
A Dynamic Model in the Labor Market: Reasons of Imbalances at the Transition Stage of the Economy

L. Matraeva¹, E. Vasiutina², S. Erokhin³, O. Kaurova⁴

Abstract:

The aim of this work is the formalization of the model of coordination of interests of employers and owners of human capital in the labor market in high-tech industries of the national economy in the conditions of transformation of the national economy. Research conducted by the authors proved that the structure of costs of reproduction of human capital and the requirements for human potential have their own distinct features that should be considered in the specification of the economic model of value creation of human capital in these sectors.

Authors propose an improved method of balancing interaction of economic interests of subjects of the labor market: employee and employer. The model reveals the mechanism of formation of the equilibrium value of human capital based on the cost approach and the income approach in modeling supply and demand in the labor market in high-tech industries. The model allows to estimate a quasi-equilibrium state of the labor market in high-tech industries with emerging trends in this market in the country as a whole.

The study provides valuable analytical information required to implement science-based economic decisions in the management of human resources and their transformation into human capital, which in turn will improve the efficiency of realization of innovation potential of the company as the subject of the high-tech industry of national economy.

At the level of state governance model allows to monitor the mismatches in the labor market that allows to develop actions to minimize their negative impacts on the national economy.

Keywords: *Equilibrium model, human capital, labor market.*

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¹Russian State Social University, Russian Federation, matraeva@rambler.ru

²Russian State Social University, Russian Federation

³Russian State Social University, Russian Federation

⁴Russian State Social University, Russian Federation

1. Introduction

Most Russian academic economists, who analyze the processes taking place in the Russian labor market, recognize that its prominent feature is the imbalance in the labor supply and demand (Shestakova, 2016, Vishnyakova, 2016). It should be noted that this imbalance works two ways. On the one hand, there is a significant percentage of unemployed economically active citizens, but, on the other hand, there is an acute professionals and skilled employees scarcity (Figure 1).

Figure 1. Organizations' demand for employees to take up vacant jobs and the unemployment level in Russia in 2010-2016 (Russian State Statistics Service, 2016)



For the analyzed period, one can note a very special feature of the Russian labor market. Proportion of demand for employees to take up vacant jobs *has in practice no correlation with the unemployment level and does not respond to its quantitative changes*. So, despite the fact that unemployment level decreased by almost 25% between 2010 and 2016, proportion of demand for employees to take up vacant jobs increased by 1% over the same period. In Russia, during the period from 2010 to 2012, demand for employees stated by employers, has increased by 1.4 times (Figure 1), also large and medium-sized organizations required more than 48 thousand professionals of higher qualification in the field of natural and engineering sciences, which is 25% of total number of vacancies. According to information of Russian State Statistics Service, at the end of December 2016, the demand for employees stated by organizations decreased by 22.3% as compared to the same period of 2014. Nevertheless, the demand for higher qualification professionals continues to increase and amounts to about 27% of total demand, in 2014 this figure was 22.5% of current demand (Data on the number and demand of organizations for employees by professional groups, 2016). Thus, the overall decrease in demand of organizations for employees practically does not affect this category.

In addition, results of a comprehensive observation of the population living conditions conducted by Russian State Statistics Service in 2016 showed that the level of job satisfaction grows together with the level of education of the population. The maximum job satisfaction is specific to higher qualification professionals: 80.1% (averagely in the Russian Federation – 68.2%), level of remuneration satisfaction – 49.8% (averagely in the Russian Federation – 37.4%).

The second peculiarity of the Russian labor market, in our opinion, is the existing imbalance in the demand and supply of labor within certain industries. Table 1 provides information on the correspondence of the obtained specialty to the job. In general, about 75% of people in the Russian Federation have a profession or a specialty which is confirmed by a special document. However, according to data for 2016, 35.0% of respondents pointed that their specialty does not correspond to their job. Among them, 26% are persons with higher education. A significantly higher percentage of respondents with secondary vocational education have jobs that do not correspond to the obtained diplomas – 42.2%.

