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Classification of the NATO Countries with Respect to Defence Spending Patterns: An Unsupervised Clustering Approach

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Abstract

Although there has been growing interest in defence expenditure studies in recent years, no necessary attention has been paid in literature to empirical analysis of composition of defence expenditure. However, limited number of non-empirical studies state that understanding composition of military budget of a country reveals remarkable insights about its economic condition and defence strategy policy choices in the future. The purpose of this study has been to gain further understanding of basic differences in defence budget allocation between NATO ally counties. To fulfil this aim, K-Means clustering approach is used and three main groups are found with the dataset of NATO that formed by four main defence expenditure categories. Moreover, the reliability of the results has been proven by additional analysis such as hierarchical clustering and K-Medoids methods. Empirical findings state that NATO countries could be categorised into three groups which are named as equipment intense expenditure cluster, personnel intense expenditure cluster, and balanced expenditure cluster.

Keywords: *Defense Expenditures, Clustering Analysis, Unsupervised Clustering, NATO, Military Budget.*

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NATO Ülkelerinin Savunma Harcama Modellerine Göre Sınıflandırılması: Denetimsiz Bir Kümeleme Yaklaşımı

Öz

Son yıllarda savunma harcamaları çalışmalarına artan bir ilgi olmasına rağmen, literatürde savunma harcamalarının kompozisyonunun ampirik analizine gerekli ilgi gösterilmemiştir. Ancak sınırlı sayıda ampirik olmayan çalışma, bir ülkenin askerî bütçesinin bileşimini anlamanın, ekonomik durumu ve gelecekteki savunma stratejisi politika seçimleri hakkında dikkate değer bilgiler ortaya koyduğunu belirtmektedir. Bu nedenle, bu çalışmanın amacı, NATO müttefiki ülkeler arasındaki savunma bütçesi tahsisindeki temel farklılıkları daha iyi anlamaktır. Bu amacı gerçekleştirmek için K-Means kümeleme yaklaşımı kullanılmış ve NATO'nun dört ana savunma harcaması kategorisinden oluşan veri seti ile üç ana grup bulunmuştur. Ayrıca, sonuçların güvenilirliği hiyerarşik kümeleme ve K-Medoids yöntemleri gibi ek analizlerle kanıtlanmıştır. Ampirik bulgular, NATO ülkelerinin teçhizat yoğun harcamalar kümesi, personel yoğun harcamalar kümesi ve dengeli harcamalar kümesi olarak adlandırılabilecek üç gruba ayrılabileceğini göstermektedir.

Anahtar Kelimeler: *Savunma Harcamaları, Kümeleme Analizi, Denetimsiz Kümeleme, NATO, Askerî Bütçe.*

Introduction

Understanding the complexity of defence expenditures has a vital importance to make effective defence strategies and policies against security concerns of each nation. Because, as discussed in Ballentine and Sherman (2003), successful armed conflict management is only possible if related state could benefit from scarce economic resources in a sustainable way and has a strong government budget to support unexpected and expected complex needs of armed forces during the conflict. Thus, over the past century, defence expenditures have received considerable scholarly attention in the field of economics, politics and resource management. From a Keynesian perspective, as a part of government spending and a tool for fiscal policy, each component of defence expenditures may have impact on the maintenance of business and economic development (d'Agostino et al., 2017). Composition of military spending formed the central focus of a study by Brauer

(1991) in which the author found that defence expenditure may lead an increase in economic growth or, at least, not harmful on arms exporter countries compared to arms importer counties. This is because these two groups of countries undoubtedly have different distributed defence budgets. Also, Sezgin (2003) argues that composition of defence budget controls economic efficiency of military expenditures. However, the role of composition of defence expenditure on economy or defence strategy development remains largely unexamined. Considering insufficient data, up to now, far too little attention has been paid to an empirical analysis of defence budget allocation.

The primary object of this paper is to propose an empirical framework to understand defence spending priorities of selected countries, based on the data from North Atlantic Treaty Organization's (NATO) press lease of Defence Expenditure of NATO Countries (2014-2021). This study aims to address the following research question: How many groups could NATO member countries be classified according to their defence spending allocation and which factors lead to dissimilarity between them? The unsupervised machine learning method K-Means clustering is used to answer research question of this paper.

The remaining part of the paper proceeds as follows: The next chapter gives a brief explanation of defence spending categorization of NATO and related dataset. The third chapter brings together the insights gained from very limited literature about the categorization of defence expenditures. The fourth chapter includes a detailed description description of K-Means approach and its algorithm. While the fifth chapter discusses empirical findings, the last chapter concludes the study.

