Unemployment in European Union During the COVID-19 Pandemic. A Cluster Analysis

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Abstract

The present paper tries to identify the dynamics of the unemployment for 27 countries from European Union and which countries have encountered the biggest cluster fluctuations (their behavior in this regard) during the COVID-19 pandemic. In order to obtain the results, a data mining analysis was made, using the specific CRISP-DM methodology. The data analysis is made using the EM and Simple K-Means cluster algorithms. For each analyzed period of time, a cluster analysis is made and each country is distributed in the most appropriate cluster. The main findings of the paper are indicating the dynamics of the unemployment based on the identified clusters and also the behavior of each country related to the movement from one cluster to another. The paper offers an original approach in which a cluster data mining analysis is made in order to identify correlation for pattern behavior in the data about unemployment. Knowing that several countries have a similar behavior when they are exposed to a certain situation, maybe strategies and regulation can be designed for all of them, reducing this way the resources consumption.

Keywords

unemployment, COVID-19 pandemic, cluster analysis, European Union

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Introduction

The present article tries to identify the changes that have occurred for the European Union regarding the unemployment between the second quarter of 2019 and the third quarter of 2021. In this regard, the authors have tried to find out information about the dynamics of the unemployment for these countries and which countries have encountered the biggest cluster fluctuations (their behavior in this regard). In the first part of the paper a literature review was done regarding the unemployment problem and the effects of the COVID-19 pandemic over the unemployment. In the second part there are presented the main causes that are affecting the unemployment in general. In the third part there are described the research methodology and its phases. In the last part of the paper, the cluster data mining analysis is done highlighting the obtained results. Based on them, it can be identified which countries from EU were prepared to deal with such an extreme situation and how much the labor market was affected. Studies like DellaVigna et al. (2020), Rosca (2020) and Stefan et al. (2020) are debating also this topic. The period of time was selected in such a manner to comprise a period before the pandemic and another one during the pandemic.

1. Review of the scientific literature

The unemployment is the notion used in the situation of the lack of paid employment for properly qualified workforces (Belostecinic et al., 2022). According to Andolfatto (2008), the unemployment may be also defined as being the "percentage of individuals in the workforce (which is the sum of those who work or

are looking for work) who do not have a job (but are looking for one)". There is no mention about necessity of a specific qualification in order a person to be considered as unemployed (Bran, Alpopi and Burlacu., 2018). Another definition of unemployment is given by Topel (2008). Many research papers (like Hall, 2005; Marturano and Vizmuller-Zocco, 2019; Shi and Di Stasio, 2022) and studies (Esmark and Liengaard, 2021; Elsby and Gottfries, 2021) have debated this topic from many points of view, unemployment being a very important aspect of any country from around the world (Balu et al., 2021). In order to understand better the unemployment phenomena, several models were developed. In papers like (Ots et al., 2022; DellaVigna et al., 2020 and Bertarelli et al., 2018) are described some of these models.

In the last two years the COVID-19 pandemic has generated severe economic problems, affecting many countries at every level (Burlacu et al., 2021). The unemployment phenomenon was also affected by the pandemic, phenomenon that has raised growing problems for governments at a large scale. Situations like never before had to be carefully managed by the leaders and special solutions applied. For the last two years, the relation between the unemployment and the pandemic was a very strong one. Research papers like (de Jong and Ho, 2021; Rajput-Ray, 2022; Belostecinic et al., 2022) are describing this relation and influence of the pandemic over the people and the unemployment.

In the European Union (EU) the COVID-19 pandemic has caused a slow down to the economies of the countries. For example, according to Rosca (2020), in Romania, right at the beginning of the pandemic, at the end of march 2020 versus march 2019: 155675 work contracts were closed, the car registrations were less with 32%, less with 15% building authorizations, less with 45,8% in selling clothes market, less with 69,8 arrivals in hotels and guest house, less 6000 companies registrations, unemployment rate was 4,6% versus 3,7% from march 2019. For this reason, for many areas of the economy, a safety plan was made, each plan having its particularities. According to EU (2020), during the pandemic period, between March 2020 and December, as a response to the EU economic crisis, there were spent aprox. 3.7 trillion euro. Some aspects aimed by the EU were: national measures taken under the flexibility of EU budgetary rules (524 bn euro), EIB – European Investment Bank Group financing for business (200 bn euro), European stability mechanism pandemic crisis support for member states (240 bn euro), national liquidity measures (2553 bn euro), direct EU budget support (70 bn euro), SURE – EU funding for short-time work schemes (100 bn euro). Also in this regard the European Central Bank (ECB) has managed 1850 billion euro though the Pandemic Emergency Purchase Programme.

