A. V. Vasilyeva, A. A. Tarasyev

DYNAMIC MULTIREGIONAL MODEL OF LABOUR MIGRATION: CONSTRUCTION AND REALIZATION[1]

This paper presents a dynamic multiregional model of labor migration in continuous time within the framework of the neoclassical economics. The model can predict the dynamics of migration flows as well as the dynamics of economic effects of migration simultaneously for host regions and source countries. Thanks to liberalization of the migratory legislation of the Russian Federation in 2007, the model can be used for Russian regions and CIS states, which citizens were granted entry without a visa and a simplified procedure of employment in Russia. Employing the model to statistical data, forecast trajectories of migration flows to Russian regions from CIS states have been received for the period since 2010 to 2016. The predicted migration looks quite realistic and has important policy consequences. In particular, these findings can be used for developing work permit quotas.

Keywords: labor migration, forecast, neoclassical theory, economic effects, dynamic modeling

Introduction

Increasing of mobility of the population is characteristic of the current period. Multinational migration, which is to say, free will or forced displacement of people through the state borders is assuming the character of universal phenomena.

The countries of western democracy in virtue of liberal and democratic traditions, high living standards and economic development, a guarantee of the rights and freedoms of a person undergo specific migration pressure. For many of these states, the immigration became a significant indicator of real adherence to the values of the political and economic liberalism assuming distribution of the civil, political and social rights to each member of society, creation and maintenance of rather free markets [18, page 6].

The resolute step towards liberalization of Migration Policy was as well made in Russia, in January 2007. The changes induced into the migration legislation of the Russian Federation consist in strong simplification of the rules of registration of foreign citizens according to place of temporary residence, and also an order of their employment. Basic changes in the migration legislation are briefly presented in table 1.

In consequence of the changes included into the migration legislation of the Russian Federation (tab. 1), the registration procedure for the citizens of CIS states with whom Russia has regulations of visa-free entry was replaced with the procedure of the migration registration, and its character is changed from permissive to notifying. Authorization procedure for temporary stay and permission for work in Russia is essentially simplified for the specified citizens. Labor migrants from CIS states have got more free access in the Russian labor market, arranging permission for work independently and gaining the right of change of an employer within a region where this permission was received. At the same time, sanctions against the employers breaking rules of hiring of foreign workers are made more rigorous.

Although the purposes of a new course of the Russia migration policy consists in the arrangement of conditions for providing the Russian labor market with legal foreign labor from the states which are historically close to Russia, and in expansion of channels of legal employment of foreign labors, the problem of illegal migration continues to be relevant for Russia as much, as in the countries of the western democracy. According to estimates of experts, Russia is the second outman of informal immigrants and the first according their part in a total number of foreign citizens (tab. 2). However on the Russian Federation territory illegal labor migrants are located non-uniformly that is caused by strong differentiation of level of socio-economic development of Russia regions [4, 10].

In the process of increasing migratory load, to control migration is more complicated from year to year. In turn the increase of number illegal migrants promotes an aggravation of a variety of risks

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Table 1

Migration control in Russia before and after 2007

Old order	Modern order
Registration according to the place of temporary residence / migration registration (all of the immigrants)	
Permissive	Notifying
According to militia permission	Upon notification of host party. Permission is not required
According to address of residential accommodation	According to address of residential accommodation or office address, intermediary one (and others) of organization
Registraion in militia	Delivery of notification to the Federal migration service or sending it by mail
A complex procedure demanding: — recorded in writing the agreement of permanently residing in the rented place and their collective corporal appearance with a migrant in militia; — abidance by standard per capita of living space (in some regions according to the local legislation)	A simple procedure only assuming the search of a host party by the migrant and sending of the notification.
Permission for work (visa-free immigrants)	
Permit for employment of migrant is given to the employer	Permission for work (the labor card) is received personally by migrant. An employer notifies migratory service on hiring of foreign worker
Long multilink procedure	A simple procedure
Quotas	
Only for visa migrants	Separately for visa and visa-free migrants

Source: [7, с. 117].

