

Modeling the Interrelation between Formation Factors of Labor Demand and Its Supply*



**Aleksandr N.
TYRSIN**

Ural Federal University
Yekaterinburg, Russian Federation
South Ural State University (National Research University)
Chelyabinsk, Russian Federation
e-mail: a.n.tyrsin@urfu.ru
ORCID: 0000-0002-2660-1221; ResearcherID: T-5975-2017



**Elena V.
VASILYEVA**

Institute of Economics of the Ural Branch of RAS
Yekaterinburg, Russian Federation
e-mail: elvitvas@ya.ru
ORCID: 0000-0002-0446-1555; ResearcherID: Q-5620-2016

Abstract. The remaining problem of the imbalance on the Russian labor market determines the relevance of studying labor demand and its supply. For this purpose, the objective of identifying the interrelation between the factors of demand and supply formation on the labor market, described using two sets (vectors) of indicators, was set and achieved. The study model also includes labor migration, informal employment, and labor activity of elderly population as factors of labor supply, which ensure that the labor shortage is filled, and the labor market is balanced. The statistical base of the study is 2006–2018 Rosstat data for Russian regions. The results of the study showed that, since 2014, there has been a growing trend in the interconnection between the factors of labor demand and its supply. In difficult macroeconomic conditions, the Russian labor market adapts not by freeing up the labor force, but by expanding labor relation practices (including underemployment of population) while maintaining a low unemployment.

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Economic decline has led to a reduction in the need for labor, which, on the background of a narrowing supply of labor resources caused by population ageing, has strengthened the balance between supply and demand on the labor market. The growth of partial and part-time employment has become a key process in reconciling the demand for labor and its supply. The inclusion of all factors, studied in this research, in the model allowed us to assess their impact on the balance of labor demand and supply. Employment of population aged 60–72 years was the most significant factor among all supply and demand indicators on the labor market, which indicates a high potential of ensuring their balance.

Key words: labor market, demand, supply, labor force, employment of population, employment of elderly population, labor shortage, underemployment.

Introduction

There is a persisting problem of an imbalance of the demand for labor and its supply in the Russian economy: it is manifested in quantitative and qualitative imbalances on the labor market [1; 2]. On the one hand, there are unclaimed workers with certain qualifications and knowledge on the labor market; on the other hand, there is a shortage of workers in specific professions and specialties. It limits the growth of labor productivity and, ultimately, hinders economic development [3]. Since 2007, the share of the working-age population has been declining annually, and it had fallen from 63.0% to 55.9% by 2019. Even considering increased retirement age, according to the Rosstat forecast¹, it will not exceed the level of 2007 (60.1–62.5%, depending on the forecast version) by 2035. Population's ageing in the future will exacerbate the unbalance problem on the Russian labor market [4; 5]. According to A.G. Korovkin [2], there might be a shortage of labor even at low rates of economic growth, when the aggregate demand for labor stagnates.

The lack of balance between the demand for labor and its supply leads to big economic losses, so it is important to look for new and improve existing tools to realize the potential of using the main

production factor – labor. It is believed that implementation of active longevity strategy is an efficient tool for solving current and future problems associated with population's aging [6; 7]. According to studies [8], a certain share of older age cohorts retains their resource potential in Russia – health, a high level of education, and significant intelligence. Moreover, the labor activity of pensioners is not a new phenomenon for Russia. However, many experts are concerned that older workers may face problems when looking for a new job and maintaining their current workplace [9]. The analysis of age discrimination [10] showed that the chances of employment for a person at the age of 29 are 1.8–2.5 times higher than at the age of 48. Accordingly, the change of working capacity limits in Russia poses new challenges for the labor market, related to this labor force and its need on the labor market [11]. The study of the interaction of factors of the demand formation for labor and its supply will allow us to assess possible further trends on the labor market, which is especially important when the ageing of population becomes a significant constraint in the formation of employment.

