

## Forecasting of Labor Market Demand Dynamics on Different Stages of Crisis in Russian Economics

V. A. Gurtov, E. A. Pitukhin, L. M. Serova, and S. V. Sigova

**Abstract**—This paper presents the evaluation of medium-term additional labor force demand based on analysis of projection scenarios of basic macroeconomic indicators of Russian Federation economics during crisis and post-crisis period until 2015. Modeling of additional labor force demand with regard for crisis processes in Russian economics was implemented by formalization of factors that influence labor force dynamics. The verification of projection evaluation of additional labor force demand based on 2009 crisis monitoring data and conditions of dismissed labor force back up during the post-crisis period.

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### INTRODUCTION

One of the key problems of the professional education and labor market systems is evaluation of the Russian economy labor force demand with the required qualification level. The solution of the problem is based on modeling the socio-economic processes considered, in particular, in works of researchers [1–4]. The development of model concepts in connection with the formulation of the projected economic personnel demand in the form of macroeconomic methods is stated by the authors of articles [5–7].

The basis of the procedure is formed by a normative approach based on a forecast of the economic growth rate, investments according to the types of economic activities, and the quantity of labor resources necessary to achieve the planned indices, the approach is unified for all Russian regions. The forecast of the average number of workers (ANW) in the economy is calculated with consideration for forecasts of the volume of produced goods and services (GDP), state of basic assets, investments, labor productivity, and other factors.

In order to determine the annual demand of the economy for qualified personnel, the ANW is structured according to levels of education and types of economic activities with consideration for the share of the annual renewal of the staff composition.<sup>1</sup>

At the last stage, the annual demand for qualified personnel is detailed for enlarged groups of specialties with higher, secondary, and primary education using matrices of profession-qualification correspondences. The US Bureau of Labor Statistics develops similar approach to occupational employment projections in a medium-term period for 50 years [8].

The figures of the predicted economic demand for personnel, developed by the authors of the paper, were used by the Russian Ministry of Education and Science when forming the project of control figures for enrolment in educational institutions of higher, secondary, and primary education for 2008 and 2009 [9].

Currently, under the conditions of a crisis, there is a need to improve the macroeconomic methods in connection with the changing internal and external factors of the impact on the labor market. The suggested paper models the behavior of demand in the labor market under the conditions of this crisis.

**Formalizing the factors affecting the dynamics of the labor market.** The notion of demand in the labor market (LM) has been considered by many Russian researchers [10–12]. This research applies the approach of S.V. Sigova [13, 14], who suggested distinguishing “additional demand” in the category of aggregate demand. According to this approach, the aggregate labor demand represents a union of the many employees working in the labor market (a synonym for the average number of workers (ANW) in the LM) and the set of opened vacancies, i.e., the existing solvent demand for them. The additional demand is also defined there as the annual necessary increment to the available quantity of the labor force up to its optimal quantity (i.e., the amount workers entering the labor market that is required by the parameters of economic development). The additional demand will be formed at the expense of the proceeding retirement of workers from the labor market with consideration for a possible change in the planned number of workers in the future period (due to the growth or decline of the economy). Therefore, additional demand is aimed at supporting the solvent labor demand of employers in a future ( $i + 1$ ) period and not in the current period ( $i$ -th).

The additional demand is stated to be an exclusively “market” category that bears relation to the

<sup>1</sup> See the article by V.A. Gurtov, E.A. Pitukhin, and L.M. Serova, “Modeling the Demand of Economy for the Personnel with Professional Education [6],” for more details.