Table 2

Population estimate of illegal immigrants

Country	Thousands of persons	in % to a total number of foreign citizens	Year
USA	12000	32,4	2008
Russia	4500	60,0	2008
Great Britain	725	11,1	2007
Italy	650	22,1	2008
Spain	570	10,9	2008
Germany	500	7,4	2005
Greece	250	43,8	2007
Austria	100	10,8	2003

Source: based on [7, 17].

and threats, including the development of shadow economy [1].

Under current conditions the search of new forms of political regulation of the processes of international migration predetermines development by the governments of strategies (political programs, projects, anti-crisis stock items), focused on the regulation of migration flows and prevention of illegal migration. Elaboration of such strategy should be based on scientifically proven estimates of the current and prospective number of migrants with emphasis of its unregistered part. As a methodical basis for receiving these estimates, the dynamic multiregional model of labour migration, allowing investigating effects of liberalization of the migration legislation is offered.

Theoretical basis of the research

Liberal or cosmopolitan model of development is focused on general democratic values, which in the western liberal tradition associate with principles of market economy. This model is based on a paradigm of human rights it approves a priority of human rights over the rights of the citizens. The right to free movement is one of the fundamental human rights in a democratic society [5] and, therefore, hypothetically (in "pure" liberal model) it should prevail over separation of rights on the principle of citizenship (non citizenship), in other words theoretically all men and women irrespective of existence of citizenship of one or another country should possess this right. The liberal model of development assumes elimination of all obstacles for mobility of migrants.

Free migratory movements are included into the economic composition of the neoclassical theory proceed on the basis that they generate are a source of redistribution of factors of production between the countries in the conditions of a common market, i.e. redeployment of labour and related to it — movements of capitals and goods. According to neoclassical economics, migration is caused by a difference in wage levels between the countries, due to the difference in labor inputs on the capital between the countries. The wage differential will stimulate workers from countries of low wages to

move to countries with a high salary while investing capital, including the human capital [6] essential for the creation of the expected income, will flow into the country with low wages. This process will proceed until the wage-rate difference between the countries is more than costs of labor moving.

Neoclassical economics is based on a principle of rational behavior of an employee. However in real life the possibilities of rational decision are limited. A laborer, making a decision on the need of migration and choosing a country of destination, faces a problem of incomplete information on conditions of a labor market and residence in other countries. The solution of this problem is promoted by migratory networks, which are understood as a set of interpersonal communications that connect migrants, the former migrants and not migrants among themselves by the medium of relatives, friendship and common social origin [24]. On the one hand, migratory networks help to spread information on living conditions in the different countries, help with employment and often insure employment. On the other hand, at achievement by migratory networks of a certain level of development, the migration becomes a self-maintained process. Here, again negative consequences of the existence of migratory networks start to predominate. Enclaves develop with their culture, rules and living conditions on the territory of the country. For the most part of migrants, already the need to study host country language, to try to adapt to new living conditions are absented. Thus, the migratory network starts to promote the inflow of migrants which national economy of reception does not need.

Approaches to migratory modeling

At the present time, the development of models of migration within a framework of neoclassical economics is actively conducted. Striyelkovski V. and Turnovets F. have developed a model for two countries, allowing assessing tendency of the rational individual to migrate on the basis of comparison of an expected income to migratory expenses [11]. In the offered model of Batishcheva G., except the listed factors, the rational individual also considers the probability of employment in an accepting region [3, pages 9-11]. At the same time, the presented models are mainly intended for description of the behavior of certain rational migrants and do not allow to receive a prediction of migration flows. As advantage of the latest model, it is necessary to point out, in this model is considered, that with

an inflow of migrants, the offer on a labor market will grow, reducing the probability of employment in the accepting region. Accordingly, the model of Batishcheva G. considers the influence of migration on a labor market of an accepting region that is one of the economic effects of migration. According to our opinion, modeling of migration flows should be carried out in respect of these effects; it is crucial for departure country, and destination of migrants [14-16, 19-23].

As distinct from considered above models, the dynamic multiregional model of labor migration developed by us allows to predict at the same time both the migration and its economic effects. Besides, the considered models are constructed for two regions, one of which is the region of leaving, another — the region of arrival; in the earlier version of our model [8] we consider one host regions and some source countries while in the new version of our model, potential migrants from several regions of origin, at making a decision on migration consider some potential regions of appointment. Such multiregional modeling allows predicting supplantation by migrants from "the poorer" countries, ready to work for smaller wages, other migrants, which, in turn can make the decision on return migration or choose other source countries.

