Population migration in the year of the Covid-19 pandemic: a case study on Romania

Raluca Elena CRISTIAN[25]
Anda Veronica DAN[26]
Ana Maria Mihaela IORDACHE[27]

Abstract

Population migration, whether it is an internal or an international approach, has always been an issue intensively studied and debated at any decision-making level. In the article we have developed an analysis of the population movement both on the Romanian territory, between counties, and of its relations with the international environment. Thus, by using data mining techniques, clustering and discriminant analysis, we classified the counties in Romania according to the indicators of population migration registered in the databases of the National Institute of Statistics. The results found were quantified in the determination of three classes of counties: the class with intense population migration, the class with moderate migration and the class with low population migration.

Keywords: population, migration, cluster, discriminant analysis, SAS Enterprise Guide, data mining

1. Introduction

Labor migration is treated as a more or less organized movement of a group of people moving to a certain territory of a country. The push and pull model was developed by the World Organization for Migration (IOM), the purpose of creating this model being to highlight the factors of attraction and rejection that underlie the decision of migration behavior between countries around the world. The migration phenomenon that takes place between economically developed countries is a selective process, less intense in duration and importance, as opposed to the migratory axis. This axis comes from poor or developing countries to developed countries. The push-pull model is based on the most important determining factors that underlie the migration phenomenon: economic, social, political, ethical, cultural, religious factors. The Pull model focuses on the existence of five factors of attraction, existing in a destination country that push them and are also the basis of the main economic and social causes of the migration phenomenon, the decision to move to another area or economic region.

The Push model consists of a series of internal factors existing in the country of origin of an emigrant, which determines and influences him to leave for a country of destination. The

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[25] Assistant Teacher, Phd, Romanian-American University, Bucharest
[26] Assistant Teacher, Phd, Romanian-American University, Bucharest
[27] Lecturer, Phd, Romanian-American University, Bucharest

Push - Pull model is considered a more subjective model, which can be applied only on a certain emigrant profile or on a certain type of country. The factors that influence the Push & Pull model have certain peculiarities.

Pull factors that are often considered factors of attraction for migrants in the destination country are: better living conditions, better paid salaries or financial opportunities, increased income of emigrants, positive experience of other people who have emigrated, the pursuit of a beaten path, the advantages of obtaining a better job and possible professional achievements and also a series of economic, political, religious and social facilities.

Push factors are considered in the literature as those internal factors in the country of origin that cause the emigrant to leave: problems of ethnic, social, religious nature in the country of origin of the emigrant, xenophobic or political persecution of some communities. of migrants. Other factors are: natural disasters or natural cataclysms that can be decisive in making a short-term decision, economic factors in the emigrants country of origin, social factors in the emigrants country of origin, declining labor productivity and wages in various fields economic activity, rising unemployment in different areas of activity, areas, regions or localities, lack of investment and infrastructure in different regions or localities, poverty of the population or total lack of income for certain families.

The international migration process is supported by different levels of economic development between different countries of the world. It promotes the creation of new jobs in countries of origin, due to the liberalization of trade and foreign investment, which takes place mainly at national level.

The reason behind the migration act is the main tool that gives the individual or subject involved in the process the opportunity to move to a place. The place or country of destination offers him more opportunities in terms of work, education, training, political and social rights, health. All these elements give people the ability to motivate themselves to emigrate, by increasing their own social, economic and political freedom.[28]

In the literature, there are a number of similarities between external and internal migrations[29]:
  a. the temporary migrations (whether external or internal), which leave in the area of origin: family, relatives, property, friends, they still maintain communication relationships.
  b. emigrations (which take place from an area or a country) and which are based on a series of determinants of a socio-economic and psychological nature of persons, of re-migrants (of those who return to the area, society or country of origin).

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2. Migration in Romania

For Romania, the most important factors that determine Romanians to emigrate are: better living conditions, better paid salaries, the experience of other people (family or strangers) who migrated to other countries, the prerequisites for getting a better job and, better paid, as well as a number of real professional opportunities.