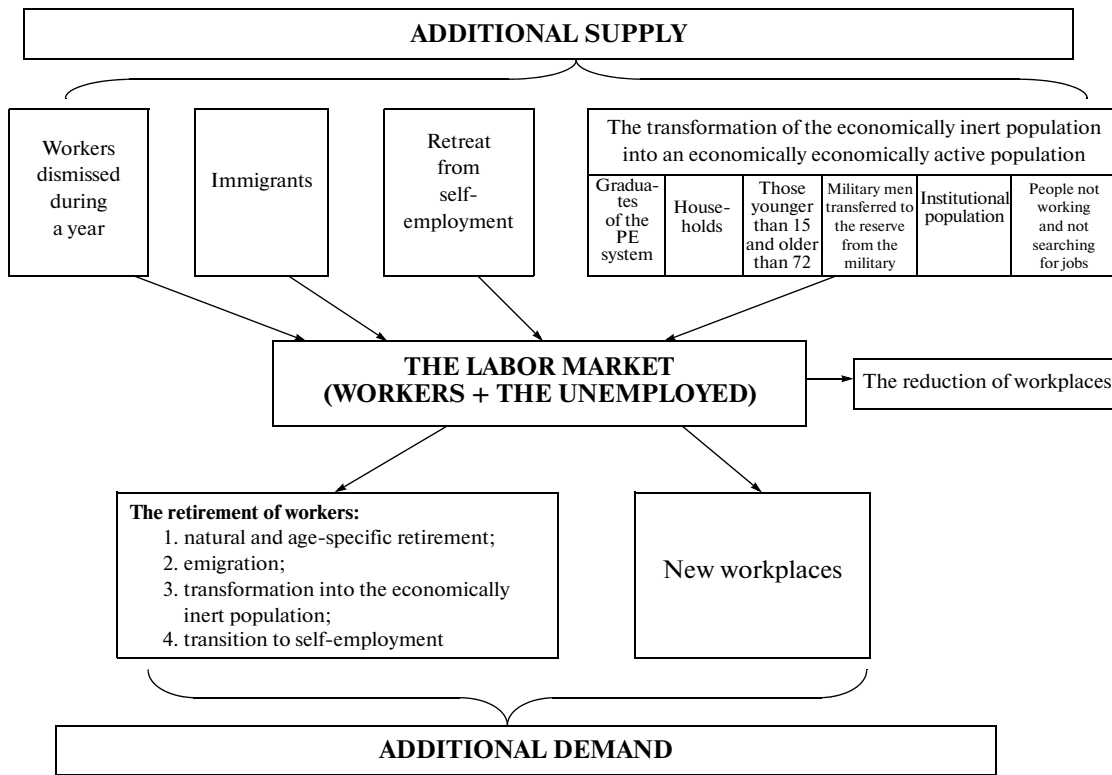


Fig. 1. A conceptual model of the labor market with consideration for the factors of additional demand and additional supply.

functioning of the labor market in the pure form. Owing to the fact that the aggregate demand is defined as the solvent labor demand of an employer, the “labor market” itself will include only the part of employees who work for a wage (“sell their capabilities to work”). Employees who do not work for a wage will remain outside the limits of the labor market.

This emphasizes the difference between the additional demand that is formed on the basis of the category of the “average number of workers (ANW) and the additional demand that is formed on the basis of the wider category of the “average number of employees,” including the entire ensemble of citizens that perform “activities bound with satisfying personal and public needs and usually bringing an earned income” [15].

Consequently, it is suggested that the category of workers—not the category of employees, which is wider and does not relate to the functioning of the labor market in the complete volume—should be used as the basis to define the additional demand in the labor market.

The conceptual model of the labor market with consideration for the factors of the additional demand and additional supply is given in Fig. 1. As is clear, the input flows of the labor force that form the additional supply come to the labor market. The flows of the labor force leaving the labor market promote the formation of additional demand. Since the nonregulated market labor is considered, it is implied that the mar-

ket will absorb as much labor force as it needs. This is only the employed additional supply merely employed part of additional supply employment. This part of the additional supply is equal to the additional demand of the labor market in the state when the market is balanced.

Within the framework of this article, the authors study the behavior of the value of the additional labor force demand in the labor market of the RF that is an economically more correct definition of the notion of “additional economic demand for personnel” used by the authors earlier [5–7].

According to the indicated concept [16], the subset of factors forming the additional demand is designated with the superscript “minus” to show the negative contribution to the volume of the number of workers in the labor market and includes the following:

$L_{SC}^{-}(i)$  is the number of workers dismissed or retired for natural and age-specific reasons (pensioners, the dead);

$L_{V}^{-}(i)$  is the number of workers dismissed for reasons other than natural and age-specific ones: by their own request, reorganization of an enterprise, or due to the crisis;

$L_{MR}^{-}(i)$  is the number of workers moved to other constituent entities of the RF (interregional migrants);

$\Delta L(i)$  is the planned annual change in the ANW in the labor market that must be added to the actual number  $L(i)$  in order to get the desired number of workers  $L(i + 1)$  in the next  $t(i + 1)$ -th year:

$$L(i + 1) = L(i) + \Delta L(i). \quad (1)$$

If  $\Delta L(i) > 0$ , then  $\Delta L(i)$  is the planned annual increase in the ANW, as determined by the development of industry and opening of vacancies for new professions and workplaces (the number of people). If  $\Delta L(i) < 0$ , then  $\Delta L(i)$  is the planned number of workers “under the dismissal” that are under the threat of being dismissed due to the crisis, decline of output, restructuring, and other factors.

The sum of all the retirement flows  $L^-(i)$  is determined by the expression

$$L^-(i) = L_{SC}^-(i) + L_U^-(i) + L_{MR}^-(i) + L_{MF}^-(i). \quad (2)$$

Then, it is necessary to summarize all the retirement flows  $\Delta L(i)$  and planned yearly change in the average number of workers  $L^-(i)$  in order to determine the additional demand  $\Delta D(i)$ :

$$\Delta D(i) = L^-(i) + \Delta L(i). \quad (3)$$

When the numeric modeling of the additional demand in the crisis period is performed, the approach based on the following principles is suggested:

(i) the average number of workers in the LM  $L^{nc}(i)$  and additional demand in the LM  $\Delta D^{nc}(i)$  are modeled according to the “pre-crisis” scenario; then the ANW in the LM  $L^{cr}(i)$  and additional demand in the LM  $\Delta D^{cr}(i)$  are modeled according to the crisis scenario of change in the affecting factors (the superscripts of the corresponding indices have the following meaning: *cr* is the crisis value of an index; *nc* is the crisis-free value of an index);

(ii) the scenarios are understood as the short-term and medium-term forecasts of socioeconomic development made by the Ministry of Economic Development of Russia;

(iii) when the ANW in the labor market is calculated, the main affecting exogenous factors are  $X(i)$  (GDP) and  $F(i)$  (social labor productivity);

(iv) the modeling is carried out while taking into consideration the presence of accessible initial data; therefore, only the natural and age-specific constituent  $L_{SC}^-(i)$  is taken into account among the components of the retirement flow. This is explained by the fact that, if the Russian Federation is regarded as a closed system, then the summary flow of internal interregional migration  $L_{MR}^-(i)$  will be zero. The number of workers dismissed for other reasons (that are not natural and age-specific)  $L_U^-(i)$  is taken to be equal to a constant (zero), so that one could compare

the obtained demands (the pre-crisis demand  $\Delta D^{nc}(i)$  and crisis demand  $\Delta D^{cr}(i)$ ) under equal conditions and obtain the difference between them in the form of the number of people dismissed in the crisis period;

(v) the modeling is performed based on the retrospective data of 2000–2008 for the medium-term prediction period from 2009 to 2015.

