegration equation, can also be used when integration levels of some independent variables are I(0). Null hypothesis corresponds to no-cointegration, while alternative hypothesis corresponds to existence of cointegration (Westerlund, 2008: 218). After detecting the existence of cointegration, Pesaran-Yamagata slope homogeneity test has been applied to the data in order to examine if cross-sections are homogeneous or not. Null hypothesis of this test corresponds to homogeneity, while alternative hypothesis corresponds to heterogeneity (Pesaran and Yamagata, 2008: 52). Finally, AMG estimator, developed by Eberhardt and Bond (2009), has been used to estimate long-term coefficients. AMG estimator has some advantages such as letting us use variables which have different stationary levels as well as taking into consideration cross-section dependency and heterogeneity of parameters (Colak et al., 2014: 276; Acaravci et al., 2015: 125).

3.RESULTS and DISCUSSION

Results of complex network approach

It is seen in Table 1 that the counts of nodes and links increase year by year. However, when we look at the density coefficient as an indicator of connectivity, it is seen that the density fluctuates around 0,03. Taking the increasing nodes in the network into account and depending on the stable density coefficient, we can say that this network is a sparse network in which the number of links of each node is so far from the maximal possible number of nodes. Although it needs further examination, this result may give an idea about existence of some central nodes within this structure.

Table 1. Descriptive network statistics

Years	Node	Link	Reciprocity	Density
1990	88	293	0.225	0.038
1991	90	304	0.211	0.038
1992	99	363	0.237	0.037
1993	99	353	0.227	0.036
1994	104	392	0.250	0.037
1995	110	406	0.232	0.034
1996	108	437	0.224	0.038
1997	107	442	0.226	0.039
1998	113	451	0.222	0.036
1999	113	481	0.254	0.038
2000	125	542	0.303	0.035
2001	130	544	0.283	0.032
2002	129	560	0.286	0.034
2003	123	565	0.304	0.038
2004	133	577	0.274	0.033
2005	139	583	0.271	0.030
2006	130	606	0.297	0.036
2007	142	647	0.291	0.032
2008	142	666	0.321	0.033
2009	138	705	0.295	0.037
2010	149	704	0.267	0.032
2011	153	746	0.300	0.032
2012	153	781	0.297	0.034
2013	161	822	0.309	0.032
2014	154	846	0.331	0.036
2015	161	826	0.327	0.032
2016	166	894	0.349	0.033
2017	162	894	0.380	0.034
2018	167	943	0.350	0.034

Increase in reciprocity, which is the proportion of mutual connections in directed graphs, indicates that some importer countries have become also exporter of hazelnut over the period. Assorttaive/disassortative structure is an important feature to detect in network analysis.

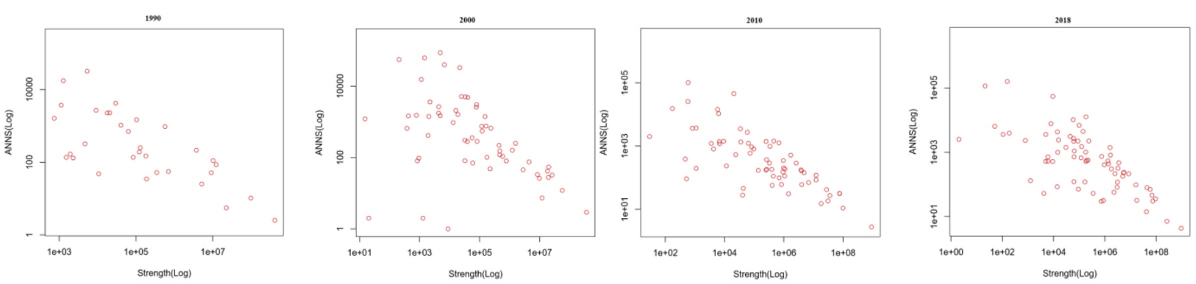

Figure 1. Assortative or disassortative mixing

In Figure 1 it can be observed that average nearest neighbor strength decreases whereas strength of nodes increases. These graphs give an idea about disassortative mixing pattern. However, it is required to examine this pattern statistically. Assortativity correlation coefficient is presented in Table 2.