If we refer strictly at Romania, the following Pull type factors can be applied, namely: better living conditions, better salaries, the experience of other people who migrated, the premises for obtaining a better job and real professional opportunities. In the case of Push type factors, social and economic conditions are the main reason for the emigration of many Romanians to countries with a real economic potential.

The main tendency of the Romanian citizen who intends to emigrate to other lands in the last decades is mainly accompanied by a series of social reasons (family reunification, close relatives working abroad). There is a predisposition to emigrate of the inhabitants of Romania from almost any generation of age, regardless of the studies carried out in the country (gymnasium, high school, higher) or of ethnic, religious or cultural ancestry. The answers would be that most Romanians emigrate abroad for money or higher incomes, due to the lack of a stable job, to ensure a decent living for his family, due to poverty in the country or in certain areas, the austere measures taken by to governors or for investments in human capital (of children or close relatives).

Migration leads to the imbalance of the labor market, by creating a surplus of labor supply in certain regions of the host country and also leads to the creation of a labor shortage in certain sectors and areas of the emigrants' country of origin.

Migrants, regardless of the destination country chosen, are trying to improve their quality of life and opportunities, especially the income level of their families. Many of the emigrants in the destination country are forced to bear various psychological costs or various discriminatory treatments related to pay that are below the level of training and professional capacity.

In order to reduce production costs and to have the effect of increasing labor productivity at regional or national level, it is ideal for an investor or producer to use labor as cheaply as possible. To achieve this goal in the medium and long term, the most effective means is the use of foreign emigrants from poor countries.

In the long run, Romania has to gain if the arrived immigrants have a clearly higher level of education and training or at least similar in different fields of activity to that of the local active employed population.

The labor market is influenced by the discrepancy in different sectors on the level of wages in different fields of activity, and these generate over time a series of social tensions (for example in the form of strikes) between the local labor force and immigrants.

3. The methodology used in the application

In this research article we want to make an analysis of population movement, in terms of domestic and international migration, for 2020, the year that coincided with the onset of the Covid-19 pandemic. Thus, we will analyze the population movement in each county in Romania.

The methodology for conducting this study is as follows:

Step 1. Choosing and defining indicators

Step 2. Classification of Romanian counties according to the indicators under analysis using SAS Enterprise Guide

Step 3. Improve the classification made in the previous step using discriminant analysis

Step 4. Identify and briefly characterize the identified classes.

4. Choosing and defining indicators

The values of the indicators regarding the migration of the Romanian population were taken from the website of the National Institute of Statistics (NIS), Tempo database, for 2020. Thus, eight indicators were chosen which, in our opinion, most accurately describe the migration to domestic and international level of the population in each county of Romania (table 1).

Table 1. The indicators used in the application

No.	Index code	Description of the indicator
1	I1	Number of foreign immigrants from Romania with temporary status
2	I2	Number of temporary emigrants by counties
3	I3	Number of permanent immigrants by destination counties
4	I4	Number of permanent emigrants by counties
5	I5	Number of people left with domicile (international migration) by counties
6	I6	Number of persons established with domicile (international migration) by counties
7	I7	Number of people who moved their residence, by counties
8	I8	Number of persons established by residence by counties

Temporary immigrants (I1) are persons who settle in Romania for a maximum period of 12 months. The data provided are obtained from two administrative sources: the General Inspectorate for Immigration and the Directorate for the Registration of Persons and the Administration of Databases, the General Directorate for Passports.

Temporary migrants (I2) are people who emigrate to another country for a period of at least 12 months. The residence of an emigrant person is the place or space where that person spends most of their rest time, without taking into account temporary absences for holidays or visits to friends or family.

Official statistics for labor migration records are obtained in accordance with the provisions of Regulation (EC) No 862/2007 of the European Parliament. Some of the data provided also comes from the national statistical offices in Italy, Spain, the United Kingdom or from the Inspectorate General for Immigration.