Table 1. *An obtained specialty and its compliance with the job in the Russian Federation, 2016*

	All respondents	including respondents having education				
		higher - total	incomplete higher (undergraduate degree)	secondary vocational	secondary general	basic general
Persons aged 15 years and over, employed in the economy and having a profession confirmed by a special document - total, incl. with their work	100.0	100.0	100.0	100.0	100.0	100.0
completely corresponding to the obtained specialty	46.7	52.0	31.9	42.3	56.7	51.7
close to the obtained specialty	18.1	21.7	23.9	15.3	9.9	7.8
not corresponding to the obtained specialty	35.0	26.0	44.2	42.2	31.6	40.5
being undefined	0.2	0.2	0.0	0.2	1.7	0.0

One of the reasons for this phenomenon is the imbalance of labor supply and demand. So, in 2016 the most popular fields were still the fields related to humanity communication (journalism, economics, legal studies, political science). In a number

of leading universities the demand for “Advertising and Public Relations”, “Linguistics and Foreign Languages”, “Oriental Studies and African Studies” has grown, the number of students admitted to these fields of study is several times more than the number of allocated budgetary places. Top unpopular fields are: machine building, printing, metallurgy, food industry, agriculture, architecture. The field of “Agriculture and Fisheries” is among “anti-leaders” (Monitoring the quality of admission to universities, 2016).

Thus, the situation in the Russian labor market is that the expansion of application of new science-intensive technologies and their development leads to a change in the professional and skill structure of demand in the labor market, increasing an employer’s demand for the quality of labor. At the same time there is an acute scarcity of skilled employees of many professions and specialties.

Consequently, a stable contradiction is emerging in the Russian labor market, it is associated with a systemic imbalance of supply and demand for skilled employees in the long term and causes significant disparities in the labor market as part of occupation types and occupational groups, and there is a scarcity of skilled employees in a number of professions and specialties. In the presence of conflicting signals coming from the labor market, families do not in a hurry to change their educational priorities and orient prospective students to the specialties that, in their opinion, are of the greatest demand – economist, manager, lawyer (Larina, 2017). At the same time, one should understand that in the conditions of modernization of production and introduction of new science-intensive technologies, the problem of the scarcity of skilled engineering and technical employees will only worsen.

2. Literature Review

With respect to labor market analysis methodology, there has always been a dichotomy between microeconomic and macroeconomic approaches. Supporters of the first approach relied on microeconomic arguments when modeling labor market equilibrium and focused on counterbalancing forces of competitive markets. Adepts of this approach were mostly neoclassicists A. Pigou, P. Samuelson, R. Hall, and in the 80’s also supply economics concept supporters D. Gilder, M. Feldstein, A. Laffer, and others. Among modern works of the first approach, there should be noted the work of Machin and Manning (Machin and Manning, 2004), who conducted a study on whether the labor market can be considered competitive.

The second approach began to develop after the work of J. Keynes, *The General Theory of Employment, Interest and Money* (Keynes, 1936). Basic concept of labor market analysis relied on macroeconomic arguments based on empirically observed processes (Krause and Lubik, 2014). However, these works were devoted precisely to matching the supply and demand curves in the short term.

Nevertheless, the synthetic approach that combines these two approaches is also actively developing and pays special attention to the by-effects of institutional changes in the labor market. The Davidson's works (Davidson, 1998; 1999; 2008) should be underlined within this approach. He was one of the first to emphasize that institutions are crucial for explaining various long-term effects labor markets. Among representatives of the Russian school, the work of (Solodukha, 2016) and (Bakumenko, 2015) is devoted to this aspect.

As to jobs related to effects on the labor market in the long term, the works of authors were devoted to the study of specific effects, but there was no single, systematic research in this field (Adascalitei, 2015) Accordingly, in the framework of this study, the basic theses were:

1. In an unstable market environment, labor market models based on macroeconomic arguments have a lower analytical and predictive ability for two main reasons. Firstly, the very arguments become more volatile in this case, and, as a result, hardly predictable. Secondly, in conditions of unstable and crisis economy, the state strengthens its regulatory function and, as a result, political decisions smooth out or completely reduce existing economic patterns. Given that the labor market is considered to be strategically important market from the point of view of state regulation, this effect reveals itself there to the greatest extent. In this regard, to describe the effects emerging in the labor market in the long term, it is most desirable to use microeconomic arguments.

2. In an unstable environment, the most important is to predict possible effects and imbalances associated with the imbalance of the market. In this regard, the main result of this work was formation of systemic dynamic logical-empirical models able to reflect the realities of supply and demand in the labor market in the long term and allowing to predict possible effects associated with implementation of state policy in this market.

