

Analysis of OECD Countries in Terms of Foreign Trade of a Wood-Based Product Group via Hierarchical Clustering

Hiyerarşik Kümeleme Aracılığıyla Odun Esaslı Bir Ürün Grubunun Dış Ticareti Açısından OECD Ülkelerinin Analizi

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Abstract

In today's globalizing world, economic cooperation is of great importance for countries to develop their trade networks. It is possible to consider the OECD as one of such collaborations. The main purpose of this study is to subject the export and import values of OECD countries in terms of plywood, veneered panel and similar laminated wood product group to hierarchical cluster analysis and to classify the countries according to their similarities. The plywood, veneered panel and similar laminated wood export and import data belonging to the years 2013-2023 of the countries subject to the study were provided from Trademap website. The results of the hierarchical cluster analysis indicated that it is possible to divide OECD countries into minimum 2 groups and maximum 4 groups in terms of export, and minimum 2 groups and maximum 5 groups in terms of import. Moreover, hierarchical cluster analysis revealed Türkiye's position among the OECD countries. It has been understood that Türkiye is in the cluster with the highest number of countries, in all clustering options in terms of both the export and import. This result demonstrated that Türkiye is similar to a large number of the OECD countries in terms of foreign trade of the relevant product group. It is possible to state that such studies may be important in terms of both seeing the current situation of the countries and making more effective assessments regarding the products or sectors under research.

Keywords: Plywood, foreign trade, hierarchical clustering, wood-based product

Özet

Günümüzün küreselleşen dünyasında ülkelerin ticaret ağlarını geliştirmesi için ekonomik iş birlikleri büyük önem taşımaktadır. OECD'yi bu gibi iş birliklerinden biri olarak dikkate almak mümkündür. Bu çalışmanın ana amacı kontrplak, kaplamalı levha ve benzeri lamine edilmiş odun ürün grubu açısından OECD ülkelerinin ihracat ve ithalat değerlerini hiyerarşik kümeleme analizine tabi tutmak ve ülkeleri benzerliklerine göre sınıflandırmaktır. Çalışmaya konu ülkelerin 2013-2023 yıllarına ait kontrplak, kaplamalı levha ve benzeri lamine edilmiş odun ihracat ve ithalat verileri Trademap web sitesinden sağlanmıştır. Hiyerarşik kümeleme analizinin sonuçları OECD ülkelerini ihracat açısından en az 2 gruba ve en fazla 4 gruba, ithalat açısından ise en az 2 gruba ve en fazla 5 gruba ayırmanın mümkün olduğunu göstermiştir. Ayrıca, hiyerarşik kümeleme analizi Türkiye'nin OECD ülkeleri arasındaki pozisyonunu ortaya koymuştur. Hem ihracat hem de ithalat açısından tüm kümeleme seçeneklerinde Türkiye'nin en fazla ülkeye sahip kümede yer aldığı anlaşılmıştır. Bu sonuç Türkiye'nin ilgili ürün grubunun dış ticareti açısından çok sayıda OECD ülkesine benzediğini göstermiştir. Bu tür çalışmaların, araştırılan ürün veya sektörlerle ilişkin hem ülkelerin mevcut durumlarını görme hem de daha etkili değerlendirmeler yapma açısından önemli olabileceğini belirtmek mümkündür.

Anahtar Kelimeler: Kontrplak, dış ticaret, hiyerarşik kümeleme, odun esaslı ürün

1. Introduction

It is obvious that the world economy is in a process of rapid transformation and development. On the other hand, it is not always easy to keep up with this rapidly advancing process and to exist within it. The countries need to create their own internal dynamics and keep up with the economic balance in order to achieve this speed. At this point, it is possible to say that the most important internal dynamics that keep countries sustain and enable them to compete with the world are the industries that will develop the countries (Gunduz et al., 2018).

Türkiye's forest products industry is among fast growing sectors in Türkiye, with its development in recent years (Koç et al., 2017). This industry or sector is an indispensable element of many industrial branches that shape the country's economy. It provides significant support or contributions to many different sectors (Şahin, 2016). When the forest products sector is evaluated in terms of production size and foreign trade volume, it is possible to state that the sector has a remarkable size in both national and international trade. The wood-based panel product group stands out within the forest products industry sector, which processes roundwood obtained from forests in various ways to obtain products with different properties (Yıldırım et al., 2016).