1. Composition of Defence Expenditure in NATO

NATO classifies defence expenditures of allies into four main categories. These are equipment expenditures, personnel expenditures, infrastructure expenditures, and other expenditures (NATO, 2021). Although this categorization does not provide very detailed information, it manages to draw a general framework about the composition of allies' defence expenditures. The equipment expenditure category covers expenditures on major defence equipment expenditures and research and development (R&D) expenditures devoted to major equipment. Precisely, even though the definition of major military equipment is not mentioned in any NATO source, Arms Export Control Act (22 US Code 2794(6)) of the USA defines it as a major military equipment that must have no less than 50 million dollars in research and development costs and no less than 200 million dollars in production costs. If NATO acknowledges that definition, major military equipment could be evaluated as a remarkable burden for the budget of any NATO member country and major military equipment exporter countries receive noticeable boost for their economic growth. The next category is formed to explain personnel expenditures. The personnel category includes all kind of payments that are paid to both military and civilian personnel of governments' military organizations. In addition, pension payments to retired personnel are also added to the personnel expenditure category. The third category is about infrastructure expenditure. Total expenditures on NATO common infrastructure and national military constructions of ally countries form the third category. Last of all, the category of other expenditure includes operations and maintenance expenditure, other R&D expenditure and expenditure not allocated among above-mentioned categories (NATO, 2021).

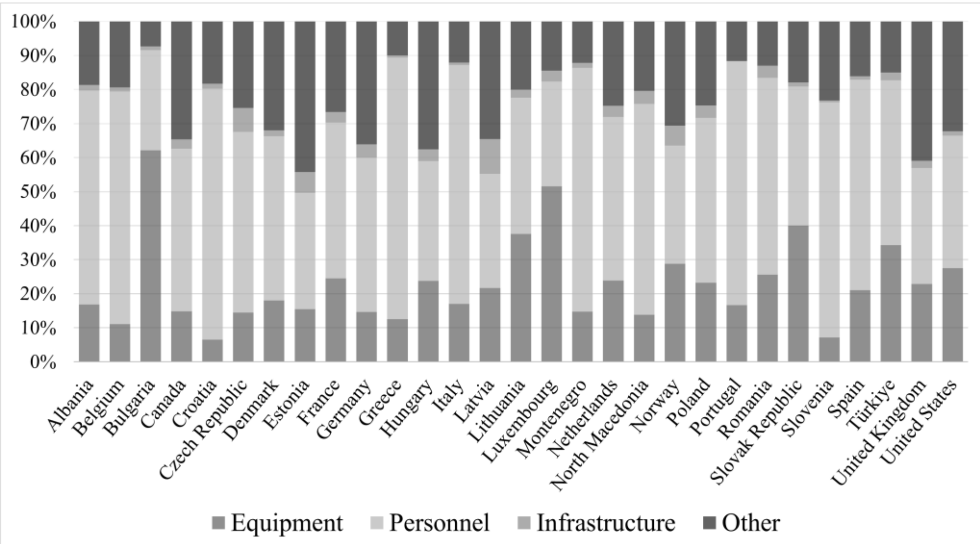

Figure 1. Defence Expenditure Composition of NATO in 2019 (NATO, 2021: 5)

2. Literature Review

There is a relatively small body of literature concerned with the composition of defence expenditures. Since most of these studies are focused on defence expenditures impact on economic growth. Because of this paper considers NATO's categorization, it is worth to mention that studies of Hartley and Peacock (1978) and Fetterly (2007) criticize the data categorization of NATO. According to writers, definition of defence expenditure and categories of it different for each ally country. Therefore, these studies argue that it is very difficult to collect data for any common understanding. From beginning of data collection to publication, NATO should determine standard rules and build a proper database. Also, there are many other categorization of defence expenditures. For instance, Mohanty, Panda and Bhuyan (2012) categorizes Indian military expenditures into two main categories that are called as capital defence expenditures and revenue defence expenditures. Capital defence expenditures includes basically all spending to infrastructure, equipment, and R&D. Despite this, revenue defence expenditures cover all kind of payments to the active and retired military personnel. In addition, according to European Statistical Office's Classification of Function of Government database, defence expenditures could be divided into five main categories which are military defence expenditure, civil defence expenditure, foreign military aid, R&D defence, and defence network-enabled capability (Dudzevičiūtė and Tamošiūnienė, 2015). Moreover, De Rezende and Blackwell (2019) investigate Brazilian national defence strategy and evaluate Brazilian defence expenditure by its three main components that are mentioned as personnel and social security, investments, and maintenance expenditure. Minini and Selem-Amachree (2021) follow same perspective with Mohanty et al. (2012) and they divide Nigerian defence expenditures into two main categories which are known as government capital defence expenditure and recurrent defence expenditure. Lasty, Sezgin (2003) argues that composition of defence expenditure's role on economic growth and his study also considers defence expenditure categorization of NATO. According to Sezgin (2003) infrastructure and personnel expenditures increase economic growth, whereas equipment and other expenditure may cause a decline in growth.