Taking into consideration the above-stated principles, the expressions for the “pre-crisis” and “crisis” ANW in the labor market will be given by

$$L^{nc}(i) = \frac{X^{nc}(i)}{F^{nc}(i)}, \quad L^{cr}(i) = \frac{X^{cr}(i)}{F^{cr}(i)}. \quad (4)$$

Taking into consideration (2), (3), and the accepted assumptions, the expressions for the additional demand have the following form:

$$\begin{aligned} \Delta D^{nc}(i) &= L_{SC}^{nc-}(i) + \Delta L^{nc}(i), \\ \Delta D^{cr}(i) &= L_{SC}^{cr-}(i) + \Delta L^{cr}(i). \end{aligned} \quad (5)$$

At the first stage of forecasting, the average number of workers  $L^{(nc)}(i)$  and  $L^{(cr)}(i)$  in the labor market in the Russian economy is calculated until 2015.

This calculation is based on formula (4) with consideration for the dynamics of GDP and investments. The connection between the indices  $L(i + 1)$ ,  $X(i + 1)$ , and  $F(i + 1)$  in a year  $i + 1$  is written in the form of the relationship

$$L(i + 1) = X(i + 1)/F(i + 1). \quad (6)$$

Having divided Eq. (6) by the corresponding Eq. (4), we obtain:

$$\frac{L(i + 1)}{L(i)} = \frac{X(i + 1)}{F(i + 1)} \cdot \frac{X(i)}{F(i)} = \frac{X(i + 1)/X(i)}{F(i + 1)/F(i)}. \quad (7)$$

Let us define the index  $ind_F(i + 1) = F(i + 1)/F(i)$  as the rate of growth in labor productivity, index  $ind_X(i + 1) = X(i + 1)/X(i)$  as the GDP physical volume, and index  $ind_L(i + 1) = L(i + 1)/L(i)$  as the rate of growth in the average number of workers in a year  $(i + 1)$ .

Taking into consideration the above-defined parameters-indices, it follows from expression (7) that

$$ind_L(i + 1) = ind_X(i + 1)/ind_F(i + 1). \quad (8)$$

Thus, ANW growth rates are equal to GDP growth rates divided into labor productivity growth rates. The rate of growth in the ANW is calculated on the basis of formula (8) as the ratio between the GDP growth rate and the labor productivity growth rate. The data on GDP and labor productivity, given in comparable prices, are used when the calculations are performed.

### MODELING THE ADDITIONAL DEMAND WITH CONSIDERATION FOR THE CRISIS PROCESSES

The indicated ratio of indices (8) is, to the greatest extent, valid for the types of economic activities where the process of production is fulfilled when the volume of GDP (or GVA) can be determined through the quantity of workers and the established level of labor productivity. The inverse will be equally valid: knowing the planned increase in the volume of GDP (or GVA) and planned increase in labor productivity, one can calculate the required quantity of workers (under the condition that the matter concerns rational employment and that inefficient workplaces appearing due to the technological modernization of production will be reduced or will not be restored in the case of the corresponding natural and age-specific retirement of workers).

In the branches of economy that can be conditionally referred to as the “social” (or “budgetary”) sector, the number of workers is determined by the normative method, which is caused by the specific features of rendering social services and their normative and legal support. As usual, budgetary institutions that depend on budgetary financing will be included into the “social” sector.

Due to the indicated specific features of how the number of workers is formed in different sectors of the economy, the division into the “production” (real) and “social” (“budgetary”) sectors of the economy will be performed in the following way for the purposes of further research.

The following types of economic activities will be referred to the “production” sector: extractive and processing industry, agriculture and forestry, fish breeding and fishery, and the production and distribution of energy resources, as well as transport, communication, and financial activities. Although the last four types of economic activities produce services and not material products for the most part, we refer them to the “production” sector according to the criterion of forming a number of workers depending on their level of labor productivity.

The “social” (“budgetary”) sector of economy includes health protection, education, science, art, social sphere, management and security, and public facilities.

Let us consider the specific features of how the crisis affects the modeling of additional demand. The financial crisis that struck the world economy in the middle of 2008 has reached Russia in the form of decrease in demand for goods and services, a loss of markets, overproduction, a decrease in return, a decrease in the staff, and a closure or bankruptcy of enterprises. It is obvious that the indicated phenomena have directly affected the “production” sector of economy. The “social” sector, depending on budgetary financing, has suffered less.

In connection with that, we suppose that the decrease in the number of workers has affected the enterprises of the production sector of the economy to a greater extent than those of the social sector. Correspondingly, additional labor demand in the production sector of the economy must decrease more than in the social one.

