Z. P. Baranyk,
DSc in Economics, Professor,
Deputy-Head of Statistics Department;
Yu. A. Kovalevskyi,
PhD in Economics;
Vadym Hetman Kyiv National Economic University

З. П. Бараник,
доктор економічних наук, професор,
заступник завідувача кафедри статистики,
E-mail: baranikz@ukr.net;
Ю. А. Ковалевський,
кандидат економічних наук;
ДВНЗ "Київський національний економічний університет
імені Вадима Гетьмана

З. П. Бараник,
доктор экономических наук, профессор,
заместитель заведующего кафедрой статистики;
Ю. А. Ковалевский,
кандидат экономических наук;
ГВУЗ "Киевский национальный экономический университет
имени Вадима Гетьмана"

Statistical Evaluation of Correlation between Labor Supply and Demand: Methodology and Practice

The aim of study is to justify theoretical and methodological principles and statistical tools for comprehensive analysis and evaluation of the correlation between labor demand and supply at the labor market. The place and role of the statistical analysis of labor demand and supply in the regulatory system is shown. The model of regulatory framework on labor demand and supply is constructed. Factors influencing labor demand and supply are grouped and analyzed. Components of comprehensive statistical analysis of labor market demand and supply are highlighted, which, once included, can significantly improve the analysis methodology. Statistical analysis of labor demand and supply in Ukraine is made.

Key words: *labor demand and supply, correlation, labor market, statistical analysis, balance, social and labor relations, proportional distribution, multi-dimensional clustering, forecasting.*

One of the key macroeconomic problems of the modern labor market in Ukraine is a structural mismatch of labor demand and supply. This mismatch effects on the national labor market functioning, reducing its effectiveness on the way of meeting future needs of the economy for qualified personnel. To ensure the supply and demand balance on the labor market there is a need for government regulation, which could bring the structure of labor supply in line with its demand. There is a problem of significant imbalance between labor supply and demand on professional qualifications, educational levels in different economic activities, economic regions and in the country as total.

Achieving and maintaining a good correlation between labor supply and demand is one of the strategic objectives of the labor market state regulation. In this regard, there is a need for a comprehensive statistical information on the labor supply and demand structure in the professionally - qualifying context. The agenda raises questions of adequate labor supply and demand assessment using statistics methods.

Availability of information, obtained as a result of a comprehensive labor demand and supply statistical analysis, will contribute to grounding the decision-making directed to development effective and efficient cause for creating new working places, to provision the job security in the process of privatization and restructuring, to support entrepreneurship and self-employment of individuals, to stimulate the expansion of public works, to increase labor market flexibility [5].

To estimate the situation of imbalance between labor demand and supply in the labor market, identify its main trends for the coming years is possible by using statistical analysis methods. The need for a statistical approach to the analysis of the above mentioned proportions in the labor market determined by the labor market functioning under conditions of variety random factors effects, their variations and mutual influence. The statistical approach allows us to compare individual and integrated performance of labor market g in time and space, to consider the grade of the changes, correlations, thus to outline logical con-

nection of quantitative and qualitative labor market parties, including the existing imbalance between the demand for skilled workforce and its supply at the regional and national levels.

The peculiarity of the chosen research topic is that it has a scientific interest between specialists in social and labor relations and labor market statistics. An important contribution to the study of theoretical and methodological foundations of labor market analysis have made domestic and foreign scholars S. Bandura, Z. Baranyk [1; 2], D. Bohynya, V. Vrublevskyy, P. Dolishniy, T. Zayats, R. Kapelyushnikov, V. Kostakov, L. Kostin, Y. Krasnov, I. Kryzhko, E. Libanova [3], L. Lisohor, N. Pavlovska, V. Novikov, V. Onikiyenko, I. Petrova, V. Petyuh, V. Savcheko and others. M. Karlin, A. Kolot, V. Lahutin, O. Umansky, A.Chuhno in their publications fully justified the role of value of workforce as a regulator of labor supply and demand in the labor market.

The study of major works of the methodology of statistical evaluation of the relation between supply and demand of labor, carried out by the author, showed the need to improve the theoretical and methodological principles and appropriate statistical tools for comprehensive statistical analysis of the correlation between the demand and supply of labor in the labor market.

Appreciating scientific achievements in solving problems of labor market effective functioning, we note that the question remains insufficiently investigated drafting theoretical-methodological approaches to statistical analysis of labor supply and demand aiming to their balancing.

Current importance of imbalance between labor supply and demand and insufficient research on the theoretical and methodological foundations of statistical analysis and evaluation of the ratio of unemployed and the number of vacancies in the current economic conditions resulted in choosing of research topic due to its theoretical and applied significance.

