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Analyzing Labor Costs in The Transport and Storage Sector in European Countries Through Trend and Cluster Analysis: 2007-2022

Avrupa Ülkelerinde Taşımacılık ve Depolama Sektöründeki İşgücü Maliyetlerinin Trend ve Küme Analizi Yoluyla Incelenmesi: 2007-2022

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Abstract: Trends in the transport and storage industry's labor markets in Europe have significantly impacted changes in labor costs. Technological advancements, increased privatization and deregulation, and changes in global capital flows are among the key reasons that have resulted in significant changes in labor costs in the logistics sector during the last few decades, especially in Europe. The amount of remuneration for logistics personnel and its pace of change over time are essential aspects influencing not just capital investment choices but also country competitiveness. The clusters of countries with similar wage increases over time are also impacted by their economic, social, and ecological problems to a similar extent. The existence of probable trends in labor costs in transport and storage on a country level, as well as cluster analysis over the countries where the trend is found, will aid in revealing significant similarities and contrasts concerning the sector and the countries involved in the research. The Labor Cost Index (LCI), according to NACE Rev. 2 Activity-nominal value, quarterly data released by Eurostat was utilized for this research. Sixty-four quarterly periods have been covered between the first quarter of 2007 and the fourth quarter of 2022. The research was based on data collected from 23 different European countries. The Mann-Kendall trend test and Sen's slope test were used for trend analysis, and the K-means clustering algorithm was used for cluster analysis.

Keywords: Labor Cost Index, Transport and Storage Sector, Mann-Kendall Trend Test, Sen's Slope Test, K-Means

JEL Classification: J40, N74, M19

Öz: Avrupa'da taşımacılık ve depolama sektörünün işgücü piyasalarındaki eğilimler, işgücü maliyetlerindeki değişimler üzerinde önemli bir etkiye sahip olmuştur. Teknolojik gelişmeler, artan özelleştirme ve deregülasyon oranı ve küresel sermaye akışındaki değişiklikler, özellikle Avrupa'da son on yılda lojistik sektöründe işgücü maliyetlerinde önemli değişikliklere yol açan temel nedenler arasındadır. Lojistik personeline ödenen ücretin miktarı ve zaman içindeki değişim hızı, sadece sermaye yatırımı tercihlerini değil aynı zamanda ülkelerin rekabet gücünü de etkileyen önemli unsurlardır. Zaman içinde benzer ücret artışlarına sahip ülke kümelerinin ekonomik, sosyal ve ekolojik sorunlarından da benzer ölçüde etkilendiği açıktır. Taşımacılık ve depolamada işgücü maliyetlerindeki olası eğilimlerin ülke bazında varlığının yanı sıra eğilimin bulunduğu ülkeler üzerinden küme analizi yapılması, sektöre ve araştırmaya dahil olan ülkelere ilişkin önemli benzerlik ve zıtlıkların ortaya çıkarılmasına yardımcı olacaktır. Bu araştırma için Eurostat tarafından yayınlanan NACE Rev. 2 Faaliyet-nominal değerine göre İşgücü Maliyeti Endeksi'ne ait üçer aylık dönemlere ait veriler kullanılmıştır. 2007 yılının ilk çeyreği ile 2022 yılının dördüncü çeyreği arasında toplam 64 çeyrek dönem ele alınmıştır. Araştırmada, 23 farklı Avrupa ülkesinden toplanan verilerden yararlanılmıştır. Trend analizi için Mann-Kendall trend testi ve Sen's eğim testi, kümeanalizi için ise K-ortalamalar kümeleme algoritması kullanılmıştır.