3. Method

Several methods currently exist for the clustering analysis, and they are grouped under two main categories. The hierarchical clustering method considers geometric distances between observations and offers a similarity tree graph which is known as dendrogram. With this outcome, researchers could have a wide-angle picture of similarities between units (countries, cities, firms etc.) that are driven by considered data set. Nevertheless, hierarchical method fails to reveal sufficient information about source of dissimilarities or similarities. Alternatively, to make up for this shortcoming, non-hierarchical clustering methods such as K-Means and K-Medoids, which are also the most commonly known unsupervised machine learning approaches, are offered. K-Means attempts to find pre-determined number of clusters (K), that are represented by their centroid vectors. The benefit of this approach is that K-Means method is not only classify data, it is also offers noticeable information about clusters (MacQueen, 1967). The present study utilizes K-Means unsupervised clustering approach to classify NATO countries according to their defence expenditures. Since, this method needs a priori information about the number of clusters, it is vital to determine optimal number of clusters before running the K-Means algorithm. To calculate optimal cluster number, total within cluster sum of square (within cluster sum of square, WSS) and silhouette method are used for this study.

The WSS method considers the total WSS (Shown in Equation (4)) as a function of the number of clusters. Hence, non-hierarchical clustering algorithm is run for specific number of clusters and WSS values are calculated. For instance, by varying cluster number from 1 to 10 and calculate 10 different WSS values. Then, if adding another cluster doesn't improve much better the total WSS, this cluster number is chosen as optimal cluster number. This situation shows itself in a WSS-Cluster number plot. As it shown in Figure 2 that is placed in the empirical study chapter, the point of a knee (bend) in the plot indicates the appropriate number of clusters. Although the WSS method is very practical tool, it still could not offer a strict rule to determine optimal cluster numbers. Conversely, Kaufman and Rousseeuw (1990) is introduced Average Silhouette (AS) method that could choose optimal cluster number more precisely. Silhouette coefficient, which is offered by the same study, should be defined first to build AS method as follows:

$$s(i) = \frac{b(i) - a(i)}{\max\{a(i), b(i)\}} \quad (1)$$

where $s(i)$ is silhouette coefficient of data point i, $a(i)$ represents average dissimilarity between data point i and other data points that place in same cluster with i.

$$a(i) = \frac{1}{|C_i|-1} \sum_{j \in C_i, i \neq j} d(i,j) \quad (2)$$

where $|C_i|$ shows the number of data points that belong to C_i and $d(i,j)$ is the distance between data points i and j. Another indicator in Equation (1) is minimum average distance between i and other data points that place in neighboring cluster.

$$b(i) = \min_{k \neq i} \frac{1}{|C_i|} \sum_{j \in C_k} d(i,j) \quad (3)$$

In equation (3), $d(i,j)$ indicates the distance between data point i of cluster C_i and data point j of cluster C_k. It is also important to state that $s(i)$ could take the values in the range of $\{-1,1\}$. Lastly, the optimization rule of AS method is written as:

$$S(k) = \max_{k} \bar{s}(k) \quad (4)$$

where $\bar{s}(k)$ is the mean of $s(i)$ values which are calculated for all observations in the dataset. According to AS method optimal cluster number (k) should maximize the value of $S(k)$.

After the determination of the optimal number of clusters with the methods that described above, any kind of unsupervised clustering approach could be used. For this study, Hartigan and Wong (1979)'s basic clustering algorithm of K-means could be explained as:

i. Determine the number of cluster and allocate the objects (data points) into these clusters randomly.

ii. Calculate all clusters' centroid vectors. Let say, we have $(C_1, C_2, \ldots, C_k)$ clusters and X_k represents i. object of C_k. Then, centroid vector of C_k could be found as:

$$M_k = \frac{1}{n_k} \sum_{i=1}^{n_k} x_{ik} \quad (5)$$

iii. Find internal cluster changings $(e_1, e_2, \ldots, e_k)$. These changings state that summation of each member objects' Euclidean distance from their centroid vector in cluster of C_k.

$$e_i^2 = \sum_{i=1}^{n_k} (x_{ik} - M_{ik})^2 \quad (6)$$

iv. In order to determine clusters space that includes K number of clusters, calculate Square Error value. It forms summation of internal cluster changing values and it is also called as total within cluster sum of square.

$$E_k^2 = \sum_{k=1}^{K} e_k^2 \quad (7)$$

v. The distance between objects in data matrix and their centroid vectors are calculated with Euclidean method. In situation that each object is represented by n variables, Euclidean distance is showed:

$$d(M_k, X_k) = \sqrt{\sum_{i=1}^{n} (x_i - M_k)^2} \quad (8)$$

Each object is allocated to pre-determine clusters by using these distance values. Assume that there are three centroid vectors that are called M_1, M_2, M_3 and one object X_i which has three different Euclidean distance from M_1, M_2, and M_3. Which centroid vector's distance is smaller than the others, X_i places that distance's cluster. This algorithm repeats until to get the smallest Square Error value that explained in 4^{th} step.