Statistical assessment of the correlation between labor supply and demand, conducted by the authors, identified a need for the development of methodological foundations of statistical tools and comprehensive statistical analysis of supply and demand of labor, the assessment of their value in the labor market.

The aim of this article is to justify the theoretical and methodological principles and statistical tools for comprehensive analysis and evaluation of the relation between demand and supply of labor in the labor market.

For effective social development management government should radically increase the role of decent and productive work: studying required volumes of professionals according to the global, national and regional economy's needs; determine the rational structure of the labor force in the context of a professional qualification in accordance with the priorities of economic activities; develop the forecasts of man-

power requirements and to optimize regional allocation of labor based on above mentioned systematic measurements.

It should be noted the regulatory role of wages, which acts as a mechanism that effects on the rational correlation between labor demand and supply. In Ukraine existed level of wages makes very little contribution to the establishment of optimal balance between labor supply and demand. Wages observed in a number of economic activities are very low to encourage the experts to be hired in that activity [4].

Recent years in Ukraine carried out economic policy aimed to the financial stabilization, weakening fiscal crisis. Not enough attention was paid on evaluating the correlation between labor supply and demand in the context of professional qualification, between unemployment and inflation, increasing of wages and institutionalization, increasing specification of private property latitude, which complicates the creation of work activating mechanism.

Existing theoretical and methodological framework for statistical analysis of labor supply and demand requires further improvement. The main stages of theoretical and methodological principles are identified. They are:

1. Using a systematic approach; adherence to its fundamental principles.

2. The place and role definition of labor demand and supply statistical analysis in the state regulation.

3. Identifying factors affecting the demand and supply of labor.

4. Justification of main directions of complex statistical analysis of demand and supply of labor, their correlation.

5. Creating the system of analytical parameters which characterize the presence or absence of an imbalance between labor supply and demand.

6. Use of statistical analysis methods in estimating labor demand and supply.

7. Improving informational and analytical support for statistical analysis of labor demand and supply.

Systematic approach to statistical study of phenomena and processes in the labor market allows us to determine its action mechanism, identify factors that affect the supply and demand of labor, determine the stages of its formation and serving the needs of demand for labor.

It should be noted that the system of labor market is functioning by creating new and improving existing labor market institutions. In Ukraine labor market institutions are established. They provide direction and keep the proportions of use the abovementioned economic active employment policy methods, the use of social tools in finding decent workforce for existing working places, increasing their competitiveness. They also play a significant role in bringing together all components of labor market regulation in the logical system.

The use of labor market regulation institutional facilities helps the unemployed to get work on available working places, which are created in various economic activities, and ensure the unity of the whole system of labor market regulation; it also connects and organizes regulatory elements, which are aimed not only at increasing employment in the country, but also on its quality, which is currently one of the main objectives of the ILO to implement employment policy in countries with socially oriented economy.

In addition to the institutional environment on the labor market affect specific institutions such as trade unions that actively are involved in the regulation of labor relations, establishing social partnership between employees and employers. All this affects on the mechanism of establishing equilibrium in the labor market.

Mechanism of regulation of subordinate policies pursued in the labor market, which aims: to provide people with quality jobs regardless of where they live; to encourage participation rate; to increase motivation for working; to develop and implement employment potential. All this will contribute to further economic growth in Ukraine.

As mentioned above, mechanism of labor market regulation functions using tools and methods controlling labor supply and demand. The result of this mechanism is the balance or imbalance between labor supply and demand either in companies and firms or regional markets, or at the national labor market. The role and place of its statistical analysis in the regulatory system are shown in Figure 1.