Figure 1 shows Türkiye's plywood, veneered panel and similar laminated wood export, import and trade balance, while Figure 2 demonstrates the plywood, veneered panel and similar laminated wood export, import and trade balance of other OECD (Organisation for Economic Co-operation and Development) countries. The data used to create Figure 1 and 2 were obtained from the Trademap website (URL-1).



Figure 1. Türkiye's plywood, veneered panel and similar laminated wood export, import and trade balance.



Figure 2. Export, import and trade balance in terms of plywood, veneered panel and similar laminated wood of OECD excluding Türkiye.

Considering the years 2013-2023, it is possible to draw a general conclusion from Figures 1 and 2 that the plywood, veneered panel and similar laminated wood import values of both Türkiye and other OECD countries are higher compared to their export values. It is seen that the trade balances are obtained in negative. On the other hand, as seen in Figure 1, the difference between import and export values in 2018 and the following years (until 2023) is significantly lower than the difference in the years before 2018 (2013-2017).

Generally speaking, it can be said that international trade is an indispensable element for the advancement or provision of both economic growth and globalization processes (Benlaria, 2024). Similarly, in another study, it was reported that the development of countries shows a close relationship with the success of foreign trade (Akyüz et al., 2020). In brief, it is possible to say that foreign trade is one of the most important driving forces of growth and development (Cicioğlu and İbrahim, 2023). In this context, countries that want to increase their foreign trade volume in today's rapidly globalizing world are in search of new markets to offer their products (Konak and Demir, 2019). Considering that international trade is one of the most important tools contributing to economic growth, its analysis and modeling are of great importance from various perspectives (Demiroğlu, 2019).

Nowadays, hierarchical clustering analysis (HCA) has been widely used in a number of fields, such as hydrochemical classification (Bu et al., 2020), evaluation of river water quality (Warsito et al., 2021), analysis of education expenditures in higher education (Turhan and Gazeloglu, 2023), customer segmentation (Afzal et al., 2024), automotive sector (Pala and

Salahuddin, 2024), analyzing long COVID symptoms (Niewolik et al., 2024), and health system performance (Braithwaite et al., 2025). Apart from these studies, HCA was occasionally used for various goals in the forest products industry. It was sometimes applied alone and sometimes in conjunction with another method, as some examples can be seen in the following researches. Akyüz et al. (2010) analyzed forest product trade relationships between Türkiye and European Union countries through the HCA and discriminant analysis. Tiriyaki et al. (2015) tried HCA in analyzing furniture foreign trade of European Union countries and Türkiye. Akyüz et al. (2019) used HCA and discriminant analysis to understand the similarity in industrial wood production of regional directorates of forestry in Türkiye. In another study, Kurt and İmren (2021) applied hierarchical and non-hierarchical cluster analyses for evaluating Türkiye's wood production. Yıldırım and Emiroğlu (2022) performed comparative analysis of some products belonging to the forest products industry sector using HCA and discriminant analysis.

As can be understood from the above studies, the relevant literature suffers from the lack of studies focusing on the comparison of foreign trade of Türkiye and other OECD countries in terms of the plywood, veneered panel and similar laminated wood product group through HCA although there are similar researches. Therefore, this study aims to comparatively analyze the foreign trade of Türkiye and other OECD countries for plywood, veneered panel and similar laminated wood product group by HCA.

2. Material and Method

2.1. Material

The export and import data (unit: US Dollar thousand) for the plywood, veneered panel and similar laminated wood product group of Türkiye and other OECD countries were obtained from the website of the International Trade Center/Trademap (URL-1). In other words, the data belonging to the product group defined with the code 4412 on this website were employed in this study. Table 1 gives the code and description of the product group considered within the scope of the current study.

Table 1. The code and description of the product group subject to the study (URL-1).

Code	Product description
4412	Plywood, veneered panel and similar laminated wood (excl. sheets of compressed wood, cellular wood panels, parquet panels or sheets, inlaid wood and sheets identifiable as furniture components)

In brief, the data of the product group described above, covering the years 2013-2023 and available on the Trademap website (URL-1) at the time of data collection, were analyzed, graphed and interpreted for the current study.