Results of K-Means clustering include richer information than any hierarchical method such as final cluster centers and distance between cluster centers. These values are going to help to interpreting clusters in terms of defence spending.

4. Empirical Study

a. Data

The data are collected from the latest NATO press lease which is entitled as Defence Expenditure of NATO Countries (2014-2021). The data of 2020 and 2021 are reported as estimated values due to ongoing uncertainty caused by pandemic. Hence, the defence expenditure data of 2019 are used to classify NATO countries. Although all variables are measured in same scale (percentage of total defence expenditure), to get better result from the clustering algorithms, the data are scaled to have zero mean and one standard deviation. The descripted statistics of non-scaled data are reported in Table 1.

Table 1. Descriptive Statistics

Category	Minimum	Maximum	Mean	Median	Standard Deviation	Skewness	Kurtosis
Equipment	6.552	62.125	22.836	21.021	12.511	1.477	5.157
Personnel	29.425	76.876	51.131	48.193	14.880	0.230	1.713
Infrastructure	0.110	10.303	2.794	2.257	2.250	1.564	5.607
Other	7.357	44.197	23.240	20.364	10.053	0.387	2.098

Table 1 states that more than 50% of military spending of NATO countries is devoted to personnel expenses. Shares of Equipment expenditures and other expenditures are very close to each other around 20%. Lastly, Infrastructure spending has the least share in total defence spending in NATO.

b. Empirical Findings

Before application of non-hierarchical clustering algorithms, optimal number of clusters is needed to be determined. Therefore, within-cluster sum of square and silhouette approaches are calculated for data set and graph of values are show in Figure 2. The findings of both methods clearly indicate that the optimal cluster number should be equal to 3.

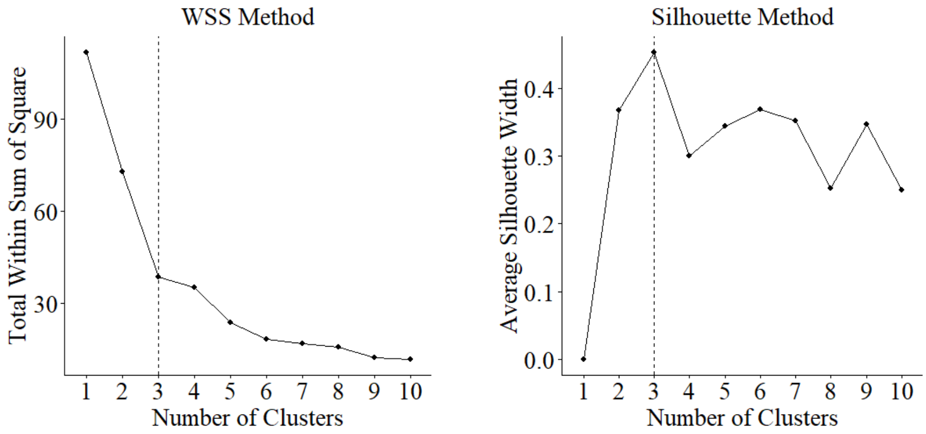

Figure 2. WSS and Silhouette Method for Optimal Number of Clusters.

Classification results on pre-determined 3 cluster are reported in Table 2. Also, with the help of principle component analysis, which operates on four variables and outputs two new variables, a scatter plot of cluster memberships and centres of clusters could be drawn, and it is shown in Figure 3. According to findings, the cluster centres are far enough away from each other, and the Cluster 1 contains Bulgaria, Lithuania, Luxembourg, Slovak Republic, and Türkiye, the Cluster 2 includes Albania, Belgium, Croatia, Greece, Italy, Montenegro, North Macedonia, and Portugal, lastly the Cluster 3 forms by Canada, Czech Republic, Denmark, Estonia, France, Germany, Hungary, Latvia, Netherlands, Norway, and Poland.

Table 2. Cluster Memberships

Cluster	Countries	WCSS
1	Bulgaria, Lithuania, Luxembourg, Slovak Republic, Türkiye	6.021
2	Albania, Belgium, Croatia, Greece, Italy, Montenegro, North Macedonia, Portugal, Slovenia, Spain	8.294
3	Canada, Czech Republic, Denmark, Estonia, France, Germany, Hungary, Latvia, Netherlands, Norway, Poland, Romania, United Kingdom, United States	24.207
WCSS: Within Cluster Sum of Squares		