The I3 indicator is represented by people who immigrate permanently, not temporarily to Romania, this implying the change of domicile or citizenship, the acquisition of Romanian citizenship.

I4 refers to persons of Romanian citizenship who emigrate abroad and change or establish their domicile on the territory of another state.

Indicator I5 represents the total number of departures of persons with domicile, respectively those who leave a locality and prove that they have provided housing or residence in another locality.

Indicator I6 refers to the total number of persons established with domicile who have arrived in a locality and can prove that their home is insured in that locality.

I7 is composed of persons who have resided in a locality other than their domicile, who, starting with January 1 or July 1, have entered in the identity document and in the population records the mention of establishing the residence.

I8 is represented by persons arriving in a locality other than the one of domicile, who from January 1 or July 1 is in the record of the population with the mention of the establishment of the residence.

5. Classification of counties using cluster analysis

Further in our scientific approach we will continue with the classification of counties using cluster analysis. Each indicator is expressed in number of persons, and their initial data are presented in table 2.

Table 2. Initial data of the indicators

County	I1	I2	I3	I4	I5	I6	I7	I8
Alba	2893	5485	5298	4662	5523	267	77	3292
Arad	3511	6114	5381	7738	7467	557	124	4172
Arges	4832	5240	8169	9333	11059	348	105	5726
Bacau	4876	4721	6251	10320	11978	782	654	5895
Bihor	4694	14222	12891	10149	9761	282	119	5512
Bistrita-Nasaud	2310	2796	3375	3920	4527	281	92	2779
Botosani	3045	3474	4935	8130	7827	366	2397	3913
Braila	2419	1291	2146	3239	4832	344	57	2996
Brasov	4626	7492	6316	11761	9742	722	398	5155
Buzau	3512	5031	5137	6843	8379	274	83	4388
Calarasi	2453	3918	3732	4561	5911	215	52	3065
Caras-Severin	2592	6681	6019	4429	5702	485	99	2953
Cluj	5890	15146	11345	16964	12444	536	353	6559
Constanta	6400	5603	5772	13020	13625	727	211	6771
Covasna	1782	2279	2323	2204	2551	60	34	2081
Dambovita	4027	4456	4091	8077	9030	381	263	5027
Dolj	5798	10534	11366	10973	11737	410	102	6503
Galati	4335	2801	4753	11705	9809	860	4396	5107
Giurgiu	2167	6112	4173	4040	4727	144	75	2818
Gorj	2946	5418	7083	5897	7544	140	44	3276
Harghita	2726	3156	3234	2903	3365	81	47	3119
Hunedoara	3253	6935	7947	5862	7743	497	128	3835
Ialomita	2361	3212	2566	3903	5105	160	59	2786
Iasi	6210	12118	8396	25182	19615	1831	5683	7307
Ilfov	3353	12620	7282	23588	9546	278	379	3836
Maramures	4176	5492	6822	5812	6631	393	171	4665
Mehedinti	2208	10736	9734	4505	5441	144	47	2585
Bucuresti	13641	27499	33396	59033	47982	3260	8687	16162
Mures	4699	6076	5443	8450	9054	355	142	5441
Neamt	3967	3405	4993	7540	8735	559	632	4694
Olt	3622	9338	8221	6484	8292	235	89	4287
Prahova	6202	8395	8165	10738	12398	499	150	7341
Salaj	1725	4533	4344	3037	3618	130	33	2133
Satu Mare	2949	3524	3438	5144	5571	284	118	3403
Sibiu	3271	5669	5089	8394	7378	602	183	3744
Suceava	4994	3739	5711	10847	10887	569	1351	6078

Teleorman	2980	6750	5233	5373	7502	333	120	3777
Timis	5872	11987	11057	19336	16596	1078	400	6608
Tulcea	1844	2329	2397	3524	4604	246	52	2115
Valcea	2894	6515	6168	6323	7614	185	62	3526
Vaslui	3035	3133	5000	10014	9969	869	3841	3817
Vrancea	2716	2986	3769	5862	6779	262	141	3384

A first step in cluster analysis is to determine for the data series certain specific indicators such as mean, standard deviation, skewness, kurtosis and bimodality. By analyzing these indicators, it is possible to identify whether or not the distribution of each indicator is close to the normal distribution, how large the vault is and whether their distributions have longer or shorter tails (table 3).