Anahtar Sözcükler: İşgücü Maliyet Endeksi, Ulaştırma ve Depolama Sektörü, Mann-Kendall Trend Testi, Sen's Eğim Testi, K-Means

JEL Sınıflandırması: J40, N74, M19

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1. Introduction

The term "logistics" presently refers to the transportation and delivery of goods, services, and information and has its roots in the military and business (Lummus, Krumwiede, and Vokurka, 2001: 427). According to APICS Dictionary, logistics is defined in commercial operations as the art and science of buying, producing, and distributing goods at the proper time, place, and quantity. Logistics in the military include personal mobility (Blackstone, 2010: 82). According to the Council of Supply Chain Management Professionals, primary operations conducted within the scope of logistics management include both inbound and outbound transportation management, fleet management, storage, materials handling, fulfillment of orders, logistics network design, management of inventory, demand and supply planning, as well as management of third-party logistics service providers ("SCM Definitions and Glossary of Terms", 2023: 117). Logistics processes encompass customer service, transportation, warehousing, and order processing, all of which contribute to and generate logistics costs (Lambert, Stock, and Ellram, 1998: 21–22). Pre-production, in-production, and post-production operations have all been included under logistics (Sun et al., 2021: 9561).

The logistics industry is one of the most significant sectors in the global economy since it allows the transportation of goods, services, people, and information across borders and continents. The logistics industry's importance in global trade growth could not be understated ("Logistics Industry Worldwide" 2023). The value of the global logistics sector was more than 8.4 trillion euros in 2021, and it is forecast to exceed 13.7 billion Euros by 2027 ("Logistics Industry - Market Size 2028" 2023). Analysis of the logistics sector's impact in countries individually revealed a significant contribution to the growth and development of those countries (Hayaloğlu, 2015: 523). One of the consequences of the logistics industry's improved effectiveness is the contribution of the country's logistics sector to enhance efficiency in every industry in the impact area. The pertinent condition essentially increases the competitiveness of countries that can continue their performance in the logistics sector. The pertinent conditions have positioned itself to be a significant factor in a country's growth and development. To improve the efficiency of this sector's operations, the initial focus area has been reducing logistics-related operations costs. A comprehensive comprehension of the size and structure of logistic costs at the national level is essential for high-level strategic analysis and formulation and implementation of regulatory measures (Rantasila and Ojala, 2015, 321–22). Indicators of a country's price competitiveness include labor costs, productivity, and exchange rate movements. It is not a reasonable method based on estimating the major impact of labor costs through country price competition. In addition to the shift in

labor costs, exploring the country's pricing competition and the trajectory of labor productivity can be helpful. Increases in labor costs may not always convert into higher prices for businesses. The concurrent boost in productivity may more than make up for the rises in labor costs (Niechoj et al. 2011, 1:9). Sustaining a competitive cost structure in the logistics sector has a significant influence on developing and maintaining a country's competitiveness (Korinek, J. and P. Sourdin, 2011: 2).

One of the primary elements influencing costs in the logistics sector is labor cost. There are several subsectors within the logistics sector, and we included the categories under section H, transportation and storage, Division 49-53 of the statistical classification of economic activities in the European Community in our research ("NACE Rev. 2" 2023: 76). A variety of national and international organizations, including the OECD and Eurostat, are known to provide labor cost statistic. For this study, the Labor Cost Index (LCI) according to NACE Rev. 2 Activity-nominal value, quarterly data published by Eurostat was used, both in terms of the countries it covers and the range of years it covers. The time period starts from the first quarter of 2007 and ends in the fourth quarter of 2022, covering a total of 64 quarterly periods. The labor cost for LCI data utilized in research includes compensation of employees plus taxes minus subsidies ("Labour Cost Index" 2023). With the use of 64 quarters of LCI data, the research seeks to analyze the results of trend presence, trend direction, and cluster analyses using trend values.

Research Question 1: Is there a statistically significant trend at LCI?
Research Question 2: What is the slope estimate if a statistically significant trend is present?
Research Question 3: What are the characteristics of clusters formed based on trend?

The methods of Mann-Kendall trend test and Sen's slope estimator were used respectively to answer the related research problems. R Studio (2023.03.1) was utilized for coding the computation process.