2.2. Methods

In this study, OECD countries, of which Türkiye is a member, were analyzed in terms of foreign trade of the product group that is the subject of the study, taking into account the years 2013-2023. For this purpose, export and import data of a total of 38 countries, including Türkiye, were taken into account. Within the scope of the research, a well-known data analysis tool, the HCA, was used to cluster OECD countries in terms of export and import of plywood, veneered panel and similar laminated wood product group.

In general terms, hierarchical clustering can be referred to as a cluster analysis method that intends to create a hierarchy of clusters. It can be subdivided based on agglomerative and divisive approaches (Shetty and Singh, 2021). In agglomerative clustering approach, hierarchical clustering begins by first treating each item as a single cluster. The next phase involves merging pairs of clusters one by one until the merging process of all clusters is completed with a single large cluster holding all the items (Bouguettaya et al., 2015; Lodhi et al., 2023). On the other hand, in divisive clustering approach, all items are initially adopted as a single cluster and the splits are performed iteratively, moving down the hierarchy (Zhang et al., 2017). It was stated that a hierarchical algorithm produces a dendrogram representing a nested grouping of items and similarity levels at which groupings change (Jain et al., 1999).

The HCA was carried out using the Ward method. As a result, the OECD countries were grouped according to their similarities. The SPSS software was used in the application of HCA.

3. Results and Discussion

3.1. Analysis of export values of plywood, veneered panel and similar laminated wood product group

Türkiye and other OECD countries were clustered in terms of export data of plywood, veneered panel and similar laminated wood product group for the years 2013-2023 using HCA. Figure 3 demonstrates the dendrogram obtained as a result of the HCA conducted using the data provided from the following reference (URL-1) and taking into account the Ward method.



Figure 3. Dendrogram of export data.

The dendrogram in Figure 3 provided visual information regarding the clustering of the countries under study. As the export data of the product group subject to the current study were taken into account, it was seen that the 38 countries of the OECD, including Türkiye, could be mainly divided into minimum 2 and maximum 4 groups or clusters as a result of application the of HCA by Ward method.

Figure 4 gives a graphical presentation of the approximate sizes of all clusters obtained according to the results of the HCA applied to the export values. Besides, Table 2 presents the countries that make up each cluster identified by taking into account the results of the analysis.

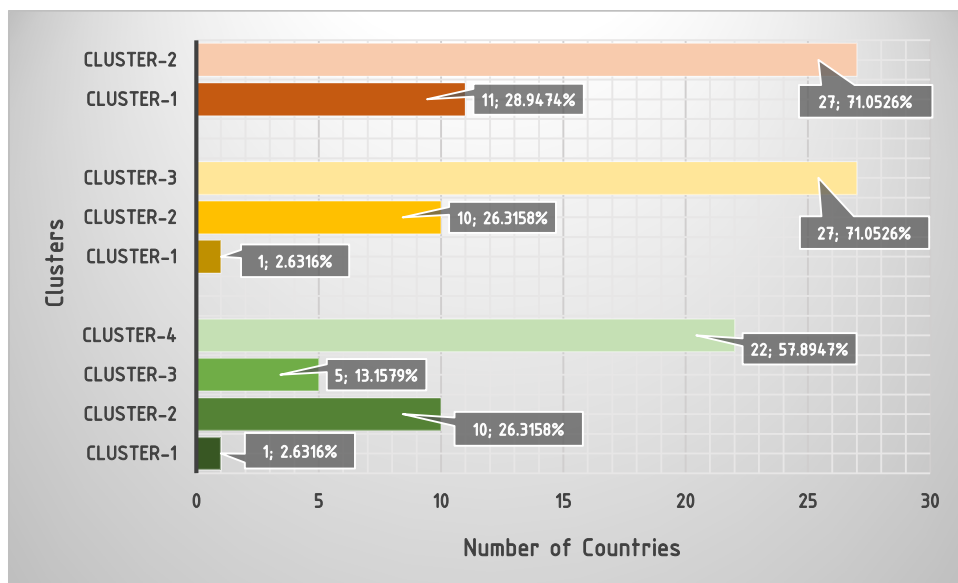


Figure 4. Graphical presentation of cluster sizes in terms of export data.