Approach

Due to a weak, for objective reasons, statistical security of the studied issue at the macroeconomic level [12], researchers face the problem of assessing and formalizing the concepts of labor demand and supply. As a rule, a number of employees

¹ *Estimated Population of the Russian Federation until 2035: Stat. Bull.* Moscow, Rosstat, 2020. Available at: <https://gks.ru/compendium/document/13285> (accessed: December 1, 2020).

and vacancies are used for the analysis of labor demand, and size of the labor force and a number of unemployed – for the supply of labor. Discrepancy between labor demand and labor supply is estimated by comparing the values of these indicators [13; 14; 15]. This approach is included in A. G. Korovkin's model of coordinating labor demand and its supply [16]. This model describes the interaction between a number of potential employees (difference between working-age population and those employed in the economy) and vacant jobs. It takes into account demographic processes, factor of movement of employees and jobs. Such approaches are widely used in assessing the balance of labor supply and demand, but they have a disadvantage associated with the statistical accounting methodology. Thus, shortcomings of the use of capital and labor, inefficiency of the labor market functioning lead to a deviation of the real employment indicator from the demand for labor². In addition, depending on the data source, there may be quite serious discrepancies in the estimate of a number of employees [15]. The declared need for employees in the form of vacancies, as V. E. Gimpelson notes [17], is far from being identical with the efficient demand for labor and the creation of jobs. Considering the aforementioned, we propose an original solution to the formalization of the concepts of labor demand and supply. The demand for labor and its supply are described using two sets (vectors) of indicators – factors of demand and supply formation on the labor market.

In the scientific literature, the question of a set of factors that form the demand for labor and its supply is not debatable. The textbooks³ highlight such macroeconomic factors of labor demand as the level of economic development, investment activity,

state of production factors, and the unemployment level. The supply, according to the theory of labor economics, reflects the willingness of workers to sell their labor for a certain reward, so it depends on the availability of labor and the level of its education and qualifications⁴ [18]. In various scientific studies, this list of supply and demand factors is similar, but, depending on the scientific goals, it is supplemented considering the specifics or features of the labor market segment. Thus, for a complete and adequate assessment of the employment dynamics and the labor market, presented by scientists from the Institute of Economic Forecasting of RAS and the Moscow School of Economics at the Lomonosov Moscow State University⁵, a total demand of the economy for labor is determined by the volume of production and investment, and a total supply – by demographic trends and the labor potential quality. In the analysis of the relationship between supply and demand on the labor market considering the gender structure of the labor force, I. B. Korolev [19] additionally identified such factors as the size of the public sector and the service sector. In studying the process of coordinating supply and demand taking into account educational features of the labor force [20], a set of factors that affect demand was significantly expanded (the level of technologies used, parameters of state policy in the field of education, availability of education, etc.; *Fig. 1*).

During a decline in working-age population, the problem of determining alternative sources of labor resources, as well as opportunities to make up for numerical labor losses, is important [21]. Therefore, for the purpose of our study, labor migration, informal employment, and labor activity of elderly population are also considered labor supply factors. These factors characterize a satisfied need (demand) for labor; each of these employment types

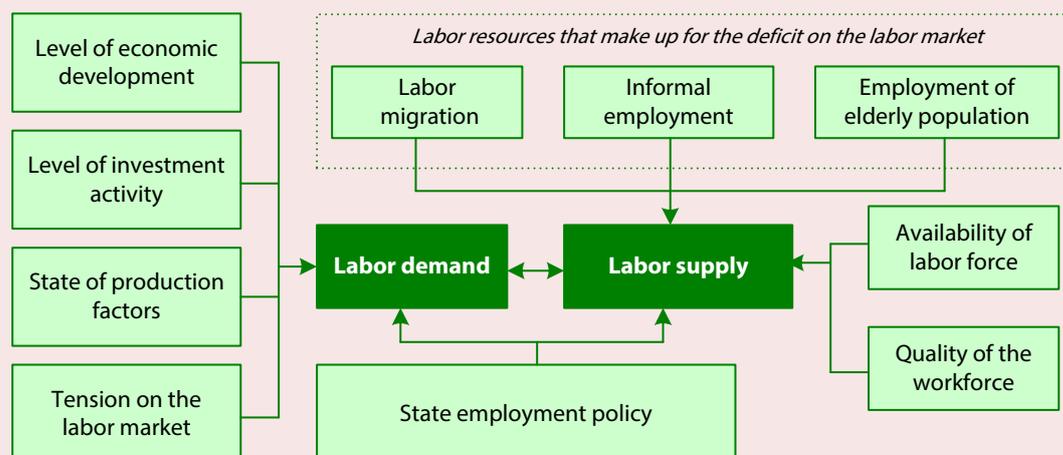
² *Applied Forecasting of the National Economy: Textbook*. Ed. by Ivanter V.V., Budanov I.A., Korovkin A.G., Sutyagin V. S. Moscow: Ekonomist, 2007. 896 p.