The impact of labor market trends and variations in labor costs on the logistics, transportation, and storage sectors has been extensively recognized. However, there is a dearth of comprehensive study on the prolonged trajectory of employee salaries and expenses, as well as the comparative examination of these changes across different economies. The status of the labor market within the sector and the effects of digitalization on the labor market are among the related areas that receive considerable attention in the analyses (Bensman 2008; Bottalico 2021; Pishvaee, Basiri, and Sajadieh 2009; Gutelius 2015; Agarwal 2023). Another area of research that attracts an increasing amount of attention is the influence that the cost of workers in the logistics industry have on the competitiveness and productivity of economies (Korinek, J. and P. Sourdin, 2011; Niechoj et al. 2011; Capuce and Sheffi 1994;

Shepherd 2011). Limited study has been conducted on the subject of employee wages, including their level and fluctuations in salary over time. Additionally, there is a lack of analysis of the patterns in salaries across countries in the geographical region. The conducted research is expected to offer significant value to the existing literature, given that it concentrates on an appropriate subject of research. This study is unique because it analyzes the labor cost trend for twenty-three countries using the Mann-Kendall trend test and Sen's slope estimator methods. Labor Cost Index (LCI) published by Eurostat has been used in the analysis. The study's progress is shown following. The following section is a review of the literature. Section 3 shows data and methodology. Section 4 presents findings and discussions. The final section is the conclusion.

2. Literature Review

Over the past 50 years, the logistics industry has experienced significant growth and development. Technological advances in transportation and warehousing and the successful resolution of labor cost pressures are cited as major drivers behind the progress (Danyluk, 2018: 3). The primary factors that raised the significance of the logistics industry were the recession, the oil embargo, cost control pressure, and high inflation that exacerbated concerns over competition (Cowen ,2014: 42). Given that the share of distribution costs in total costs in some companies reached up to 45% in the last thirty years of the twentieth century, it forced companies to focus on lowering distribution costs, and the resulting situation has pushed companies in the logistics sector to a more cost-conscious position (La Londe, Grabner, and Robeson, 1971: 45). Logistics companies became more cost-conscious after 1974 as oil prices more than quadrupled (Hummels, 1999: 11). Among the primary strategies the logistics sector uses to achieve cost reductions are labor-saving technologies and low worker wages (Danyluk,2018: 7). Labor costs in the logistics industry are not a popular research topic. An important topic of research in those fields is the analysis of the relationship between labor costs and international competitiveness.

Studies have indicated that countries' productivity and labor wage levels move in tandem (Brill et al. 2017; Mishel, 2012). This shows that countries with high labor costs do not threaten countries with low labor costs in the short run. In particular, it is known that lower productivity levels predominantly characterize countries with low labor costs (Güneş, Yeşilyurt, and Karaalp Orhan, 2013, 16). Research on the EU-15 has shown that the main driver of the region's competitiveness is low productivity rather than high labor wages (Ark, Stuivenwold, and Ypma, 2005: 8). Several studies showing the inverse relationship between