3. The authors selected high-tech industries as the subject of research, since, on the one hand, they are of strategic importance for the development not only of Russia but also of any state in the conditions of modern economy, on the other hand, it is these sectors that have certain features in terms of demand and supply, which allows them to be grouped to a separate class for research (Krebs and Scheffel, 2013).

4. The Methodology

The following general scientific methods were used in course of research: a method of content analysis intended for analyzing the semantic content of textual arrays on the subject of research, as well as tools for inductive and deductive analysis, allowing to combine separate conclusions on this problem and formulate the author's vision of the problem. Special methods were also used: absolute and relative statistical indicators, indicators of dynamics, logical-empirical models for the formation of supply and demand in the labor market, and methods for visualizing

the results of research. In course of formation and description of models, the authors tried to adhere to the principles of an integrated approach that allows to establish the most significant interrelations and trends in phenomena and processes in the labor market and formalize the most significant effects. Information base of the research consisted of official statistical materials of the Federal State Statistics Service of Russia.

5. Imbalances in the labor market: natural or dangerous?

Analysis of the labor market and causes of imbalances in it at different times included analysis of supply and demand, and the factors determining them. The basis for imbalance and emergence of such phenomena as unemployment, many scientific schools sought in that the basic arguments of functions of supply and demand for labor initially differ (Keynes, 1936). The inconsistency of factors determining the reaction of supply and demand led to emergence of the labor market conditions known as quasi-equilibrium. Their main difference is that the market can be in equilibrium only within the short-term period and in its deep state is close to the simultaneous excess and/or scarcity of labor. Quasi-equilibrium states are especially observed in the sectoral labor markets, as there are no compensating effects and the overflow of labor relative to industries or economy sectors does not smooth out these contradictions (Velu, 2016; Thalassinos *et al.*, 2011).

However, some imbalances in the labor market can be considered as natural, since they exist during the short term and are related to the fact that decision-making both by companies and by the subjects forming labor supply is accompanied by significant transaction expenditures (Avdagic, 2013) The reason for this imbalance between supply and demand is imperfect information about counterparties and what is called the measurement costs. An example may be a situation where the employee does not quite meet the requirements, but it's either long or expensive for a company to look for a new employee and, vice versa, when an employee becomes unsatisfied with a company after employment.

At the same time, the system of labor imbalances can arise in the labor market, for example, when an employer cannot find employees with certain skill level and there is a demand for the profession of a certain specialty along with high unemployment rates. This situation is extremely dangerous for the development of industries where (labor) remuneration is the determining factor in the production of goods, since in this case there is no production key factor in the market, which first causes stagnation, then loss of competitiveness of such industries in the world market. Such industries include, in particular, high-tech industries (Benati and Lubik, 2014).

Another example of long-term imbalance is the excess of highly qualified employees who can not find a decent job in the domestic market. Then, there occurs the "brain drain effect", that is, the outflow of this category of workers to external labor markets.

The key aspect this work is devoted to is that if there is unemployment in the short term while there are vacancies in the labor market, then this process is natural for such a market. But for the *long term*, this imbalance is not so much related to the specifics of the labor market, but to the result of the decision-making process by rational subjects, companies and households. The main task of the state should be the smoothing out of a significant long-term imbalance and this process must be taken into account for assessment of effectiveness of state policies in the labor market.

6. Simulation of equilibrium in the labor market: different approaches to the model architecture

Variety of factors affecting the supply and demand of labor in its essence still implies coordination of interests through intervention of government and overcoming of those failures that the market can not manage (Maloletko, 2016).

However, quasi-equilibrium states can also be revealed in another aspect, once the labor market model starts taking the time factor into account. In many researches, the time factor was taken into account by lagging the variable for the supply of labor, which allowed us to solve applied problems on the analysis and forecasting of the market, but the model described the market well in conditions when the external environment and macrofactors were in a relatively stable state, there were no significant technological shifts and institutional changes were not directional. As soon as conditions that previously had a status quo were consistently removed from the economies of the countries, complex models began to decrease reliability of description of the processes taking place in the labor market, and in fact the only way out was not to fine-tune the models, but to rethink the approach and return to the classical labor demand and supply functions where remuneration amount is the price factor.