Table 3. Descriptive statistics for indicators

Index	Mean	Std. Dev.	Skewness	Kurtosis	Bimodality
I1	3900.1	2030.1	2.8367	12.1595	0.5877
I2	6641.9	4732.4	2.4214	8.276	0.5963
I3	6641.9	4956.9	4.0338	20.964	0.7138
I4	9519.5	9386.4	3.9194	19.097	0.7327
I5	9252.4	7044.1	4.2753	22.8283	0.7397
I6	500	541.3	3.7323	16.9757	0.7388
I7	767.9	1756.3	3.2499	10.9904	0.8129
I8	4586.5	2347.5	3.0417	13.8207	0.6012

The eigenvalues of the covariance matrix provide information about the amount of information brought by each of them and, implicitly, how many indicators will be retained further in the analysis (table 4). In this case, all the indicators in the analysis will be retained, even if the informational contribution brought by each of them has relatively low values.

Table 4. Eigenvalues of the covariance matrix

	Eigenvalue	Difference	Proportion	Cumulative
1	183101740	174513477	0.9262	0.9262
2	8588263	4770760	0.0434	0.9696
3	3817503	2577056	0.0193	0.9889
4	1240447	663940	0.0063	0.9952
5	576507	229868	0.0029	0.9981
6	346639	326784	0.0018	0.9999
7	19855	11039	0.0001	1

8	8816		0	1

The chosen classification method is Wards method which aims to minimize the sum of squares of errors, by calculating the Wards distance. Thus, depending on the minimum distance from the centroids of the future clusters, the future groups can be built, resulting in the dendrogram (figure 1). Furthermore, depending on the place of its sectioning, the classes will result. Thus, if the dendrogram is cut above the value 0.2 of the Oy axis, then there will be two inhomogeneous classes: one consisting of a single element and another composed of all the other elements. If, on the other hand, the cut will be around 0.1 of the Oy axes, then three rather inhomogeneous classes will result. If, instead, it is sectioned at a level closer to 0.05, then there will be four classes, three of them will be very well defined, homogeneous, with similar elements and another formed from a single element called outlier. Further in the analysis, the outlier (Bucharest) will be brought to the nearest class.
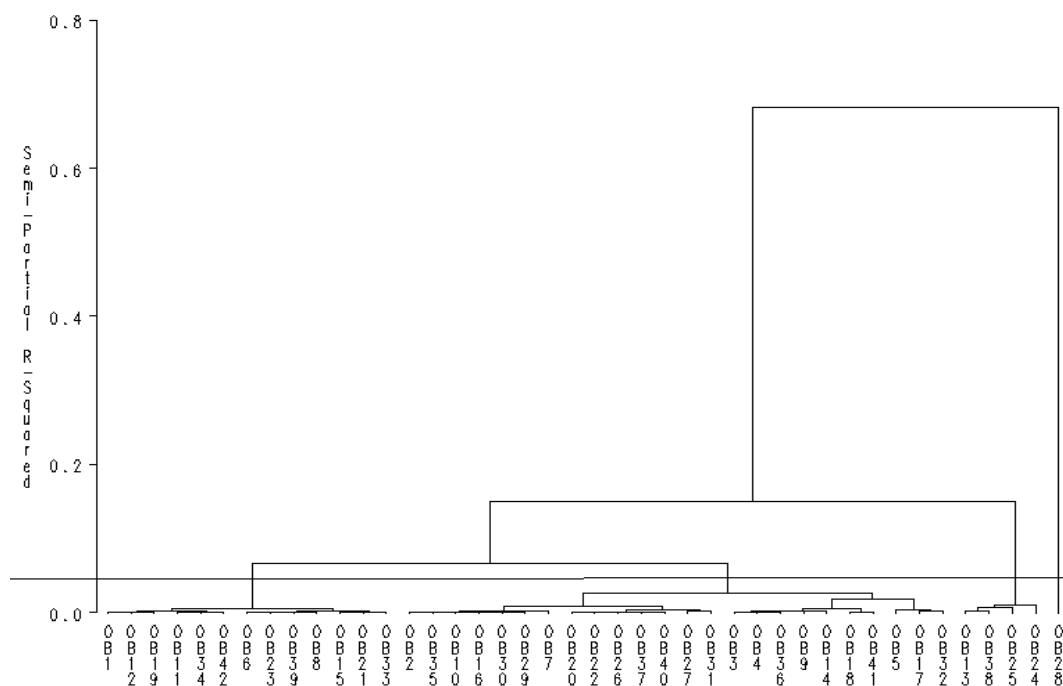