output growth and the growth rate of unit labor costs have pointed to a paradox that does not lead to a clear conclusion (Kumar and Felipe, 2011, 4). Studies demonstrating a similar rise in compensation for employees in fast-growing economies in exports and GDP and the inverse provide pertinent support. The related phenomenon is called Kaldor's Paradox in the literature (Felipe, 2005: 3). The logistics sector has adopted a low labor cost approach globally, which is anticipated to have several strategic consequences. According to past experience, low labor cost strategies lessen the requirement for capital expenditures, new technologies, and integrated systems. Low labor cost tactics might negatively affect international commerce, including lost sales, an increase in inventory, and higher insurance costs (Bensman, 2008: 2). In the United States, the percentage of logistics expenses in GDP fell from 19% to less than 10%. Since the latter decade of the twentieth century, several countries have experienced similar circumstances. This is mostly attributable to the sector's increased efficiency. It is emphasized that the social decline in working conditions in the logistics sector and the decline in working standards play a role in the relationship between the course of labor cost and the decline in logistics costs (Bonacich and Wilson, 2008: 20:21). Businesses across a variety of sectors, including those in the logistics sector, are increasingly choosing to use contractors, temp agencies, and franchisees rather than recruiting employees directly for filling positions that arise. Event-study evaluations carried out in Germany, including the logistics industry, revealed that the labor costs of outsourced roles are reduced by about 10% to 15% compared to comparable non-outsourced employment (Goldschmidt and Schmieder, 2017: 1165). Bonacich and Wilson (2008) attribute the logistics sector's relatively low labor costs to the involvement of outsourcing, subcontracting, and temporary employment agencies in meeting labor demands as an important contributor. Another important factor in the study is that falling wages in the logistics sector have become a determining feature of the sector's labor market (M. Coe, 2014: 242). Estimated labor force participation in the transportation industry varies from 3-6% among countries in the OECD. Digitalization, particularly autonomous vehicles, will significantly impact the number of human beings engaged in this sector. It has been expected that the digitalization process will have an impact on the labor market in the logistics sector. The change will rely on the skill level of the job in the sector, and digitalization will mostly eliminate the low-skilled position in the logistics sector (Hayaloğlu ,2015: 1000:1001). Among the effects of digitalization in logistics processes on employees is an increase in work intensity. In the research on this issue, 21.6% of low-skilled employees in the logistics sector stated that the digitalization of workload increased their work intensity (Ittermann et al,. 2019: 159). Some of the primary

possible negative concerns identified among the effects of digital transformation in a variety of sectors, including the logistics sector, are a reduction in labor expenses, an increase in the number of informal jobs, and a decline in hiring trends (Popelo et al,. 2021:160). It is common knowledge that the logistics sector struggles with worker wages. The availability of hiring qualified employees in the logistics industry presents significant challenges, particularly for countries in the lowest 40% of the logistics performance index (Mareï and Savy, 2021: 154). The digital transformation in the logistics industry has altered job profiles, labor skills and qualifications, employee numbers, and labor costs, particularly concerning autonomous systems, which have a substantial influence on the logistics labor force. Advanced skills are needed for a range of positions in the logistics sector, particularly in port work and railway work (Bottalico, 2021: 122).

The analysis of the trend in wage rates yielded three main categories of countries as a result. Greece, Portugal, Ireland, Italy, and Spain have been categorized as countries with above-average wage raise. France, the Netherlands, Belgium, Finland, and Austria have been classified as countries where the trend has been on or around average. Germany and the United Kingdom have been characterized as below-average countries (Niechoj et al. 2011, 10).

According to the findings of the review of the literature, academic research on the workforce in the logistics sector focuses on the influence of labor market changes on global trade and competition, as well as the impact of digital transformation on the logistics sector labor market. The literature search results revealed a restricted amount of research that analyzed labor cost trends for European countries.

3. Data and Methodology

The data set used in the study was obtained from the Labor Cost Index (LCI), which is provided by Eurostat, the statistical agency of the European Union, which is in charge of disseminating high-quality statistics and indicators for all of Europe in order to facilitate comparisons between multiple countries and regions. The time frequency of the Index used is quarterly. The data is neither seasonally nor calendarally adjusted. In 2016, the Index was set to 100. The Index's statistical classification of economic activities in the European Community is based on NACE Rev. 2, and only transportation and storage have been chosen to be researched in the present study. Labor cost for LCI includes compensation of employees plus taxes minus subsidies in this research. The initial data for Turkey was included in the Index in the first quarter of 2007, and the appropriate date was established as

the research period's beginning date. The most current data available at the time of the research was for the fourth quarter of 2022, and the study was based on quarterly data between the pertinent dates. Countries with missing data in the relevant period were excluded from the study, and the study was conducted on the data of 23 European countries in total ("Labour Cost Index" 2023).