It is stressed, that the regulatory system of relation between labor supply and demand functions by
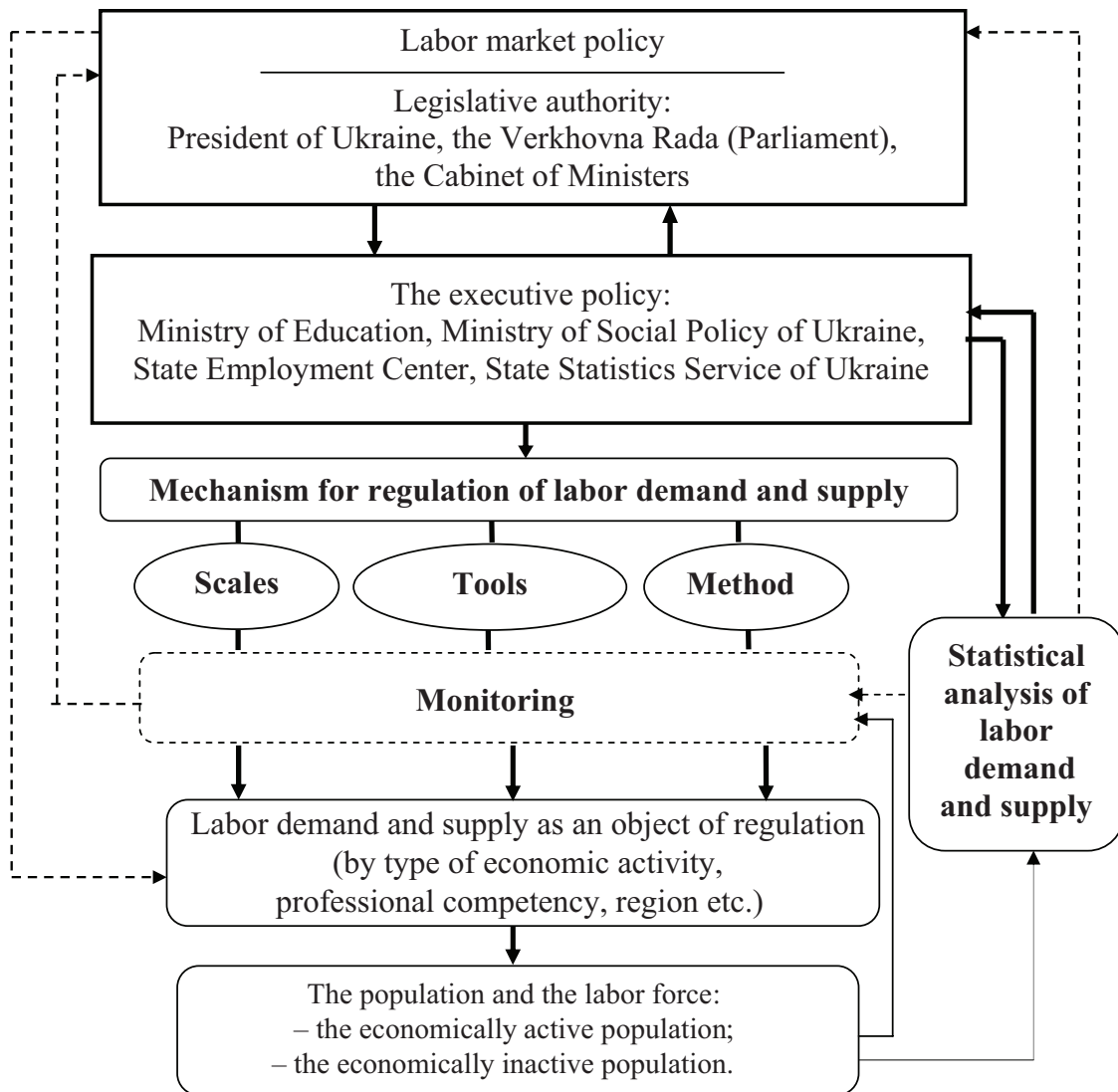

Fig. 1. Place and role of the statistical analysis of labor demand and supply in the regulatory system

