“The data science tools for research of emigration processes in Ukraine”

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THE DATA SCIENCE TOOLS FOR RESEARCH OF EMIGRATION PROCESSES IN UKRAINE

Abstract

The process of world globalization, labor, and academic mobility, the visa-free regime with the EU countries have caused a significant revival of migration processes in Ukraine. However, there is still the research gap in the most informative, and, at the same time, accurate method of the assessment and forecasting of the migration flows. Thus, the object of research is migration processes (mostly emphasizing the emigration flows). The motives, causes of emigration processes, and their relationship with the economic state were analyzed. The impact factors of external labor migration on the economy of the host countries were revealed, particularly the negative and positive impacts of emigration on the socio-economic situation in Ukraine and the migration attitude of Ukrainians were assessed.

The main result of study is further development of the econometric model for forecasting the number of emigrants from Ukraine to other countries in the nearest future. The model considers the factors of minimum wage lavel in Ukraine, the number of open vacancies in the countries of Eastern Europe, and the level of competition for jobs. According to the results of forecasting based on Maple computer algebra system and Microsoft Power BI analytical platform, by the end of 2019, the number of emigrants from Ukraine supposed to be the largest in the last four years and to reach the estimates in the range from 2,444 to 2,550 million people, which may indicate a new third wave of emigration processes.

Keywords migration, forecasting, Maple, Microsoft Power BI, regression

JEL Classification C53, C89, F22, J11, J61

INTRODUCTION

In contemporary conditions of socio-economic relations in Ukraine, the issue of migration is becoming more and more acute. Emigration is one of the most painful issues during the development of independent Ukraine. Each of the waves absorbs a certain part of the young, talented, and promising population of the country. Today's scale of migration is influenced not only by world globalization, but also by the internal situation. For Ukraine, unresolved problems with the labor market, increase in unemployment, low living standards, annexation of the Crimea, and deployment of hostilities in the Donbas region are claimed as the main reasons to push inhabitants out of the state in search of the better life. The latter is a direct catalyst for an increase in the outflow of population from the country – young people and migrant workers. Today, on the European labor market, Ukraine is, as a rule, an exporter of workforce. Usually, highly skilled professionals are migrating, but only a small percentage of them are guaranteed with the employment and appropriate labor standards. Thus, research in the field of migration and its consequences in Ukraine is very relevant, especially for higlighting the prospects of such human loss for the country.

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The article aims to analyze the dynamics of external migration depending on the socio-economic situation and to study the prospects of emigration of the Ukrainians using modern tools of business analytics. The structure of the paper is divided into 4 sections: discussing the theoretic background of the issue in the literature review (section 1), analyzing the main tendencies (section 2) and causes of the migration (section 3), particularly in Ukraine, highlighting the methodology in section 4, modeling and forecasting the main migration tendencies (sections 5 and 6), and finalizing with conclusion and discussion.

1. LITERATURE REVIEW

Hundreds of millions of people leave their homes and travel thousands of kilometers in search of a better life. The migration plays an important role in the development of society and has become a global process that has covered virtually all continents and countries, as well as different strata of the population. A comprehensive numerical analysis of world tourist flows proves that the total number of international migrants is steadily increasing (A. Roskladka, N. Roskladka, Dluhopolskyi, Kharlamova, & Kiziloglu, 2018).

By official definition, "migration" is any, regardless of duration, frequency, and destination, territorial movement from one place of residence to another (State Migration Service of Ukraine, 2019). In 2019, the UN reported that the total number of international migrants in the world is 272 million people, which is approximately 3.5% of the total population. By 2050, the number of international migrants can rise to 405 million people (United Nations, 2019).

According to the State Border Guard Service of Ukraine (2019), today, more than ten million Ukrainians live outside the country, and each year, this number is increasing.

The research of migration processes in Ukraine is a subject of study for many scholars (i.e., Mostovaya & Rakhmanin, 2017; Sociological group "Rating," 2017; Dmytruk & Chudaieva, 2018, etc). Undoubtedly, the main reason for the outflow from Ukraine is the low salary level (Mostovaia & Rakhmanin, 2018). The salary of a Ukrainian is twice less than the average salary in Russia and ten times less than in the developed countries of Europe (Eurostat, 2019). According to the research, Ukrainian migrants are usually well educated and fluent in foreign languages. They call the search for better living conditions the main reason for migration (Dmytruk & Chudaieva, 2018).

The labor migration occupies a special place in the overall emigration flows (Fisher, 2014; Libanova, 2018). Fisher (2014) notes that migration of the workforce is a process of organized or spontaneous displacement of able-bodied population from one country to another within the international labor market for more than a year due to the nature of the development of productive forces and industrial relations, and the effect of economic laws.