Dynamic multiregional model of labour migration

The dynamic multiregional model of labour migration is constructed in continuous time within the framework of the neoclassical economics. Consider n as host regions and m as source countries of migrants in which all obstacles for mobility of labor force are eliminated. The number of migrants from i country of origin into host regions of j at the moment of time of t are defined as $x_{ij}(t)$.

A rational individual makes a decision on migration from a source country of i to host region of j on the basis of comparison of its characterizing levels of wage (w_i and w_j respectively). This decision will be positive if an expected income is positive according to a wage gap in a country of origin and a host region region of appointment of the migrant, i. e. $w_j - w_i > 0$.

As a result of inflow of migrants $x_j(t) = \sum_{i=1}^{m} x_{ij}(t)$ from m source countries into host regions of j, the offer on a labor market will grow leading decreasing the probability of employment of a migrant of p_j. This probability is defined on the

basis of assumptions that prior to the beginning of the migration process in host regions of j number of workplaces equal to sum of volume of employment E_j and number of vacant positions of V_j, but a number of job applicant equal to sum of volume of employment of E_j and number of the unemployed of U_j according to formula (1):

$$p_j(x_j(t)) = \frac{E_j + V_j}{E_j + U_j + x_j(t)}. \qquad (1)$$

In turn, decrease of the probability of employment of a migrant will lead to competition growth on a labor market, resulting in decreasing the wage level of migrants in host regions of j according to function (2):

$$w_j(x_j(t)) = w_{j\_av} p_j(x_j(t)), \qquad (2)$$

where w_{j_av} — is an average salary of migrants in host regions of j.

In turn, as a result of outflow of migrants $x_i(t) = \sum_{j=1}^{n} x_{ij}(t)$ from i source country into n host region, on the contrary, will occur the decrease in supply of labor force on a labor market, leading to growth of wage level

$$w_i(x_i(t)) = w_{i\_av}\left(\frac{E_i + V_i}{E_i + U_i - x_i(t)}\right), \qquad (3)$$

where w_{i_av} — is an average salary in i country of origin; E_i — numbers employed in i host country; V_i — number of the vacant positions in i source country; U_i — number of the unemployed in i host country. Taking into account a process of level alignment of wage in i source country and j host region, decision-making process on migration is represented as follows:

1) $w_j(x_j(t)) - w_i(x_i(t)) > 0$ — making a decision on migration from i country into j;

2) $w_j(x_j(t)) - w_i(x_i(t)) < 0$ — making a decision on returnable migration into i country or moving to another $k \neq j$ host region for which the following condition is satisfied $w_k(x_k(t)) - w_i(x_i(t)) > 0$.

At making a decision on migration, a rational individual will not only seek to maximize expected income, but also to minimize migratory expenses, including direct costs of resettlement. Under otherwise equal conditions n individual chooses from a set of potential regions of migration the one, which is closer. The model of the influence of this factor on decision-making about migration reflects an r_{ij} indicator (distance from a capital of i source country to a j regional host center).

Migratory networks which support the migration of nationals is a crucial institute of self-regulation of migratory processes. Development of these networks directly depends on a number of the migrants who have earlier arrived to the j region of attraction from the same i source country, for this reason in our model the influence of migratory networks on decision-making about migration reflects an indicator: $x_{ij}(t)$.

Taking into account that population outflow from the i source country is limited by quantity of its potential migrants of M_i, the flows of labor migrants from an i country of departure to a j host region is described by the differential equation (4):

$$\frac{dx_{ij}(t)}{dt} = \alpha \frac{1}{r_{ij}} x_{ij}(t)\left(M_i - \sum_{j=1}^{n} x_{ij}(t)\right) \times$$
$$\times \left(w_j(x_j(t)) - w_i(x_i(t))\right), \qquad (4)$$

where α — the calibration factor reflecting the influence of unrecorded factors in the model, mainly — not economic, on a tendency to migration.

The described model has been realized in the MatLab 7.10.0 program (R2010a).