The primary goal of trend analysis is to determine the direction of data gathered over time. Following the trend analysis, the parameter's expected incline in the future is computed. The significant methods that could potentially be employed in trend analysis are Mann-Kendall Trend Analysis and Sen's slope test. We used Python 3.10 for the K-means cluster analysis approach outlined above. R version 4.3.0 and RStudio 2023.03.1 Build 446 have been used in Mann-Kendall Trend Analysis and Sen's slope test. The Mann-Kendall test is one of the most frequently used non-parametric trend analysis methods to determine the trend in time series, predominantly in the fields of hydrology and climatology, but also in a number of other fields including supply chain management and finance (Hossain, Rahman, and Sun, 2022; Vurdu, 2021; Beşel and Kayıkçı, 2019). The hypothesis test applied in the method analyzes the presence of a trend. The data are assumed to be equally distributed among the population of independent realizations, which is the null hypothesis. The alternative hypothesis for the two-sided test is that the data exhibit a monotonic trend. The Mann-Kendall test statistic is computed using the equations 1-2 shown below (Thorsten Pohlert, 2023);

$$S = \sum_{k=1}^{n-1} \sum_{j=k+1}^{n} sign(x_j - x_k) \quad (1)$$

sgn is the signum function. The mean of S is μ = 0. Variance with correction term for ties.

$$\sigma^2 = \frac{\left\{\left(n(n-1)(2n+5) - \sum_{j=1}^{p} t_j\ (t_j-1)\ (2t_{j-1}+5)\right)\right\}}{18} \quad (2)$$

Equation 3 is used to compute the probability function (Gunes, Basara, and Şişman, 2021, 203).

$$Z = \begin{cases} \frac{S-1}{\sqrt{var\,(S)}} & S > 0 \\ 0 & S = 0 \\ \frac{S+1}{\sqrt{var\,(S)}} & S < 0 \end{cases} \quad (3)$$

Sen's slope is used to calculate linear rate of change. According to Sen's method, this test computes the slope. In order to calculate a collection of linear slopes, equation 4 has been provided. Sen's slope, which is derived as the median of all slopes, is calculated using equation 5 (Thorsten Pohlert ,2023).

$$d_k = \frac{x_j - x_i}{j - i} \qquad (1 \le i < j \le n) \quad (4)$$

where d is slope, x is the variable, n is the number of data,

$$b_{s_{en}} = median\,(d_k) \quad (5)$$

The partition of data into homogenous subgroups is the focus of clustering, which is constrained by two separate objectives: data items within one cluster should be similar, while those inside other clusters should be distinct (Handl and Knowles, 2006, 2). Clustering techniques are separated into two groups. These are approaches for both hierarchical and non-hierarchical clustering. Agglomerative and divisive approaches are two distinct categories of hierarchical clustering. Non-hierarchical clustering methods are further categorized into four sub-categories: partitioning, density-based, grid-based and other approaches (Gülagiz and Sahin, 2017, 6). Before any clustering, non-hierarchical methods typically need the user to define the number of clusters (Sai Krishna, Yesu Babu, and Kiran Kumar, 2018, 301). K-means clustering, which was used in our research, is a partitioning approach that is widely used because of its simplicity. We used Python 3.10 for the K-means cluster analysis approach outlined above. The elbow approach is used to obtain the most suitable value for K in the K-means clustering algorithm. Elbow plots between inertia and k values ranging from 1 to 9 are shown in the figure below for each dataset.

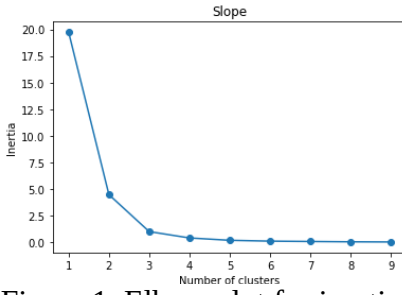

Figure 1. Elbow plot for inertia

The above graphs clearly show that there has been a significant decrease in the number of clusters from 2 to 3, so the K value for all datasets has been determined as 3 in this study.

4. Findings and Discussions

The Mann-Kendall test was performed on LCI for the 23 European nations. H_0 is rejected if the p-value is less than the significance level (alpha) which equals to 0.05. Accepting H_0 implies no trend was observed, whereas rejecting H_0 suggests a trend in the time series. When the null hypothesis is rejected, the result is considered to be statistically significant. The results submitted at Table 1 show that the Null Hypothesis was accepted for only one country, Greece.