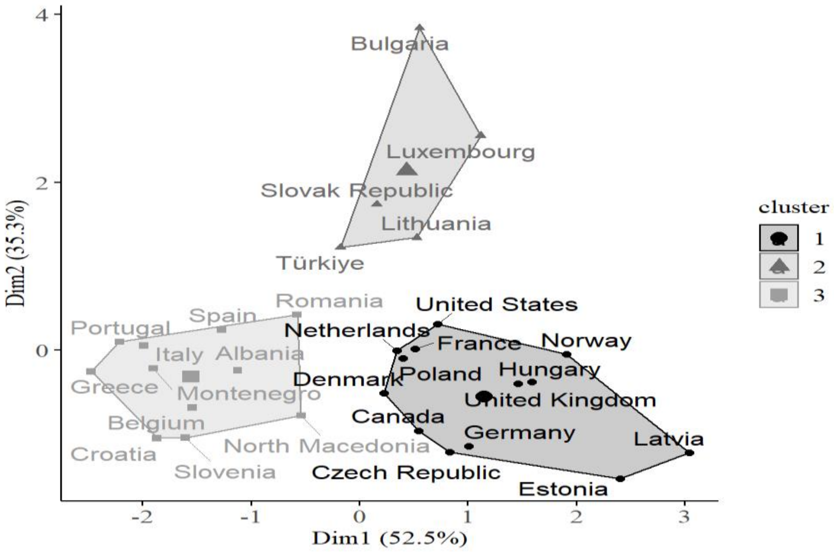

Figure 3. Cluster Memberships and Centres of Clusters

To understand each clusters' distinguishing features, mean of each variable by clusters are calculated and reported in Table 3.

Table 3. Mean of Each Variable by Clusters

Cluster	Equipment	Personnel	Infrastructure	Other
1	45.136	37.879	2.014	14.970
2	14.805	67.825	1.468	15.902
3	21.054	42.102	4.216	32.629

As shown in Table 3, Cluster 1 includes NATO countries that devote the largest share of their defence budget on equipment. Also, the second largest infrastructure spending belongs to Cluster 1. On the other hand, personnel expenses are main defence budget burden of assigned countries in Cluster 2. Additionally, Cluster 2 countries are the ones that allocate the least defence budget share to equipment and infrastructure in NATO. Last of all, countries, that assigned in Cluster 3, stand out in the NATO with their expenditure on infrastructure and category of the other. In addition, the second largest defence budget share of Cluster 3 countries are spent on equipment and personnel.

c. Robustness Check

In order to be sure of the validity of the empirical results that reported on previous chapter, a hierarchal clustering algorithm and K-Medoids algorithm, which is another unsupervised clustering method, are applied on the defence expenditure data set of NATO countries. The Hierarchical clustering approach refers to a collection of closely related clustering techniques that produce a hierarchical clustering by starting with each point as a singleton cluster and then repeatedly merging the two closest clusters until a single, all-encompassing cluster remains (Tan et. al., 2013). On the other hand, K-Medoids is a robust alternative to K-Means clustering which is method that depends on determine observations as a centre of cluster instead of calculating a specific cluster centre such as K-Means (Kassambara, 2017). These approaches are used to achieve robustness check and the theoretical explanations of them are beyond the scope of this paper. This is why, details about these methods are not reported. However, the empirical findings of hierarchical clustering and K-Medoids could be seen in Figure 4 and Table 4 respectively.