Data

Model approbation on Russia regions and CIS states demand a data bulk. Data for Russia regions on quantity of labor migrants, a monthly average wage, a number of the employed and the unemployed were taken from publications of Federal state statistic service. [12]. Data for CIS states on average monthly wage, a number of the employed, and the unemployed were taken from sources of Interstate statistical committee CIS [9]. Number of potential migrants was defined on the basis of the results of a public opinion poll, which was carried out by Gallup in 12 Post-Soviet countries [13].

As source countries of migrants Tajikistan, Uzbekistan, Kyrgyzstan, Kazakhstan, Armenia, Azerbaijan and Ukraine were chosen. In 2007–2010, 60–70 % from a total number of labor migrants in Russia (tab. 3) were from these countries (tab. 3).

As regions of attraction we consider Moscow, St. Petersburg and the Sverdlovsk region in which 35-45% of a total number of labor migrants in Russia are concentrated (see tab. 4).

Calibration of data

The model was calibrated according to data for the period since 2006 to 2008. The affected period

Table 3

Composition of labor migrants in Russia

Country	2006		2007		2008		2010	
	1000 persons	%	1000 persons	%	1000 persons	%	1000 persons	%
Azerbaijan	28,3	2,8	57,6	3,4	76,3	3,1	40,3	2,5
Armenia	39,8	3,9	73,4	4,3	100,1	4,1	59,8	3,6
Kazakhstan	5,0	0,5	7,6	0,4	10,4	0,4	8,3	0,5
Kyrgyzstan	33,0	3,3	109,6	6,4	184,6	7,6	117,7	7,2
Tajikistan	98,7	9,7	250,2	14,6	391,4	16,1	268,6	16,4
Uzbekistan	105,1	10,4	344,6	20,1	642,7	26,5	511,5	31,2
Ukraine	171,3	16,9	209,3	12,2	245,3	10,1	167,3	10,2
Sum	481,2	47,5	1052,3	61,4	1650,8	67,9	1173,5	71,6
In total	1014,0	100,0	1804,0	100,0	2425,9	100,0	1640,8	100,0

Source: based on [12, 302].

Table 4

Allocation of labor migrants according to Russia regions

Region	2006		2007		2008		2010	
	persons	%	persons	%	persons	%	persons	%
Moscow	355533	35,1	532311	29,5	623160	25,7	345142	21,0
St. Petersburg	34811	3,4	163449	9,1	115398	4,8	120875	7,4
Sverdlovsk region	52845	5,2	11061	0,6	109167	4,5	82969	5,1
Sum	443189	43,7	706821	39,2	847725	34,9	548986	33,5

Source: based on [12, c. 305-307].

is characterized by large inflow of migrants from CIS states (see fig. 1) in connection with liberalization of migration policy; therefore, we infer that this period rather exactly reflects its consequences and data, corresponding to this time interval, can be successfully applied to the calibration of the dynamic multiregional migration model. Reduction in the number of quotas for the issue of work permits since 2008–2010 has led to decrease in a number of registered labor migrants and growth of level of illegal labor migration in Russia for this reason, data of the next years for model calibration was not used.

In consequence of model calibration, the values of the calibration factor for host regions have been received: 0,0295 (Moscow), 0,0885 (St. Petersburg) and 0,1056 (Sverdlovsk region). Accuracy of the model from the absolute value of migration flows is 95%. Consequently, at making a decision about migration, indeed an individual seeks to maximize an expected income according to a wage gap in a host region and a source country at minimization of expenses of moving including an influence of migratory networks, and the offered dynamic model of labour migration is applicable for forecasting of labor migration flows to Russia regions from CIS states.
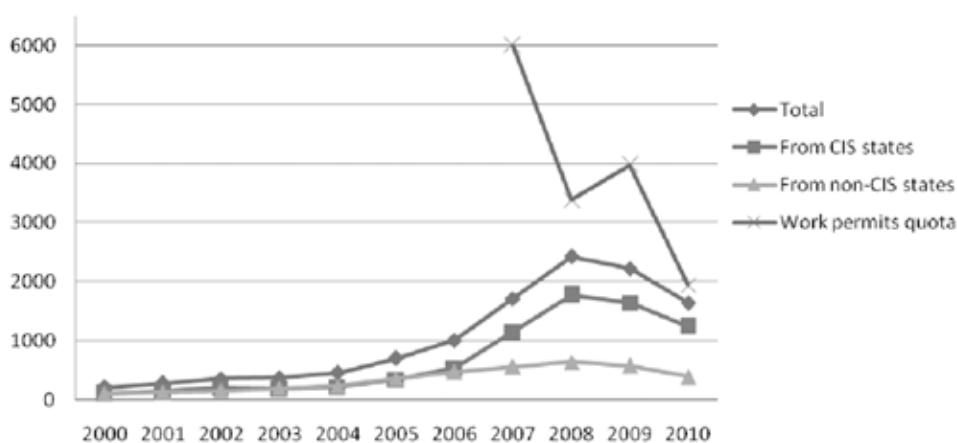