It is worth adding that migration is an important part of the national and economic security of the state, influencing the level of trade, production and development of the neighboring countries. During the last years, the technological processes created the conditions for full automatization of production, which led to the so-called Industry 4.0 with a relatively low human presence. Instead, people play an important role in providing services, new technologies, and creative industries (Stavytskyy, Kharlamova, Giedraitis, & Sengul, 2019). Such processes lead to increased inequality in incomes and, therefore, for social aggressiveness. The competence for human capital became a vital issue in the globalization process, stimulating more possibilities for higher incomes for more active part of the population. Beyond doubt, it creates more possibilities for dissimilating new goods, services, trade routes. On the one hand, in the short run, such a situation has to sufficiently increase the developing migration from countries to richer ones. On the other hand, in the long run, it should either equalize the standards of living in the countries or destroy the poorest ones. Stavytskyy et al. (2019) have shown that European countries lean to follow the first scenario and will try to build high-income equally distributed society.

As it was shown earlier, for Ukraine, migration processes play an important and sometimes a crucial role in the state's livelihood. The country has relatively high parameters in human capital, opened borders, which cause mass migration for neighboring countries. Many people work nowadays in Poland, Czech Republic, Slovakia, Germany, Russia, providing the substantial payments (remittances) to Ukrainian relatives. According to the National Bank of Ukraine (2019), the volume of remittances reaches USD 12,2 billion or about 11% of Ukrainian GDP. It is absolutely clear that such value creates not only more possibilities for development, but also some risks for the economy in the case of problems with migrants. Therefore, the outflow of Ukrainians abroad is a crucial problem that needs to be addressed immediately. To make effective management decisions, it is necessary to know the tendency in the number of migrants and to quantify their number for the near future.

The most common indicator characterizing the migration processes is the migration balance – the difference between immigration to the country and emigration beyond its borders. Having a glance at the trends of labor migration, there is a dependence on typical phenomena such as economic cycles, investment flows, employment status, etc. Depending on the duration of the transfer, international labor migration is divided into permanent migration (the exit (entry) of the population to another country for permanent residence), temporary migration (work abroad for a limited time, with the subsequent return to the homeland or moving to another country), seasonal migration (annual migration for the period of a certain season with subsequent return to the homeland), pendulum migration (a permanent job in one country while residing in another, in the presence of necessary international agreements between countries) (Fisher, 2014). The defining criterion that allows migration to be isolated from other movements of citizens across borders is motivation. The motivation is the reason that induces an economic entity to work to achieve a certain goal, the presence of interest in this activity, and how to implement it (Deckers, 2018). It includes such motives:

- political (escape from political persecution, racial, national discrimination, etc.);
- military (evacuation, re-evacuation, etc.);
- economic (job search, higher income, etc.);
- social (marriage, recreation, health, etc.);
- environmental disasters (mass contamination in one form or another of the environment, droughts, floods, etc.), etc.

Thus, the main reasons for the existence of international labor migration are:

a) for the donor country – high population density, mass unemployment, low standard of living and wages, production need (for specialists working in underdeveloped countries);

b) for the recipient country – the need for additional labor, mostly highly skilled or inverse – cheap labor (Fisher, 2014).

According to the scientific publications (Roskladka et al., 2018; Mostovaya & Rakhmanin, 2017; Sociological group "Rating," 2017; Dmytruk & Chudaieva, 2018, etc.), it is possible to conditionally divide all migration factors into "factors of attraction" and "factors of repulsion," which, in its turn, are conditionally divided into five groups: economic, social, cultural, political and ecological (Table 1).

Table 1. Key factors of migration processes

Source: Built by the authors based on Mostovaya and Rakhmanin (2017), Dmytruk and Chudaieva (2018).

Factors of attraction	Factors of repulsion
Economical	
Low wages	High salary
Low quality of life	High quality of life
High unemployment	Availability of vacancies
Economic instability	Stable economic development
Aggravating tax system	Liberal tax system
Social	
Low-quality education	High-quality education
Bad working conditions	Good working conditions
Inaccessible healthcare system	A high-quality healthcare system is available
Lack of opportunities for professional self-realization	Availability of opportunities for professional self-realization
Cultural	
Religious persecution	Freedom of religion
Ethnic discrimination	Lack of ethnic discrimination
Racism	Lack of racial discrimination

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Table 1 (cont.). Key factors of migration processes

Factors of attraction	Factors of repulsion
Political	
Lack of democracy	Developed democracy
Political instability	Stability of the political system
Corruption of power structures	No corruption
Ecological	
Polluted environment	Good ecological situation
Low-quality drinking water and food	Clean drinking water and eco-friendly food

The great challenge for Ukraine is that officials are not fully aware of the exact number of Ukrainians who went abroad. V. Voskoboynyk, Chairman of the All-Ukrainian Association of International Employment Companies, claims that there is such a situation that people who go to work abroad are not removed from the state register and are not registered in the recipient state. Therefore, ten million migrants from Ukraine is a completely realistic number (Eurostat, 2019). This number covers both labor migrants and entrepreneurs who develop their business abroad, as well as students studying outside Ukraine. The State Statistics Service of Ukraine (2019) traditionally underestimates the migration since migrant workers are considered only as those who are abroad less than one year (others do not meet the criteria of a permanent resident of the country of origin and are considered to be emigrants). According to the State Statistics Service of Ukraine, during 2005–2008, over 1.1 million people worked abroad at the same time, 1.2 million during 2010–2012, 1.3 million during 2015–2017. The vast majority of other sources of information do not impose such restrictions; therefore, the results of their research give higher estimates.