Table 2. Assortativity correlation coefficient

Years	Assortativity Corr. Coefficient	Years	Assortativity Corr. Coefficient
1990	-0.067	2005	-0.058
1991	-0.088	2006	-0.070
1992	-0.065	2007	-0.070
1993	-0.050	2008	-0.074
1994	-0.060	2009	-0.066
1995	-0.068	2010	-0.050
1996	-0.077	2011	-0.059
1997	-0.068	2012	-0.053
1998	-0.079	2013	-0.051
1999	-0.071	2014	-0.049
2000	-0.074	2015	-0.048
2001	-0.056	2016	-0.057
2002	-0.082	2017	-0.051
2003	-0.074	2018	-0.062
2004	-0.049		

Accordingly, international trade network of hazelnut has disassortative mixing pattern for each year. As explained in methodology section, disassortative pattern corresponds to core-periphery structure in networks.

Table 3. Core-periphery fit correlation

Years	Core-periphery fit correlation	Cores	Years	Core-periphery fit correlation	Cores
1990	0.700	Germany, Turkey	2005	0.704	Italy, Turkey
1991	0.700	Germany, Turkey	2006	0.704	Italy, Turkey
1992	0.699	Germany, Turkey	2007	0.698	Italy, Turkey
1993	0.705	Germany, Turkey	2008	0.694	Italy, Turkey
1994	0.704	Germany, Turkey	2009	0.688	Italy, Turkey
1995	0.705	Germany, Turkey	2010	0.685	Italy, Turkey
1996	0.704	Germany, Turkey	2011	0.687	Italy, Turkey
1997	0.704	Germany, Turkey	2012	0.676	Italy, Turkey
1998	0.706	Germany, Turkey	2013	0.678	Italy, Turkey
1999	0.702	Germany, Turkey	2014	0.699	Italy, Turkey
2000	0.700	Germany, Turkey	2015	0.696	Italy, Turkey
2001	0.702	Germany, Turkey	2016	0.692	Italy, Turkey
2002	0.697	Germany, Turkey	2017	0.688	Italy, Turkey
2003	0.703	Germany, Turkey, Italy	2018	0.689	Italy, Turkey
2004	0.698	Italy, Turkey			

Core-periphery fit correlation, developed by Borgatti and Everett (2000), fluctuates between 0,68 and 0,70. These coefficients indicate in what ratio these trade networks fit an ideal core-periphery network structure. It can be stated that international trade network of hazelnut highly fits core-periphery structure. Germany and Turkey are the cores of this network structure till 2003. Afterwards, Italy and Turkey have become the core countries of the international hazelnut trade network.

Table 4. Fitness to power-law distribution

Years	Skewness	Kurtosis	K-S alpha	p-value	Years	Skewness	Kurtosis	K-S alpha	p-value
1990	8.527	76.540	1.319	0.662	2005	11.281	130.865	1.392	0.901
1991	8.437	75.524	1.332	0.900	2006	11.035	124.406	1.304	0.164
1992	9.165	87.916	1.325	0.269	2007	11.146	129.324	1.907	0.994
1993	9.415	91.635	1.355	0.987	2008	11.247	131.031	1.874	0.998
1994	9.747	97.746	1.346	0.729	2009	10.868	123.819	1.348	0.672
1995	10.196	105.889	1.344	0.535	2010	11.594	138.823	1.393	0.866
1996	9.802	99.482	1.944	0.998	2011	11.649	140.786	1.944	0.999
1997	9.834	99.788	1.319	0.610	2012	11.681	141.370	1.350	0.737
1998	10.172	106.339	1.394	0.850	2013	11.658	142.837	1.345	0.839
1999	9.954	102.954	1.332	0.648	2014	11.482	138.086	1.355	0.779
2000	10.471	114.101	1.302	0.932	2015	11.914	147.505	1.992	0.999
2001	11.046	124.540	1.319	0.641	2016	11.413	139.374	2.228	0.999
2002	10.584	116.654	1.319	0.822	2017	11.273	135.783	2.324	0.999
2003	10.071	106.890	1.348	0.802	2018	11.258	135.898	2.108	0.999
2004	10.943	123.542	1.754	0.999					