In this context, the jobs, employers, employees and workforces were in many cases well protected and financed in order to overcome the challenges that have appeared (Profiroiu et al., 2020). The main challenge was how to maintain the unemployment at a certain rate and how to keep the existing jobs for the people (Bodislav et al., 2020).

The present article tries to find out the answers to the following research questions: how were the dynamics of the unemployment for the countries from EU during the pandemic and which countries have encountered the biggest cluster fluctuations (behavior)?

In order to find the answers to these questions there were used data expressed in percent from Tempo-online database (*http://statistici.insse.ro:8077/tempo-online/#/pages/tables/insse-table*), for 2019 (quarters Q2, Q3, Q4), 2020 (quarters Q1, Q2, Q3, Q4), 2021 (quarters Q1, Q2, Q3). Selecting this period of time, the impact of the pandemic over the unemployment it can be very easy highlighted because the 2019 represents a post pandemic period and starting with 2-nd quarter (Q2) from 2020 it is the pandemic period.

2. Unemployment and its causes

The unemployment is a component of the labor market, market which has its specific aspects and which can be controlled by the intervention of the government. According to Phillips (2017), the labor market implies demand and supply relations, contractual basis and self-employment, sectorial and territorial constrains, internationalization (which represents the possibility of a person to move free in the EU in order to find a certain job). Also, the government may intervene with tools like creating a legal framework, managing the employees from the public sector, aligning to international treaties and regulations, creating passive and active employment policies (Profiroiu, Burlacu and Sabie, 2019).

In general, most encountered causes of the unemployment are the demand deficient and the supply side. According to Pettinger (2021) the demand deficient is based on high interest rates, financial crisis, negative multiplier effect, and global recession and the supply side is based on frictional unemployment, structural mismatch of skills, geographical immobility, real wage unemployment, and technological change. Also, for the second category supply side it can be elements like no experience, they are to too old, health

condition, not willing to take a job for less money, high population growth in the region (Figure no. 1). Pettinger (2021) describes the causes of unemployment as follows:

- Supply site:
  - Frictional unemployment – this type of unemployment it is represented by the people who spend time between the actual job and the next one;
  - Structural unemployment – this type occurs because of a lake of skills in the labor market and it can be caused by the occupational immobilities (difficulties that occur in learning new skills needed to a new industry), geographical immobilities (the need to move to another area to get a certain job), technological change, structural changes in the economy;
  - Classical or real-wage unemployment – situation when wages in a strong and competitive labor market are situated above the equilibrium.
  - Voluntary unemployment – this unemployment appears when people choose to remain unemployed rather than take the available jobs on the market. Friction
- Demand deficient ("Cyclical unemployment"): occurs when the economy is not at its full capacity. For example, having a decrease in outputs, the companies will employ fewer people because they are making fewer goods.