Since the independence of Ukraine, there have been two waves of labor migration. The first one took place in 2009–2010, when the global economic crisis undermined the financial well-being of Ukrainians. The next wave of migration began after the annexation of the Crimea and hostilities in the Donbas (2015–2016). However, the main factor driving Ukrainians to go abroad (both for earnings and for permanent residence) is the difference in wages. According to a Eurostat report (Eurostat, 2019), the average salary in Ukraine was around €250 in 2018, in Russia – €500, and in the EU, it exceeded €1,500. In particular, in Poland – €750, in the Czech Republic – €870, in Italy – €1,760, in Germany – €2,300, in Ireland – €2,500 (Figure 1).

The generalized welfare criterion of the population is the so-called "Ranking of happiness," which takes into account not only objective measurement characteristics, but also the level of satisfaction of the population in their country. The components of the happiness index are:

- freedom to make life choices;
- healthy life expectancy;
- perceptions of corruption;
- GDP per capita;
- social support;
- generosity.

Figure 2 shows the numerical values of the ranking of happiness for some European countries

Source: Built by the authors based on Eurostat data (2019).

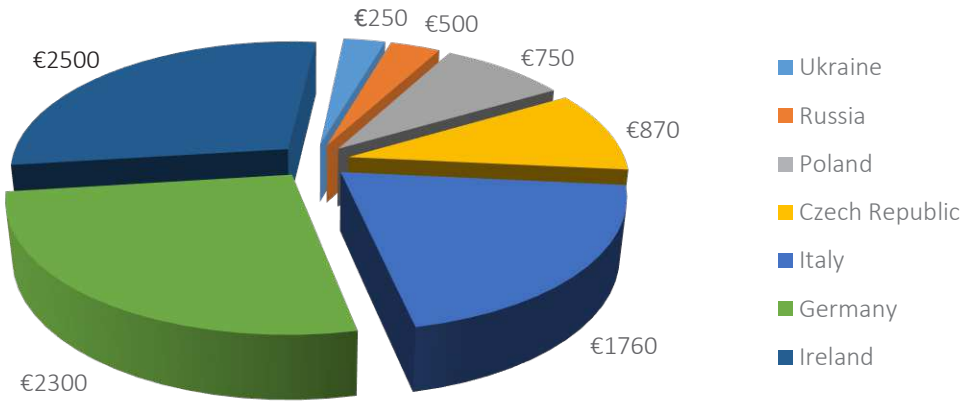
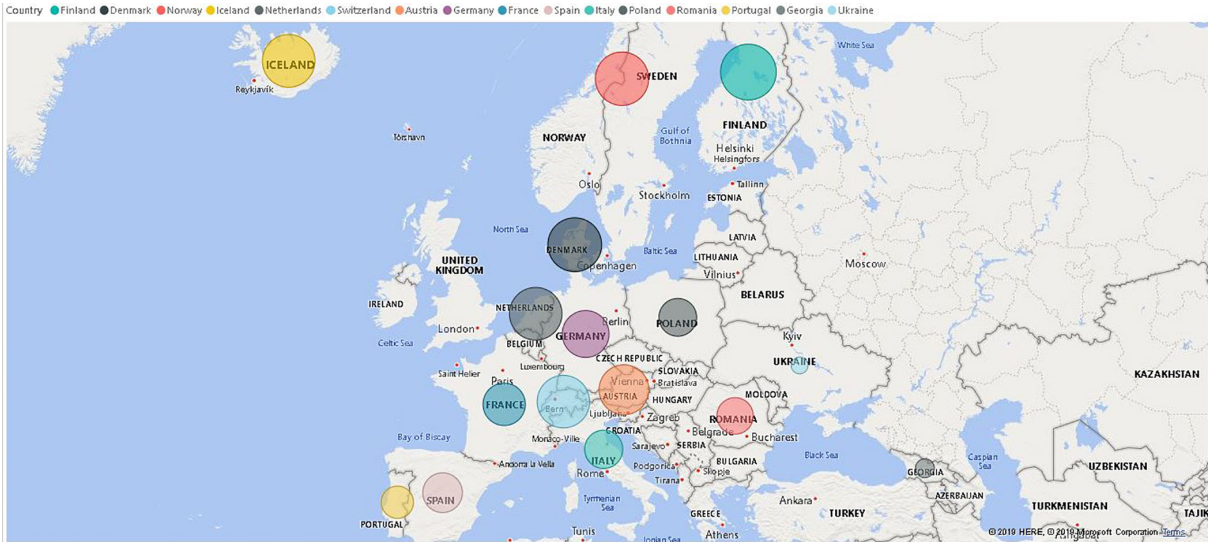


Figure 1. Average salaries in some European countries

Source: Authors.



Country	Ranking of happiness	Country	Ranking of happiness	Country	Ranking of happiness	Country	Ranking of happiness
Finland	7.769	The Netherlands	7.488	France	6.592	Romania	6.070
Denmark	7.600	Switzerland	7.480	Spain	6.354	Portugal	5.693
Norway	7.554	Austria	7.246	Italy	6.223	Georgia	4.519
Iceland	7.494	Germany	6.985	Poland	6.182	Ukraine	4.332

Figure 2. Visualization of the values of the ranking of happiness among some European countries

and visualization of the distribution of this ranking, performed by the Microsoft Power BI system (Powell, 2017).