Table 2. Results of HCA in terms of export data.

Division into four clusters	
Cluster-1 (1 country)	Finland
Cluster-2 (10 countries)	Canada, Italy, Chile, Latvia, Germany, Spain, Austria, Belgium, USA, Poland
Cluster-3 (5 countries)	Estonia, Czech Republic, France, Netherlands, Slovakia
Cluster-4 (22 countries)	<i>Türkiye</i> , Slovenia, Japan, Hungary, Sweden, United Kingdom, New Zealand, Greece, Norway, Lithuania, Denmark, Australia, Mexico, Portugal, Switzerland, Korea, Republic of, Ireland, Luxembourg, Israel, Colombia, Costa Rica, Iceland
Division into three clusters	
Cluster-1 (1 country)	Finland
Cluster-2 (10 countries)	Canada, Italy, Chile, Latvia, Germany, Spain, Austria, Belgium, USA, Poland
Cluster-3 (27 countries)	Estonia, Czech Republic, France, Netherlands, Slovakia, <i>Türkiye</i> , Slovenia, Japan, Hungary, Sweden, United Kingdom, New Zealand, Greece, Norway, Lithuania, Denmark, Australia, Mexico, Portugal, Switzerland,

	Korea, Republic of, Ireland, Luxembourg, Israel, Colombia, Costa Rica, Iceland
Division into two clusters	
Cluster-1 (11 countries)	Finland, Canada, Italy, Chile, Latvia, Germany, Spain, Austria, Belgium, USA, Poland
Cluster-2 (27 countries)	Estonia, Czech Republic, France, Netherlands, Slovakia, <i>Türkiye</i> , Slovenia, Japan, Hungary, Sweden, United Kingdom, New Zealand, Greece, Norway, Lithuania, Denmark, Australia, Mexico, Portugal, Switzerland, Korea, Republic of, Ireland, Luxembourg, Israel, Colombia, Costa Rica, Iceland

USA symbolizes United States of America

As can be seen in Table 2, the HCA performed to classify the countries with similar export data indicates that except for the separation into two clusters, which is one of the results of the dendrogram, Finland formed a separate cluster on its own for all other cases. When the data collected from the following reference (URL-1) were examined, it became clear that Finland is leading among the OECD countries in terms of export value of the relevant product group in the considered time period. Another striking finding of the HCA is that most of the OECD countries are in a single group in all clustering alternatives. In other words, the results demonstrated that a significant number of these countries are similar in terms of export values. Speaking of Türkiye, it is possible to specify that Türkiye is in the largest cluster, that is, in the cluster with the largest number of countries, in all clustering options. As can be seen in Figure 4, the largest number of countries, including Türkiye, are located in clusters 2 and 3 with cluster sizes of approximately 71% when the countries are divided into 2 and 3 clusters respectively, and in cluster 4 with a cluster size of approximately 58% when the countries are divided into 4 clusters. This means that Türkiye's export values for the relevant product group are similar to many OECD countries.

3.2. Analysis of import values of plywood, veneered panel and similar laminated wood product group

Türkiye and other OECD countries were clustered in terms of import data of plywood, veneered panel and similar laminated wood product group for the years 2013-2023 using HCA. Figure 5 demonstrates the dendrogram obtained as a result of the HCA conducted using the data provided from the following reference (URL-1) and taking into account the Ward method.



Figure 5. Dendrogram of import data.

When the dendrogram obtained as a result of HCA conducted by using the import values of OECD countries for the product group under consideration are examined, it is seen that the countries are clustered in minimum 2 groups and maximum 5 groups.

Figure 6 indicates a graphical presentation of the approximate sizes of clusters obtained according to the results of the HCA applied to the import values. Furthermore, Table 3 gives the countries that make up each cluster identified by taking into account the results of the analysis.