Table 1. Mann-Kendall Test Results

Country	z-value	p-value
Belgium	7.1449	9.006e-13
Bulgaria	10.783	< 2.2e-16
Czechia	9.2872	< 2.2e-16
Germany	6.5878	4.464e-11
Estonia	10.214	< 2.2e-16
Ireland	4.0276	5.635e-05
Greece	0.20279	0.8393
Spain	7.6723	1.69e-14
France	6.269	3.633e-10
Italy	6.5075	7.642e-11
Latvia	10.023	< 2.2e-16
Lithuania	9.942	< 2.2e-16
Luxembourg	8.6511	< 2.2e-16
Hungary	9.5828	< 2.2e-16
Malta	9.3924	< 2.2e-16
Austria	7.8452	4.322e-15
Poland	9.9599	< 2.2e-16
Portugal	5.1682	2.364e-07
Romania	11.193	< 2.2e-16
Slovenia	7.4747	7.736e-14
Slovakia	9.5836	< 2.2e-16
Finland	4.9193	8.686e-07
Türkiye	11.257	< 2.2e-16

LCI values for Greece have been presented in the figure below, as the Mann-Kendall Test revealed no trend in LCI values over 60 quarters. As a result, of the the Mann-Kendall Test revealed test Greece was excluded from the subsequent tests, and the analysis was continued with 22 countries.

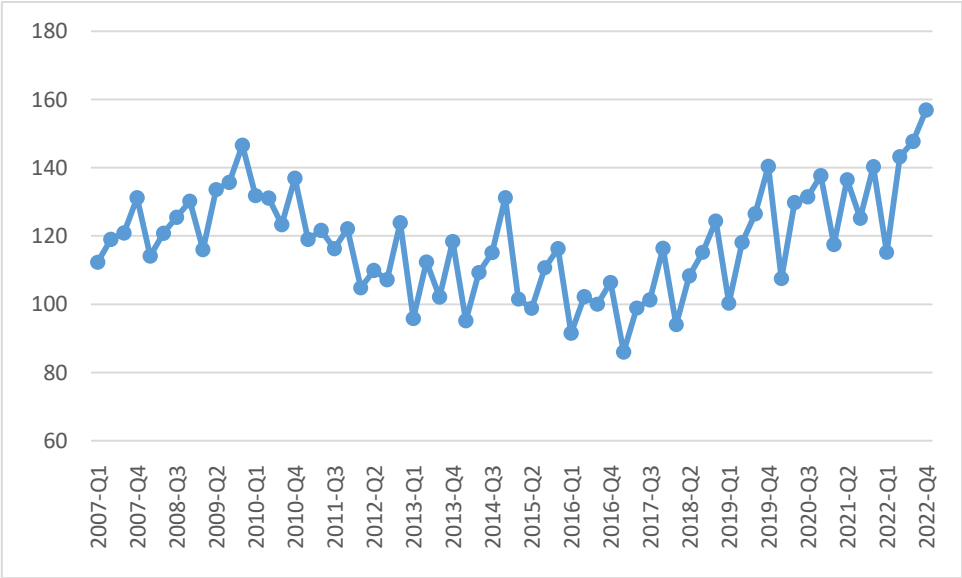

Figure 2. Greece Labour Cost Index: 2007/Q1-2022/Q4

Sen's Slope test was used to analyze trend directions in the next step. Table 2 shows the Sen's Slope Test results for 22 European countries. Analyzing the p-values obtained at the end of Sen's slope test, it can be seen that there is significant parallelism between the results of the Mann-Kendall test.