With a view to separately taking into accounting the indicated specific features in order to calculate the additional demand for each sector taken separately, it is expedient to divide the average number of workers in the economy by the average number of workers in the production sector  $L_R(i)$  and in the social sector  $L_B(i)$ :

$$L(i) = L_R(i) + L_B(i). \quad (9)$$

This being the case, the crisis and post-crisis additional demands will be calculated for each of the distinguished sectors according to formula (5), respectively, and the resultant additional demand will be calculated by summarizing the corresponding constituents:

$$\begin{aligned} \Delta D^{nc}(i) &= \Delta D_R^{nc}(i) + \Delta D_B^{nc}(i), \\ \Delta D^{cr}(i) &= \Delta D_R^{cr}(i) + \Delta D_B^{cr}(i). \end{aligned} \quad (10)$$

Table 1 [17] presents the “pre-crisis” scenario of calculating the predicted ANW for the labor market of the RF. It is to be noted that the rate of growth in the ANW for the production sector in the 2009–2015 period were calculated according to formula (8). The forecast of the absolute values of the ANW for the production sector was obtained on the basis of the GDP growth rate and labor productivity growth rate (column 3), as well as the initial value of the ANW for 2008. The similar meanings for the social sector (column 2) in the 2009–2015 period were calculated on the basis of the linear dependence between the ANW and population of an working age (this calculation gives the decreasing dynamics of the average annual number of workers). The decrease in the number of workers in the “social” sector is determined by the normative requirements, due to the decrease in both the total population and population of an working age. The summary average number of workers (column 1) is calculated by summarizing the values of the ANW in the social and production sectors according to formula (9). As Table 1 shows, the average number of workers will decrease in the 2009–2015 period.

It is necessary to note that the impetuous dynamics of development of the crisis processes in the Russian economy has made it necessary to constantly correct the short- and medium-term forecasts. Since December 17, 2008, the Ministry of Economic Development of Russia has developed six scenarios of changes in the main macroeconomic parameters of forecasting the socioeconomic development of the RF for 2009 and for the 2010–2012 period with different variations in the GDP growth rate, investments, and labor produc-

**Table 1.** The calculation of the predicted values of the ANW, according to the pre-crisis scenario on the basis of CLD–2020\*

Year	The average pay-roll number of workers (ANW), people			The total rate of growth on the ANW, %	The GDP growth rate, %	The rate of growth in labor productivity, %
	total	the social sector	the production sector			
A	1	2	3	4	5	6
2000	51238200	19821600	32316600			
2001	50613200	18915700	31697500	98.8	106	107.3
2002	50615350	19344400	31270950	100.0	105.5	105.5
2003	49881819	19605800	30276019	98.6	107.6	107.0
2004	49130000	19622600	29507400	98.5	107.4	106.5
2005	48197242	19538200	28659042	98.1	107.6	105.5
2006	48096407	19681700	28414707	99.8	108.3	106.0
2007	48943666	19892981	29050685	101.8	108.3	105.6
2008	49362888	20101964	29260924	100.9	105.6	104.9
2009	48976105	19660539	29315566	99.2	107.3	107.1
2010	48811363	19441053	29370310	99.7	107.3	107.1
2011	48374465	19196118	29178347	99.1	106.4	107.1
2012	47927584	18939945	28987639	99.1	106.4	107.1
2013	47454928	18683615	28771313	99.0	106.4	107.2
2014	46978505	18421903	28556602	99.0	106.4	107.2
2015	46506138	18162645	28343493	99.0	106.4	107.2

\* The data of the Russian State Statistical Service were used for the 2000–2008 period (columns 1–6); the data of the CLD–2020 were used for the 2009–2015 period (columns 5–6). CLD–2020 is the Concept of long-term development of Russian Federation until 2020.

tivity. The forecast of the RF Ministry of Economic Development as of July 13, 2009, is the most reliable and has been used to plan the three-year budget for 2010–2012.

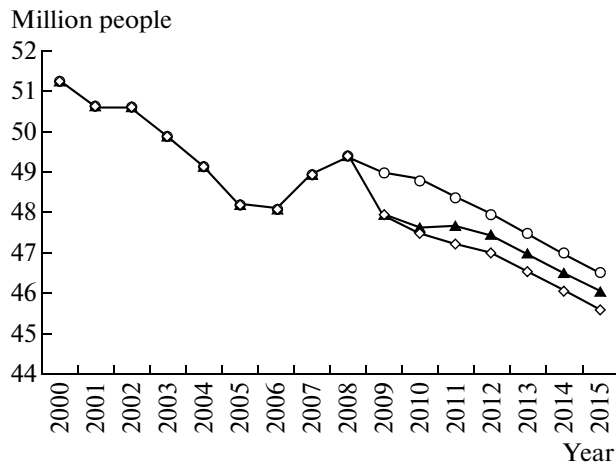
The macroeconomic indicators of the specified forecast that are given in Table 2 have been subsequently used to calculate the additional demand according to the crisis scenario.

According to the expert estimates of the Russian Ministry of Economic Development, the crisis processes in the Russian economy include the phase of the acute crisis (2009), the stationary phase (2010), the phase of the economy retreating from the crisis (2011–2012), and the return to the pathway of the innovative economic development (2013) [18].

Because of this, the data for the 2000–2008 period remain permanent in Table 2, and the predicted values of GDP indices and labor productivity in the 2009–2012 period are taken from the forecast of the RF Ministry of Economic development as of July 13, 2009 [19] according to two scenarios (scenario “1a” and scenario “2a”); the predicted values of the GDP growth rate and labor productivity in the 2013–2015 period will coincide with the data of the pre-crisis scenario of the CLD–2020 (the concept of long-term development until 2020) (see Table 1).

The calculation of the average number of workers according to the crisis scenario that is given in Table 2 was also carried out according to formula (9) the same way as when calculating the ANW according to the predicted indices of the GDP growth rate and labor productivity growth rate according to the pre-crisis scenario given in Table 1. The constituents of the ANW for the production and social sectors in the 2009–2015 period were calculated separately. The forecast of the values of the average number of workers for the production sector was obtained according to formula (8) on the basis of the GDP growth rate (6) and labor productivity growth rate (column 6), as well as the initial value of the ANW for 2008. The forecast of the average number of workers for the social sector (column 3) in the 2009–2015 period was made on the basis of the linear dependence between the ANW and the population at the working age. The summary average number of workers (column 1) is calculated by summarizing the constituents of the ANW for the social and production sectors according to formula (9).