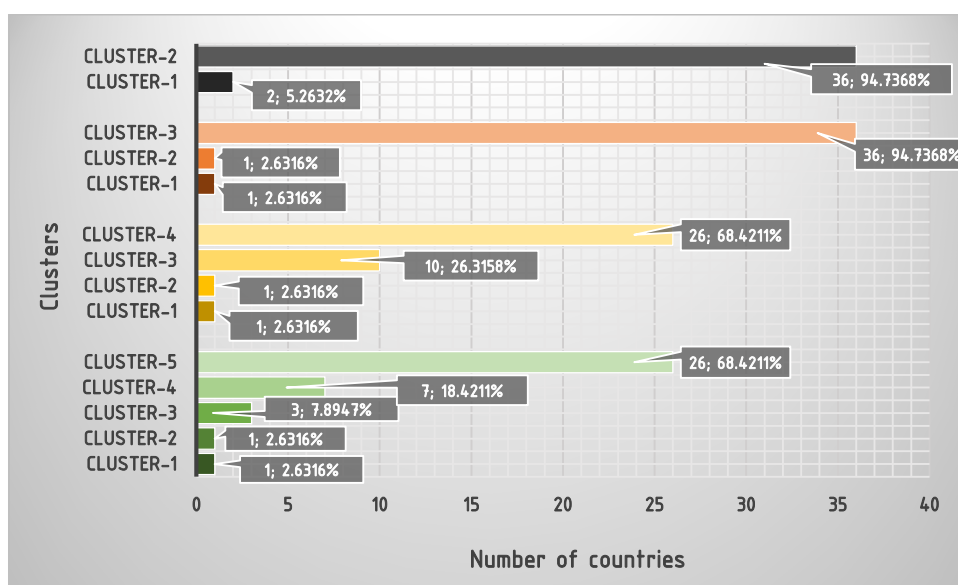


Figure 6. Graphical presentation of cluster sizes in terms of import data.

Table 3. Results of HCA in terms of import data.

Division into five clusters	
Cluster-1 (1 country)	USA
Cluster-2 (1 country)	Japan
Cluster-3 (3 countries)	Germany, United Kingdom, Korea, Republic of
Cluster-4 (7 countries)	Netherlands, France, Mexico, Australia, Canada, Italy, Belgium
Cluster-5 (26 countries)	Switzerland, <i>Türkiye</i> , Austria, Israel, Denmark, Spain, Sweden, Norway, Czech Republic, Portugal, New Zealand, Hungary, Slovenia, Lithuania, Greece, Finland, Estonia, Latvia, Poland, Chile, Slovakia, Ireland, Colombia, Luxembourg, Iceland, Costa Rica
Division into four clusters	
Cluster-1 (1 country)	USA
Cluster-2 (1 country)	Japan
Cluster-3 (10 countries)	Germany, United Kingdom, Korea, Republic of, Netherlands, France, Mexico, Australia, Canada, Italy, Belgium
Cluster-4 (26 countries)	Switzerland, <i>Türkiye</i> , Austria, Israel, Denmark, Spain, Sweden, Norway, Czech Republic, Portugal, New Zealand, Hungary, Slovenia, Lithuania, Greece, Finland,

	Estonia, Latvia, Poland, Chile, Slovakia, Ireland, Colombia, Luxembourg, Iceland, Costa Rica
Division into three clusters	
Cluster-1 (1 country)	USA
Cluster-2 (1 country)	Japan
Cluster-3 (36 countries)	Germany, United Kingdom, Korea, Republic of, Netherlands, France, Mexico, Australia, Canada, Italy, Belgium, Switzerland, <i>Türkiye</i> , Austria, Israel, Denmark, Spain, Sweden, Norway, Czech Republic, Portugal, New Zealand, Hungary, Slovenia, Lithuania, Greece, Finland, Estonia, Latvia, Poland, Chile, Slovakia, Ireland, Colombia, Luxembourg, Iceland, Costa Rica
Division into two clusters	
Cluster-1 (2 countries)	USA, Japan
Cluster-2 (36 countries)	Germany, United Kingdom, Korea, Republic of, Netherlands, France, Mexico, Australia, Canada, Italy, Belgium, Switzerland, <i>Türkiye</i> , Austria, Israel, Denmark, Spain, Sweden, Norway, Czech Republic, Portugal, New Zealand, Hungary, Slovenia, Lithuania, Greece, Finland, Estonia, Latvia, Poland, Chile, Slovakia, Ireland, Colombia, Luxembourg, Iceland, Costa Rica

