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STATISTICAL ANALYSIS OF EDUCATION EXPENDITURES IN HIGHER EDUCATION: THE CASE OF TURKEY BETWEEN 2011-2021

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Abstract – The economic growth and structural change of countries are significantly influenced by physical and human capital. Education stands at the forefront of the essential components of human capital. As the level of education increases, human capital is positively affected and grows. This study aims to examine education expenditures in Turkey between 2011-2021 using statistical methods. The research focuses on both the total amount of expenditures made and the average expenditure per student. Additionally, the equivalent of the expenditures in dollar exchange rate has been included in the calculations. For the classification of the data, a hierarchical clustering method called the Between-Groups Linkage method has been used. In this method, the similarities and differences between the data have been determined using the Euclidean distance measure. As a result, a tree diagram (dendrogram) has been created, the analysis of which can identify different groups and similarities. Furthermore, graphs based on the year have been drawn to make the data more understandable and readable, and comparisons have been made. These graphs show how education expenditures in Turkey have changed over time and which years showed increases or decreases. In this way, the trends and tendencies of education expenditures can be better understood. This study aims to examine the changes and comparisons on a yearly basis by statistically analyzing education expenditures in Turkey. Such studies can help us better understand the impact of education expenditures on economic growth and the development of human capital.

Keywords – Higher Education, Education Expenditures, Cluster Analysis, Statistical Analysis, Türkiye

I. INTRODUCTION

One of the factors playing a significant role in the development process of countries is education. Countries aim to develop human capital, increase knowledge and skills, and enhance the overall welfare of the society with their investments in education systems. Therefore, higher education holds special importance in terms of strengthening a country's knowledge base, enhancing research and innovation capacity, and cultivating qualified human resources.

Higher education is a stage where the young population can continue their education and learning, gaining more in-depth knowledge and skills. During this period, students access opportunities to set career goals, specialize, and contribute to society. The quality and accessibility of higher education are determinant factors for a country's talents, innovation potential, and international competitiveness. Higher education is an important component within a country's education system, and expenditures at this stage include investments towards providing quality education environments, improving the quality of faculty members, and strengthening research

infrastructure. These investments aim to adapt to societal needs, employment demands, and global changes while developing a country's higher education system.

Education expenditures are a significant factor affecting a country's level of development. Human resources development stands at the forefront of the significant effects of education expenditures on the levels of development in countries. In this sense, education expenditures are directly related to factors such as a qualified workforce, productivity increase, innovation, and technological advancement. Education allows individuals to enhance their knowledge and skills, directing them towards higher-qualified jobs and enabling them to take on more effective roles in production. Another significant effect is its contribution to the labor market. Education expenditures influence the balance of demand and supply in the labor market. Individuals who have received adequate education have the opportunity to access better job opportunities and have a chance to be employed at higher wages. This raises individuals' living standards and reduces poverty rates.

From the perspective of innovation and technological advancement, education expenditures can also be considered. Supporting investments in scientific and technological research leads to the emergence of new products and services and the spread of productivity-enhancing innovations. Education forms a foundation that supports this process and encourages the emergence of new ideas. Improvements in social development are also directly related to investments made in education. In this sense, the importance of education policies and investments is great for societal development and social progress. Education has the potential to reduce social inequalities, poverty, and discrimination. A good education system encourages individuals to understand democratic values, form a participatory society, and take social responsibility for a better future.

Lastly, education policies and expenditures can be considered from a health and human development perspective. Education expenditures increase access to health services and develop health consciousness. Educated individuals adopt healthy living habits, make more informed decisions about disease prevention and treatment.

In recent years, Turkey's education expenditure policy has gained significant importance and has been supported by various reforms. Turkey has made significant increases in its education budget in recent years with the aim of allocating a certain percentage of national income to education. These increases have allowed for investments in areas such as improving the educational infrastructure, raising teacher salaries, and updating technology and resources. On the other hand, Turkey's education expenditure policy has focused on efforts to increase school enrollment rates. Policies supporting the extension of compulsory education, the promotion of early childhood education, and the access of girls to education have had positive effects on enrollment rates. Another important focus of investments has been to improve the quality of education. Steps such as investing in the professional development of teachers, updating textbooks, improving technological infrastructure, and implementing support programs for students have contributed to improving the quality of education. Alongside these, significant steps have been taken in the field of vocational education. Increasing the number of vocational high schools, developing vocational training programs aimed at sectors, and offering students opportunities to establish closer ties with the business world have aimed to increase the employability of young people. Recently, Turkey's education expenditure policy has accelerated efforts to expand access to higher education. Supports such as increasing university quotas, scholarships and loan programs have enabled more students to have the opportunity to receive university education. With the implementation of these policies, Turkey has made significant gains in education. Increases in enrollment rates, improvements in the quality of education, expansion of vocational training opportunities, and advances in access to higher education can be considered as positive effects of Turkey's education expenditure policy. However, there are still areas that need improvement and efforts to further advance Turkey's education system are ongoing.