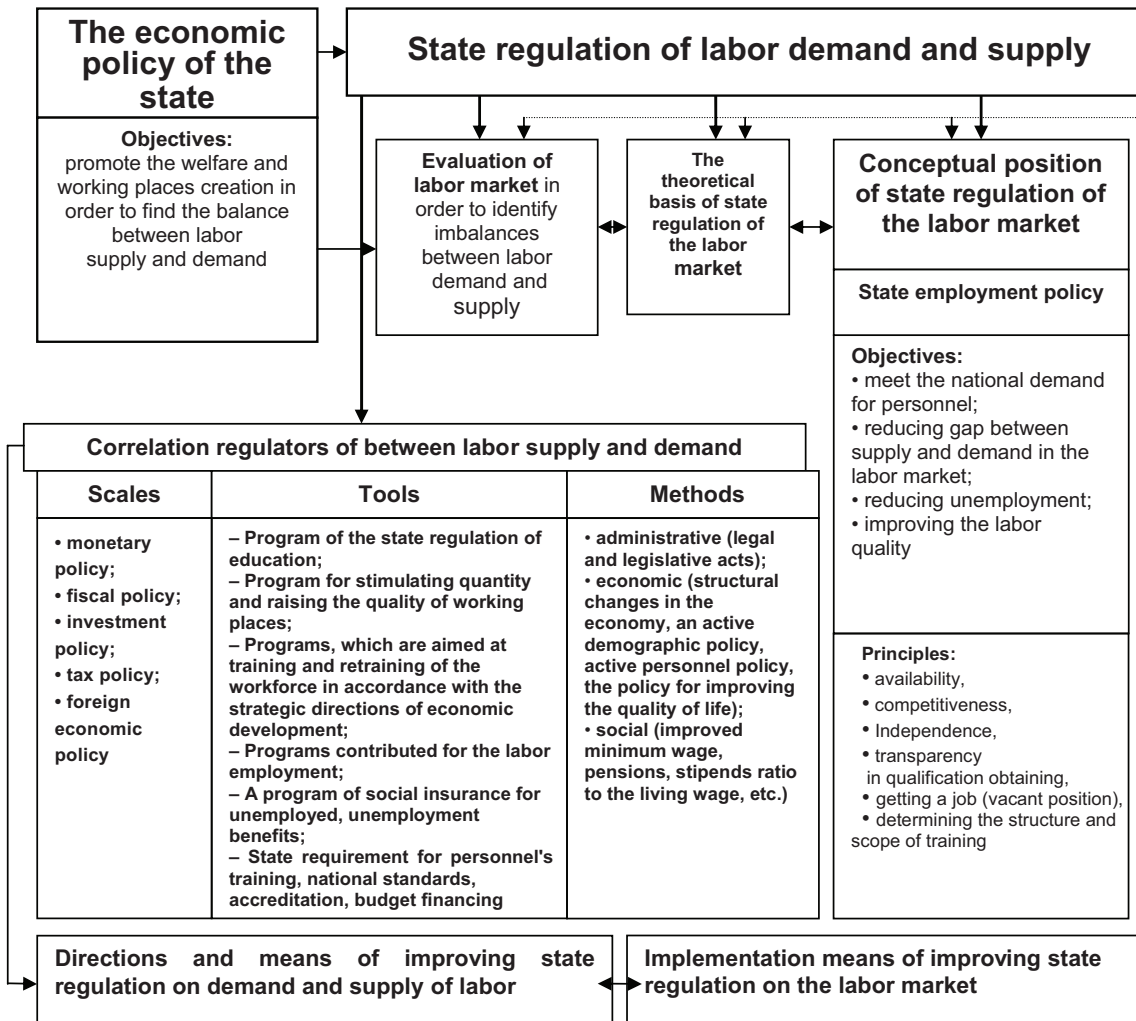*Source: constructed by the authors on the basis of [1]*

The economic policy of the state	State regulation of labor demand and supply		
Objectives: promote the welfare and working places creation in order to find the balance between labor supply and demand	**Evaluation of labor market** in order to identify imbalances between labor demand and supply	**The theoretical basis of state regulation of the labor market**	**Conceptual position of state regulation of the labor market**

State employment policy

Objectives:
• meet the national demand for personnel;
• reducing gap between supply and demand in the labor market;
• reducing unemployment;
• improving the labor quality

Correlation regulators of between labor supply and demand

Scales	Tools	Methods
• monetary policy; • fiscal policy; • investment policy; • tax policy; • foreign economic policy	– Program of the state regulation of education; – Program for stimulating quantity and raising the quality of working places; – Programs, which are aimed at training and retraining of the workforce in accordance with the strategic directions of economic development; – Programs contributed for the labor employment; – A program of social insurance for unemployed, unemployment benefits; – State requirement for personnel's training, national standards, accreditation, budget financing	• administrative (legal and legislative acts); • economic (structural changes in the economy, an active demographic policy, active personnel policy, the policy for improving the quality of life); • social (improved minimum wage, pensions, stipends ratio to the living wage, etc.)

Principles:
• availability,
• competitiveness,
• Independence,
• transparency in qualification obtaining,
• getting a job (vacant position),
• determining the structure and scope of training

Directions and means of improving state regulation on demand and supply of labor

Implementation means of improving state regulation on the labor market

Fig. 2. The model of regulatory framework for labor demand and supply

Source: constructed by the authors

creating new and improving existing labor market institutions. In Ukraine established labor market institutions that provide direction and keep the proportions concerning the use of the mentioned economic methods devoted to active employment policy, use of social tools in choosing the decent working force for existing vocations, increasing their competitiveness. They also play a significant role in bringing together all components of labor market regulation in the logical system. The model of regulatory framework for labor demand and supply is shown in Fig. 2.

Labor demand and supply is conditioned by various factors of labor market. Their effect depends on the natural, social, environmental and material conditions in which they occur.

By factors of labor market functionality we understand the conditions and causes which change causes variations in the intensity of labor market functionality. They are: the driving force or reason that cause its level changes. Among that forces are scientific and technical progress, improvement of production and labor management.