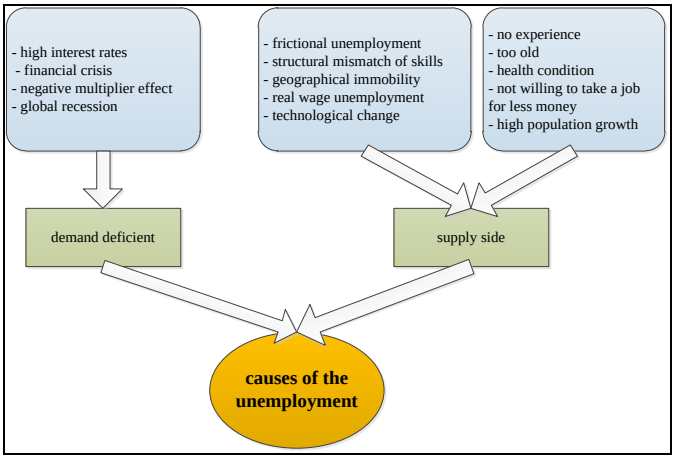

Figure no. 1. Causes of the unemployment
Source: Pettinger, 2021

According to Eurostat [https://ec.europa.eu/Eurostat], the unemployment rate in UE was 7,5% in December 2021 and 8,3% in Euro area. In the same month and year, from the 27 countries of EU, the most highest rates were recorded in Spain (16,2%), Lithuania (10,1%) and Italy (9%) and the lowest ones in Germany (4,6%), Slovenia (4,7%), Bulgaria (4,8%) and Romania (4,9%).

3. Research methodology

For the EU, in the context of the COVID-19 pandemic, despite of all the strategies and policies taken by governments, the unemployment has increased gradually. Because during the pandemic period some results of the taken measures have been seen, the unemployment had fluctuations. In order to identify these fluctuations and which countries have the biggest ones, a data mining analysis based on cluster was realized. There were analyzed the unemployment rates express in percent starting with 2019 (Q2) and ending with 2021(Q3) for 27 European countries. The data source is Tempo online database.

In order to process the data and to obtain the final results, a data mining specific methodology was used, namely DM-CRISP methodology (*https://www.datascience-pm.com/crisp-dm-2/, accessed on March 3, 2022*) which has several steps. These steps are: requirements understanding, data understanding, data preparation, data modeling, results evaluation, and deployment. The dataset obtained after data preparation step contains 11 attributes and 27 records. Main activities made over the dataset were:

- collecting the data from the data source;
- creating the excel file with the needed data
- the excel file was transform into an arff file. This type of file was uploaded in Weka software for the data mining analysis (Figure no. 2.) (Bouckaert et al., 2010; Bodea et al., 2011).

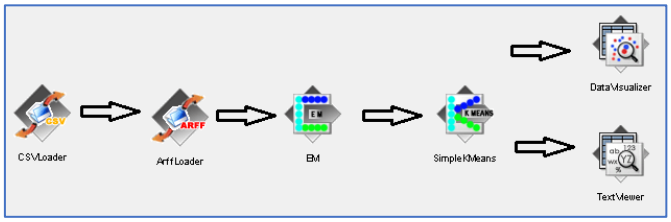

Figure no. 2. Processing steps for data

The algorithms used for the data mining cluster analysis were specific cluster algorithms EM and Simple K-Means. The EM algorithm was used to identify the number of clusters in the dataset for quarters. Then the Simple K-Means algorithm was used in order to identify the cluster of each country for a certain quarter (Q). It can use either the Euclidean distance (default) or the Manhattan distance. If the Manhattan distance is used, then centroids are computed as the component-wise median rather than mean. Manhattan distance MD1 between 2 vectors a and b in a n-dimensional real vector space, having Cartesian coordinates, is the sum of the lengths of the projections of the segments between the points on the coordinate axes.

4. The cluster analysis

The cluster analysis uses an arff file that is uploaded in WEKA software. The data preprocess tab offers the possibility use the arff, to see the number of the attributes (11), the number of the records (27 countries from EU) and also to see the minimum, maximum, mean and standard deviation values for the numerical attributes. One or more attributes may be selected. In this case, each quarter was selected and for it the EM and Simple K-Means algorithms were applied (Bouckaert et al., 2010).

In the tab Cluster, there are applied the two algorithms. For the Simple K-Means algorithms there were used the following parameters: the computed distance (Manhattan), maximum iteration number (500), number of clusters (4 - identified based on the results offered by EM algorithm), preserve instance order (false).

The results for the cluster analysis are mentioned in Table no. 1. For each analyzed quarter, there were identified 4 clusters, and for each one there were mentioned (Table no. 1): the number of countries from that cluster, the most representative country for that cluster, the centroid's value.