Turkey is a country that attaches great importance to higher education investments. Investments made in the field of higher education aim at objectives such as improving the university infrastructure, increasing research capacity, strengthening international collaborations, and

providing better educational opportunities for students. At the forefront of Turkey's higher education investments are increasing the number of universities, infrastructure development, research and development (R&D) supports, international collaborations, and scholarship and loan programs. Scholarships and loans are offered to students to finance their higher education, especially within the scope of the scholarship and loan program. Scholarships are given to high-achieving students, while education loan opportunities are provided to needy students. These programs support more students to access higher education opportunities and continue their education. All these investments have contributed to the development of Turkey's higher education sector and aimed to make the country a competitive higher education center at the international level. Nevertheless, continuous improvement efforts continue and the importance of Turkey's higher education investments persists.

II. Materials and Method

Higher education is an important phase that contributes to individuals developing their vocational skills and realizing their personal and intellectual potential. However, the process of higher education can bring significant financial burdens for students and their families. Education expenses are influenced by a range of factors from the process of students entering university to the graduation stage. The first factor is the type of higher education. A second factor is the differences between local and international students. A third factor is the financial aid options that students can use to cover their education costs. Lastly, living expenses also play a significant role in students' education expenses.

A. *Cluster analysis*

Clustering analysis is a method used to group data points with similar features and is used as a statistical data analysis technique. This analysis method is widely used by statisticians and data scientists across various disciplines.

Clustering analysis is a multivariate analysis method that allows summary information to be obtained by bringing together units with similar features from data clusters, and is used in almost all branches of science from sociology to astronomy, from medicine to psychology (Yavan and Gazeloglu, 2022).

Clustering analysis is used in various application areas. For example, it can be used in many areas such as dividing customers into specific segments in the field of marketing, grouping individuals with similar features in social sciences, classifying types of diseases in the field of medicine. It can also be used as a preprocessing step in the data analysis process, as it provides useful information to understand the structure in the data set and to divide the data points into more meaningful groups.

Clustering analysis aims to divide data points into homogeneous groups by identifying similarities in the data set. This analysis method is based on the measure of similarity or distance between data points. While data points with similar features are brought together, data points that show differences are separated into different groups.

The general aim of clustering analysis is to classify ungrouped data according to their similarities and assist the researcher in obtaining suitable, useful summary information. The number of clusters in clustering analysis is unknown and it cannot be used in the future because it only gives results related to the current state of the data. In clustering analysis, as in multivariate analyses, there is an assumption of normality, but the assumption of normality remains in principle, and the normality of distance values is considered sufficient (Tatlıdil, 2002).

In clustering analysis, different algorithms and approaches are used. The most commonly used clustering algorithm is the k-Means algorithm. This algorithm creates a certain number of cluster centers and groups the data points closest to these cluster centers. Other popular clustering algorithms include methods such as hierarchical clustering, density-based clustering, and Gaussian mixture modeling.

B. *Euclidean Distance Measure*

$$d(x_i, x_j) = \sqrt{\sum_{k=1}^{p}(x_{ik} - x_{jk})^2} \qquad (1)$$

In equation 1, x_i and x_j represent the observation vectors, while $d(x_i, x_j)$ represents the distance value.

C. *Intergroup Connection Method*

Hierarchical clustering is the most commonly used clustering method in hierarchical cluster analyses. Essentially, the method starts by combining the units closest to each other and then creates clusters by combining the next closest unit to the units it has combined. The method continues these operations consecutively, expanding the clusters created at each stage (Yavan and Gazeloglu, 2022). In the method, assuming that the i. and j. units are combined, the distance measure of the combined cluster with the k. cluster is calculated using the formula given in equality 2 below.

$$d_{k(i,j)} = Min(d_{ki}, d_{kj}) \quad (2)$$

where

$d_{k(i,j)}$ **:** the distance of the k. cluster to the previously formed i. and j. Clusters,

d_{kj} **:** the distance of the k. cluster to the j. cluster,

d_{ki} : the distance between the k. cluster and the i. cluster.