The rates of growth in the summary ANW (column 4) are determined by the ratio between the summary values of the ANW (column 1) of the current year and those of the previous year, and not according to formula (8), since this formula is applicable only to the production sector.



**Fig. 2.** The dynamics of change in the average statistical number of workers in the RF labor market: ○— the pre-crisis calculation according to the CLD-2020; ▲— the crisis calculation according to the data of the forecast of the Ministry of Economic Development as of July 13, 2009 (variant 1a); ◇— the crisis calculation according to the data of the forecast of the Ministry of Economic Development as of July 13, 2009 (variant 2a).

Figure 2 visualizes the dynamics of change in the average number of workers in the labor market of the RF according to variations in the country's economic development.

The following stage of research is to calculate the volumes of additional labor demand for different scenarios in the development of the ANW on the basis of formulas (5) and (4). The results of calculating the additional demand according to the pre-crisis scenario (CLD-2020) are given in Table 3, which presents the values of the additional labor demand and its components: demands in the production and social sectors.

Columns 1, 4, and 7 show the index  $L_{SC}^-(i)$ , i.e., the number of workers dismissed or retired for natural and age-specific reasons (pensioners, the dead), which is a social constituent of the additional demand. This number is estimated through the dependence on the total volume of ANW in the sum of 4% of the previous year's number of retired workers, which must be compensated for (substituted):

**Table 2.** A calculation of the predicted values of the ANW, according to the crisis scenario based on the forecast of the MED as of July 13, 2009\*

Year	The average number of workers (ANW), people			The total rate of growth on the ANW, %	The GDP growth rate, %	The rate of growth in labor productivity, %
	total	the social sector	the production sector			
A	1	2	3	4	5	6
2000	51238200	18921600	32316600	—	110.6	—
2001	50613200	18915700	31697500	98.8	106.0	107.3
2002	50615350	19344400	31270950	100.0	105.5	105.5
2003	49881819	19605800	30276019	98.6	107.6	107.0
2004	49130000	19622600	29507400	98.5	107.4	106.5
2005	48197242	19538200	28659042	98.1	107.6	105.5
2006	48096407	19681700	28414707	99.8	108.3	106.0
2007	48943666	19892981	29050685	101.8	108.3	105.6
2008	49362888	20101964	29260924	100.9	105.6	104.9
2009	47932709	19660539	28272170	97.1	91.5/91.5	94.7/94.7
2010	47628744/47461293	19441053	28187691/28020240	99.4/99.0	100.1/101.0	100.4/101.0
2011	47664284/47216358	19196118	28468166/28020240	100.1/99.5	101.5/102.6	101.5/102.6
2012	47435723/46987205	18939945	28495778/28047260	99.5/99.5	103.2/103.8	103.1/103.7
2013	46966738/46521567	18683615	28283123/27837952	99.0/99.0	106.4	107.2
2014	46493958/46052109	18421903	28072055/27630206	99.0/99.0	106.4	107.2
2015	46025207/45586655	18162645	27862562/27424010	99.0/99.0	106.4	107.2

\* For 2000–2008 (columns 1–6)—the Rosstat data; 2009–2015 (columns 1–4) calculations of the authors; 2009–2012 (columns 5–6)—data of the forecast of the Ministry of Economic Development as of 13.07.2009, variants 1a/2a; 2013–2015 (columns 5–6)—data of the CLD-2020.

**Table 3.** The calculation of the additional demand in the labor market of the RF according to the pre-crisis scenario of economic development of Russia\* (people)

Year	The additional demand								
	the social sector			the production sector			total		
	$0.04 \cdot \text{ANW}(i-1)$	$\text{ANW}(i) - \text{ANW}(i-1)$	The summary ANW	$0.04 \cdot \text{ANW}(i-1)$	$\text{ANW}(i) - \text{ANW}(i-1)$	The summary ANW	$0.04 \cdot \text{ANW}(i-1)$	$\text{ANW}(i) - \text{ANW}(i-1)$	The summary ANW
A	1	2	3	4	5	6	7	8	9
2001	756864	-5900	750964	1292664	-619100	673564	2049528	-625000	1424528
2002	756628	428700	1185328	1267900	-426550	841350	2024528	2150	2026678
2003	773776	261400	1035176	1250838	-994931	255907	2024614	-733531	1291083
2004	784232	16800	801032	1211041	-768619	442423	1995273	-751819	1243454
2005	784904	-84400	700504	1180296	-848358	331938	1965200	-932758	1032442
2006	781528	143500	925028	1146362	-244335	902026	1927890	-100835	1827055
2007	787268	211281	998549	1136588	635978	1772566	1923856	847259	2771115
2008	795719	208983	1004702	1162027	210239	1372266	1957747	419222	2376969
2009	804079	-441425	362654	1170437	54642	1225079	1974516	-386783	1587733
2010	786422	-219486	566936	1172623	54744	1227367	1959044	-164742	1794302
2011	777642	-244935	532707	1174812	-191963	982850	1952455	-436898	1515557
2012	767845	-256173	511672	1167134	-190708	976426	1934979	-446881	1488098
2013	757598	-256330	501268	1159506	-216326	943180	1917103	-472656	1444447
2014	747345	-261712	485633	1150853	-214711	936142	1898197	-476423	1421774
2015	736876	-259258	477618	1142264	-213109	929155	1879140	-472367	1406773

\* The years 2001–2008—the authors' calculations, based on the Rosstat data; for 2009–2015—based on the CLD–2020 data.

$$L_{NS}^{nc-}(i) = 0.04L^{nc}(i-1), \quad (11)$$

$$L_{SC}^{cr-}(i) = 0.04L^{cr}(i-1).$$

Columns 2, 5, and 8 present the value of growth in the number of workers with consideration for the planned ANW for the next year, which forms the production constituent of additional demand. It is necessary to note the circumstance that the values in column 2 often have a negative mark, which can be interpreted as a negative planned growth in the number of workers, for example, due to the planned restructuring of production and growth in labor productivity with the subsequent release of inefficient workplaces.