Figure 1. The dendrogram results from the cluster method

From the dendrogram (figure 1) results three classes and an outlier (Bucharest):

  - class 1: Alba, Bistrita-Nasaud, Braila, Calarasi, Caras-Severin, Covasna, Giurgiu, Harghita, Ialomita, Salaj, Satu Mare, Tulcea, Vrancea

- class 2: Arad, Arges, Bacau, Bihor, Botosani, Brasov, Buzau, Constanta, Dambovita, Dolj, Galati, Gorj, Hunedoara, Maramures, Mehedinti, Mures, Neamt, Olt, Prahova, Sibiu, Suceava, Teleorman, Valcea, Vaslui

- class 3: Cluj, Iasi, Ilfov, Bucuresti, Timis.

6. Classification of counties using discriminant analysis

Discrimination analysis involves finding a determining space and the equations of discrimination rights. The discrimination equations are of linear type, having general forms such as equations (1) and (2):

$$Sk1_i = \sum_{j=1}^{8} Ij_i * Ck1_j + ak1, \forall i = \overline{1,42}, k = 1,2,3 \tag{1}$$

$$Sk0_i = \sum_{j=1}^{8} Ij_i * Ck0_j + ak0, \forall i = \overline{1,42}, k = 1,2,3 \tag{2}$$

where:

- $Sk1_i$ represents the probability of the county and (the score) to be in the class k;

- $Sk0_i$ represents the probability of the county and (the score) of not being in the class k;

- Ij_i represents the value of the indicator Ij for the county i, j=1...8;

- $Ck1_j$ represents the function coefficients that calculate the probability of belonging to a county to class k (k = 1,2,3) results from SAS Enterprise Guide Software;

- $Ck0_j$ represents the function coefficients that calculate the probability that a county does not belong to class k (k = 1,2,3) results from SAS Enterprise Guide Software;

- ak1 and ak0 are constants related to linear functions that calculate probabilities;

- i represents the county order number.

Based on the application of general equations (1) and (2) of the discrimination model for class 1, the relations (3) and (4) resulted. These relationships will further help calculate the probabilities of a county belonging to class 1.

$$S10_i = -5.89 * 10^{-3} * I1 + 1.2 * 10^{-3} * I2 - 0.85 * e^{-6} * I3 - 0.45 * 10^{-3} * I4 - 0.98 * 10^{-3} * I5 - 1.51 * 10^{-3} * I6 + 0.6 * 10^{-3} * I7 + 10.75 * 10^{-3} * I8 - 8.33, \forall i = \overline{1,42}$$ (3)

$$S11_i = -6.27 * 10^{-3} * I + 0.83 * 10^{-3} * I2 - 0.6 * 10^{-3} * I3 - 0.4 * 10^{-3} * I4 - 0.8 * 10^{-3} * I5 + 0.9 * 10^{-3} * I6 + 0.05 * 10^{-3} * I7 + 9.4 * 10^{-3} * I8 - 3.85, \forall i = \overline{1,42}$$ (4)