In cluster analysis, determining the correct number of clusters is important, and it can vary depending on the characteristics of the dataset and the objectives of the analysis. The appropriate number of clusters should be chosen, and the results should be carefully evaluated.

In conclusion, cluster analysis is a statistical analysis method used to group data points by identifying similarities in the dataset. This analysis method is commonly used in various disciplines for data analysis and segmentation. Selecting the appropriate algorithm, determining the correct number of clusters, and carefully evaluating the results are crucial for a successful cluster analysis.

III. RESULTS

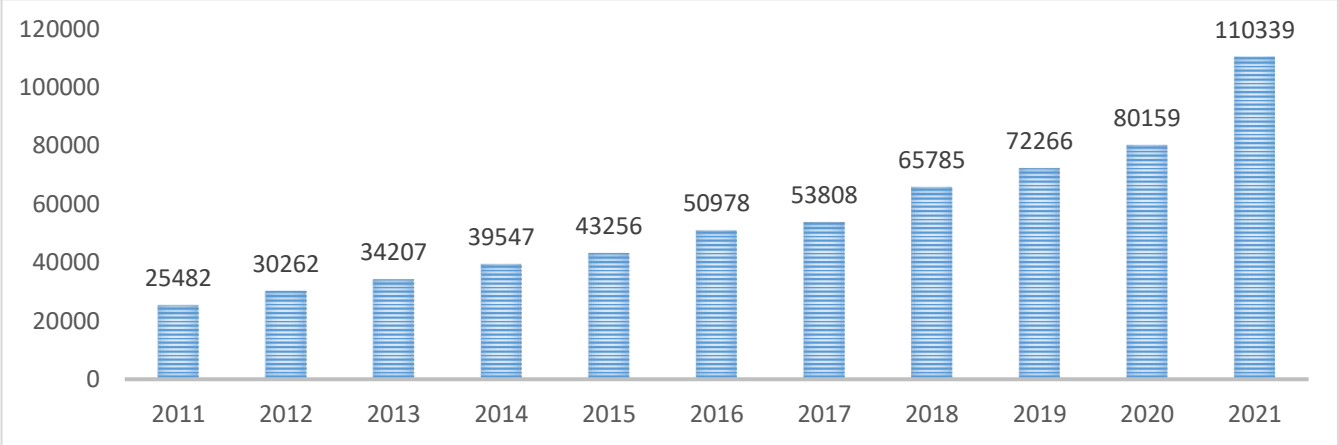


Fig 1. Education expenditure (Million TRY)

According to the analysis, the distribution of educational expenditures in higher education between the years 2011 and 2021 can be observed in Figure 1. It is evident from Figure 1 that the total expenditure in 2011 was 25,482 million TL. This expenditure has continued to increase over the years. By the year 2021, this amount was determined to be 110,339 million TL. When compared to 2011, it is approximately 4.33 times higher. In other words, it can be stated that the total expenditure in higher education in 2021 was approximately 4.5 times higher than that in 2011. For a detailed view of the expenditures in other years, please refer to Figure 1.

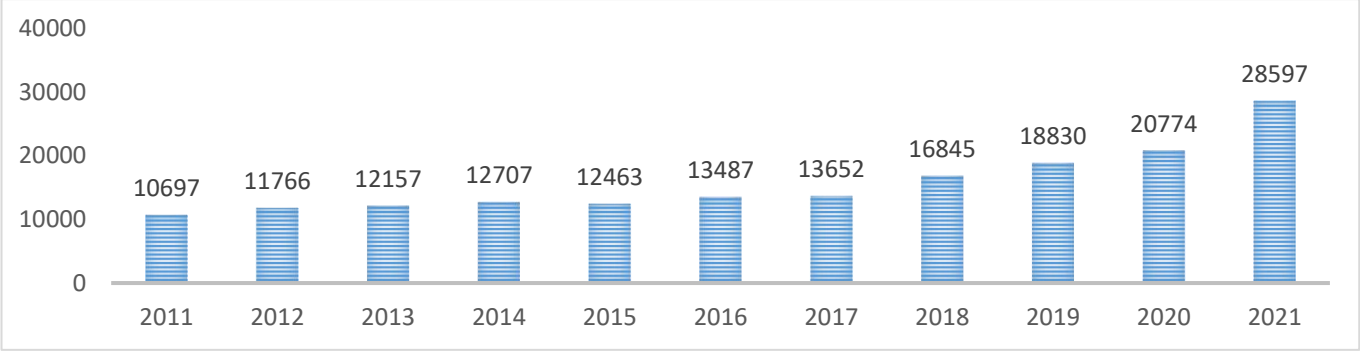


Fig 2. Education expenditure per student (TRY)