The growth in the number of workers (column 2) in the social sector in the 2009–2015 period equals a negative value, which is caused by the decrease in both the total population and population at the working age.

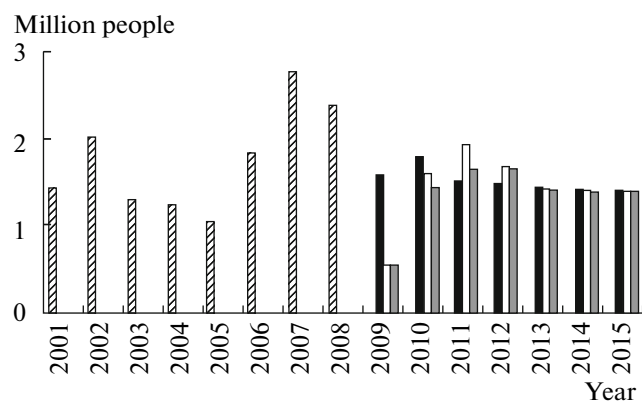
Table 4 presents the results of a calculation of additional demand according to the crisis scenario of development of the Russian economy based on the

forecast of the Ministry of Economic Development as of July 13, 2009 [19].

Column 9 indicates the resultant values of additional demand that amount to (1.4–1.8) mln. people in the period from 2009 to 2015.

The considered variants (1a and 2a) are basic in the forecast for the 2010–2012 period and take into account a conservative estimate of the development of external conditions (in the first place, the moderately low dynamics of oil prices). Variants 1a and 2a differ in hypotheses about the scales of support to the priority fields of socioeconomic development from the state in 2010–2012, which is finally expressed in the value of the federal budget deficit, as well as the reaction of business on the crisis.

Since the value of additional demand in 2001–2008 is an actual parameter, these same values will be also valid for the crisis scenario. The values of the ANW and additional demand for the “social sector” also remain permanent since the crisis does not affect this sector of economy. Table 4 gives only the values of



**Fig. 3.** The forecast of change in additional demand in the labor market of the RF: ▨ (1) the calculation according to the Rosstat data; ■ (2) the pre-crisis calculation according to the CLD–2020 (2009–2015); □ (3) the crisis calculation according to the data of the forecast of the Ministry of Economic Development as of July 13, 2009 (variant 1a); ▤ (4) the crisis calculation according to the data of the forecast of the Ministry of Economic Development as of July 13, 2009 (variant 2a).

the additional demand that are bound with the production sector.

Consequently, as the data of Table 4 show, the decrease in the average annual number of workers due to the decrease in GDP in the sharp crisis period of 2009 amounts to 1.4 million people, including 1 million people in the production sector of the economy, regardless of variations in the forecast. As a consequence, the additional labor demand in 2009 decreased in compar-

ison with the pre-crisis scenario from 2 million 380 000 people to 540 000 people (2008).

According to variant 1a, the change in the average annual number of workers in the production sector in 2011 and 2012 (the time of economic escape from the crisis) is positive (column 2), which characterizes the increase in the aggregate demand of economy for personnel. However, the final value of the change in the average annual number of workers in two sectors (production and social sectors) (column 5) for 2012 becomes negative, which speaks for the ANW being affected by the tendency of the change in the number of workers in the social sector of the economy.

Figure 3 gives a graphic illustration for the predicted dynamics of the additional demand depending on different scenarios of economic development.

Figure 3 shows that the final additional labor demand in 2009 differ greatly according pre-crisis and crisis scenarios.

#### VERIFYING THE PROJECTION ESTIMATES OF ADDITIONAL DEMAND ACCORDING TO THE 2009 CRISIS MONITORING DATA

Let us use the indices of the detailed monitoring of the situation in the labor market in 2009 with a view toward verifying the prediction estimates of the additional demand on the basis of relationship (10). Figure 4 shows the dynamics of the number of workers intended to be dismissed, actually dismissed, and employed due to the crisis. The interpolating curves in the actual range in the form of a quasi-linear function

**Table 4.** The additional demand in the labor market of the RF according to the crisis variant of the economic development of Russia on the basis of the forecast by the Ministry of Economic Development as of July 13, 2009\*