Table 2. Sen's Slope Test Results

Country	p-value	95 % Confidence Interval	Sen's slope
Belgium	9.006e-13	0.2894737 0.4724138	0.3785774
Bulgaria	< 2.2e-16	1.300 1.588	1.44316
Czechia	< 2.2e-16	0.8366667 1.1058824	0.9720991
Germany	4.464e-11	0.3375 0.5180	0.4232684
Estonia	< 2.2e-16	1.163636 1.380000	1.285016
Ireland	5.635e-05	0.0900000 0.2384615	0.1702941
Spain	1.69e-14	0.2083333 0.3157895	0.2622024
France	3.633e-10	0.2250000 0.3857143	0.2860556
Italy	7.642e-11	0.2450000 0.4181818	0.3342607
Latvia	< 2.2e-16	1.117391 1.307273	1.211806
Lithuania	< 2.2e-16	0.9836735 1.1476190	1.065
Luxembourg	< 2.2e-16	0.4565217 0.6125000	0.5357143
Hungary	< 2.2e-16	1.038636 1.426087	1.226201
Malta	< 2.2e-16	0.8391304 1.0416667	0.93
Austria	4.322e-15	0.6777778 0.9357143	0.7958754
Poland	< 2.2e-16	0.8653061 1.0652174	0.9550505
Portugal	2.364e-07	0.3275862 0.5955556	0.4625
Romania	< 2.2e-16	1.630952 2.066667	1.871941
Slovenia	7.736e-14	0.3200000 0.4666667	0.3879808
Slovakia	< 2.2e-16	0.8961538 1.1688889	1.035574
Finland	8.686e-07	0.1655738 0.3340426	0.2490741
Türkiye	< 2.2e-16	4.135714 5.390000	4.773206

Sen's Slope Test results were used to perform a cluster analysis, which divided the countries into three groups: Group A, which included the low-slope countries, Group B, which included middle-slope countries; and Group C, which included high-slope countries. Table 3 lists the locations of cluster centers.

Table 3. Cluster Centers

Group	Center
A	0.3489927799999999
B	1.162883909090909
C	4.773206

Twenty countries in the EU are included in the Eurozone, and 17 of these countries were included in the study. Since Greece did not meet the relevant condition, a cluster analysis of Sen's slope was conducted for the remaining 16 euro area countries and a total of 5 non-euro

area countries, including 4 EU members and Turkey. The countries that are included in the appropriate cluster are listed in the figure below. Plotly Express in Python 3.10 is used in the visualization of figure.

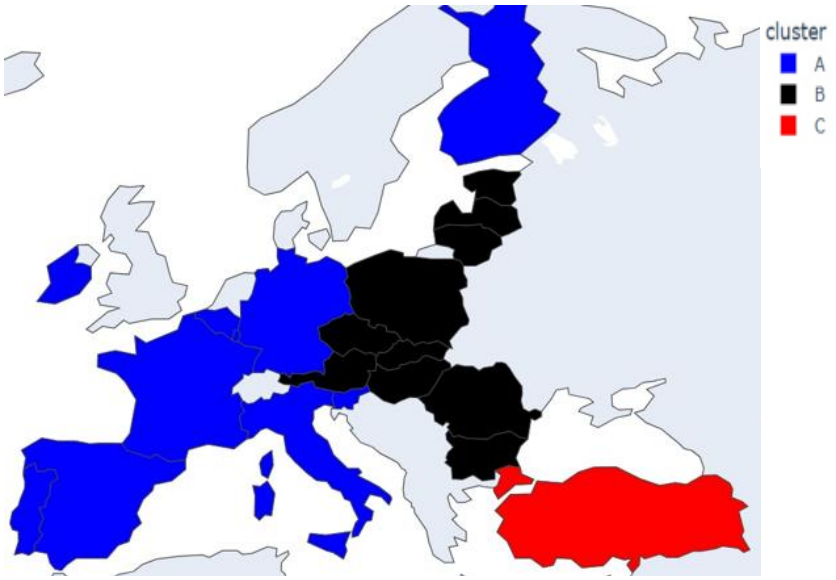

Figure 3. Sen's Slope Country Cluster Map

In the framework of cluster analysis, it is seen that a total of ten countries constitute group A, which classifies countries with a low slope of LCI change. For the corresponding cluster, the two countries furthest from the meridian are Ireland, with a Sen's slope value of 0.1702941, and Luxembourg, with a Sen's slope value of 0.5357143. There are 11 countries in Group B, which classifies countries with a moderate slope. Although in Group B, Austria is closest to Group A with a Sen's slope value of 0.7958754. Romania is the country with the highest value of the Sen's slope in group B. Turkey has the highest Sen's slope value and is the only country in Group C. The map above's significant indicator is the probable association between the cluster to which countries belong and their geographical position alongside neighboring countries.