Positive skewness and kurtosis values give an idea about right-skewed and heavy-tail distribution. However, it is also required to test fitness to power-law distribution statistically. Kolmogorov-Smirnov test results exist also in Table 4. The null hypothesis of fitness to power-law distribution cannot be rejected due to p-values higher than 0,05. Hence, strength distribution of these networks follow power-law, meaning that there is heterogeneity in these networks in terms of connectedness.

After detection of core-periphery and power-law properties of the network, it is informative to examine centrality measures in order to determine these cores and peripheries. As mentioned in the methodology section, we used hub and authority centralities developed by Kleinberg (1999). In the present study, hub centrality corresponds to export impact while authority centrality corresponds to import impact of the nodes. Since the period of the analysis is long and centralities of countries are dynamic, we plotted the centralities of the countries in top five ranking for 1990-2018 period.

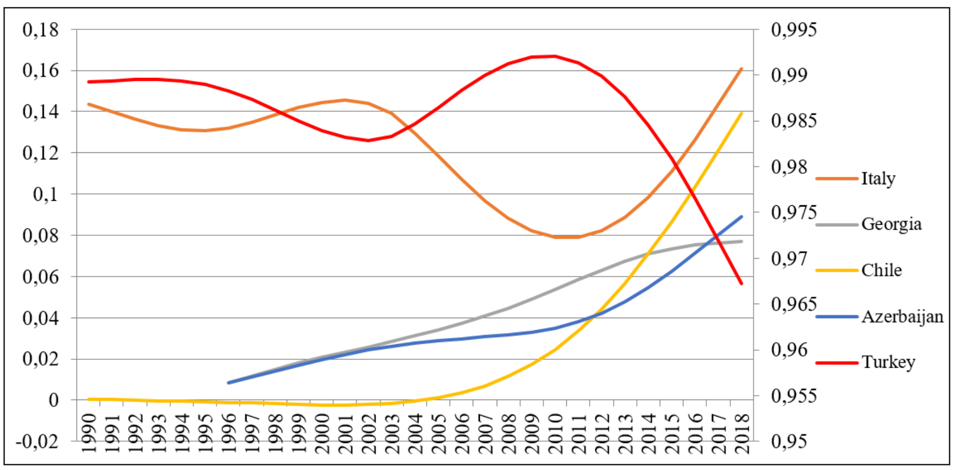

Figure 2. Hub centrality scores (1990-2018)[i]

It is observed in Figure 2 that hub centrality of Turkey has a declining trend especially after 2010. However, Italy, Georgia, Chile and Azerbaijan have increasing trend. Even if Turkey has the highest hub centrality score (meaning export impact) among these top 5 countries, this result can be evaluated as the increasing potential competitive power of the other countries.

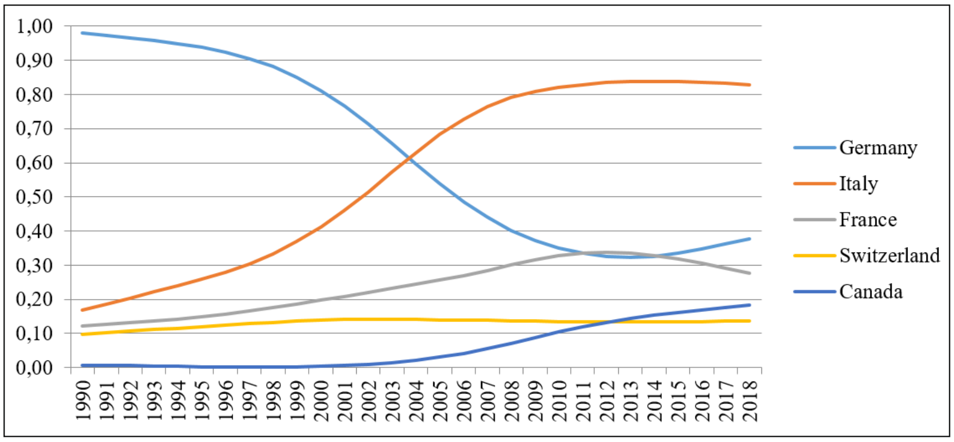

Figure 3. Authority centrality scores (1990-2018)[ii]