³ Ermolaeva S.G. *Labor Market: Study Guide*. Yekaterinburg: Izd-vo Ural. un-ta, 2015. 108 p.; Rofe A.I. *Labor Market: Textbook*. 3rd Ed. Moscow: Knorus, 2015. 376 p.

⁴ *Labor Market: Textbook*. Ed. by V.S. Bulanova, N.A. Volgina. 3rd Ed. Moscow: Ekzamen, 2007. 479 p.

⁵ *Applied Forecasting of the National Economy: Textbook*. Ed. by Ivanter V.V., Budanov I.A., Korovkin A.G., Sutyagin V. S. Moscow: Ekonomist, 2007. 896 p.

Figure 1. Factors of the formation of demand for labor and its supply



Source: own compilation.

occupies a specific segment, a “niche” on the labor market [22–26]. At the same time, they ensure replenishment of the deficit and the balance on the labor market, which characterizes the potential supply of labor. The inclusion of these factors in the model will allow assessing their impact on the balance between labor demand and its supply.

Research data

The statistical basis of the study is Rosstat data for 2006–2018 for the regions of Russia, including the results of sample surveys of the labor force. The corresponding indicators are selected for the chosen factors of the formation of labor demand and its supply (Tab. 1).

Table 1. Indicators of supply and demand factors on the labor market

Indicator designation	Indicator, measurement unit
Indicators of demand factors	
X_1	Degree of depreciation of fixed assets for the full range of organizations, %
X_2	Indices of the physical volume of investments in fixed capital, in comparable prices, as a percentage of the previous year
X_3	Unemployment rate of population aged 15–72 years, %
X_4	Labor productivity index, as a percentage of the previous year
X_5	Index of the physical volume of the gross regional product, in constant prices, as a percentage of the previous year
X_6	Labor market tension coefficient, units
Indicators of supply factors	
Y_1	Employed in the informal sector, as a percentage of a total employed population*
Y_2	Labor force participation rate of population aged 15–72, %**
Y_3	Population with higher and secondary vocational education, as a percentage of the workforce**
Y_4	Number of employed people entering work, as a percentage of a number of employed people in a corresponding region
Y_5	Employment of population aged 60–72 years, %
* The indicator partially describes informal employment.	
** Considering changes in the terminology of statistical accounting of Rosstat.	
Source: own compilation.	

The model does not include regions that do not have statistical data on the selected indicators, as well as regions with indicator values that deviate more than twice from the average value for a year. As a result, a sample of 68 entities of the Russian Federation was obtained.

Model

The employment level of population aged 60–72 years is one of the indicators of supply factors on the labor market. However, the labor market is a relationship between two sets (vectors) of indicators – supply and demand. There is no output variable here, so it is difficult to use regression analysis. In this case, one of the tools can be the coefficient of closeness of interdependence between random vectors, earlier introduced in the study [27]. For a particular case, when vectors $\mathbf{X} = (X_1, \dots, X_m)$ and $\mathbf{Y} = (Y_1, \dots, Y_l)$ have joint normal distributions, the coefficient of closeness of the interdependence between random vectors \mathbf{X} and \mathbf{Y} is determined by the formula:

$$D_e(\mathbf{X}, \mathbf{Y}) = 1 - \frac{|\mathbf{R}_{\mathbf{X} \cup \mathbf{Y}}|}{|\mathbf{R}_{\mathbf{X}}| \cdot |\mathbf{R}_{\mathbf{Y}}|} \quad (1)$$

where: $|\mathbf{R}_{\mathbf{X}}|$, $|\mathbf{R}_{\mathbf{Y}}|$, $|\mathbf{R}_{\mathbf{X} \cup \mathbf{Y}}|$ are determinants of correlation matrices of random vectors \mathbf{X} , \mathbf{Y} , $\mathbf{Z} = \mathbf{X} \cup \mathbf{Y} = (X_1, \dots, X_m, Y_1, \dots, Y_l)$, $0 \leq D_e(\mathbf{X}, \mathbf{Y}) \leq 1$.

The higher the coefficient value $D_e(\mathbf{X}, \mathbf{Y})$, tighter the relationship between the random vectors \mathbf{X} and \mathbf{Y} is. Value $D_e(\mathbf{X}, \mathbf{Y}) = 1$ indicates the presence of a linear functional relationship between, at least, two components of the vectors \mathbf{X} and \mathbf{Y} . If $D_e(\mathbf{X}, \mathbf{Y}) = 0$, then random vectors \mathbf{X} and \mathbf{Y} are linearly independent.