Another point to underline is the link between the currency in use and the group of countries. The first point to underline is that all countries in Group A are in the Eurozone. Another factor to be added to this is the fact that six countries in group B are in the euro area. Austria, Estonia, Latvia, Lithuania, Malta, and Slovakia are these countries. Referring to the study's research questions, the response to the first research question is that there has been a statistically significant trend in LCI in all countries studied except Greece. Table 2 contains the pertinent information for the second research question, and the pertinent table includes the slope values for the countries having a statistically significant trend regarding the second

research question. The research's findings indicate that three primary clusters, including low, medium, and high slope values, have been determined in response to the last research question related to the characteristics of the clusters formed based on trend in LCI.

5. Conclusion

Developments in the labor markets of the logistics sector in European countries have significantly determined the change in LCI values. Advances in technology, a faster rate of privatization and deregulation, and changes in global capital movements are among the primary causes that have led to substantial changes in labor costs in the logistics sector in the past few decades. The level of compensation for workers in the logistics sector, as in any other sector, and its rate of change over time are among the significant factors in capital investment decisions. The level of compensation for workers in the logistics sector, as in any other sector, and its rate of change over time are among the significant factors in capital investment decisions. The structure of the clusters in which countries with similar changes are located is among the most critical factors influencing the development of a range of economic, social, and ecological factors.

The anticipated outcome of the study is that the number and structure of the clusters will provide valuable insights for future studies in this area of study. A primary constraint of the study is its sole concentration on transportation and storage. By including additional operational domains of LCI, it would provide the possibility of conducting comparative analyses across various operational sectors. Examining the fluctuations in the index across other domains, such as production, is believed to have a substantial effect on the current state of studies. The significance of this research for the logistics industry and its professionals lies in its capacity to assess the relationship between the development of the trends in countries where firms operate and the corresponding trend in those countries. The professionals in the field may also find it advantageous to utilize the findings of the pertinent study to examine the relationship between cost trends in the countries where competitors conduct business and their own labor cost trends. The resulting insights can be implemented across various facets of strategic planning, with particular emphasis on the development of competitive strategies.

The study's key finding is that Greece is the sole country among those included in the study, where no statistically significant trend in LCI was observed. Considering the economic turbulences that Greece experienced during the period under study, the evolution of the wages of workers in the logistics sector in Greece, and the possible effects and causes are among the topics that may be useful for future research. The second significant result of the research was

the structure of the clusters created as a consequence of the cluster analysis carried out on Sen's slope estimations. The research results highlighted the possible relationship between a country's economic size and geographical location, and wage growth in the logistics sector. Another issue that needs to be highlighted is the possible relationship between wage changes in other sectors and changes in the logistics sector. In particular, comparing the manufacturing sector will provide important insights into the evolution of countries' competitive characteristics.

As a consequence of the analysis of the trend in wage rates, three primary categories of countries emerged. The countries of Belgium, Finland, France, Germany, Ireland, Italy, Luxembourg, Portugal, Slovenia, and Spain are classified as having a low LCI change slope. Slovakia, Poland, Romania, Austria, Bulgaria, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, and Malta have all been categorized as middle-slope countries. Turkey has been described as a country with a high LCI change.

One of the findings that should be emphasized in the research of interest and on which research should be concentrated is the results obtained about Turkey. A number of research topics could provide important explanatory insights into the situation, including the value of investment in the sector, the possible change in the competence structure of employees, and the difference between the change in wages in other sectors.

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