The variety of concrete ways and means to achieve higher levels of labor market functioning demands consideration of the factors influencing labor demand and supply. The factors of supply and demand on the labor market are: restructuring; economic crisis; scientific and technical progress; privatization of property; bankruptcy of insolvent units; development of entrepreneurship, small business, self-employment; integration into the world market; state policy of employment; standard of living; level of workers and employers wages; development of social partnership; education and qualification of the workforce; demographic trends, and others [3].

Depending on the above mentioned factors of influence on labor demand and supply, they can be divided into two groups: the first group – factors affecting the demand on labor, the second group – factors affecting on the supply.

The first group of factors include: restructuring; the economic crisis; privatization of property; bankruptcy; enterprise development, small business, self-

employment; degree of wage workers and employers; development of social partnership.

The second group of factors include: standard of living; educational and qualification of the workforce; demographic processes.

In addition, labor demand and supply impact on scientific and technological progress, the country's integration into the global market, state employment policy.

The above mentioned factors can either exacerbate or ease tensions in the labor market, depending upon the factors' direction.

The factors increasing tension in the labor market include restructuring, the economic crisis, privatization of property, bankruptcy, and the factors reducing it are business development, small business, self-employment, state policy of employment, development of social partnership.

Furthermore, the influence of factors specific to labor market in a developed economy is significantly different from the influence of similar factors in a transition economy. These factors include restructuring caused by economic crisis, the country's integration into the global market. Moreover, both categories of countries may include the following characteristic group of factors affecting the labor market performance: bankruptcy of insolvent units; enterprise development, small business, self-employment; employment policy; standard of living; education qualification of the workforce; demographic processes.

Improving of methodological foundations for comprehensive statistical analysis of labor demand and supply from the system standpoint involves the following components of statistical analysis: determination of labor demand and supply; evaluation of the structure of demand and supply of labor; analysis of the dynamics and forecast demand and labor supply; assess the impact of socioeconomic factors on the supply and demand of labor; analysis of demand and supply of labor for the professional staff; proportionality analysis of the distribution of demand and supply of labor; multidimensional clustering regions of the similarity structure of demand and supply of labor; analysis of the difference in wages by economic activity.

There grounded the stages of complex statistical analysis of labor demand and supply caused by the need to develop management decisions based on the results of the study.

Evaluation of labor demand and supply – determination of the number of unemployed people, including those who do not have a profession, including unemployed in the context of economic activities, occupations, professions, regions and economic areas. The analysis developed measures to ensure the balance of labor in the labor market

Evaluation of the structure of labor demand and supply – objective assessment of structural changes of unemployed, unemployed by gender, age group,

economic activity, employment status, occupational group, cause of unemployment, education, region, economic areas build an information base for developing effective programs and arrangements for the effective use of human resources based on their redistribution.

Analysis of the dynamics and forecast demand and labor supply – results of dynamic analysis and forecasting of labor demand and supply and their correlation (including the seasonal component) is an information base for development the effective programs and labor market development scenarios based on identified trends.

Assessing the impact of socioeconomic factors on the labor supply and demand – results of correlation and regression analysis allow to evaluate the impact of major socio-economic factors (average salary, gross regional product per capita, the level of employment, foreign investment per capita, number released, etc.) on labor supply and demand and on this basis to develop real mechanisms to reduce the burden on a workplace (vacant position) in various economic activities, occupations, professions, regions and economic areas that create the optimal conditions of the market work.

Labor demand and supply analysis by professional staff – an objective assessment of occupational composition of Ukraine in the labor market. Analysis of labor demand and supply for occupational groups over time give grounds for management bodies to provide strategic planning and forecasting vocational and higher education in accordance with changes in the labor market, in society as a whole.

Analysis of proportional labor demand and supply distribution – quantitative and qualitative assessment of consistency proportions between supply and demand on the labor market. Complex analysis methods of proportionality help to determine the degree of influence of individual factors on the distribution of labor demand and supply using concentration ratios and partial distribution characteristics – localization indicator. The analysis results in developing proposals for improving the management of distribution and redistribution of labor by region.

Multidimensional clustering regions by the similarity in labor demand and supply structure – results of cluster analysis enable regions to sort by the similarity in structure of economic activity supply and demand. This will develop a program of effective functioning of regional labor markets based on economic status of certain territories.

Analysis of the difference in wages by economic activity – development of arrangements for state the labor market regulation relating to the establishment of the country's equilibrium price of labor in terms of successive approximation to the European way of life.