Based on the results obtained in Table no. 1 we may conclude that:

- the cluster 0 is the one that has the largest variation for the unemployment rate. The minimum is 3,9% in Q3 of 2019 and the maximum 9,9% in Q1 – 2021. For this cluster, the most representative country is Austria for the entire analyzed period.
- the cluster 1 has a minimum unemployment rate of 5,15% and a maximum of 8,1%. The most representative country is Belgium in most of the quarters.
- the cluster 2 is the most stable one, having values 3,1% and 4%. So, countries that are allocated in this cluster were the least affected during the pandemic period. The most representative country is Czechia.
- the cluster 3 is has a minimum rate of 3,95% and a maximum one of 6,6%, the most representative country being Bulgaria in most of the quarters.

In Figure no. 3 it can be observed the dynamics for each cluster based on the cluster centroid for each period of time.

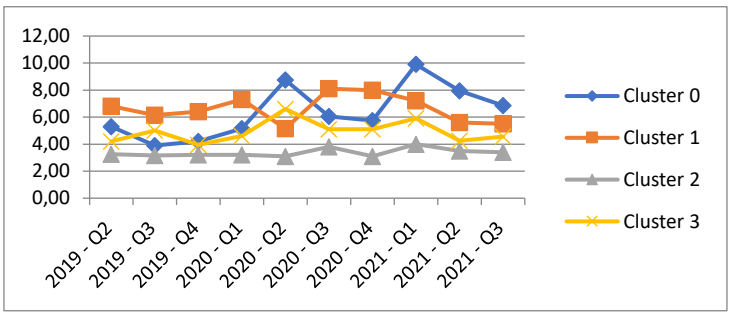

Figure no. 3. Unemployment rates in percent – cluster centroids

Table no. 1. Cluster centroids for unemployment in UE

Year - Q		Clusters			
		0	**1**	**2**	**3**
2019 - Q2	No. of countries within cluster (percent)	5 (19%)	12 (44%)	6 (22%)	4 (15%)
	Country most representative	Austria	Belgium	Czechia	Bulgaria
	Centroid (percent)	5,3	**6,8**	**3,25**	4,2
2019 – Q3	No. of countries within cluster (percent)	4 (15%)	14 (52%)	6 (22%)	3 (11%)
	Country most representative	Austria	Belgium	Bulgaria	Denmark
	Centroid (percent)	3,9	**6,15**	**3,15**	5
2019 – Q4	No. of countries within cluster (percent)	5 (19%)	14 (52%)	6 (22%)	2 (7%)
	Country most representative	Austria	Belgium	Czechia	Romania
	Centroid (percent)	4.2	**6,4**	**3,2**	3,95
2020 – Q1	No. of countries within cluster (percent)	4 (15%)	13 (48%)	6 (22%)	4 (15%)
	Country most representative	Austria	Belgium	Czechia	Bulgaria
	Centroid (percent)	5,15	**7,3**	**3,2**	4,6
2020 – Q2	No. of countries within cluster (percent)	8 (30%)	8 (30%)	4 (15%)	7 (26%)
	Country most representative	Austria	Belgium	Czechia	Bulgaria
	Centroid (percent)	**8,75**	5,15	**3,1**	6,6
2020 – Q3	No. of countries within cluster (percent)	2 (7%)	16 (59%)	6 (22%)	3 (11%)
	Country most representative	Austria	Belgium	Bulgaria	Malta
	Centroid (percent)	6,05	**8,1**	**3,8**	5,1
2020 – Q4	No. of countries within cluster (percent)	4 (15%)	14 (52%)	4 (15%)	5 (19%)
	Country most representative	Austria	Belgium	Czechia	Bulgaria
	Centroid (percent)	5,75	**8**	**3,1**	5,1
2021 – Q1	No. of countries within cluster (percent)	7 (26%)	9 (33%)	5 (19%)	6 (22%)
	Country most representative	Austria	Belgium	Czechia	Bulgaria
	Centroid (percent)	**9,9**	7,2	**4**	5,9
2021 – Q2	No. of countries within cluster (percent)	14 (52%)	5 (19%)	4 (15%)	4 (15%)
	Country most representative	Austria	Belgium	Czechia	Denmark
	Centroid (percent)	**7,95**	5,6	**3,5**	4,25
2021 – Q3	No. of countries within cluster (percent)	14 (52%)	5 (19%)	6 (22%)	2 (7%)
	Country most representative	Austria	Denmark	Czechia	Bulgaria
	Centroid (percent)	**6,85**	5,5	**3,4**	4,55