Fig. 1. *Origin Composition of Foreign Labor Force in Russia, thousand persons (based on [2, 8])*

Forecast trajectories of migration flows to Russia

Employing the model to statistical data, forecast trajectories of migration flows to Russian regions from CIS states have been received for the period since 2010 to 2016. Long-range plan composition of labor migrants in Moscow and St. Petersburg has similarity — the maximum part will be composed by natives of Uzbekistan (fig. 2, 3). However, this composition not long will remain: migrants from Ukraine become dominating on a labor market of Moscow by 2014, in St. Petersburg — by 2012 that

is caused by the greatest number of potential migrants [13] and geographic proximity of Ukraine and these host centers of labor. It should be noted that in resulting of reorientation of migration flows observed in recent years from the western CIS states towards Europe, the real inflow of labor migrants from Ukraine can be slightly lower than the predicted.

Common value of foreign labour force will reach 700 thousand people in Moscow by 2016 (fig. 2).

In St. Petersburg common value of foreign labor force will be 580 thousand people by 2016 (fig. 3).
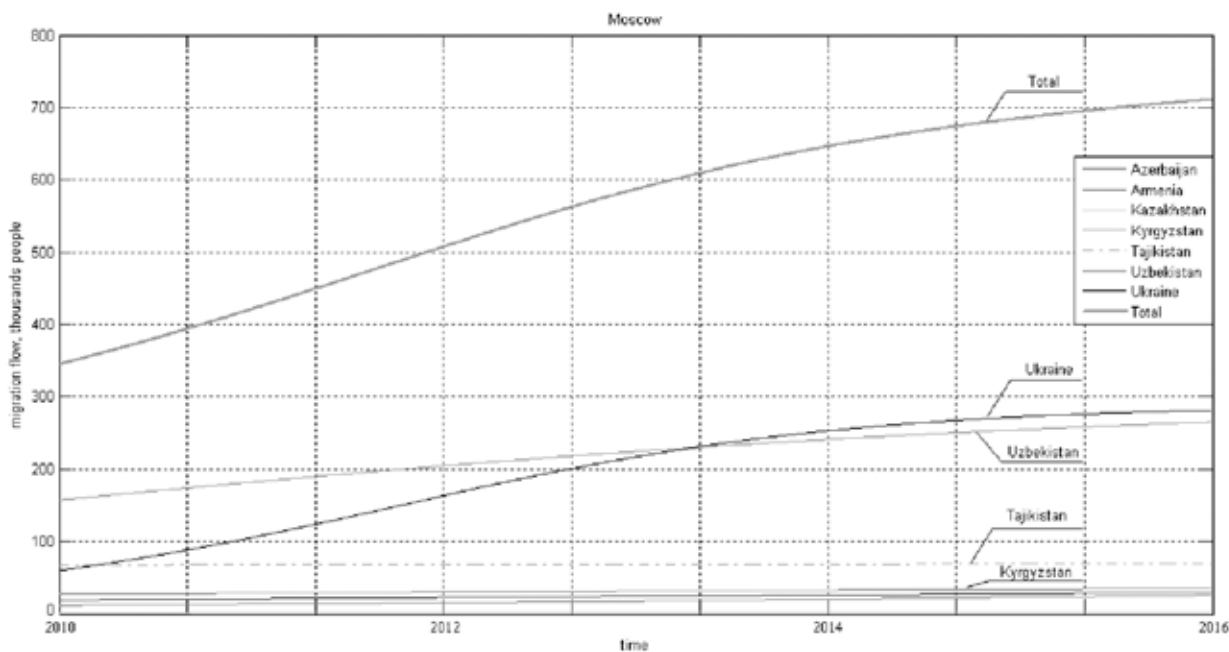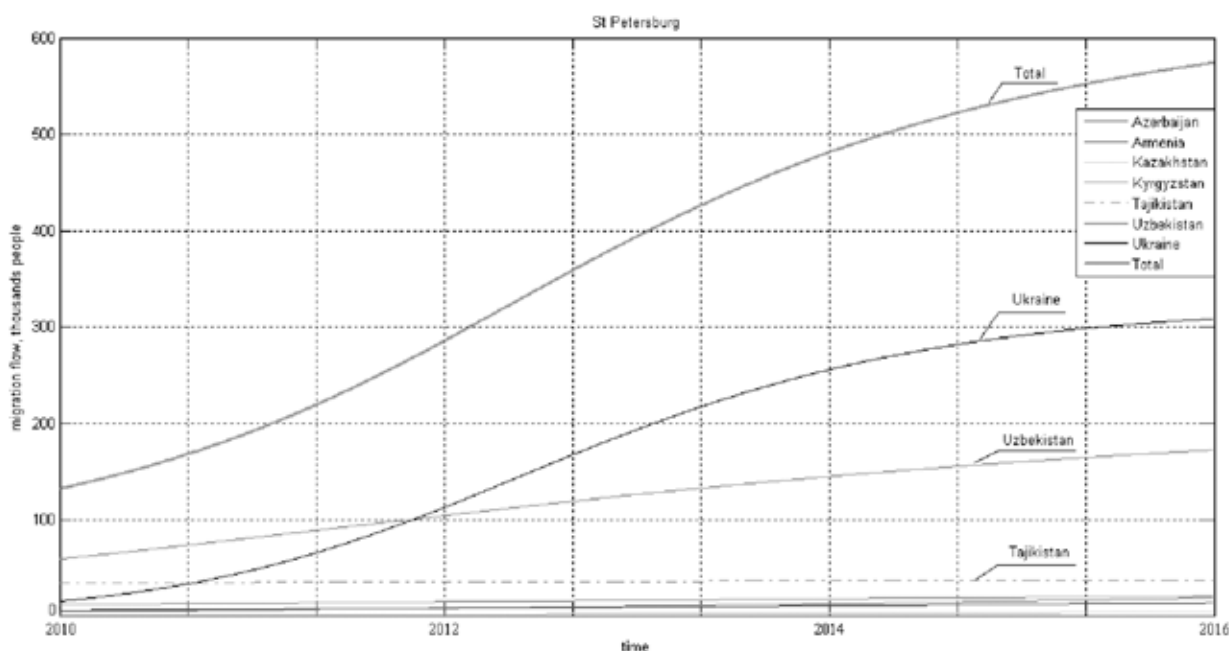