In this case, we have vectors of indicators of demand $\mathbf{X} = (X_1, \dots, X_6)$ and supply $\mathbf{Y} = (Y_1, \dots, Y_5)$ factors. The analysis showed that they can be described by multidimensional normal distribution laws.

Along with (1), we also introduce an estimate of the contribution to the joint relationship of individual components of \mathbf{X} and \mathbf{Y} vectors:

$$\Delta D_e(\mathbf{X} \setminus X_i, \mathbf{Y}) = D_e(\mathbf{X}, \mathbf{Y}) - D_e(\mathbf{X} \setminus X_i, \mathbf{Y}), \quad i = 1, 2, \dots, 6,$$

$$\Delta D_e(\mathbf{X}, \mathbf{Y} \setminus Y_j) = D_e(\mathbf{X}, \mathbf{Y}) - D_e(\mathbf{X}, \mathbf{Y} \setminus Y_j), \quad j = 1, 2, \dots, 5.$$

Results and discussion

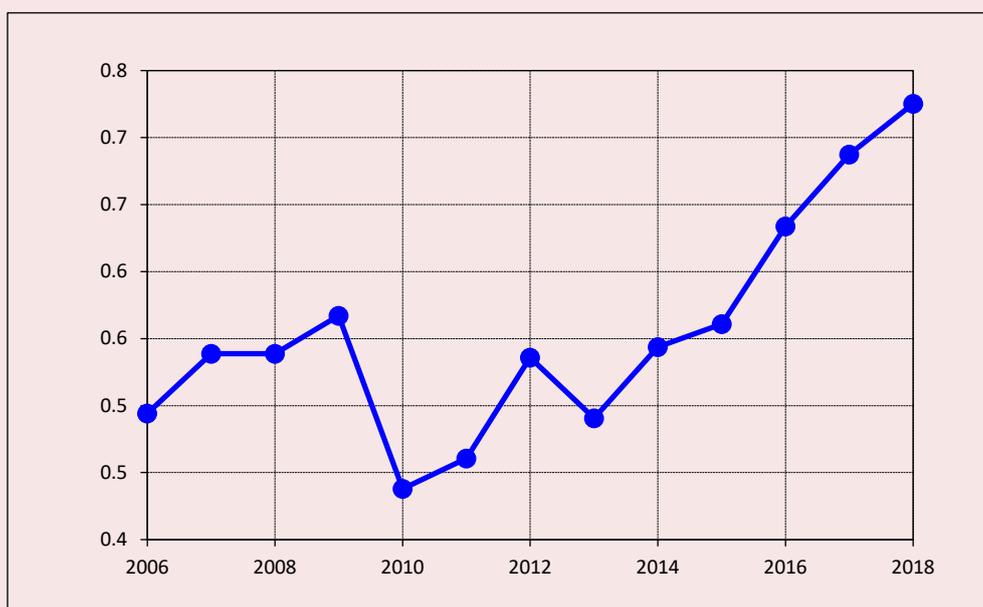
Figure 2 shows the dynamics of the interdependence closeness coefficient between the indicators of supply and demand factors on the labor market for 2006–2018. Since the need for labor varies significantly over time [1; 28], it is expected that the values of the interdependence closeness coefficient between the indicators of labor demand and supply factors changed significantly during the studied period with the financial and economic crisis, economic downturn, sanctions against Russia, and countersanctions.

Thus, closeness of the interconnection significantly decreased in 2010, when a negative balance of the movement of jobs was formed after the implementation of several anti-crisis measures – organization of public works and the creation of temporary jobs (in 2009–2010, the economy lost 2.4 million jobs). On the one hand, these crisis measures stabilized the situation on the labor market. On the other hand, in the post-crisis period, they did not contribute to improving the efficiency of employment and economic development.

Since 2014, there has been a trend of establishing a balance on the labor market. O. I. Izryadnova explains such a reaction in difficult macroeconomic condition by the policy of retaining qualified personnel in the conditions of a real reduction in the labor cost, expectations of increased economic activity, and a shortage of labor supply due to demographic factors and the outflow of migrants [29].