In Figure 2, the distribution of per-student educational expenditures in higher education between the years 2011 and 2021 can be observed. According to the analysis, in 2011, an average of 10,697 TL per student was spent. This amount was determined to be 11,766 TL in 2012. In 2013 and 2014, it was 12,157 TL and 12,707 TL, respectively. By the year 2015, the per-student expenditure slightly decreased compared to the previous year, i.e., 2014. However, after 2015, the per-student annual expenditure continued to increase, and by the year 2021, it was determined to be 28,597 TL.

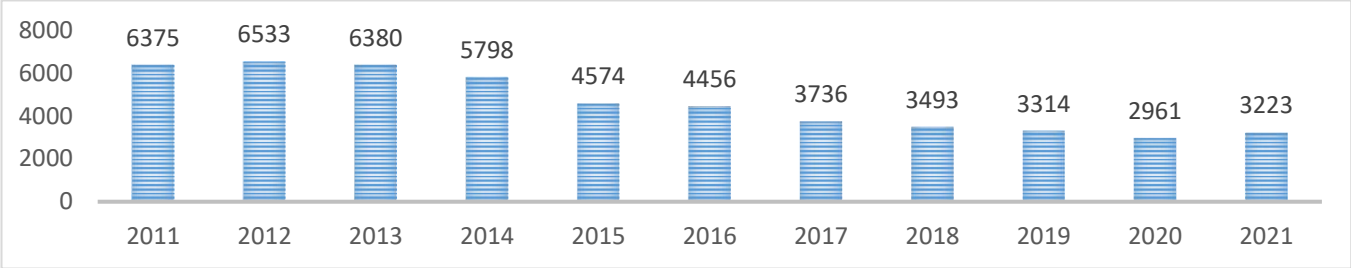
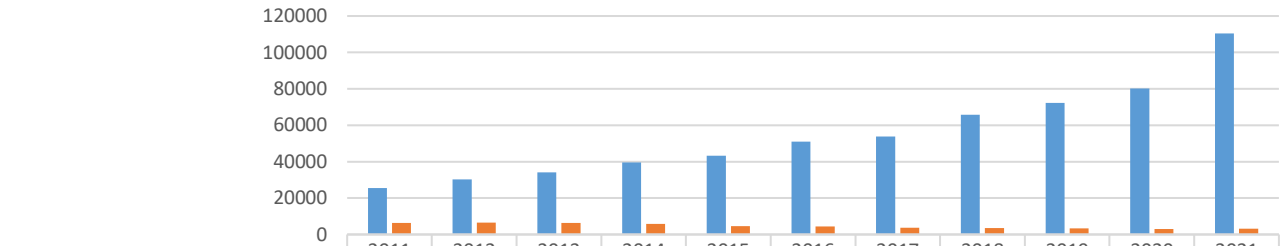


Fig 3. Education expenditure per student ($)

In Figure 3, the per-student dollar equivalent of educational expenditures in higher education between the years 2011 and 2021 is shown. The average calculations were made taking into account the exchange rate of each year. According to this information, in 2011, the per-student expenditure was 6,375 dollars, and in 2012, it was determined to be 6,533 dollars. From then on, the calculated value continuously decreased until the year 2020. Only in 2021, there was an increase of 262 dollars compared to the previous year, and it was calculated to be 3,223 dollars.