Year	Additional demand											
	Variant 1a						Variant 2a					
	production sector			total			production sector			total		
	$0.04 \cdot \text{ANW}(j-1)$	$\text{ANW}(j) - \text{ANW}(j-1)$	The summary ANW	$0.04 \cdot \text{ANW}(j-1)$	$\text{ANW}(j) - \text{ANW}(j-1)$	The summary ANW	$0.04 \cdot \text{ANW}(j-1)$	$\text{ANW}(j) - \text{ANW}(j-1)$	The summary ANW	$0.04 \cdot \text{ANW}(j-1)$	$\text{ANW}(j) - \text{ANW}(j-1)$	The summary ANW
A	1	2	3	4	5	6	7	8	9	10	11	12
2009	1170437	-988754	181683	1974516	-1430179	544337	1170437	-988754	181683	1974516	-1430179	544337
2010	1130887	-84479	1046408	1917308	-303965	1613343	1130887	-251930	878957	1917308	-471416	1445892
2011	1127508	280475	1407983	1905150	35540	1940690	1120810	0	1120810	1898452	-244935	1653517
2012	1138727	27612	1166339	1906571	-228561	1678010	1120810	27020	1147830	1888654	-229153	1659501
2013	1139831	-212655	927176	1897429	-468985	1428444	1121890	-209308	912582	1879488	-465638	1413850
2014	1131325	-211068	920257	1878670	-472780	1405890	1113518	-207746	905772	1860863	-469458	1391405
2015	1122882	-209493	913389	1859758	-468751	1391007	1105208	-206196	899012	1842084	-465454	1376630

\* The authors' calculations.



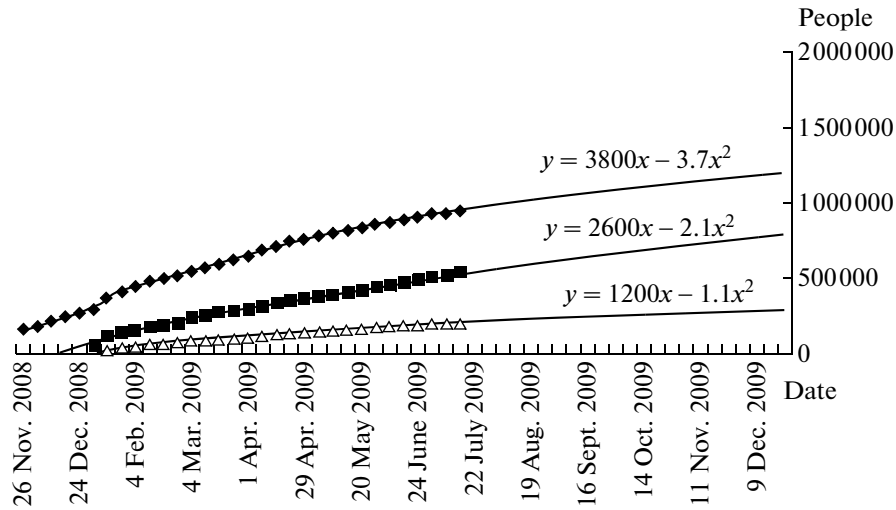


Fig. 4. The dynamics of the number of workers that were intended to be dismissed (—◆—), those that actually were dismissed (—■—), and those that were employed (—△—) due to the crisis phenomena [20].

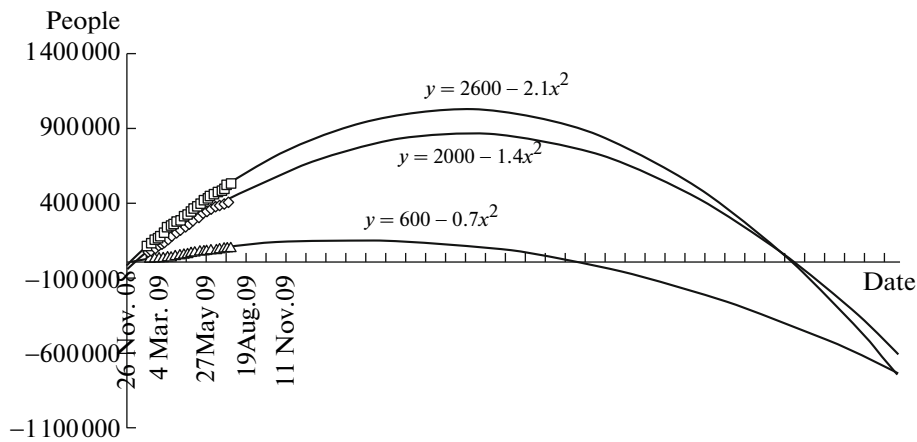


Fig. 5. The dynamics of the number of workers dismissed in 2009 from the social (—□—) and production (—◇—) sectors of economy, as well as the total number of workers dismissed since the beginning of release (—△—).

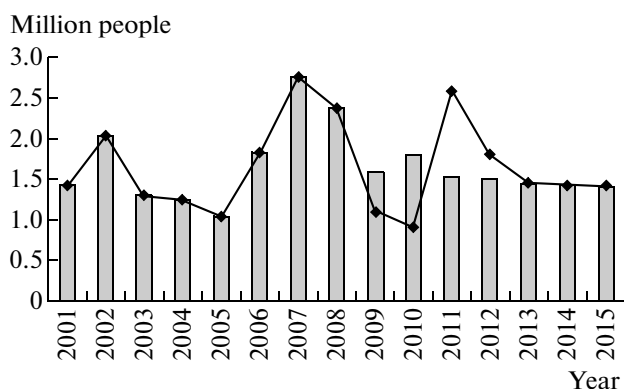
(with an insignificant negative quadratic member predicting the saturation of functional dependence) are also presented here. The extrapolation of functional dependencies by December 30, 2009, shows the following predicted data: workers that are planned to be dismissed (1200000 people), dismissed workers (800000 people), and employed workers (400000 people). The solid lines represent the interpolating polynomial of people planned to be dismissed ( $y = 3800x - 3.7x^2$ ), those dismissed ( $y = 2600x - 2.1x^2$ ), and employed people ( $y = 1200x - 1.1x^2$ ). The  $R^2$  factor is equal to  $R^2 = 0.99$  for all the functions.