So, Poland is the most favorable country for the legal employment of Ukrainian citizens. In particular, the promotion of migration appears in the liberalization of legislation. This was accompanied by the acquisition of a visa-free status, and, therefore, the possibility, firstly, completely legally to be in European countries for three consecutive months, looking for a decent job. In conjunction with the radical simplification of Poland, the procedure for obtaining a so-called working visa by Ukrainians and a lack of a language barrier (at least in oral communication) naturally caused an increase in the flow of labor migrants from Ukraine to Poland. It is necessary to add very active encouragement of the study migration of Ukrainian youth to professional educational institutions of most Eastern European countries – special programs are opened, grants and scholarships are given, special language courses are being prepared (Libanova, 2018).

In assessing the consequences of labor migration for Ukraine, the most important component is the intention to return and its implementation. If the temporary migration has both positive and negative consequences, then leaving Ukraine forever is an almost exclusively negative one. And in this context, it is very optimistic that 65% of potential labor migrants want to return to Ukraine even if they have a permanent job abroad. Undoubtedly, intentions may change, but the opinion of that 23% who would not want to return is also not necessarily implemented. Considering that 41% of Ukrainian labor migrants in 2015–2018 are younger than 35 and only 20% are older than 50, the negative consequences of a large-scale outflow of the economically active population will be inevitable (Libanova, 2018). Hence, according to the information of the HeadHunter Ukraine personnel portal, 92% of Ukrainian citizens would like to work in other countries. At the same time, 37% consider work abroad as a chance to make money or stay there. The overwhelming majority believes that work in another country is paid much better than the same in Ukraine. At the same time, only one-third of those polled know what they say,

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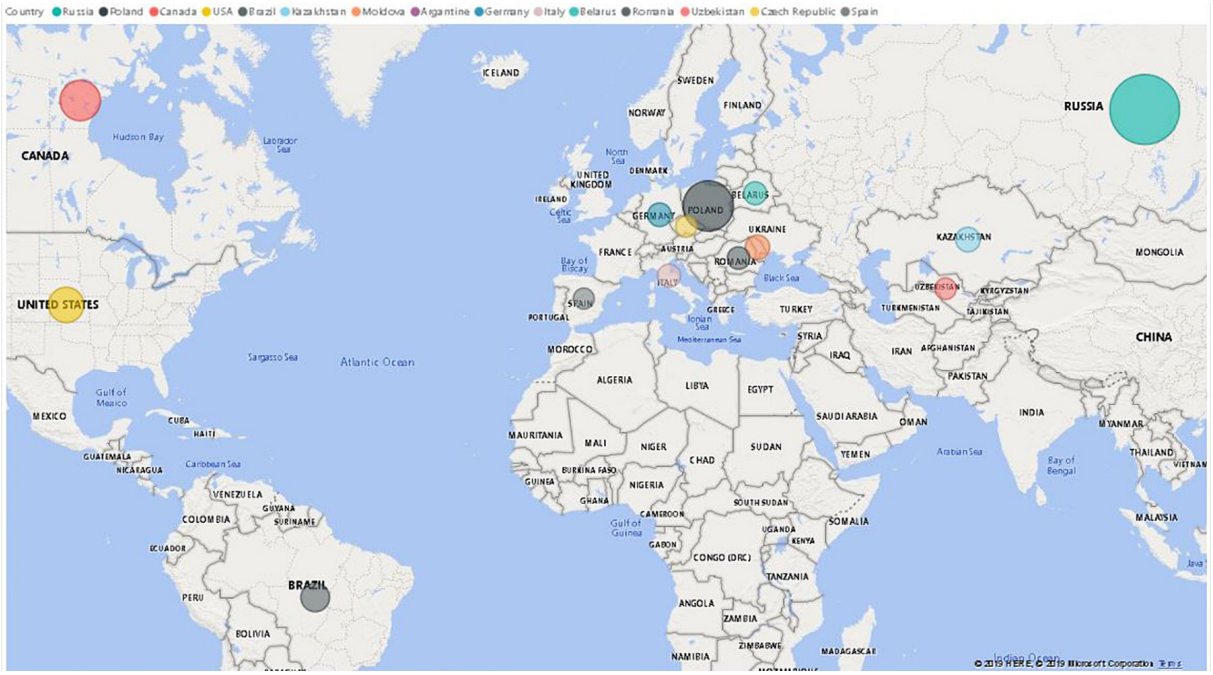
Source: Built by the authors based on InterNations (2018).



Country	Amount	Country	Amount	Country	Amount	Country	Amount
Russia	3,269,992	Brazil	600,000	Germany	272,000	Uzbekistan	124,602
Poland	2,000,000	Kazakhstan	338,022	Italy	234,354	Czech Republic	110,245
Canada	1,359,655	Moldova	325,235	Belarus	225,734	Spain	100,000
USA	1,028,492	Argentine	305,000	Romania	200,000		

Figure 3. The number of the Ukrainian diaspora in the world and its visualization in Power BI

because they have foreign experience (Dmytruk & Chudaieva, 2018; Libanova, 2018; HeadHunter Ukraine, 2019).