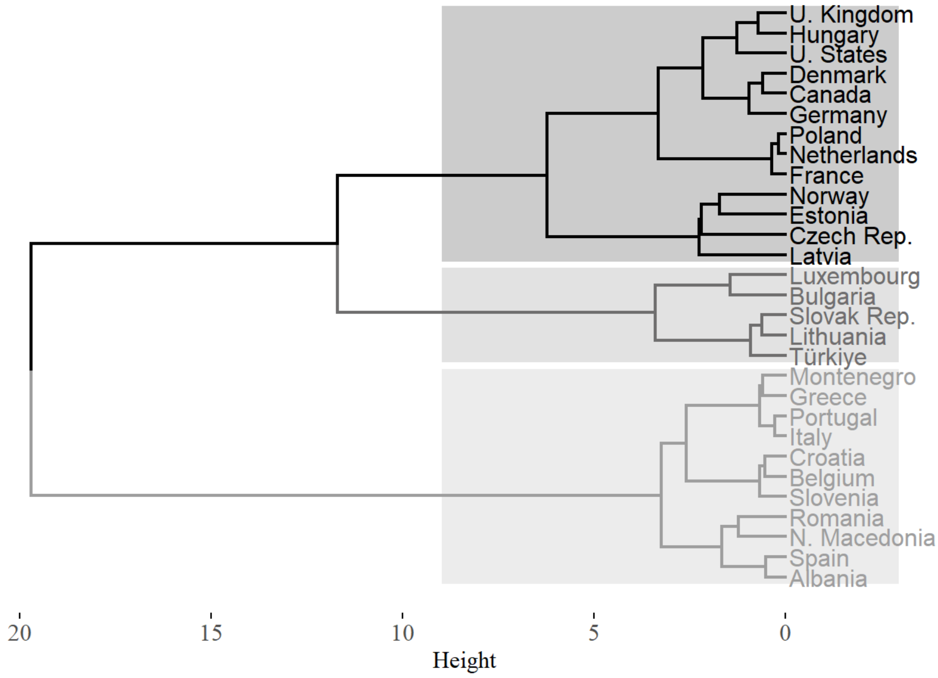

Figure 4. Dendrogram of Hierarchal Clustering

Table 4. K-Medoids Cluster Memberships

Cluster	Countries	Medoids
1	Bulgaria, Lithuania, Luxembourg, Slovak Republic, Türkiye	Slovak Republic
2	Albania, Belgium, Croatia, Greece, Italy, Montenegro, North Macedonia, Portugal, Slovenia, Spain	Belgium
3	Canada, Czech Republic, Denmark, Estonia, France, Germany, Hungary, Latvia, Netherlands, Norway, Poland, Romania, United Kingdom, United States	France

The reported findings of robustness check in Figure 4 and Table 4 clearly indicate that three different approach address identical results. Therefore, estimated three clusters and assignment of countries in these clusters are interpreted as valid empirical results[1].

5. Discussion

Before discussion of policy implications, each of three clusters needed to be identified with respect to empirical findings. From the Table 3, it is clearly understood that Cluster 1 could be called as equipment spending intense cluster. The second cluster is formed by countries that devote the largest share of their defence budget on personnel payments. Therefore, this cluster could be named as personnel payment intense cluster. Lastly, the third cluster includes the ally countries that have been able to distribute the defence budget relatively more balanced into four main NATO categories. Hence, it is proper to call the third cluster balanced cluster.

As mentioned in previous chapters, equipment expenditure covers both purchasing major military equipment and R&D cost for same class equipment. According to Sezgin (2003), from an economical point of view, equipment expenditure may have negative effects on economic growth (Eryiğit, Eryiğit and Selen, 2012). However, the equipment spending in intensive cluster member countries should be evaluated carefully because the impact of purchasing equipment and payment for R&D on economic growth are expected to be different. For instance, according to Emerging Suppliers in The Global Arms Trade, 2020 report of Stockholm International Peace Research Institute (SIPRI), Türkiye is the one of the five fastest growing arms exporter countries in the global arms market (Béraud-Sudreau et al., 2021). This is why it can be expected that Türkiye may allocate a relatively larger share to R&D activities in equipment expenditures. On the other hand, as shown in Figure 5, remarkable increases in equipment expenditure could be observed in all cluster members from 2014 to 2019 (NATO, 2021). Undoubtedly, the main reason for equipment expenditure is national security concerns of related countries. Even though developing economies of equipment spending intense clusters could avoid harmful economic impact of equipment expenditure by devoting more resources for R&D studies to produce required major military equipment.

[1] Data sample file and R programming language code are provided for the researchers as per need.

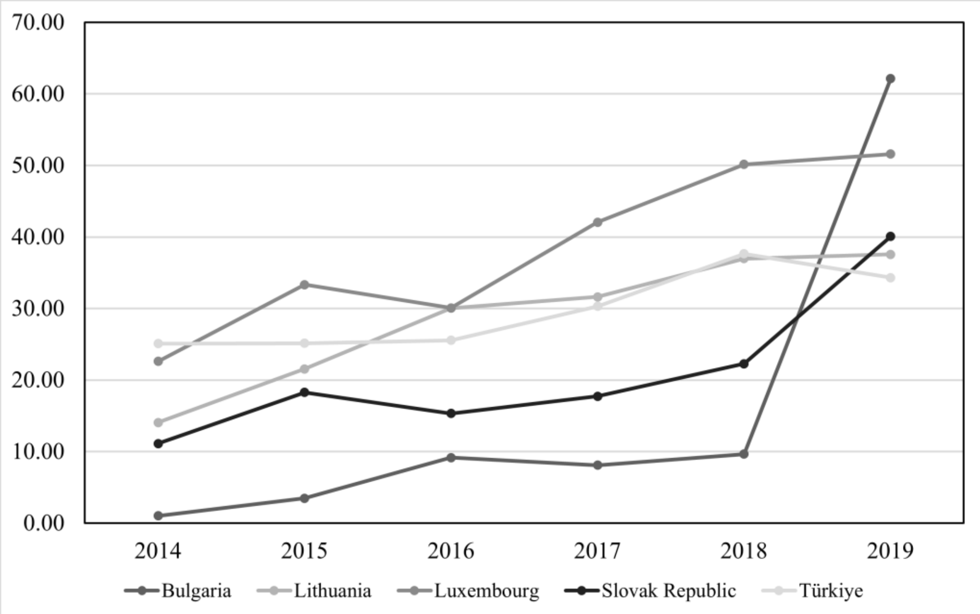

Figure 5. Equipment Expenditure of Cluster 1 Members (NATO, 2021: 13)