Fig. 2. *Migration Flows to Moscow*

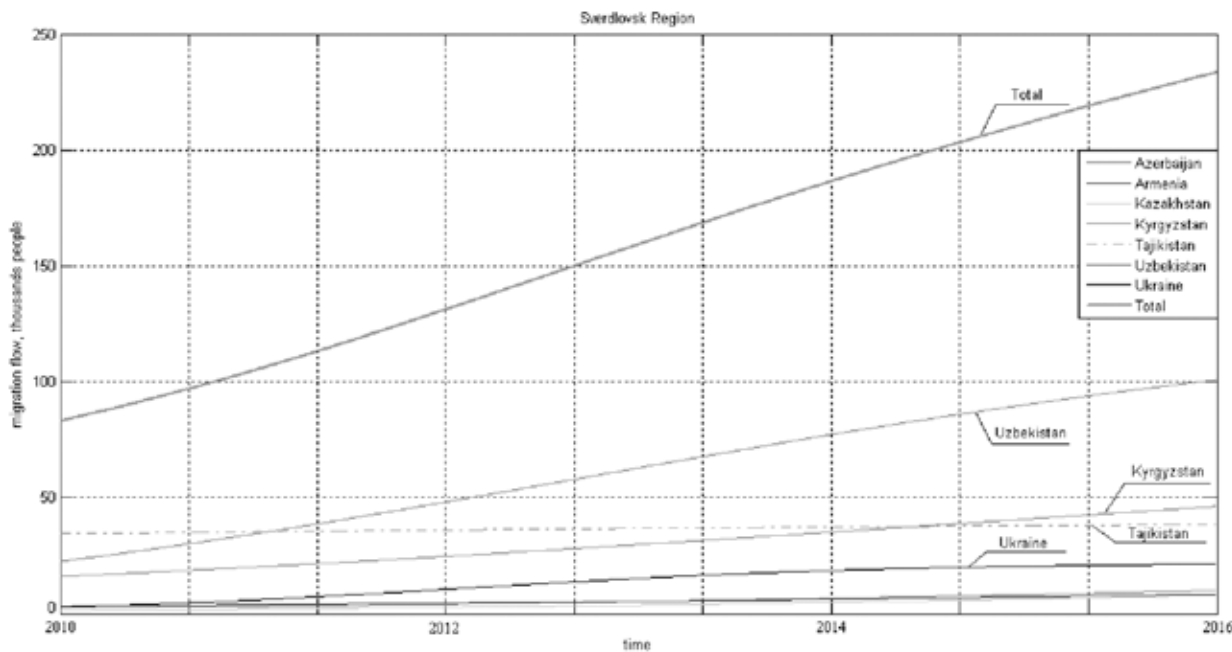**Fig. 3.** *Migration Flows to St. Petersburg*

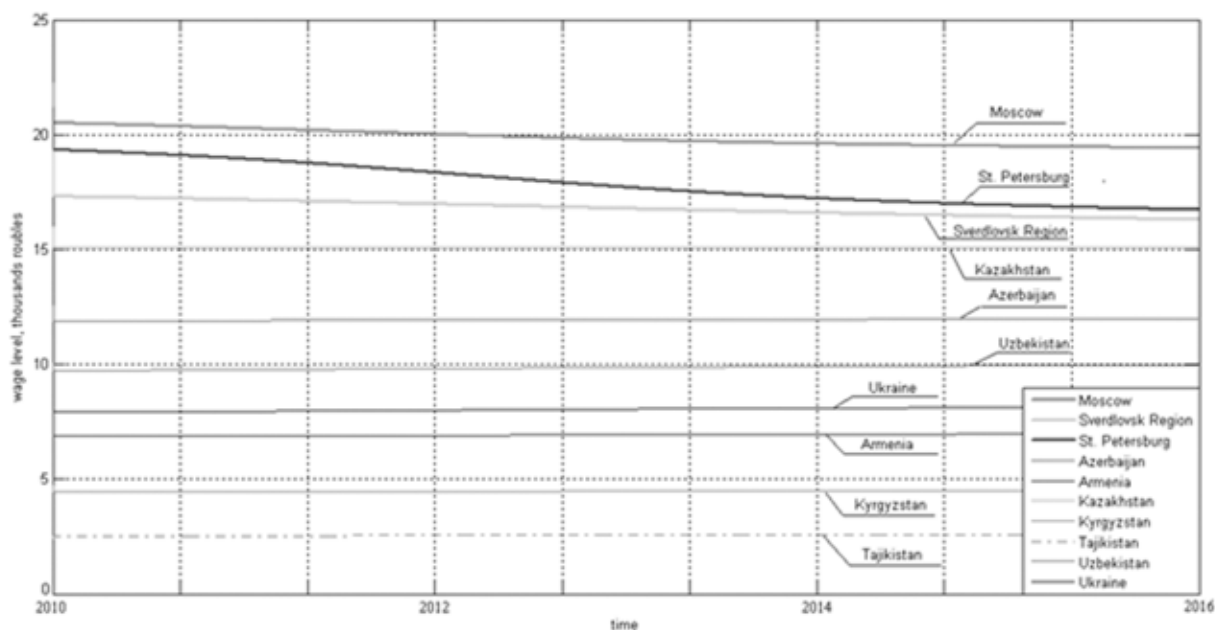**Fig. 4.** *Migration Flows to Sverdlovsk Region*

Fig. 5. *Wage Level*

By reason of geographic proximity of Sverdlovsk region and Central Asia, the origin composition of foreign labor force in Sverdlovsk region will differ from earlier considered regions (fig. 4). Uzbekistan is distinguished among other countries of Central Asia by the greatest number of potential migrants [13] becomes the leading country of departure of migrants. The total number of foreign laborers in Sverdlovsk region will be 230 thousand people by 2016.