An average Ukrainian migrant is 32 years old. 72% of them are women, and only 28% are men. 57% of Ukrainians who migrated abroad are employed (18% are employed in the IT sphere), 7% – in job search, and 6% are students.

As it was already mentioned, Russia has the largest number of Ukrainian emigrants – 3.3 million. This is evidenced by the study of InterNations (2018). Among European countries, most Ukrainians live in neighboring Poland – about 2 million people, in Canada – 1.3 million, slightly more than 1 million – in the United States (InterNations, 2018). Figure 3 shows a list of countries with a population of more than 100,000 in the Ukrainian diaspora.

However, those who return come with new skills, new experience, new work culture – people learn to work at modern enterprises and later can use this experience at home. However, the tendency of returners is that mostly they are seasonal workers and those who go to work for 6-9 months and then go home for several months to relax. Some of them, after several such tours, are thinking of moving their family abroad if there is already a stable job and favorable conditions. A disappointing tendency is observed: the higher the qualifications of an employee, the fewer the chances of his/her return home.

2. RESEARCH METHODOLOGY

The logic of the research is developed in two directions: to provide some modeling of the process for so-called dashboarding, and to assess the impact of the factors on the process. The toolkit of the first part of the research is the modern tool of data science: the Maple computer algebra system – the world-recognized certified leader in analytical computing and Microsoft Power BI. It is a new line of business in-

telligence development that is a suite of cloud-based business intelligence services for analyzing and visualizing the data (Lynch, 2010; Powell, 2017).

The cubic spline approximation method is used for modeling in the Maple system. The forecast accuracy decreases with an increasing degree of the polynomial function. This drawback can be eliminated by using the segments of low degree polynomials for an approximation that are used for individual parts of the statistical forecasting base. The most effective method of such approximation is spline approximation based on the use of segments of cubic polynomials.

Forecasting in Power BI is based on a method of exponential smoothing for time series prediction. The exponential smoothing method has a good track record in both academia and business and has the advantage that it suppresses noise or unwanted variation that can distort the model, while efficiently capturing the trends.

The second part of the paper is based on the regression analyses for the data of 28 EU states (flows of emigrants) and Ukraine.

To build a model of migration from Ukraine to the EU countries, the following variables are used: the dependent variable – immigration in the EU from Ukraine; factors – minimum wage, unemployment, personal income tax, the number of social benefits, the number of vacancies per year, the number of residents who are nationals of non-EU countries. The data source is the State Statistics Service of Ukraine, State Migration Service of Ukraine, and State Border Guard Service of Ukraine, Eurostat, World Bank.

Any country considers the successful development of the national economy with simultaneous social security for the population. The decisions that are taken by the governing bodies of the countries to manage the economy often have negative consequences, so predicting these effects and choosing the best way to solve a particular situation is the main task of state management. In given this, the role of socio-economic processes forecasting in such a state as Ukraine increases.

The development of the theory and methods of forecasting the socio-economic processes enables the simulation of the future development of certain events by applying new technologies and modern computer technology, which provides the choice of a rational way of management.

The approach is that Maple (Lynch, 2010) and Microsoft Power BI (Powell, 2017) tools are quite effective for forecasting the development of migration processes. The study of interstate migration of the Ukrainian population allowed forming a statistical basis for forecasting, which contains quarterly data on the number of migrants, from 2014 till the first quarter of 2019.

Computer algebra system Maple is a recognized global certified leader in the field of analytical calculations and has in its arsenal powerful prediction tools, including methods of extrapolation splines. Given the lack of monotony in changing the number of migrants, the most promising method of forecasting is the extrapolation of splines (Yemets & Roskladka, 1999). Splines allow representing a complex functional dependence in the form of a set of cubic polynomials that are smoothly interconnected. In order to implement the method of spline extrapolation, the Maple system contains *Spline* function, which is part of the *CurveFitting* library (Figure 4).

A cubic spline is a spline constructed of piecewise third-order polynomials which pass through a set of m control points. The second derivative of each polynomial is commonly set to zero at the endpoints since this provides a boundary condition that completes the system of m-2 equations. This produces a so-called "natural" cubic spline and leads to a simple tridiagonal system, which can be solved easily to give the coefficients of the polynomials.

The spline function in the Maple system has the form following:

$$spline(X, Y, z, d),$$

where X, Y – two vectors or two lists of the data, z – variable name, d – (optional) positive integer degree or name of spline type.

The spline function computes a piecewise polynomial approximation to the XY data values of degree d (default $d = 3$ – cubic spline) in the variable z. The X values must be distinct and in ascending order.

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There are no conditions on the Y values.