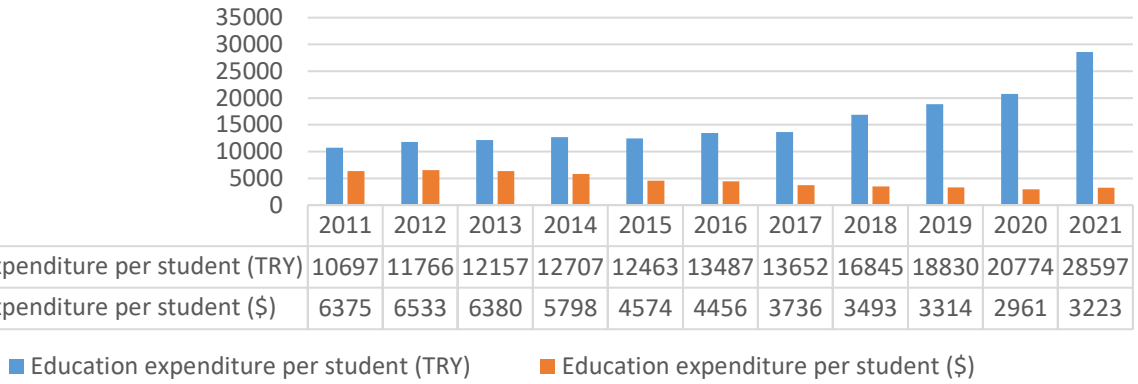


	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Education expenditure (Million TRY)	25482	30262	34207	39547	43256	50978	53808	65785	72266	80159	110339
Education expenditure per student ($)	6375	6533	6380	5798	4574	4456	3736	3493	3314	2961	3223

Fig 4. Year-based total education and per capita ($) education expenses

In Figure 4, the total expenditures made in higher education in Turkish Lira (TL) and the per-student expenditures in terms of the equivalent value in US Dollars are shown for the mentioned years. It can be observed that the TL-based total expenditure consistently increased over the years, while the per-student expenditure in dollars decreased.

Please note that exchange rate fluctuations could account for the apparent decrease in per-student expenditure when converted to US Dollars, despite the continuous increase in TL-based total expenditure.



	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Education expenditure per student (TRY)	10697	11766	12157	12707	12463	13487	13652	16845	18830	20774	28597
Education expenditure per student ($)	6375	6533	6380	5798	4574	4456	3736	3493	3314	2961	3223

Fig 5. Year-based total education and per capita ($) education expenses

In Figure 5, the changes in per-student expenditures in both Turkish Lira (TL) and US Dollars between the years 2011 and 2021 in higher education are displayed. It can be observed that until 2017, the TL-based expenditure did not show significant changes, but after 2017, it experienced significant increases, reaching 28,597 TL in 2021. This value was determined to be 10,697 TL in 2011. When these changes are examined in dollars, the highest expenditure was observed in 2011, with 6,375 dollars per student. However, by the year 2021, the per-student expenditure decreased to 3,223 dollars.