The use of statistical indicators allows analyzing and evaluating the correlation between labor demand and supply in the country and its individual regions. The
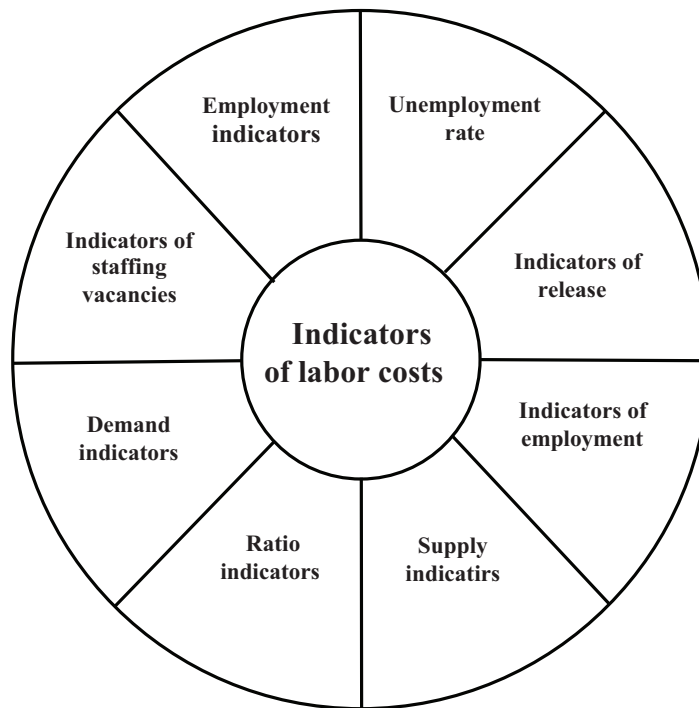
Fig. 3. The main groups of statistical indicators of labor demand and supply

Source: compiled by the authors

basis of the system of parameters assigned systematic approach that allowed structuring them by the relevant nine blocks, which are considered as separate subsystems and describe key aspects of labor market equilibrium, taking in account the availability of official statistical reporting on labor and determine the composition of indicators for each block. The system of statistical indicators characterizing key aspects of equilibrium in the labor market is constructed (Figure 3).

Established system of statistical indicators of labor demand and supply assists to measure: the volume of labor demand and evaluating labor supply, taking into account the employment index professions and qualifications on the labor market.

This approach makes it possible to specify the functionality of each of these blocks indicators to prove the practical significance of this distribution and isolate indicators that require further study.

An important area of studies the existing imbalances between labor demand and supply is the assessment of labor demand and supply and their structure.

An objective assessment of structural changes of unemployed, unemployed by gender, age group, economic activity, employment status, and occupational group, cause of unemployment, education, regions and economic areas is a reliable informational base for the development effective policies and measures on the use of labor on their redistribution.

Evaluation of the labor market at the national and regional levels, as for the balance or imbalance of labor demand and supply and its value, plays a key role in the regulation of employment policies. Quality management decisions in employment depend on providing objective information that can be obtained in the statistical analysis of supply and demand of labor.

Figures 4–6 show the dynamics of labor demand and supply in Ukraine.

The survey results in identifying the structural correlation between supply and demand in the labor market in terms of future professions and specialties. This allows the authorities to adjust the number of vocational training of unemployed, including unemployed in the context of professions, specialties and areas; also to adjust the number of training according to labor market demand, optimize the ratio between demand and supply of labor measures of active employment policy.

The centralization of primary production, which mostly leads to a concentration of jobs and the need for new labor, is significant for Ukraine.

Significant imbalance between labor demand and supply is found across the Ukrainian regions, except for Kyiv, where the indicator "unemployed burden for 1 vacancy (vacant position)" in recent years has remained unchanged (1 person). In other regions the indicators is much higher, especially in Vinnitsa region, where the situation is one of the worst – the load grew from 58 persons to 78 persons.