Time management becomes possible through rejection of static equilibrium models and change-over to the simplest dynamic models, such as a cobweb model. For technologically advanced industries, such models become very relevant, since time is a factor that can either further stimulate, or severely hamper, and in some cases also stop the development of the industry due to the lack of key resource – qualified employees. Then, labor demand formed by companies depends on the amount of remuneration that is an element of expenditures of the current period for the producer and the decision on employment will be based on the cost of labor that meets certain qualification requirements as of today: $D_L = f(W_t)$, where D_L – labor demand, W_t – labor remuneration for the moment of t .

Labor supply with qualitative and quantitative characteristics, formed by households, focuses on the remuneration actual for an earlier period. This is because the potential employee invests in human capital by getting education in a certain specialty, focusing on remuneration of a professional group in the basic period, but

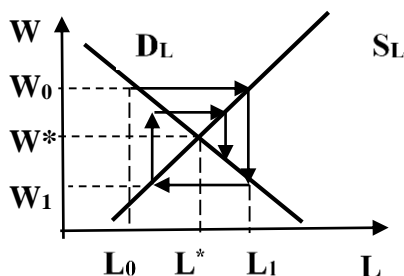
in fact entering the labor market and being able to provide supply only with a certain time lag (in 4-6 years) depending on the term of the specialty: $S_L=f(Wt-n)$, where S_L – labor supply, $Wt-n$ – remuneration as of the moment of education investment decision ($n=1,2,\dots,6$) (Douglas, 2010) Thus, even in the presence of representative functions of supply and demand for labor, only quasi-equilibrium states can be established in the market within the short-term period. The main question that arises and must be solved is the architecture of the operating algorithm for such a model in the long-term period.

7. Specification of the author's dynamic cobweb model for the labor market in high-tech industries

As is known, the reaction of supply and demand to instability of equilibrium or the need for further adjustment can lead to the three potential scenarios:

1. The model reflects the situation in the labor market, when the system, compensates for the time lag in decision-making, tends to move from quasi-equilibrium to a stable equilibrium (Figure 2).

Figure 2. Cobweb model of the labor market (stable equilibrium)

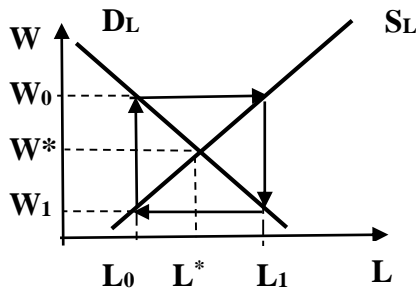


In fact, this will be expressed in the fact that the lag between supply and demand of labor will be reduced over time, and the remuneration fluctuations will have a fading character. For the development of a high-tech industry, such scenario is the most optimal, since barriers to growth and further development are removed by the supply of qualified employees. In addition, during the period of “adaptation” of supply and demand to each other, it is possible to build a system of adaptation of professional competencies to changing technological shifts, which can allow them to quickly overcome retardation of professional skills to requirements of employers

2. The model will enter the cycle format, reproducing and repeating errors in the decision-making concerning supply and demand from period to period (Figure 3). In this case, a quasi-equilibrium state is the only acceptable state with very vague prospects for the development of industry itself and its competitiveness. As a result, the “closed circle” problem arises: an industry can not reach an acceptable level of profitability and competitiveness due to a lack of skilled employees providing a key

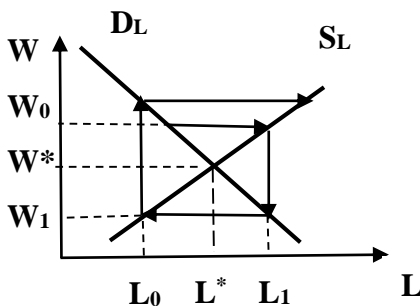
contribution to its development. In turn, the unavailability of a fully functioning industry narrows the labor market of a labor grade and gives rise to the problem of entry into the labor market after obtaining higher education.

Figure 3. Cobweb model of the labor market (the “cycle” situation)



3. The catastrophe model – in this case, the periods of labor scarcity and its overestimation relative to the real contribution to the final product will lead to a sharp surge in labor supply over a certain period of time, but due to lack of key resource for the development of technologically complex industries, speed of increase in the number of jobs will not match the speed of training of new skilled employees, as a result, we will observe either a "brain drain" or their re-qualification to specialties that are in greater demand at the moment, or search and employment in the jobs which do not correspond to the obtained professional competences profile (Figure 4).