USA symbolizes United States of America

Generally speaking, when the results of the HCA conducted by using the import data of 38 OECD countries were examined, it was understood that in particular the USA and Japan are different from other member countries. The analysis of all clustering results demonstrated that these two countries, either alone or together, formed different clusters without other countries. When the data obtained from the following reference (URL-1) were examined, it was seen that they have a larger share in terms of the import values of the plywood, veneered panel and similar laminated wood product group compared to other OECD countries for the time period considered in the study. On the other hand, Finland, which generally stands out from other countries with its export data and forms a cluster on its own in most cases, could not show this feature in the analysis of the import data and was in the same group or cluster with many other OECD countries. Similar to the situation in the analysis of export values, one of the striking findings of the HCA in terms of the import data is that most of the OECD countries are together in a single group in all clustering alternatives. In other words, the results of HCA revealed that a significant number of these countries are similar in terms of import values. In an evaluation regarding Türkiye, it is possible to say that Türkiye is in the largest cluster, that is, in the cluster with the largest number of countries, in all clustering options. As can be seen in Figure 6, the largest number of countries, including Türkiye, are in clusters 2 and 3 with cluster sizes of approximately 95% when the countries are divided into 2 and 3 respectively, and in clusters 4 and 5 with cluster sizes of approximately 68% when the countries are divided into 4 and 5, respectively. This means that Türkiye's import values in terms of the relevant product group

are similar to many OECD countries. Moreover, when evaluated from this perspective, it is clear that this case reached regarding import values is similar to the result obtained regarding the export.

The results of the current study, in which the OECD countries are divided into different clusters in terms of export and import values of plywood, veneered panel and similar laminated wood product group, are generally consistent with the results of some previous similar studies conducted in the forest products industry with this aspect. In studies conducted in different fields of the forest products industry and exemplified in the following literature (Akyüz et al., 2010; Tiriyaki et al., 2015; Akyüz et al., 2019; Kurt and İmren, 2021; Yıldırım and Emiroğlu, 2022), it was observed that the items considered in the studies were divided into a varying number of clusters in terms of export, import or production of various products as a result of HCA. On the other hand, it should be emphasized that the current study shows important differences from the sample studies given above in terms of the parameters or research variables used in the study.

4. Conclusion

In this research, plywood, veneered panel and similar laminated wood export and import values of 38 OECD members, including Türkiye, for the years 2013-2023 were subjected to the HCA and the member countries were classified according to their similarities. The main outputs obtained as a result of clustering the OECD members in terms of the export and import values of the product group under study through the HCA are as follows:

It was seen that the minimum 2 and maximum 4 clusters for 38 countries of OECD in terms of the export values could be formed by the use of HCA with the Ward method. Apart from the division of countries into two clusters, which is one of the results of the dendrogram, Finland formed a separate cluster on its own in all other cases, indicating that it has a different position than other countries in terms of export data. Another important outcome of the HCA is that most of the member countries are similar in terms of export values. When an evaluation was made for Türkiye, it was seen that the country was included in the cluster with the highest number of countries in each clustering option resulting from the HCA. This result reveals that Türkiye is similar to many OECD countries in terms of export values of the relevant product group.

The HCA results showed that minimum 2 and maximum 5 clusters can be obtained for import data of 38 member countries of OECD in terms of the product group considered in the current study. Analysis of all clustering results indicated that the USA and Japan, in most cases alone and together when OECD countries are divided into two clusters, formed distinct clusters or groups without other countries, revealing that they differ from other members in terms of

import values. Similar to the results of export data, the HCA results of import data showed that the most of OECD countries are together in a single group. Based on the results of the analysis in terms of import; it is possible to say that Türkiye is in the cluster with the highest number of countries, in all clustering options.

This study divided OECD countries into clusters in terms of export and import data of plywood, veneered panel and similar laminated wood product group. In conclusion, it is thought that the study can contribute to better understanding or evaluation of foreign trade behavior of the countries in terms of the relevant product group.

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