Figure 5 [20] gives data that are the most important to take into consideration the crisis processes: the number of workers dismissed since the beginning of release  $L^-(i)$ , which is additionally divided into two sectors: the social  $L_B^-(i)$  and production  $L_R^-(i)$  sectors:

$$L^-(i) = L_R^-(i) + L_B^-(i), \tag{12}$$

where  $i$  is the time with the selected interval of discretization. The solid lines represent the interpolating polynomial of workers of the social ( $y = 600x - 0.7x^2$ ) and production ( $y = 2400x - 1.4x^2$ ) sectors dismissed in 2009 and the total quantity of dismissed workers ( $y = 2600x - 2.1x^2$ ). The  $R^2$  factor is equal to  $R^2 = 0.99$  for all the functions.

It follows from Fig. 5 that the value of the number of laid-off workers (total) is asymptotically estimated at 800000 people, including those dismissed from the production sector (650000 people) and from the social sector (150000 people). This being the case, it is to be noted that 40% of workers dismissed in the social sector belong to economic activities such as state management and support of military security, as well as compulsory social support.



**Fig. 6.** The forecast of change in the additional demand in the labor market of the RF: □ (1) the pre-crisis calculation according to the CLD-2020; ♦ (2) the crisis calculation with consideration for the return of dismissed workers in 2011–2012.

According to the forecast, the total number of workers planned to be dismissed is the upper estimate of the verified data on the additional demand; this being the case, the total quantity of workers planned to be dismissed will not exceed 1.2 million people by the end of 2009 (see Fig. 4). The contribution of the social sector to the total number of those who are planned to be dismissed will amount to approximately 300000 people, and the contribution of the production sector of the economy will amount to approximately 900000 people.

The obtained numbers of laid-off workers and workers planned to be dismissed in 2009 on the basis of the data of crisis monitoring correlate with changes in the additional demand, calculated according to relationships (9) and (11) and data presented in Table 4, which speaks for the relevance of the model.

## THE CONDITIONS OF RESTORING THE NUMBER OF WORKERS IN THE POST-CRISIS PERIOD

In connection with the models and calculations considered above, the question arises as to what are the values of the scenario conditions (GDP growth rate and labor productivity growth rate) at which the additional demand can change so that part of workers dismissed in 2009 could be sought-after and return to the labor market in 2011 and 2012?

The suggested model of the additional demand (1)–(11) permits one to carry out the inverse calculation of the average number of workers (Table 5), depending on the desirable values of the additional demand.

According to the results of the calculations presented in Table 5, it is clear that the values of the GDP growth rate in the RF in the 2011–2012 period that would ensure the employment of workers at the expense of desirable volumes of additional demand ( $ind_x(2011) = 103.0$  and  $ind_x(2012) = 104.5\%$ ) will be optimal to ensure employment.

The result of calculating the additional demand is presented in Fig. 6. The data of the figure show that an increase in the demand of up to 2.2 million people in 2011–2012 is achieved at the following values of the GDP growth rate (103.0% and 104.5%) and labor productivity growth rate (101.5 and 103.1%). The data on the additional demand for the 2001–2008 period that are presented in the figure were obtained using the initial statistical data for the average number of workers, which is reflected in Table 3.

**Table 5.** The forecast of macroeconomic indices of the RF according to the crisis scenario while taking into account the earlier laid-off workers that will return in 2011–2012\*

Year	The average number of workers (ANW), people			The total rate of growth in the ANW, %	The GDP growth rate*	The rate of growth in labor productivity*
	total	the social sector	the production sector			
A	1	2	3	4	5	6
2009	47932709	19660539	28272170	97.1	91.5	94.7
2010	47628744	19441053	28187691	99.4	100.1	100.1
2011	48084995	19196118	28888877	101.0	103.0	101.5
2012	48221105	18939945	29281160	100.3	104.5	103.1
2013	47746259	18683615	29062644	99.0	106.4	107.2
2014	47267662	18421903	28845759	99.0	106.4	107.2
2015	46793137	18162645	28630492	99.0	106.4	107.2

\* For the 2009–2015 period (columns 1–4)—the calculations of the authors.

For the 2009–2015 period (columns 6)—the forecast of the Ministry of Economic Development as of 13.07.2009 (variant 1a).

For the 2009–2010 (columns 5)—the forecast of the Ministry of Economic Development (variant 1a).

For the 2011–2012 (columns 5)—the calculations of rate of growth in the GDP that is necessary for the part of workers dismissed in 2009 could return to the labor market in 2011 and 2012 and would be claimed there.

For the 2013–2015—the CLD-2020.

## CONCLUSIONS

Data assumed as the basis of the authors' calculations orient to the transition from the decline to the revival and growth of the Russian economy. Analysis of the prediction scenarios of the main macroeconomic indices of the Russian economy for the crisis and post-crisis period until 2015 made it possible to obtain the estimates of the additional labor demand the same time period. The desirable GDP growth rate at the phase of retreating from the crisis in the 2011–2012 period, at which the additional labor demand must increase and ensure the return of previously laid-off workers, has been calculated. Meanwhile, according to the prediction estimates of the Ministry of Economic Development as of July 13, 2009, "in all the variations, the economy will not reach its maximal level of 2008 in the prediction period until 2012, even under the conditions of variations with a relative growth in oil prices and a less rigid monetary policy," and "all the considered variations of the forecast do not ensure the complete return to the indices of innovational development" [19]. Consequently, the Russian economy still has to overcome all the consequences of the crisis in order to return to its former pathway of development.

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