The result is returned in the form following:

$$S(x)=\begin{cases} C_1(x), & x_0 \le x \le x_1; \\ \dots & \\ C_i(x), & x_{i-1} \le x \le x_i; \\ \dots & \\ C_1(x) & x_{n-1} \le x \le x_n, \end{cases}$$

where $C_i(x)=a_i x^3+b_i x^2+c_i x+d_i$ – third-degree polynomial.

As this method does not use a single polynomial of the degree n to fit all $n+1$ points at once, it avoids high degree polynomials and thereby the potential problem of overfitting. These low-degree polynomials need to be such that the spline $S(x)$ they form is not only continuous, but also smooth.

So, Figure 5 is a graphical interpretation of the resulting cubic spline along with a set of points that form the statistical basis for forecasting. The implementation of the splines extrapolation method in the Maple system gave the forecast of the value of 2520 emigrants from Ukraine in 2019.

Microsoft Power BI analytics platform is a new direction for business intelligence development, which is a set of cloud-based business analytics solutions for analyzing and visualizing the data that includes the prediction function.

When creating a forecast, the additional input parameters are specified, such as the length of the forecast, the confidence interval, and so on. The main advantage of the Power BI analytical platform is the super-powerful means of visualizing analytical reports (Figure 6).

By the results of forecasting, with the help of the Microsoft Power BI analytical platform, the predicted value of 2,444 emigrants was obtained by the end of 2019. A tendency for an increase in the number of migrants in 2019 compared to 2018 is observed. It should be noted that the projected value of the number of emigrants is the largest over the last four years, which may be well indicative as a new third wave of migration processes.

Source: Built by the authors.

```
with(CurveFitting)
[ArrayInterpolation, BSpline, BSplineCurve, Interactive, LeastSquares, PolynomialInterpolation,
    RationalInterpolation, Spline, ThieleInterpolation]                                   (1)
Year := [2014.25, 2014.50, 2014.75, 2015.00, 2015.25, 2015.50, 2015.75, 2016.00, 2016.25, 2016.50,
    2016.75, 2017.00, 2017.25, 2017.50, 2017.75, 2018.00, 2018.25]
[2014.25, 2014.50, 2014.75, 2015.00, 2015.25, 2015.50, 2015.75, 2016.00, 2016.25, 2016.50,
    2016.75, 2017.00, 2017.25, 2017.50, 2017.75, 2018.00, 2018.25]                       (2)
Amount := [2136, 2695, 3107, 3407, 2604, 3075, 3690, 4252, 2386, 2341, 2357, 2107, 1836, 2370,
    2214, 2131, 1975]
[2136, 2695, 3107, 3407, 2604, 3075, 3690, 4252, 2386, 2341, 2357, 2107, 1836, 2370, 2214,
    2131, 1975]                                                                           (3)
A := [[2014.25, 2136], [2014.5, 2695], [2014.75, 3107], [2015.00, 3407], [2015.25, 2604],
    [2015.50, 3075], [2015.75, 3690], [2016.00, 4252], [2016.25, 2386], [2016.50, 2341], [2016.75,
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    [2016.75, 2357], [2017.00, 2107], [2017.25, 1836], [2017.50, 2370], [2017.75, 2214],
    [2018.00, 2131], [2018.25, 1975]]                                                     (4)

spline(Year, Amount, x, 3)
```

$$\begin{cases} -4978731.42 + 2472.81\,x - 3789.04\,(x-2014.25)^3 & x < 2014.50 \\ -3547599.75 + 1762.37\,x - 2841.78\,(x-2014.50)^2 + 9537.19\,(x-2014.50)^3 & x < 2014.75 \\ -4287714.80 + 2129.70\,x + 4311.11\,(x-2014.75)^2 - 32119.73\,(x-2014.75)^3 & x < 2015.00 \\ 3503839.85 - 1737.19\,x - 19778.68\,(x-2015.00)^2 + 55517.73\,(x-2015.00)^3 & x < 2015.25 \\ 2455071.07 - 1216.95\,x + 21859.62\,(x-2015.25)^2 - 37823.19\,(x-2015.25)^3 & x < 2015.50 \\ -5279559.67 + 2621.00\,x - 6507.78\,(x-2015.50)^2 + 23455.05\,(x-2015.50)^3 & x < 2015.75 \\ -7585479.86 + 3764.94\,x + 11083.51\,(x-2015.75)^2 - 68605.00\,(x-2015.75)^3 & x < 2016.00 \\ 7174657.56 - 3556.75\,x - 40370.25\,(x-2016.00)^2 + 98964.96\,(x-2016.00)^3 & x < 2016.25 \\ 10458539.35 - 5185.94\,x + 33853.48\,(x-2016.25)^2 - 55318.86\,(x-2016.25)^3 & x < 2016.50 \\ -2757264.28 + 1368.51\,x - 7635.66\,(x-2016.50)^2 + 9670.46\,(x-2016.50)^3 & x < 2016.75 \\ 1285229.30 - 636.11\,x - 382.82\,(x-2016.75)^2 - 4290.98\,(x-2016.75)^3 & x < 2017.00 \\ 3294007.22 - 1632.08\,x - 3601.05\,(x-2017.00)^2 + 23173.46\,(x-2017.00)^3 & x < 2017.25 \\ -1838740.31 + 912.42\,x + 13779.04\,(x-2017.25)^2 - 35538.85\,(x-2017.25)^3 & x < 2017.50 \\ -2294358.61 + 1138.40\,x - 12875.10\,(x-2017.50)^2 + 23301.95\,(x-2017.50)^3 & x < 2017.75 \\ 1878785.36 - 930.03\,x + 4601.36\,(x-2017.75)^2 - 8836.93\,(x-2017.75)^3 & x < 2018.00 \\ 579837.32 - 286.28\,x - 2026.34\,(x-2018.00)^2 + 2701.79\,(x-2018.00)^3 & otherwise \end{cases} \quad (5)$$

Figure 4. Practical realization of finding the predictive function by the method of splines extrapolation

Source: Built by the authors.