The application of the discriminant analysis for the affiliation of each county to class 2 was performed with equations (5) and (6).

$$S20_i = -6.28 * 10^{-3} * I1 + 0.82 * 10^{-3} * I2 - 0.6 * 10^{-3} * I3 - 0.4 * 10^{-3} * I4 - 0.8 * 10^{-3} * I5 + 1.04 * 10^{-3} * I6 + 0.04 * 10^{-3} * I7 + 9.37 * 10^{-3} * I8 - 4.28, \forall i = \overline{1,42}$$ (5)

$$S21_i = -6.58 * 10^{-3} * I1 + 0.75 * 10^{-3} * I2 - 0.03 * 10^{-3} * I3 - 0.68 * 10^{-3} * I4 - 0.95 * 10^{-3} * I5 - 1.54 * 10^{-3} * I6 + 0.63 * 10^{-3} * I7 + 11.35 * 10^{-3} * I8 - 7.47, \forall i = \overline{1,42}$$ (6)

For the last class the same algorithm was applied, the functions after which the probability of belonging to a county to class 3 was calculated are represented by equations (7) and (8).

$$S30_i = -6.11 * 10^{-3} * I1 + 0.92 * 10^{-3} * I2 - 0.67 * 10^{-3} * I3 - 0.2 * 10^{-3} * I4 - 0.8 * 10^{-3} * I5 + 1.19 * 10^{-3} * I6 - 6.52 * e^{-6} * I7 + 9.12 * 10^{-3} * I8 - 4.87, \forall i = \overline{1,42}$$ (7)

$$S31_i = -0.38 * 10^{-3} * I1 + 4.43 * 10^{-3} * I2 - 4.44 * 10^{-3} * I3 + 1.95 * 10^{-3} * I4 - 0.82 * 10^{-3} * I5 + 5.56 * 10^{-3} * I6 - 1.16 * 10^{-3} * I7 + 1.41 * 10^{-3} * I8 - 29.38, \forall i = \overline{1,42}$$ (8)

Table 4. Resubstituting and cross validation results for every county

No	County	Resubstituting Results			Cross Validation Results		
		Class 1 (%)	Class 2 (%)	Class 3 (%)	Class 1 (%)	Class 2 (%)	Class 3 (%)
1	Alba	60.74	50.64	0	57.84	53.74	0

