Relationship between Supply and Demand Factors in Regional Labor Markets

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Abstract: The article presents the author's approach to the analysis of matching labor demand and supply. The essence of the approach is to dynamically assess the closeness of the relationship between two sets of indicators describing their factors. The proposed model for calculating the coefficient of the closeness of the relationship made it possible to consider the factors of formation of demand for labor and its supply simultaneously, as well as to make quantitative estimates. Approbation of the approach was carried out on the example of the constituent entities of the Russian Federation included in the Ural Federal District. The estimation results show that the tightness of the relationship between the indicators of labor market supply and demand factors has increased over 2000-2019. The most significant contribution to the alignment of supply and demand in regional labor markets is made by the demographic factor - the share of the population of working age.

1 INTRODUCTION

In the context of economic instability and decline in the working-age population, the search for fundamentally new approaches to more efficient use of productive resources, the most important of which is labor, is of particular importance. To improve the policy in labor resources management, it is necessary to study the mechanisms affecting the alignment of labor demand and supply.

An obvious approach to analyzing the matching of labor demand and supply is to compare them (Korovkin et al., 2012). According to A.G. Korovin (2011), labor supply and demand exist in satisfied and unsatisfied (current) states. The number of employed in the economy characterizes the satisfied, and the number of vacancies characterizes the unsatisfied demand for labor. As a whole, they constitute the aggregate demand for labor. Similarly, in the aggregate labor supply, there is a part identically equal to satisfied demand for labor and a part corresponding to unsatisfied (current) supply - the number of unemployed population. Therefore, in theory, if the number of the employed population and the number of vacancies is equal to the number of the employed and unemployed population, there is equilibrium in the labor market. However, in practice, when comparing these indicators of supply and demand, there is a problem of accurately determining their values - a problem of statistical accounting.

Demyanova A. and Ryzhikova Z. (2020) noted that the problem of the validity of the adopted labor market aggregate measures is not new and has accompanied economists throughout the XX century. CardD. (2011) describes approaches to the definition of "unemployment" and searches for theoretical justification of its measurement. At present, in Russian statistics, the number of unemployed is measured by the number of the population officially registered with the employment services or calculated according to the methodology of the International Labour Organization. There are also two main sources of data on the total number of employed people in Russia: sample surveys of the population on employment problems and estimates based on the labor resources balance methodology. As a result, there are rather serious discrepancies between such alternative estimates of the number of the

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unemployed and employed population (Kapelyushnikov and Oshchepkov, 2014). In statistics, the number of vacancies is estimated through the indicator "employers' declared need for workers", which raises questions about the adequacy of this measurement. Thus, Gimpelson V.E. (2004) believes that the declared need for workers is far from being identical to the solvent demand for labor and job creation. Tkachenko A.A. and Ginoyan A.B. (2017) express a more categorical point of view. There is no statistical basis for forecasting the economy's needs in qualified personnel and high-demand professions in Russian reality. Moreover, given hidden unemployment, shadow, and secondary employment, the proposed indicators cannot be adequate (accurate) measures of labor demand and supply.

To get away from objectively existing limitations in statistical accounting, in the framework of this study, the demand for labor and its supply are described not by separate indicators but by a set of indicators - two sets of indicators (vectors) that characterize the factors of their formation. The proposed author's approach to the analysis of matching between the demand for labor and its supply consists of a dynamic assessment of the closeness of the relationship between the two sets of indicators describing their factors.

2 LABOUR DEMAND AND SUPPLY FACTORS

The scientific and academic literature considers the main macroeconomic conditions and trends as factors shaping the demand for labor. The study by E.S. Mironova (2010) describes this formation process as follows: rather high economic growth rates determine the expansion of demand for labor, and, conversely, under the impact of production decline, a significant part of the labor force is released. Moreover, the investment component of economic growth matters for the formation of demand for labor. In the textbook prepared by the Institute of Economic Forecasting of the Russian Academy of Sciences and the Moscow School of Economics of MSU (Ivanter et al., 2007), this is explained by the fact that growth of production and investment creates new jobs. Uzyakova E.S. (2011) also considers gross output and the amount of capital employed as basic indicators that determine the economy's demand for labor, as they reflect the scale of production.

In addition, the demand for labor is determined by the demand for goods in society (Ermolaeva, 2015), which is consistent with the Marshall-Hicks laws - laws of derived demand: the demand for factors of production (including labor) is derived from the demand for the final product. As noted by S.S. Nosova (2001) and F.N. Mailyan (2009), the following factors underlie the changes in demand for labor:

- changes in the demand for a product: all else being equal, a change in the demand for a product that is produced by a particular type of labour will lead to a shift in the demand for labour in the same direction;
- change in labor productivity: if other factors remain unchanged, a change in labor productivity leads to a unidirectional change in the labor demand curve
- change in price of other resources: the change in price of one resource on the demand of another resource depends on the degree of interchangeability or complementarity of these resources.