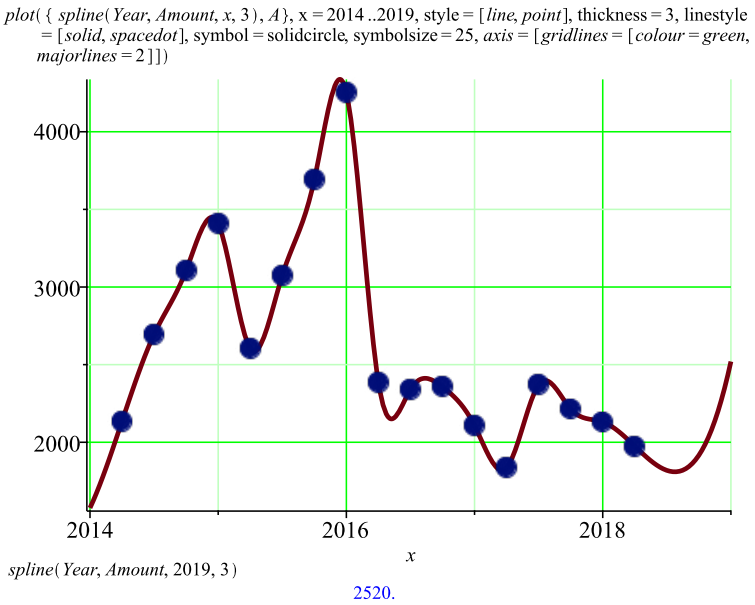

Figure 5. Graphical interpretation in the Maple system of the forecasting of Ukrainian emigrants number

Source: Built by the authors.

Year/quarter	Amount
2014.25	2136
2014.50	2695
2014.75	3107
2015.00	3407
2015.25	2604
2015.50	3075
2015.75	3690
2016.00	4252
2016.25	2386
2016.50	2341
2016.75	2357
2017.00	2107
2017.25	1836
2017.50	2370
2017.75	2214
2018.00	2131
2018.25	1975

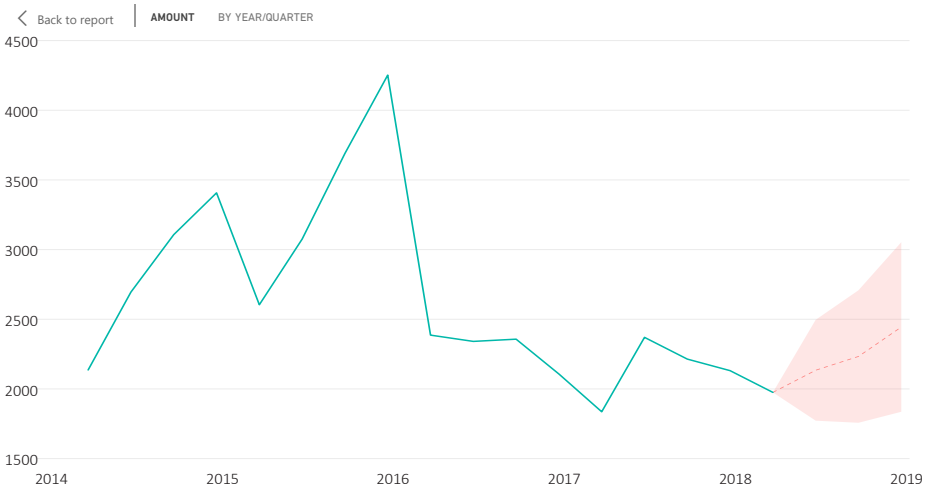

Figure 6. The number of Ukrainian emigrants and visualization the forecasting process in Power BI

3. RESULTS

However, the dynamics of migrants is not just the question of time-series variation, but the fluctuating of the volumes of migrants under the impact of different external factors. It is proved by the results of correlation analyses when the high correlation between immigration from Ukraine to the EU and the factors of the free open vacancies per year (JOB) and the number of non-EU residents (CITI) is received (Table 2).

The most appropriate regression model to highlight this dependence is the following:

$$LOG(IM) = 0.684761 \cdot LOG(MW) + \\ +0.499136 \cdot LOG(JOB) + \\ +0.169932 \cdot LOG(CITI) - 3.12296$$

$$(adjR\text{-}sq = 0.68,\ DW = 2.27),$$

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Table 2. Correlation matrix (EViews screen result) for the dependence between the immigrants in the EU from Ukraine (IM) and the set of the external factors

Source: Authors.