Burden on vacancies and jobs in the regions mentioned above is the result of a significant reduction in the demand for labor.
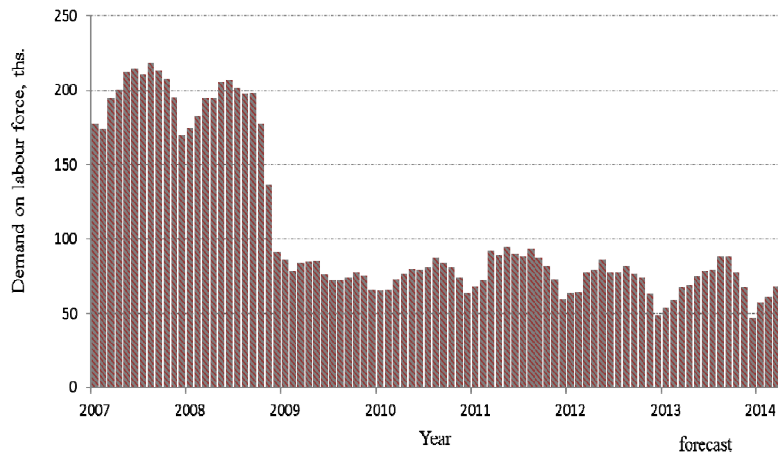
Fig. 4. The dynamics of labor demand in Ukraine (2007–2014)
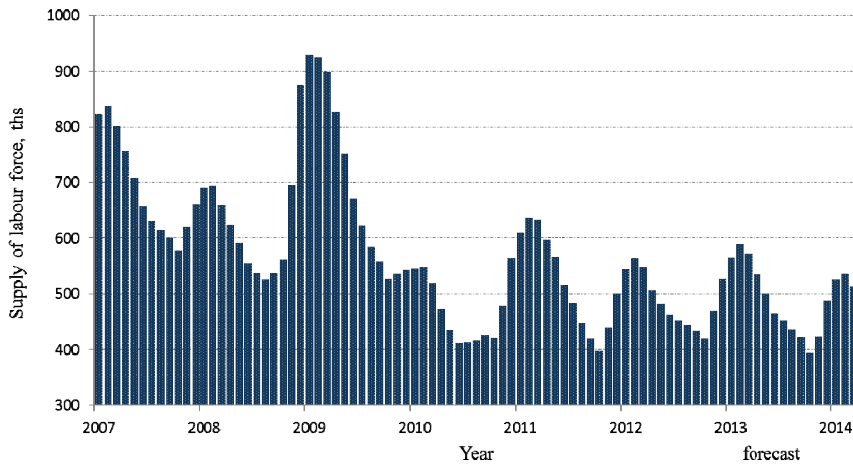
Source: constructed by the authors on the basis of [6]

Fig. 5. The dynamics of labor supply in Ukraine (2007–2014)

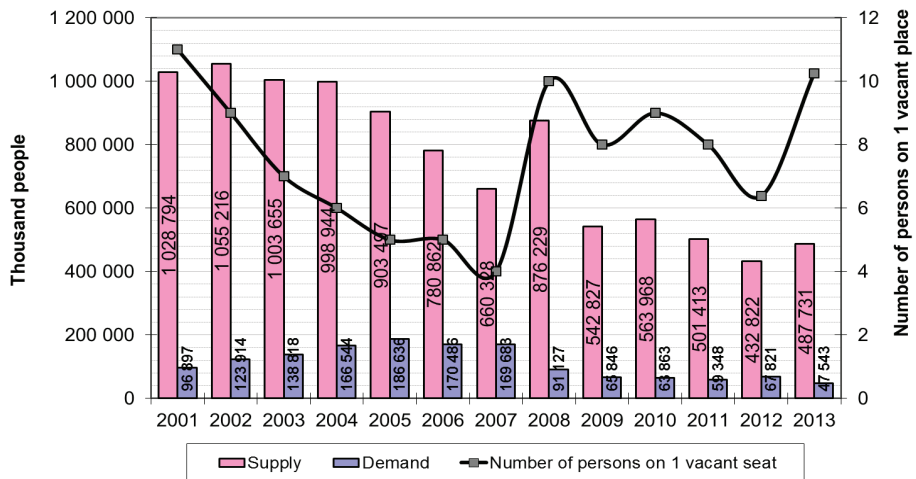*Source: constructed by the authors on the basis of [6]*

Fig. 6. The dynamics of labor demand and supply in Ukraine (2001–2013)

Source: constructed by the authors on the basis of [6]

The greatest imbalance between supply and demand of labor is found in the western and central regions of Ukraine, the "leaders" being Vinnytsia, Khmelnytsky and Cherkasy regions with burden per vacancy and vacant position 78, 76 and 43 persons respectively.

For a summary of proportionality distribution characteristics of demand for labor and population in the regions used the Lorenz curve of concentration and concentration indicator whose value (0.298) indicates a low degree of concentration in labor demand by region. A large number of vacancies are concentrated in the major centers of production, while in other regions there are an insufficient number of jobs for the population living there.

Use of an indicator of concentration and localization in studying distribution of labor demand and supply with the number of people living in Ukrainian regions allows for identifying the regions with significant structural imbalances in regional labor markets.