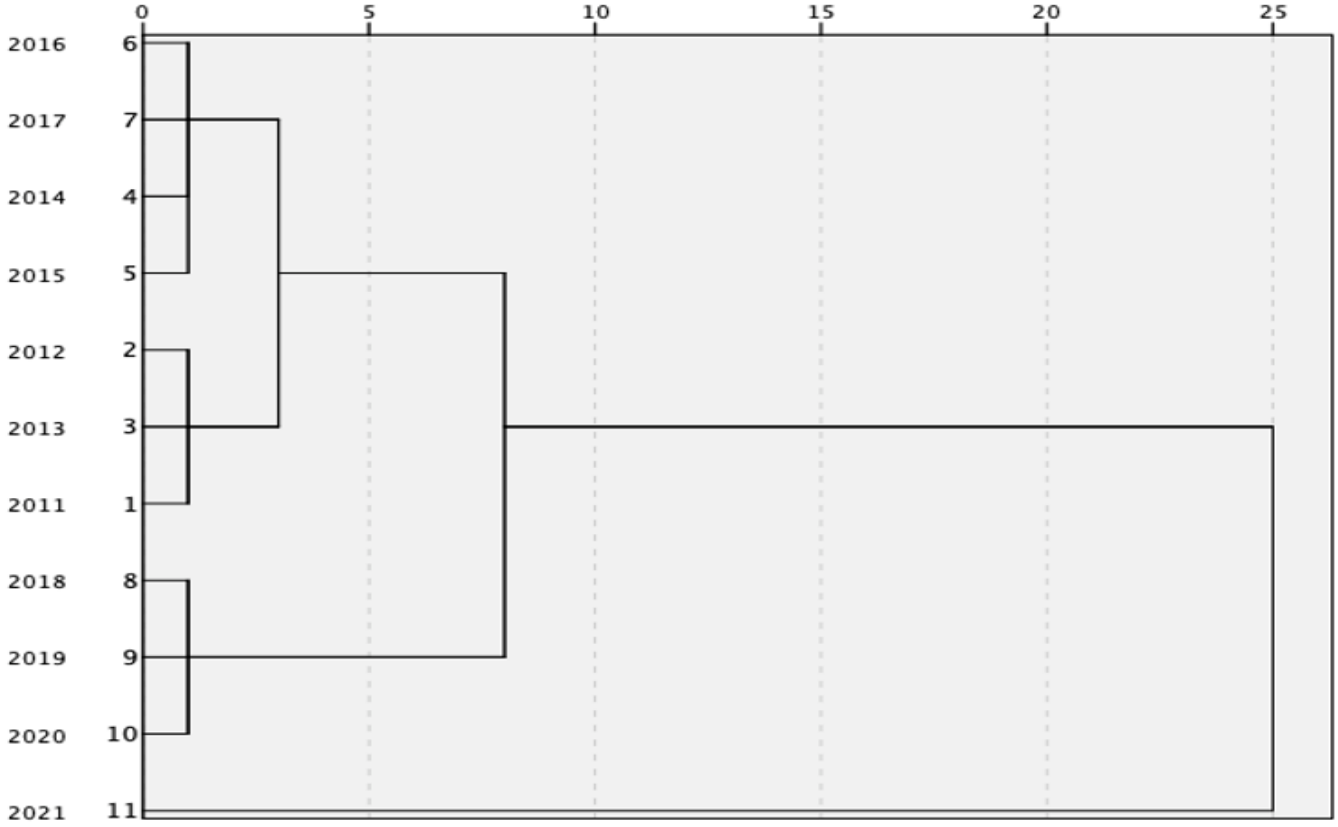


Fig 6. Year-Based Education Expenditure (Million TL) Dendrogram

Figure 6 represents a dendrogram of the total amount of educational expenditures made in higher education between the years 2011 and 2021, showing which years are clustered together based on their similarities in total expenditure. According to the analysis, the years 2014 to 2017 form the 1st cluster, the years 2011 to 2013 form the 2nd cluster, and the years 2018 to 2020 form the 3rd cluster, while the year 2021 forms a separate 4th cluster on its own. Later, the 1st and 2nd clusters merge to create a new cluster, which then combines with the 3rd cluster. One notable observation is that the year 2021 stands out by forming a separate cluster on its own, distinct from the other years.