The greater part of the literature on defence economics ignores military personnel expenditure's role on economic growth. However, as mentioned in Sezgin (2003) military personnel is a part of total government employees and increasing military personnel expenditure leads to a rise in aggregate demand. Also, Chairil, Sinaga and Febrianti (2012) argues that military personnel expenditure contributes to economic growth if it supports the development of the human capital of related countries. Because it is a very undiscovered area of expertise, there is no sufficient data or information about military personnel spending's direct impacts on the economy. Therefore, from an economics perspective, it is not possible to provide policy implications for personnel payment intense cluster member allies. On the other hand, a new era in the history of war began when the first unmanned combat aerial vehicle was used by the United State army in Afghanistan in 2001 (Borg, 2020). This new era of unmanned war machines and artificial intelligence has expanded rapidly and embraced ground and naval forces with new R&D projects (Wang et al., 2020; Martin et al., 2019). It is obvious that the future of military strategies will be based on machines which will not need any more human assistance. Hence, the volume of military personnel of an army may be a burden for defence and public finance policy of any country in the future. For this reason, personnel payment intensive cluster member countries of NATO should consider allocating more resources for acquisition of unmanned vehicles and/or their R&D projects.

It is not surprising to realize most of the members of the Cluster 3 could be classified as a developed economy. These countries distribute their defence budget among four categories of NATO much more homogeneously. Moreover, some of the balanced defence expenditure cluster member countries such as the United States, Germany, United Kingdom and Canada have advanced defence industry and they are also main suppliers of the global arms market (Béraud-Sudreau et al., 2021). Therefore, it might be expected that the allies that are assigned to Cluster 3 devote their resources to growth supporting defence expenditures. By doing that, they have succeeded in balancing the constructive and destructive aspects of defence spending on the economy. In addition, the future of defence technologies and ideas are shaped by many proven defence companies of balanced defence expenditure cluster member allies. All in all, the main factor that determines a country's defence expenditure is national security concerns. However, Cluster 3 may be considered as a reference cluster for all other allies to form defence budget distribution policy.

6. Conclusion

The purpose of the current study was to determine the groups that formed by defence expenditure components of NATO ally countries. To achieve this, K-Means Unsupervised Clustering Approach was used. The findings clearly indicate that NATO allies could be classified under three clusters. Each cluster's policy implications are discussed in the previous chapter. The results reported here shed new light on planning defence budget allocations of all NATO allies. Also, this is the first study to report empirical evidence of defence consumption characteristic of related countries. Therefore, the present study has offered a framework for the exploration of the importance of defence budget allocation. However, several limitations to this pilot study need to be acknowledged. The sample year for this study is chosen as 2019 because the data which belonged to 2020 and 2021 are reported as estimated values not measured values. Moreover, NATO's classification of defence expenditure is not very detailed and informative. For this reason, NATO should employ new projects to build more comprehensive databases that include vital data of allies for future data science studies about NATO. Overall, further studies need to examine more closely the links between each component's defence expenditures impacts on economic growth and military capabilities of NATO countries.

Genişletilmiş Özet

Savunma harcamaları makro iktisadi çalışmaların önemli bir araştırma konusu iken aynı zamanda savunma ekonomisine yönelik literatürün temel dayanağıdır. Savunma harcamalarının çeşitli makro iktisadi faktörlere olan etkisi detaylıca incelenmesine rağmen askerî harcamaların bileşenleri ve bu alt kalemlerin iktisadi döngüdeki veya ulusal savunma stratejilerindeki rolü dikkatlerden kaçmıştır. Bu hususa ilk olarak Brauer (1991) değinmiş ve savunma harcamalarının farklı ülkelerde iktisadi büyüme üzerinde gözlenen zıt etkilerinin sebebi olarak savunma harcamalarının bileşenlerinde görülen farklılaşmanın yattığını iddia etmiştir. Buna göre gelişmiş ekonomiye sahip bir ülke aynı zamanda silah ihracatçısıdır ve askerî harcamalarının çoğu araştırma ve geliştirme gibi değer üretici alanlara dağıtılmaktadır. Böylelikle gelişmiş ekonomilerde savunma harcamaları büyüme getirir. Aksi durumda ise sürekli silah ithalatı için askerî harcama yapan bir ülkede bu harcamaların büyümeye katkı sunması beklenmez. Ayrıca sadece iktisadi olarak değil, savunma harcamalarını gelir yaratıcı faaliyetlere yönlendiren sanayi ülkeleri aynı zamanda geliştirdikleri silah ve sistemler ile geleceğin savunma stratejilerini de belirlerler. Tüm bunlar göz önüne alındığında bu çalışmanın amacı Kuzey Atlantik Antlaşması Örgütü (North Atlantic Treaty Organization, NATO) üyesi ülkeleri ittifak merkezince yayınlanan savunma harcaması alt kalemleri verilerine göre sınıflandırmaktır. Böylelikle ittifak içindeki ülkelerin askeri harcamalarının karakteristiği ortaya koyularak gerek iktisadi gerekse gelecek savunma stratejileri açısından ittifakın içinde bulunduğu durumun bir fotoğrafı çekilecektir.