2	Arad	53.38	39.04	0	61.92	29.48	0
3	Arges	24.93	90.58	0	29.88	89.89	0
4	Bacau	33.85	74.11	0	41.28	68.76	0
5	Bihor	4.61	89.64	0	3.92	87.72	0
6	Bistrita-Nasaud	82.85	35.48	0	81.10	39.20	0
7	Botosani	46.47	72.38	0	59.53	64.68	0
8	Braila	83.31	42.30	0	80.12	49.59	0
9	Brasov	30.72	33.91	0.19	36.42	23.20	0.95
10	Buzau	39.15	70.71	0	44.55	66.81	0
11	Calarasi	72.78	41.27	0	69.75	45.21	0
12	Caras-Severin	78.72	26.59	0	69.84	34.20	0
13	Cluj	1.74	60.55	99.99	1	86.59	68.61
14	Constanta	9.76	72.07	0	14.07	21.76	99.98
15	Covasna	83.07	35.72	0	81.37	39.43	0
16	Dambovita	23.46	76.71	0	28.34	71.79	0
17	Dolj	4.23	94.76	0	3.86	94.95	0
18	Galati	22.37	80.73	0	42.28	64.35	0
19	Giurgiu	57.61	42.62	0	45.92	50.91	0
20	Gorj	75.57	47.53	0	92.66	25.26	0
21	Harghita	50.53	70.86	0	41.16	79.01	0
22	Hunedoara	69.33	51.76	0	78.34	43.33	0
23	Ialomita	72.81	36.56	0	67.87	41.64	0
24	Iasi	6.82	8.88	100	5.88	30.37	100
25	Ilfov	47.14	0.31	100	100	0	100
26	Maramures	28.59	86.02	0	37.38	83.40	0
27	Mehedinti	65.81	39.66	0	85.99	17.77	0
28	Bucuresti	0.25	30.69	100	0	100	100
29	Mures	10.31	85.78	0	10.92	84.71	0
30	Neamt	51.41	68.03	0	55.65	65.37	0
31	Olt	23.06	75.13	0	26.86	70.84	0
32	Prahova	1.43	97.85	0	0.79	98.56	0
33	Salaj	84.84	29.18	0	83.42	32.03	0
34	Satu Mare	63.09	46.66	0	61.37	48.69	0
35	Sibiu	73.34	17.92	0	82.41	9.52	0
36	Suceava	14.14	90.95	0	16.36	90.26	0
37	Teleorman	45.42	55.01	0	55.79	44.32	0
38	Timis	31.71	11.54	99.76	43.84	15.20	3.75
39	Tulcea	92.09	15.14	0	90.61	17.65	0

40	Valcea	57.73	48.16	0	65.95	40	0
41	Vaslui	75.52	36.75	0	90.41	18.41	0
42	Vrancea	75.88	41.47	0	72.13	46.85	0

After an overall analysis of the results obtained from the discriminant analysis and taking into account both the maximum probability of belonging a county to a class and the probability of validating the results (table 4), the final classification of counties is as follows:

- class 1: Alba, Arad, Bistrita-Nasaud, Braila, Calarasi, Caras-Severin, Covasna, Giurgiu, Gorj, Hunedoara, Ialomita, Mehedinti, Salaj, Satu Mare, Sibiu, Tulcea, Valcea, Vaslui, Vrancea;

- class 2: Arges, Bacau, Bihor, Botosani, Brasov, Buzau, Constanta, Dambovita, Dolj, Galati, Harghita, Maramures, Mures, Neamt, Olt, Prahova, Suceava, Teleorman;

- class 3: Timis, Bucuresti, Iasi, Ilfov, Cluj.

Class 1 is characterized by intense migration of the population, both domestically and internationally. The second class contains counties in which the population movement is at a moderate level, and in the third class the population movement is at a minimum level.

The causes of migration can be various: from economic to social and political. People leave an area, either because they are looking for development opportunities and a better socio-economic level, or because they take refuge in another area due to calamities or disasters: wars, religious or even political persecution. Migration can be explained from a macroeconomic point of view, as a way of balancing some deficiencies resulting from the labor market, as a result of a gap between labor demand and supply.[30]

7. Conclusion

The changes produced by domestic and international migratory movements are presented at the level of economic, political, social, cultural and religious life for each country involved in the process. They manifest themselves both in the place of origin, from where the potential emigrants must leave, and in the place of destination, where, in the end, they settle. The migration exodus knows and presents important repercussions (especially negative) on the labor market, but also on unemployment and social protection policies in the countries of destination of emigrants. For many countries, external migration is an important factor in reducing the supply of domestic labor, both quantitatively and qualitatively. The short-term consequences of this are not long in coming; this is observed by a decrease in the unemployment rate or a lack of labor force in a certain area or region.

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To improve the study conducted in this research paper, the authors recommend refining the classification using advanced techniques of pattern recognition or artificial intelligence, such as genetic algorithms or neural networks. If we follow the approach of artificial intelligence, we can train a neural network with three layers: the first layer (input) will contain indicators, the second layer will contain a number of neurons determined experimentally, and the output layer will contain three neurons, one for each class.

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