The supply of labour is determined by the availability of labour and its quality. Supply is influenced by demographic and migration trends (Ivanter et al., 2007). Demographic processes shape the potential size of the labor force and its separate age groups (Ahapkin, 2012), while immigration flows are a resource for its increase (Uzyakova, 2011). The determining factor of labor supply in terms of its quality is the level of professional training.

The literature review showed that macroeconomic trends (economic growth, scale of production, investment, consumer demand, and labor productivity) are the main drivers of labor demand. The main factors of labor supply are demographic and migration trends, as well as the level of professional education of the population.

3 SURVEY DATA

The statistical base for the study was Rosstat data by Russian regions, including the results of sample labor force surveys. The period from 2000 to 2019 is chosen as the analyzed time series because, on the one hand, it allows us to estimate the indicators of interrelation quite correctly, and, on the other hand, it is still possible to study the dynamics. Following the factors of formation of demand for labor and its supply identified based on the literature review, indicators have been selected. Indicators of labor demand and supply factors are shown in Table 1.

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

Designation	Indicator, unit of measurement
Demand factor indicators	
X_1	Index of the physical volume of gross regional product (GRP) in constant prices, in percent to the previous year
X_2	Index of physical volume of investment in fixed capital in comparable prices, as a percentage of the previous year
X_3	Growth rate of labor productivity per employee (adjusted for inflation), percent
X_4	Index of physical volume of retail trade turnover, percent
Indicators of supply factors	
Y_1	Proportion of working-age population in the total population, percent
Y_2	Graduation of specialists in the total population, persons per thousand people.
Y_3	Migration growth rate, persons per 10,000 population

The index of physical volume of GRP (X_1), was chosen as an indicator of economic growth and scale of production. In contrast, the index of physical volume of investment in fixed assets (X_2) was chosen as an indicator of investment volume. The index of physical volume of retail trade turnover (X_4) was used as solvent consumer demand. The growth rate of labor productivity (X_3) is calculated as the growth rate of the ratio of GRP volume to the number of employed in the economy, adjusted for consumer price indexes. To describe demographic and migration factors of labor supply we used indicators of the share of working-age population in the total population (Y_1) and migration growth rate (Y_3). The level of professional education of the population is calculated as the aggregate of mid-level specialists, bachelors, specialists and masters per 10,000 population (Y_2).

4 MODEL

For small samples, the analysis does not reveal the difference of indicators distributions from the normal distribution law. Therefore, we consider the special case when vectors $\mathbf{X}=(X_1,X_2,\ldots,X_m)$ и $\mathbf{Y}=(Y_1,Y_2,\ldots,Y_l)$ have joint normal distributions, the coefficient of closeness of interdependence between random vectors **X** and **Y** is determined by the formula (Tyrsin, 2018)

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

where $\left|\mathbf{R}_{\mathbf{X}}\right|$, $\left|\mathbf{R}_{\mathbf{Y}}\right|$, $\left|\mathbf{R}_{\mathbf{X}\cup\mathbf{Y}}\right|$ – determinants of correlation matrices of random vectors **X**, **Y**, $Z = \mathbf{X} \cup \mathbf{Y} = (X_1, \ldots, X_m, Y_1, \ldots, Y_l)$,
$0 \le D_e(\mathrm{X}, \mathrm{Y}) \le 1$. In this case we have the vectors of demand $\mathbf{X} = (X_1, X_2, X_3, X_4)$ and supply $\mathbf{Y} = (Y_1, Y_2, Y_3)$.

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

The contribution of the demand factor X_i to the change in the closeness of interdependence between the random vectors **X** and **Y** is defined as

$$\Delta D_e(X_i) = D_e(\mathbf{X}, \mathbf{Y}) - D_e(\mathbf{X}\setminus X_i, \mathbf{Y}),$$

where $\mathbf{X}\setminus X_i = (X_1, \ldots, X_{i-1}, X_{i+1}, \ldots, X_m)$, i.e. it is equal to the difference between the coefficient of close interdependence between all demand and supply factors and the same coefficient without the demand factor X_i.

Similarly, the contribution of the supply factor Yj to the change in the closeness of interdependence between the random vectors **X** and **Y** is defined as

$$\Delta D_e(Yj) = D_e(\mathbf{X}, \mathbf{Y}) - D_e(\mathbf{X}, \mathbf{Y}\setminus Y_j),$$

где $\mathbf{Y}\setminus Y_j = (Y_1, \ldots, Y_{j-1}, Y_{j+1}, \ldots, Y_l)$.