Figure 4. Cobweb model of the labor market (the “catastrophe” situation)



And unlike the second scenario, imbalance will only increase, leading to the destruction of an industry as a whole and disappearance of labor market for this specialty (Berg, 2015). And the implementation of a specific type of scenario depends on correlation of demand and supply functions slope angles:

- 1) equilibrium is stable if the slope of supply curve is steeper than the slope of demand curve;
- 2) equilibrium is unstable, with explosive fluctuations in the level of employment and unemployment of individual labor grades if the slope of labor demand curve is steeper than the slope of labor supply curve;
- 3) employment is presented as regular fluctuations around the equilibrium position if the slopes of supply and demand curves are equal.

In its turn, the angle of slope is determined by sensitivity of producers and households to changes to price of the resource. To assess sensitivity of producers to changes in remuneration there is a specific indicator – variable resource marginal product reduction factor, labor in our case. If the marginal product of labor decreases slowly as it is added to a fixed number of other factors, then the MRP_L , or labor demand curve, will decrease slowly and tend to be highly elastic. Even a slight decrease in price of such a resource leads to a relatively large increase in the required amount of the resource. And on the contrary, if the marginal productivity of the resource sharply decreases, then MRP_L , or resource demand curve, will have a steep slope angle. This means that a relatively large increase in wages is followed by a very modest decrease of amount of this resource, the labor demand will not be inelastic.

It can be assumed that the factor of reduction of marginal product of labor in high-tech industries is characterized by a low elasticity. The logic of such assumptions is the following: on the one hand, the proportion of remuneration in cost of final product of high-tech industries is high, that is, the labor with the required qualification characteristics is the key resource for creating the product. On the other hand, demand for final product itself is characterized by low elasticity, since advanced technologies have the ability to compensate for the overestimated costs of development and introduction of innovations through the price. Thus, demand for the resource that determines the development of production and success (also commercial) of finished products, remains insensitive to the value of this resource, that is, remuneration.

Sensitivity of the high-tech industries labor supply to changes of remuneration is related to time factor, established institutional system and state regulation policy. For Russian economy, the index of elasticity of labor supply in high-tech industries remains less than one, this is connected with the education system reform, deregulation of the educational services market, false signals from the labor market, and structural distortions of the national economy itself. For now, an acute scarcity of skilled employees capable of joining the social production sector is becoming chronic. This means that even when remuneration in high-tech sectors is high relative to the average one existing in the economy, labor supply remains relatively stable and reacts poorly to price signals. The problem is primarily in fact that existing vacancies impose on applicants for employment certain requirements of professional competences and skills, which require significant time and money

expenses to obtain. In the labor market, there is a very limited number of applicants with required skills, which, for objective reasons, initially reduces the sensitivity of demand to remuneration change.

The general conclusion on the analysis of demand and supply curves in the labor market of high-tech industries shows that both functions are characterized by low elasticity and are graphically represented with a steep slope. However, the actual question remains: which angle of slope (either of the demand curve or the supply curve) is steeper, it can reveal implementation of a potentially possible model.

8. Conclusion

Two types of imbalances should be distinguished in the labor market of high-tech industries: within the short-term period, the instability of equilibrium parameters of employment and remuneration is estimated as natural and can be minimized by affecting the amount of transaction expenses. However, within the long-term period, the labor market of high-tech industries can increase the contradictions in decision-making carried out by employers and employees, since they are not synchronized in time.

Consideration of the time factor in modeling of the labor market functioning leads to the conclusion that it is necessary to change-over to dynamic models, as their evaluation gives three development scenarios: quasi-equilibrium states through a certain period of time change to a stable equilibrium; quasi-equilibrium states are reproduced from period to period to period (cycle), they allow balancing the labor supply and demand for the current time, but in fact do not contribute to the development of the industry and the establishment of objective remuneration amounts in the labor grade; quasi-equilibrium states shake the labor market and the industry, generating false signals, on the one hand, and leading to complete degradation of the industry, on the other. Since the type of model, and therefore the development scenario depends on correlation of the slopes of the demand and supply curves in the labor market, the state regulation policy must completely change. A complex of measures must be formed taking into account the effect of elasticity of the labor demand and supply curves to the amount of remuneration.

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