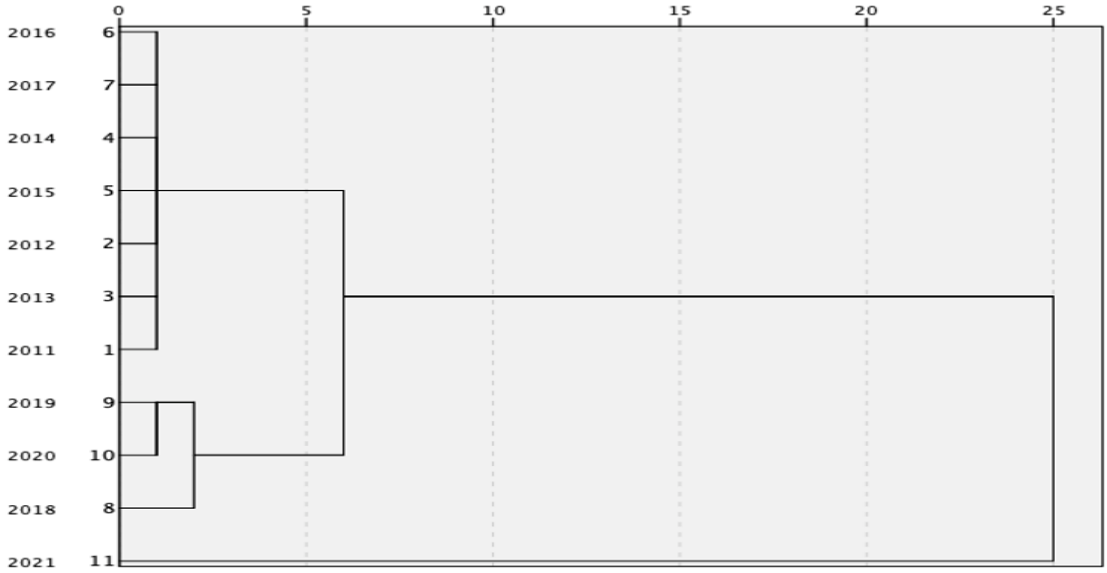


Fig 7. Year-Based Per Capita Education Expenditure (TL) Dendrogram

In Figure 7, the clustering structure of per capita TL-based education expenditures between the mentioned years is displayed. The 1st cluster consists of the years 2011 to 2016. The 2nd cluster includes the years 2018 to 2020, while the year 2021 forms a separate cluster on its own. Later, the 1st and 2nd clusters merge to create a new cluster, which ultimately combines with the 3rd cluster to complete the structure.

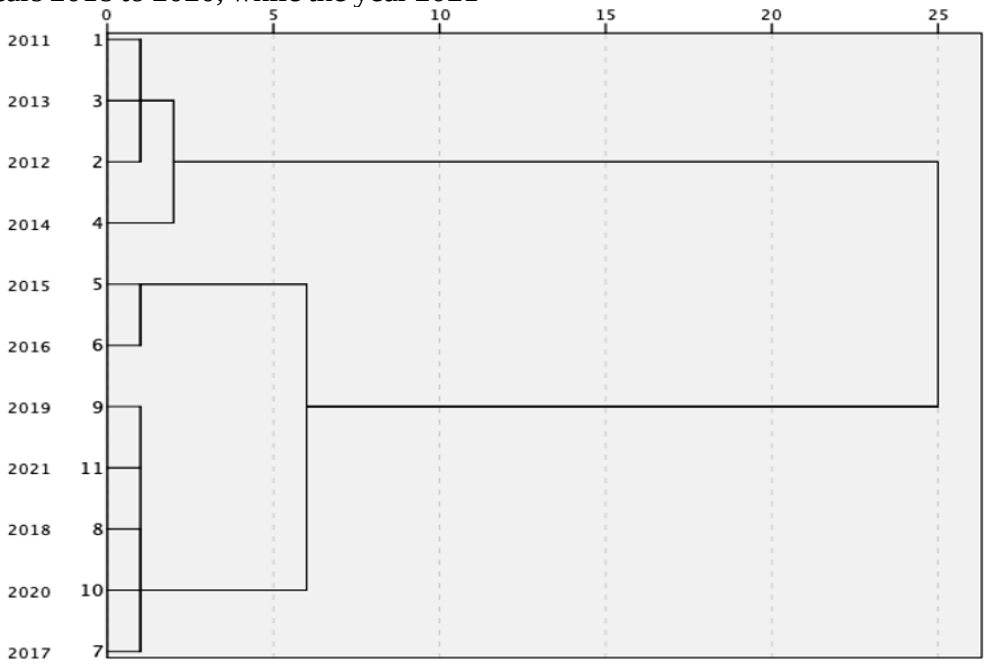


Fig 8. Year-Based Per Capita Education Expenditure ($) Dendrogram

In Figure 8, the dendrogram of per capita education expenditures in US dollars for the years 2011 to 2021 in higher education is displayed. According to the dendrogram, the 1st cluster consists of the years 2011 to 2014, the 2nd cluster includes the years 2015 and 2016, and the 3rd cluster consists of the years 2017 to 2021. Later, the 2nd and 3rd clusters merge to create a new cluster, which then combines with the 1st cluster to complete the structure.

IV. DISCUSSION

The results of this research are based on the examination of total and per capita expenditures in higher education in Turkey between 2011 and 2021. The analyses indicate a continuous increase in total expenditures and per capita expenditures in Turkish Lira. However, it also shows that per capita expenditures in US dollars generally decreased over the same period. This result highlights the depreciation of the Turkish Lira's value and its impact on higher education expenditures. Furthermore, cluster analysis identified similarities and differences in expenditure trends between the years. Specific years were found to have similar expenditure patterns, particularly between 2011-2013 and 2014-2017. However, in 2021, a significantly different expenditure profile was observed, indicating a potential increase in education spending, possibly reflecting a policy change or an outcome of economic recovery.

V. CONCLUSION

In conclusion, the findings of this research illustrate how expenditures in higher education have changed over time and their impact on per capita expenditures. This information can aid in the development of higher education policies and strategies. It also sheds light on the influence of exchange rates and economic conditions on education expenditures. These results can contribute to making more informed and sustainable decisions in education policies and budget planning.

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