This situation requires differentiated employment policy to provide proportional development of territories with maximum local conditions and resources. To achieve this objective, multidimensional clustering of the regions by indicators of labor demand and supply was made. Ward's method was used as a method for clustering of the Ukrainian regions. The parameters of the examined regions show the same conditions of regional labor markets. The results of the proposed approach will help choose the measures to improve the situation in selected homogeneous regions, reduce social tensions in regional labor markets in terms of setting balance between labor demand and supply and improve the mechanisms of its rational correlation.

The article stresses the methical approach of rating evaluation regions on the basic parameters of demand and supply of labor. The ranking of each region was performed by using the resulting integrated assessment of the functioning of regional labor markets. Rating evaluation of regional labor markets will help to differentiate areas of state employment policy in support of regional development, taking into account certain rating and similar trends.

The necessity of statistical analysis of labor demand and supply for economic regions is outlined.

It should be noted, that there are significant disproportions between labor supply and demand in the regions. This situation requires differentiated employment policies to ensure proportional development of areas with maximum local conditions and resources. It was the reason to carry out multidimensional grouping of regions according to the similarity in structure of supply and demand by economic activity by method of cluster analysis.

In different economic activities five clusters are identified by similarity of the demand structure, and 8 clusters – by supply structure. Cluster-hierarchical analysis allowed for identifying similar regions of Ukraine by structure of labor demand and supply. This will help develop effective mechanisms for regulating the labor market, taking into account peculiarities of the cluster in areas that are part of it.

The need for forecasting labor demand and supply of labor in Ukraine and its regions in 2014–2015 is caused by significant cross-region and cross-border movement of labor force due to the unstable political, economic and social situation in the country. This is associated with the relocation of residents from Donetsk and Luhansk regions and the Autonomous Republic of Crimea to other regions.

The forecasting of main characteristics of regional labor markets was performed by the procedure of exponential smoothing, since this model takes into account both the basic trend of development, and internal seasonal fluctuations.

The main criterion for selection of the trend model is the minimum value of the standard deviation of the smoothed values of basic characteristics of regional labor markets and the actual smallest approximation error.

The forecasting based on the dynamic model is substituted in the original model values relevant forecast period (time) and calculating confidence limits of the forecast.

Expected load of unemployed for 1 vacancy (vacant position) in Ukraine in 2015 will amount to average of 9 persons.

Statistical evaluation of labor demand and supply, their value for the future is a necessary tool for implementation of active employment policy in the country, is a reference balance at both the national and regional labor markets.

Comprehensive implementation of the proposed ways of improving the statistical analysis of labor supply and demand will help in balancing the labor market by occupation, profession, economic activity, region, to meets the needs of the economy and ensure its innovation-driven development.

The article is devoted to the theoretical generalization and new solutions of scientific tasks, which lies in the substantiation of the theoretical and methodological foundations of statistical tools and comprehensive analysis of the demand and supply of labor, evaluating their relationship, determining the characteristics of differentiation of supply and demand in regional labor markets. The received theoretical and practical results indicate achievement.

References

1. Baranyk Z. P. (2007). *Funktsionuvannya rynku pratsi: statystychna otsinka* [Labour market functioning: statistical estimation]. Kyiv: KNEU, 370 [in Ukrainian].

2. Baranik, Z. & Kowalewski Yu. (2011). Statystychne upravlinnya analizom rehionalnogo rynku pratsi [Statistical management of regional labor market analysis]. *Suchasni problemy transformatsiynoho protsesu v krainakh Tsentalnoyi ta Shidnoyi Yevropy – Contemporary problems of transformation process in the Central and east European countries*. Lviv: The Lviv Akademy of Commerce, 184–189 [in Ukrainian].

3. Libanova E., Palii O. (2004). *Rynok pratsi ta sotsialny zakhyst* [The labor market and social protection]. Kyiv : Vydavnytstvo Solomii Pavlychko "Osnovy", 491 [in Ukrainian].

4. The official site of European Foundation for the improvement of Living and Working Condition (2015), available at :

http://www.eurofound.europa.eu/ – Screen title.

5. The official site of European Commission's DG for Employment, Social Affairs & Inclusion (2015), available at :

http://ec.europa.eu/social/main.jsp?catId=89&langId=en

6. The official site of StatSoft (2015), available at :

http://www.statsoft.ru/ – Screen title.

З Днем працівників статистики!

Щиро вітаємо всіх працівників статистичних органів,
науковців, викладачів, студентів
із професійним святом!
Бажаємо здоров'я, особистого щастя, сімейного благополуччя,
натхнення у праці, нових творчих успіхів.

Рада засновників та редколегія журналу
"Статистика України"