In the next table (Table no. 2) it was analyzed for each country the cluster to which it belongs for each period of time and a characteristic was marked in the last column. The meaning for the values from the last column is:

- CT (constant cluster variation) – if the cluster was the same for the entire period. In this category are the following countries: Austria, Czechia, Germany, and Poland;
- SV (small cluster variation) - if there are up to 3 different clusters for the entire period. In this category are the following countries: Belgium, Croatia, Cyprus, Finland, France, Greece, Italy, Latvia, Lithuania, Netherlands, Portugal, Slovenia, Spain, Sweden;
- LV (large cluster variation) – if there are up to 4 different clusters for the entire period. In this category are the following countries: Bulgaria, Denmark, Estonia, Hungary, Ireland, Luxemburg, Malta, Romania, and Slovakia.

In Figure no. 4 there is represented the cluster distribution based on the unemployment rate for each country in the first analyzed quarter (Q2 from 2019). In Figure no. 5 there is represented the cluster distribution based on the unemployment rate for each country in the last analyzed quarter (Q3 from 2021).

Table no. 2. Unemployment in UE – cluster dynamics

No	Country	2019 - Q2	2019 - Q3	2019 - Q4	2020 - Q1	2020 - Q2	2020 - Q3	2020 - Q4	2021 - Q1	2021 - Q2	2021 - Q3	Obs
1	Austria	0	0	0	0	0	0	0	0	0	0	**CT**
2	Belgium	1	1	1	1	1	1	1	1	1	0	SV
3	Bulgaria	3	2	0	3	3	2	3	3	1	3	LV
4	Croatia	1	1	1	1	3	1	1	0	0	0	SV
5	Cyprus	1	1	1	1	3	1	1	0	0	0	SV
6	Czechia	2	2	2	2	2	2	2	2	2	2	**CT**
7	Denmark	3	3	0	0	1	0	0	3	3	1	LV
8	Estonia	0	0	0	0	3	1	1	1	0	1	LV
9	Finland	1	1	1	1	0	1	1	1	0	0	SV
10	France	1	1	1	1	3	1	1	1	0	0	SV
11	Germany	2	2	2	2	2	2	2	2	2	2	**CT**
12	Greece	1	1	1	1	0	1	1	0	0	0	SV
13	Hungary	2	2	2	2	1	2	3	2	3	2	LV
14	Ireland	0	3	0	3	1	1	0	1	0	1	LV
15	Italy	1	1	1	1	0	1	1	0	0	0	SV
16	Latvia	1	1	1	1	0	1	1	1	0	0	SV
17	Lithuania	1	1	1	1	0	1	1	1	0	0	SV
18	Luxembourg	0	1	1	1	3	1	0	3	1	1	LV
19	Malta	2	0	2	2	1	3	3	2	2	2	LV
20	Netherlands	2	2	2	2	2	2	2	3	3	2	SV
21	Poland	2	2	2	2	2	2	2	2	2	2	**CT**
22	Portugal	1	1	1	1	1	1	1	1	1	0	SV
23	Romania	3	0	3	3	1	3	3	3	1	1	LV
24	Slovakia	0	1	1	0	3	1	1	1	0	0	LV
25	Slovenia	3	3	3	3	1	3	3	3	3	3	SV
26	Spain	1	1	1	1	0	1	1	0	0	0	SV
27	Sweden	1	1	1	1	0	1	1	0	0	0	SV