	W	UR	TAX	SB	JOB	IM	CITI
W	1.000000	–0.272292	0.784530	0.842279	0.343505	0.459798	0.290114
UR	–0.272292	1.000000	0.107221	–0.234213	–0.286323	–0.138689	0.172944
TAX	0.784530	0.107221	1.000000	0.630881	0.183847	0.332673	0.285874
SB	0.842279	–0.234213	0.630881	1.000000	0.215316	0.337668	0.226388
JOB	0.343505	–0.286323	0.183847	0.215316	1.000000	0.772703	0.656867
IM	0.459798	–0.138689	0.332673	0.337668	0.772703	1.000000	0.810739
CITI	0.290114	0.172944	0.285874	0.226388	0.656867	0.810739	1.000000

Table 3. Correlation matrix (EViews screen result) for the dependence between the emigrants from Ukraine (EM) and the set of the internal factors

Source: Authors.

	EM	CR	IL	P	RW	SG
EM	1.000000	0.373025	0.345822	0.918059	0.120509	–0.397172
CR	0.373025	1.000000	–0.140552	0.408522	0.031976	–0.130198
IL	0.345822	–0.140552	1.000000	0.361343	0.037334	–0.122816
P	0.918059	0.408522	0.361343	1.000000	0.280595	–0.377497
RW	0.120509	0.031976	0.037334	0.280595	1.000000	–0.429832
SG	–0.397172	–0.130198	–0.122816	–0.377497	–0.429832	1.000000

where MW is the minimum wage factor, IM – immigrants from Ukraine to the EU, JOB – the free open vacancies per year, $CITI$ – the number of non-EU residents.

Thus, the model detected that the main factors that are in the statistical correlation with the flow of the migrants from Ukraine to the EU are not only about financial issues (like the higher minimum wage), but also the more open market of job vacancies and possibilities to realize personal potential, and the trend of the globalization – as the EU is attractive for not just Ukrainian people to migrate (the significance of $CITI$ variable).

If to have a look on the internal factors that push people to migrate in Ukraine, the correlation analysis provided the result that the poverty (P) is the main reason for the emigration from Ukraine (Table 3), while the crime (CR), the level of health security (IL), the real wages (RW), and the level of trust in the government (SG) were detected as non-significant. However, these factors were claimed as significant in the vast amount of scientific papers (i.e., Kharlamova & Sitnitskiy, 2016; Bilan, 2014, etc.).

CONCLUSION

Motives, causes of emigration processes and their interrelation with the economic environment in Ukraine are analyzed; the features and factors of the influence of external labor migration on the economy of the countries-adopters of migration processes are revealed; the negative and positive effects of emigration on the socio-economic situation in Ukraine was assessed; the number of Ukrainian emigrants and their migratory sentiment were analyzed; the variant forecast for the migration of population of Ukraine for 2019 has been developed based on the Maple computer algebra system and the Microsoft Power BI analytical platform. This may lead to the development of an information system for emigration, migration, and immigration forecasting in the future.

The migration movement of the population is an integral part of the process of globalization, and then further, the scale of external migration will grow, more and more people will live outside the country of

origin and throughout the life will change the country of residence more than once. Changing the priorities for potential migrants, in particular, the reorientation of a significant part of them from Russia to European countries, is not coincidental and of a permanent nature.

The main motive for the departure of most Ukrainians is undoubtedly the hope of receiving significantly higher wages, and the evidence of the received model supports it. But economic factors are not the only catalysts of migration processes. More and more migrants are paying attention to social security, level of corruption, and other parameters that form the "Ranking of happiness." Therefore, raising wages to the level comparable to the neighboring countries will undoubtedly reduce the extent of the spread of migratory sentiment, but will not completely eliminate it.

At the same time, the inflow of financial capitals from migrants, new investments, the expansion of the economic influence of the European Union can lead to the modernization of Ukrainian enterprises, providing new technologies and, therefore, to demand a new type of workers, who can support innovations. It could be the catalyst for the dramatic increase in salaries that happened during the last years. This process can significantly decrease the number of people desiring to leave Ukraine. This consequence started a new approach to changing the Ukrainian mentality. If many years the dominant philosophy of Ukrainian people was "my house is off the edge," which led to hiding incomes, avoiding paying taxes, weak maintenance of infrastructure, then nowadays more and more people unite to realize some infrastructure projects for themselves, which improves their life quality. Such an approach definitely decreases the level of migration. The other issue that also stimulates a decrease of emigration lies in the fact that many people who could not find themselves in Europe returned and decided to build their life in Ukraine. It leads to more political responsibility of citizens, which also should make Ukrainian people happier.

The construction of the proposed migration modeling system is aimed at creating an instrument for the study of migratory movements of the population. With the help of the modern tools of business analytics based on the input information, conclusions are drawn about the readiness of a person to emigrate. The results of implementation of the migration process modeling system in the activities of the governing bodies should be aimed at simplifing the processes of assessing the migration status of the population. Combining this knowledge with the information on the number of people allows assessing the potential migration situation.

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