NATO her yıl yayınladığı raporda üyesi olan ülkelerin savunma harcamalarını dört kategoride yayınlamaktadır. Bunlar ekipman harcamaları, personel harcamaları, altyapı harcamaları ve diğer harcamalardır. Ekipman harcamaları hem ekipman alımları için hem de ekipman geliştirmek için harcanan kaynağın miktarını vermektedir. Personel harcamaları ise emeklilik ve diğer sosyal ödemeleri de içerisine alacak şekilde ülke savunmasında görev alan askerî ve sivil personele yapılan toplam harcamayı kapsamaktadır. Altyapı harcamaları ise gerek ülke gerekse müttefikler için sunulan altyapı hizmetlerine ayrılan bütçe payını temsil eder. Son olarak tüm bu sayılan kategorilerde yer almayan harcamalar diğer kategorisinde toplanmıştır. Bu çalışmada NATO üyesi ülkeler bu kategorilerde yayınlanan verilere göre sınıflandırılmışlardır.

Çalışmada makine öğrenimi alanında oldukça sık kullanılan ve denetimsiz kümeleme yaklaşımlarından biri olan K-Ortalamalar yönteminden faydalanılmıştır. Bu yaklaşımın tek dezavantajı küme sayısının önsel olarak araştırmacı tarafından belirleniyor oluşudur. İdeal küme sayısının belirlenmesi için küme içi kareler toplamı ve siluet yaklaşımlarından faydalanılmış ve uygun küme sayısı üç olarak belirlenmiştir. Daha sonra K-Ortalamalar ile elde edilen kümeleme sonuçların tutarlılığı hiyerarşik kümeleme yaklaşımı ve K-Ortalamalar yönteminin başka bir alternatifi olan K-Medoids yöntemi ile de teyit edilmiştir.

Kümeleme analizi sonuçlarına göre elde edilen üç kümeyi birbirlerinden ayıran temel karakteristik farklılıkları vardır. İlk küme ekipman harcamalarına ağırlık veren ülkelerin oluşturduğu kümedir. Bu kümede Bulgaristan gibi son yıllarda oldukça fazla miktarda ekipman alımı yapan bir ülke olduğu gibi Türkiye gibi son on yılda savunma sanayisine büyük yatırımlar yapan bir ülke de yer almaktadır. NATO verileri ne yazık ki askerî ekipmanlar üzerine gerçekleşen bu iki farklı harcama eğilimini ayırt etmeye izin vermemektedir. İkinci küme ise savunma bütçelerini ağırlıklı olarak personel giderlerine ayıran ülkelerden oluşmaktadır. Personel harcamalarının ekonomiye katkısı tartışmalıdır ancak bu ülkelerin insan gücü ağırlıklı bir savunma stratejisine sahip olma olasılıkları oldukça yüksektir. Bu kümenin kalabalık olması tüm dünyada her geçen gün ağırlığı artan insansız muhabere sistemleri göz önüne alındığında ittifakın geleceği için başka bir soru işareti doğurmaktadır. Son küme ise askerî bütçesini dört kategori içerisinde nispeten daha dengeli dağıtabilmiş ülkeleri içermektedir. Üçüncü küme dikkatlice incelendiğinde birçok üyesinin gelişmiş ekonomiler olduğu ve dolayısıyla NATO'nun büyük silah üreticisi ülkelerinden meydana geldiği görülmektedir. Bu kümedeki müttefikler savunma harcamalarının ekonomi üzerindeki yapıcı ve yıkıcı etkilerini gelir üretici savunma sanayilerine ve diğer alanlara da kaynak aktararak dengelemeyi başarmışlardır. Bu özelliği ile eldeki kısıtlı verilere dayanarak bu küme, müttefik ülkelerin savunma bütçelerinin dağılımında örnek alabilecekleri (içinde yer almak isteyecekleri) bir küme olarak değerlendirilebilir.

Savunma harcamalarının yüksek olması gerek iktisadi gerekse ulusal savunma tehditlerini bertaraf etmek açısından doğrudan olumlu veya olumsuz olarak nitelendirilemez. Bu bağlamda askerî harcamaların detaylı bir röntgenini çekebilmek ve her bir alt kalemin yarattığı etkileri ampirik olarak incelemek oldukça önemlidir. Ancak yayınlanan veriler arzu edilen bilgileri ortaya koyma konusunda henüz istenilen detayda sunulmamaktadır. Erişimi mümkün olan NATO verileri ile ilk kez bu çalışmada gerçekleştirilen kümeleme analizi, daha detaylı bilgiler sunan veriler ile gerek ülke bazında gerek ittifakın tamamı için gelecekte uygulanacak birçok diğer makine öğrenimi çalışmalarına ışık tutacaktır.

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