The key feature of the Russian labor market is this adaptation to fluctuations of the economic environment that occurs due to changes of the labor price, rather than the level of employment and unemployment [30]. The labor market adapts not by freeing up the labor force, but by expanding the practices of labor relations. In most cases,

Figure 2. Dynamics of the interdependence closeness coefficient between indicators of supply and demand factors on the labor market, 2006–2018



Source: own compilation.

while choosing between laying off employees and transferring them to part-time work, employers selected the latter, and it allowed them to keep unemployment at the same level. During economic

instability, a number of part-time workers increases [31]. According to Rosstat, in 2012–2018, the share of such employees increased from 5.2 to 11.0% (Tab. 2), and it continues to grow. The highest

Table 2. Change in the number of employees of organizations engaged in part-time work, by type of economic activity, in % to a list number of employees

	2012	2014	2016	2018
Total	5.2	9.9	10.7	11.0
Agriculture, hunting, and forestry	3.7 ^a	7.3	8.1	9.8 ^b
Mining operations	2.3	6.9	8.3	8.8
Manufacturing industries	8.9	21.3	22.0	21.2
Production and distribution of electricity, gas, and water	2.0	6.1	7.0	7.2 ^c
Construction	5.6	15.4	18.1	17.6
Wholesale and retail trade; repair of motor vehicles, motorcycles, household goods, and personal items	2.8	7.2	8.5	9.9 ^d
Hotels and restaurants	n/d	21.6	26	29.8 ^e
Transport and communications	3.2	11.3	12.6	10.1 ^f
Financial activities	1.9	6.1	7.1	8.8 ^g
Real estate transactions, rent, and provision of services	n/d	10.8	11.8	9.8 ^h
Education	n/d	6.7	6.8	7.6
Healthcare and social services work	n/d	6.3	7.0	8.1
Provision of other public, social, and personal services	n/d	8.7	9.7	12.0 ⁱ

End of Table 2

References:
1. Number of part-time employees in organizations:
- at the initiative of an employer;
- by agreement between an employee and an employer;
- those who were unemployed due to the fault of an employer and for reasons beyond the control of an employer and an employee;
- those who were granted leave without pay at the request of an employee.
2. Taking into account changes in the All-Russian Classifier for Economic Activities:
a – Logging operations
b – Agriculture, forestry, hunting, fishing, and fish farming
c – Provision of electricity, gas and steam; air conditioning
d – Wholesale and retail trade; repair of motor vehicles and motorcycles
e – Activities of hotels and catering establishments
f – Transportation and storage
g – Financial and insurance activities
h – Activities related to real estate transactions
i – Provision of other types of services
Source: Rosstat data.

increase rate of this indicator was recorded in the construction sphere: after the investment downturn, the share of list part-time workers grew up from 5.6 to 17.6%. Such high level of part-time employment keeps unemployment down, but, simultaneously, the labor market underperforms.

Thus, with a narrowing labor supply mostly caused by demographic trends, there has been a reduction in labor demand since 2014 influenced by a decline in economic growth. It has led to an

increased tight balance between labor demand and its supply. The growth of partial and part-time employment has become a key process in coordinating supply and demand on the labor market.

Table 3 presents an assessment of an average contribution of each studied supply and demand factor to ensuring the balance on the labor market for 2006–2018. Since the contribution values of factors like the unemployment rate, share of

Table 3. Average contribution of labor demand and supply factors to ensuring the balance on the labor market for 2006–2018

Factor	Average contribution value
Demand factor	
X_1 – Degree of deterioration of fixed capital for the full range of organizations, %	0.074
X_2 – Indices of the physical volume of investments in fixed capital, in comparable prices, as a percentage of a previous year	0.030
X_3 – Unemployment level among population aged 15–72 years, %	0.085
X_4 – Labor productivity index, as a percentage of a previous year	0.052
X_5 – Index of physical volume of the gross regional product, in constant prices, as a percentage of a previous year	0.065
X_6 – Labor market tension coefficient, unit	0.062
Supply factor	
Y_1 – Employed in the informal sector, as a percentage of total employed population	0.061
Y_2 – Labor force participation rate of population aged 15–72, %	0.070
Y_3 – Population with higher and secondary vocational education, as a percentage of workforce	0.080
Y_4 – Number of employed people entering work, as a percentage of a number of employed people in a corresponding region	0.043
Y_5 – Employment among population aged 60–72 years, %	0.096
Source: own compilation.	

population with higher and secondary vocational education in the structure of economically active population, and employment of population aged 60–72 years are quite significant and remain stable, we can conclude that they do have an impact on the functioning of the labor market.