Difference in wage level between countries of origin and the accepting regions, conditioning dy-namics of number and composition of migrants, are presented in figure 5. According to the received re-sults, influence of migration on level of a wage gen-erally in accepting regions will be visible.

As a result of economic growth of Azerbaijan and Kazakhstan in which wage levels are the high-est among the source countries (fig. 5), decrease in migration flows to Russia from these countries is observed. However, emerging economies of Kazakhstan already have become a strong rival of Russia for labor migrants from Central Asia (first of all, natives of Uzbekistan).

Conclusions and recommendations

On the basis of application of the dynamic multiregional model of labour migration to data of regions of Russia and CIS states, possible consequences of liberalization of migration policy in Russia were analyzed. The received forecasts appear rather realistic and have practical relevance. In particular, due to lack reliable methods of calculation of demand for foreign labor force, the offered forecast of the labor migrant flows can be used at the formation of quotas of delivery to foreign citizens of work permits. In point of fact, small quotas for "visa-free" migrants from CIS states instead of actualizing the priority right of the Russian citizens for work, promote growth of illegal employment of foreign citizens in Russia.

The dynamic multiregional model of labour migration has potential of further development, at least, according to three directions. Firstly, account must be taken of migratory expenses. Secondly, function of a wage should consider elasticity between wage and offer of foreign labor force. Thirdly, it is necessary to enter the classification of migrants by the qualified groups. The listed directions of developments of the model will be realized within a framework of further researches of authors.

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Information about the authors

Vasilyeva Aleksandra Vladimirovna (Yekaterinburg, Russia) — PhD in Economics, research associate at the Center for economic security, Institute of Economics, Ural Branch of the Russian Academy of Sciences (620014, Yekaterinburg, Moskovskaya st., 29, e-mail: sa840sha@mail.ru).

Tarasyev Aleksandr Aleksandrovich (Yekaterinburg, Russia) — economist at the Center for economic security, Institute of Economics, Ural Branch of the Russian Academy of Sciences (620014, Yekaterinburg, Moskovskaya st., 29, e-mail: alextarassiev@mail.ru).

Ю. С. Пиньковецкая

ЗАКОНОМЕРНОСТИ РАЗВИТИЯ ПРЕДПРИНИМАТЕЛЬСКИХ СТРУКТУР В РЕГИОНАХ

Рассматриваются закономерности и тенденции, характерные для трех типов предпринимательских структур — малых и средних предприятий и индивидуальных предпринимателей. Целью исследования являлось подтверждение возможности описания показателей совокупности предпринимательских структур с использованием функций нормального закона распределения. Представлен предложенный автором методический подход и результаты построения функций плотности распределения основных показателей для различных объектов: совокупностей предпринимательских структур в Российской Федерации и ее регионах, а также предприятий и предпринимателей, специализированных на определенных видах экономической деятельности. Все разработанные функции, как показал логический и статистический анализ, обладают высоким качеством и хорошо аппроксимируют исходные данные. В целом предложенный методический подход является универсальным и может использоваться в дальнейших исследованиях совокупностей предпринимательских структур. Полученные результаты могут применяться при решении широкого круга задач анализа и управления, обоснования потребностей в трудовых и финансовых ресурсах на федеральном, региональном и муниципальном уровнях, а также формировании планов и прогнозов развития предпринимательства и совершенствования этого сектора экономики.

Ключевые слова: предпринимательские структуры, малые предприятия, средние предприятия, индивидуальные предприниматели, численность работников, оборот, инвестиции, экономико-математические модели, функции распределения, виды экономической деятельности

В статье рассмотрены три типа предпринимательских структур — малые предприятия, средние предприятия и индивидуальные предприниматели. Для них характерны одинаковые основные виды экономической деятельности, они конкурируют на одних и тех же рынках, имеют во многом аналогичную технологию производства, ведут рисковую деятельность. К настоящему времени роль предпринимательских структур в нашей стране существенно возросла. В 2010 году в России было 1,62 млн малых предприятий. В малых предприятиях работало