5 RESULTS AND DISCUSSION

The proposed approach to the analysis of matching supply and demand has been tested on the example of the RF subjects that are part of the Ural Federal District. The obtained results of the assessment of the dynamics of the coefficient of close interdependence between the two vectors - two sets of indicators of supply and demand factors in the labor market - are presented in Table 2. The $D_e(\mathbf{X}, \mathbf{Y})$ coefficient was estimated for periods of 13 years. This period allows us, on the one hand, to smooth out the random component and, on the other hand, allows us to highlight the main trends in the labor market of the RF subjects.

Table 2: Dynamics of the coefficient of closeness of interdependence between the indicators of supply and demand factors on the labor market.

Period	Kurgan region	Sverdlovsk region	Tyumen region	Chelyabinsk region
2000-2012	0.622	0.851	0.798	0.692
2001-2013	0.652	0.804	0.812	0.678
2002-2014	0.717	0.847	0.844	0.778
2003-2015	0.744	0.903	0.904	0.908
2004-2016	0.750	0.983	0.936	0.945
2005-2017	0.762	0.976	0.957	0.952
2006-2018	0.908	0.890	0.967	0.911
2007-2019	0,863	0.882	0.921	0.933

Over the analyzed period, the tightness of the relationship between the indicators of labor demand and supply factors has increased for all the subjects of the Russian Federation under consideration. The most significant increase in interconnection is observed in the Kurgan region, explained by the "low start effect". Moreover, the differentiation (gap) between the RF subjects by this coefficient decreased over 2000-2019. But the trajectory of the interdependence curve differs by constituent entities of the Russian Federation. For example, Sverdlovsk region peaked in 2004-2016, Tyumen and Kurgan regions in 2006-2018, and the Chelyabinsk Oblast in 2005-2017.

Table 3 shows the values of $D_e(\mathbf{X}, \mathbf{Y})$ coefficient on the whole sample from 2000 to 2019. The strongest correlation between the indicators of supply and demand factors in the labor market is observed in the Sverdlovsk region, where there is a relatively favorable macroeconomic situation. Thus, GRP growth rates in Sverdlovsk region are slightly higher, with an annual growth rate of 104.9% over 2000-2019 (in other subjects of the Urals Federal District it varies from 102.6% to 103.9%).

Table 3: Values of the coefficient of close interdependence between the indicators of supply and demand factors in the labor market in the subjects of the Ural Federal District in 2000-2019.

Period	Kurgan region	Sverdlovsk region	Tyumen region	Chelyabinsk region
2000-2012	0.675	0.874	0.746	0.742

Table 4 presents an estimate of the average contribution over 2000-2019 of each analyzed supply and demand factor to the consistency between them in the labor market. In Kurgan, Sverdlovsk and Chelyabinsk regions the determining factors on the demand side are the volume of retail trade turnover (X_4), and on the supply side - the share of working-age population (Y_1). In addition to the demographic factor of labor supply (Y_1), the volume of investment in fixed capital (X_2) and the output of specialists (Y_2) have a significant impact on the labor market in Tyumen regions.

Table 4: Average contribution of each of the factors to changes in the tightness of the relationship between supply and demand factors over the period 2000-2019.

Contribution of factors	Kurgan region	Sverdlovsk region	Tyumen region	Chelyabinsk region
X_1	0.013	0.062	0.061	0.043
X_2	0.085	0.007	0.104	0,067
X_3	0.014	0.100	0.010	0.041
X_4	0.233	0.229	0.069	0.411
Y_1	0.226	0.468	0.273	0.474
Y_2	0.104	0.121	0.221	0.058
Y_3	0.141	0.053	0.077	0.048

As the results of the assessment show, matching labor demand and supply is weakly responsive to changes in output, which is an important feature of the Russian labor market. Researchers (Mironova, 2010; Gimpel'son et al., 2017) note that in a crisis situation, adaptation in the labor market occurs not through changes in employment and unemployment, but the spread of various forms of underemployment. Earlier research (Tyrsin and Vasil'eva, 2021) on the Russian labor market showed similar trends.

6 CONCLUSIONS

This study presents the author's approach to the analysis of matching labor demand and supply. The essence of the approach is to dynamically assess the closeness of the relationship between two sets of indicators describing their factors. Using the correlation coefficient made it possible to consider all indicators of supply and demand factors in the labor market simultaneously and make quantitative estimates. The approach was tested on the example of the constituent entities of the Russian Federation that

make up the Ural Federal District. The estimation results show that the tightness of the relationship between the indicators of labor market supply and demand factors has increased over 2000-2019. The most significant contribution to the alignment of supply and demand in regional labor markets is made by the demographic factor - the share of the population of working age. Besides, in some subjects of the Russian Federation, the functioning of the labor market is significantly influenced by the turnover of retail trade, the volume of investments in fixed capital, and the output of specialists. The proposed indicators of supply and demand factors adequately characterize the labor market and can be used in the study of employment based on the coefficient.

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