When it comes to authority centralities in Figure 3, the shift between Germany and Italy (mentioned above while discussing core-periphery structure) can be observed. Italy has become the highest authority within this network since 2004. In general, authority scores of all of these countries have an increasing trend, meaning that there is an increasing demand by developed countries for hazelnut within this trade network.

Results of econometric analysis

The data used in the econometric analysis covers the period 1996-2018. The reason of the limitation on the period is the lack of availability of trade data for Azerbaijan and Georgia. Detailed information is given in in Table 5.

Table 5. Description of the data

Data	Definition	Data source	Mean	Std. Dev.
Hub	Hub centrality scores	Authors' calculation	0.243	0.376
Log (Area)	Logarithm of 'areas harvested (ha)'	FAO	4.489	0.718

The hub scores which correspond to export impact of countries are the data obtained as a result of network analysis. The Log (Area) variable refers to the harvested area for hazelnut. We aimed to examine the impact of some other factors such as count of the filberts, subsidies to hazelnut producers etc. on export impact of countries. However, these data were not available in a regular form for these countries. When we examine hub scores obtained from network analysis for the whole period from 1990 to 2018, we observed that Turkey is always the leader of this international trade network and that Italy, Georgia, Chile and Azerbaijan are the countries on the rise. That's why these five countries were selected in econometric analysis.

Table 6. Cross-section dependence test results

Variable	$CDLM_1$	$CDLM_2$	LM_{adj}
Hub	61.05199*	10.29754*	10.1839*
	(0.000)	(0.000)	(0.000)
Log (Area)	80.7007*	14.69112*	14.57749*
	(0.000)	(0.000)	(0.000)

**corresponds to 1% significance level.*

When cross-section dependence test results are examined as a first step of panel data analysis, it is seen that p-values are lower than 0.05, meaning that the null hypothesis of no cross-section dependence can be rejected. This result means that all the other countries is affected when there is a shock for one country in terms of the variable. After detection of cross-section dependence, CIPS unit-root test as a second-generation test were applied to the variables.

Table 7. Unit-root test results

Variables	Test statistics	
	Constant	Constant and trend
Hub	-1.575	-2.7
Δ Hub	-5.094*	-5.299*
Log (Area)	-2.415**	-2.386
Δ Log (Area)	-	-4.853*
10%	-2.21	-2.73
5%	-2.33	-2.86
1%	-2.57	-3.1

and correspond to 1% and 5% significant levels, respectively.*

According to the CIPS unit-root test results, it can be observed that both of the variables become stationary at first-difference in constant and trend model, meaning that integration level of the variables is I (1). Since the integration levels of the variables are I (1), there may be a long-run relationship between them. Cointegration tests are applied to examine the existence of this long-run relationship. However, cross-section dependence test is applied to the residuals belong to the long-run equation before choosing the cointegration test. In the present study, a cross-section dependence test result for the model is given in Table 8.

Table 8. Cross-section dependence test result for the model

Model	**$CDLM_1$**	**LM_{adj}**
Constant	47.58*	21.95*
	(0.000)	(0.000)
Constant and trend	34.96*	13.34*
	(0.000)	(0.000)

**corresponds to 1% significance level. *corresponds to 1% significance level. CDLM1 refers to Breusch-Pagan cross-section dependence test statistics; CDLM2 refers to Pesaran scaled cross-section dependence test statistics; LM_{adj} refers to bias-corrected scaled cross-section test statistics.*

Accordingly, null hypothesis of no cross-section dependence is rejected for both constant model and constant-trend model. Based on this result, Durbin-Hausman test, as a second-generation cointegration test, was applied to the model.