Employment of population aged 60–72 years provided the greatest contribution to ensuring the balance between indicators of supply and demand factors on the labor market. This is an indication of its high potential in meeting labor demand. Employment among population of the older age groups has responded more sensitively to the reduction in the need for labor in certain economic sectors. A.L. Lukyanova and R.I. Kapelyushnikov's analysis of employment among population [32], based on the Rosstat labor force survey for 2005–2017, showed that the decline in employment in the manufacturing industry occurred among the older population with a significant advance in comparison with all other age groups. Moreover, the employment of older people in education and healthcare fields has increased. It is explained by a low attractiveness of these spheres for most young workers. In this regard, a labor resource like labor force of elderly population can fulfill the deficit on the labor market. As noted by M. Ivanova, A. Balaev, E. Gurvich, the growth of labor supply in older age groups is a necessary condition for the equilibrium of the Russian labor market in the medium term [33; 34]. Currently, many countries are actively developing and implementing public policies to stimulate and support employment among older people, since they contribute, on the one hand, to the growth of the economy, and, on the other hand, to the well-being of an ageing society [35].

Conclusion

In this paper, we propose an original formula for calculating the closeness coefficient of the correlation relationship between two random vectors (sets of indicators of supply and demand

factors on the labor market). The research, based on the calculation of this coefficient, allowed considering the factors of their formation and making quantitative estimates. Indicators of factors of demand for labor and its supply adequately characterize the labor market, and they can be used for studying employment. The assessment of the closeness of the relationship between two sets of indicators assesses the equilibrium on the labor market as a dynamic process that is influenced by the factors of demand and supply formation.

The results of the study showed that there has been a trend of establishing a balance between the demand for labor and its supply since 2014. In difficult macroeconomic conditions, the Russian labor market has adapted not by freeing up the labor force, but by expanding labor relations practices (including means of underemployment) while maintaining a low unemployment rate. Economic downturn has led to a reduction in the need for labor that, on the background of a narrowing supply of labor resources caused by population's ageing, has strengthened the balance between supply and demand on the labor market. The growth of partial and part-time employment has become a key process in reconciling the demand for labor and its supply. Currently, the "coronavirus crisis" has intensified this trend, new forms of employment actively develop on the labor market, and the so-called "hidden unemployment" is growing. V.E. Gimpelson and R.I. Kapelyushnikov's study based on the Internet-survey "Work and Employment during the Epidemic"⁶ showed new adaptation forms on the Russian labor market.

⁶ HSE experts study how the Russian labor market is adapting to the COVID-19 crisis. National Research University "Higher School of Economics". Available at: <https://www.hse.ru/news/expertise/369700469.html> (accessed: December 1, 2020).

The inclusion of factors in the model allowed assessing their impact on the equilibrium on the labor market. The most significant factor among all indicators of supply and demand on the labor market was the employment of population aged 60–72 years.

A significant excess of closeness interdependence coefficient between the indicators of factors of labor demand and its supply for individual regions, compared with the all-Russian indicator, indicates the presence of existing differentiation and specifics on regional labor markets.

The study of the interaction of factors of labor demand and its supply formation will allow assessing

possible further trends on the labor market, which is especially important in conditions when population's ageing becomes a significant constraint in the formation of employment. It is necessary to create conditions for expanding the employment forms (including new ones: outstaffing, smartstaffing, outsourcing, etc.) and stimulating labor activity among elderly population to achieve a balanced labor market. Diversified employment relations will improve the adaptation of the labor market to various socio-economic challenges, but the realization of its potential benefits depends on institutions and policies that require productive employment of potential workers.

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Information about the Authors

Aleksandr N. Tyrsin – Doctor of Sciences (Engineering), Professor of Department, Ural Federal University (19, Mira Street, Yekaterinburg, 620002, Russian Federation; e-mail: a.n.tyrsin@urfu.ru), Leading Researcher, South Ural State University (National Research University) (76, Lenina Street, Chelyabinsk, 454080, Russian Federation)

Elena V. Vasilyeva – Candidate of Sciences (Economics), Acting Director, Center for Economic Security, Institute of Economics of the Ural Branch of the Russian Academy of Sciences (office 523, 29, Moskovskaya Street, Yekaterinburg, 620014, Russian Federation; e-mail: elvitvas@ya.ru)

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