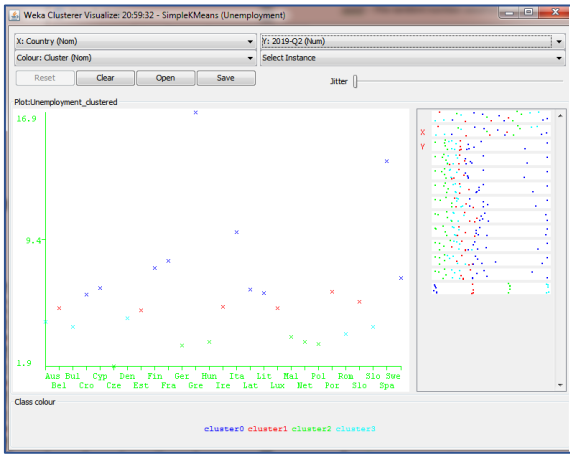

Figure no. 4. Unemployment rate (in percent) in Q2 from 2019

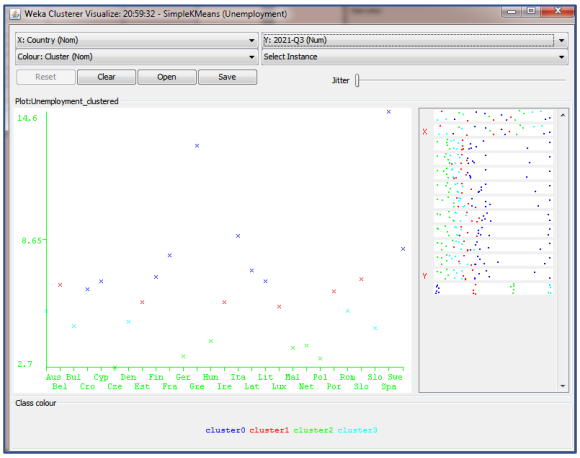

Figure no. 5. Unemployment rate (in percent) in Q3 from 2021

5. Results and discussions

The results of the data mining analysis indicate that the COVID-19 pandemic had a big influence from the unemployment point of view for all the 27 EU countries. However, not all of them have had the same behavior. Based on the policies and strategies that the governments have implemented, some countries have had a large fluctuation (countries as Austria and all of the other countries from luster 0), medium fluctuation (like those countries from cluster 1 and 3) and small fluctuation (like those from cluster 2 where the Czechia is the most representative one).

For the answers regarding the research questions: “How were the dynamics of the unemployment for the countries from EU during the pandemic?” and “Which countries have encountered the biggest cluster fluctuations?” we may conclude the following:

- The dynamics of the unemployment for the countries from EU before and during the pandemic may follow 4 patterns based on the number of the identified clusters. The countries from the cluster 0 have the biggest unemployment rate variation, around 6%, and the smallest variation was 0,9% for the cluster 2.

- For this situation, if a country is in the same cluster for the entire period means that has the same behavior for the entire period (based on the cluster characteristics) and if it is very different means the behavior is quite unpredictable. Countries like Austria, Czechia, Germany, and Poland have the same cluster distribution for the entire period. On the other hand, countries like Belgium, Croatia, Cyprus, Finland, France, Greece, Italy, Latvia, Lithuania, Netherlands, Portugal, Slovenia, Spain, and Sweden have a small cluster variation. Countries like Bulgaria, Denmark, Estonia, Hungary, Ireland, Luxemburg, Malta, Romania, and Slovakia have a large cluster variation.

Conclusions

The present article tries to identify the changes that have occurred for 27 countries from European Union regarding the unemployment during 2019 and 2021 period. In this regard, the authors have tried to find out information about the dynamics of the unemployment for these countries and which countries have encountered the biggest cluster fluctuations. In the first part of the paper a literature review was done regarding the unemployment problem and the effects of the COVID-19 pandemic over the unemployment. In the second part there were highlighted the main causes that are increasing the unemployment. In the third part it was described the research methodology that was used. In the last part the cluster data mining analysis was done emphasizing on the obtained results. Based on them, it can be identified what countries from EU were prepared to deal with such a situation and how much the labor market was affected. The period of time was selected in such a way to comprise a period before the pandemic and another one during the pandemic. Limitation of this paper may be considered that the values for the unemployment rates (which are expressed in percent) are at a country level. In a future research, an analysis of the unemployment components could offer interesting results.

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