Table 9. Cointegration test results

Group statistics	**Panel statistics**
0.132	3.736*
(0.447)	(0.000)

**corresponds to 1% significance level.*

According to the results in Table 9, null hypothesis of no cointegration is rejected based on the panel statistics. Thus, it can be said that there is long-run relationship in the model. After detection of this relationship, long-run coefficients belong to this relation can be estimated. Pesaran-Yamagata slope homogeneity test results are given in Table 10:

Table 10. Slope Homogeneity Test Results

Delta	**Delta adj**
4.042*	4.335*
(0.000)	(0.000)

**corresponds to 1% significance level.*

Accordingly, null hypothesis of slope homogeneity is rejected depending on the results in Table 10, meaning that the countries examined are heterogeneous. Based on this, long-run coefficients are estimated specifically to each country. Long-run coefficient estimation results based on AMG method are presented in Table 11.

Table 11. AMG Estimation of Long-run Coefficients

Dependent variable: Hub	
Countries	Log (Area)
Italy	-0.405
	(0.263)
Georgia	0.149*
	(0.000)
Chile	0.102*
	(0.000)
Azerbaijan	0.150*
	(0.000)
Turkey	0.034**
	(0.031)

and *correspond to 1% and 5% significant levels, respectively.*

According to the Table 11, Log (Area) variable has statistically positive impact on hub scores of the countries examined, except Italy. Log (Area) has not significant impact on Italy's export impact. When the coefficients are compared to each other, it is seen that the highest impact is for Azerbaijan and Georgia. Chile is the third in terms of the comparison of this impact. When compared these countries, Log (Area) has the lowest impact in Turkey.

4.CONCLUSION

In the present paper, complex network analysis has been applied to examine the evolution of international hazelnut trade structure for the period of 1990-2018. As a result of the complex network analysis, it was found that Turkey, Italy, Chile, Azerbaijan and Georgia have the highest export impact in the world in 2018. Italy, Chile, Azerbaijan and Georgia, among these countries, are the ones with increasing impact, contrary to Turkey.

Although these are the countries with the highest export impact, some remarkable differences between the indicators of world hazelnut production attract attention. Although these countries have the highest export impact (in Figure 6), it is seen that (in Figure 9) the average share of the top five countries in world hazelnut production for 1990-2018, which is the period covering the network analysis, Chile does not appear among the top five hazelnut producer countries. It can be inferred that Chile, as an important hazelnut producer in recent years, has become one of the countries with high export impact, especially with the encouragement of the US for hazelnut production. This is explained through the implementation of competitive policies against Turkey. Turkey is the world leader in hazelnut exports in the world as it is in hazelnut production. As a result of this leadership, Turkey is the price setter country on the world hazelnut market. On the other hand, Italy, Germany and the US, as important manufacturers of chocolate, of which ingredient is hazelnut, desire to establish control on determinative role of Turkey on the market. The US supports the new hazelnut producer countries as a rival to Turkey. In addition, Italy is producing hazelnut (Caporali et al., 2003) and following a different policy; important Italian companies producing chocolate with Turkish hazelnuts, began to perform hazelnut production by buying the harvested area in the Black Sea region of Turkey. Hence, these companies could produce by themselves the most valuable hazelnut benefiting from the advantages of Turkey's soil and climatic conditions. The results of econometric analysis also show that the harvested hazelnut area is important for the largest hazelnut producers except for Italy.

In the panel data analysis, we aimed to test the impacts of some other indicators on hub centralities (such as count of filbert, subsidies etc.). However, we could not include these indicators due to lack of data availability. This is the limitation of the present study and can be extended by a future research.

ENDNOTES

[i]Right-axis: Turkey; Left-axis: Italy, Georgia, Chile, Azerbaijan. The trends of the series are obtained by Hodrick-Prescott method. The trade data for Georgia and Azerbaijan are available from 1996.

[ii]The trends of the series are obtained by Hodrick-Prescott method.

Contribution Rate of Researchers Declaration Summary

The authors declare that they have contributed equally to the article and have not plagiarized.

Conflict of Interest Declaration

The authors of the article declare that there is no conflict of interest between them.

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