

# Dynamic Modeling of Labor Migration Impact on the Economic System Development

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**Abstract:** In this paper we present a model description of the impact of labor migration on the development of economic systems in countries of migration attraction. It should be emphasized that labor migration is one of the major factors in the development of the labor market. The inflow of migrants into a region should correspond to the labor resources demand of the labor market. To estimate and predict the migration flows between countries with different level of socio-economic development we elaborated a dynamic multi-factor model, which is based on the assumptions of the positional games theory and allows to predict the behavior of each individual, depending on economic factors. According to the model idea, potential migrants have the information on the difference of living and working conditions in both countries of origin and migration attraction. This model takes into account several economic theories of migration and describes the migrant's behavior in terms of migration barriers absence. At the final step of modeling we provide an assessment of migration impact on the development of socio-economic systems in the countries of migration attraction using an approach, which is based on a production function of Cobb-Douglas type.

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**Keywords:** dynamic modeling, games theory, positional games, Cobb-Douglas production function, labor market, labor migration, migration potential, GDP.

## 1. INTRODUCTION

In this paper we present a model description of the labor migration impact on the development of economic systems in countries of migration attraction. Causes of migration can be economic, social, political or environmental. Basically, there are two types of migration, such as internal migration and external (international) migration. In this article, we will focus on international migration. International labor migration is defined as the movement of people from one country to another for the purpose of employment. Migrant workers are usually casual and unskilled workers, who systematically move from one region to another, offering their services on a temporary basis.

Labor migrants are preferable for both sending and receiving countries. Countries of origin benefit from labor migrants, because they are exempt from unemployment and receive remittances for national development. On the other hand, destination countries can manage well the supply of labor to meet labor shortages. Therefore, migrant workers are an integral part of economic development for both countries of origin and destination. The migration flow significantly affects the business cycle of the country. The business cycle means alternating the ups and downs of the economy, which is an integral part of the country's economic development. There is a strong correlation between the migration flow and the business cycle found in the research on reducing the wage

gap in Mexico and their illegal migration wave (Dadush, 2014).

With business cycles, immigration helps to reduce the wages of workers in the workplace, but also increases incentives for firms to invest in the medium term to benefit the indigenous population. However, immigration can have a positive impact on the economics of countries of destination through many other channels, besides the net expansion of labor supply. In the case of skilled migration, immigrants can stimulate innovation, as they bring new ideas, knowledge and skills and increase productivity. On the other hand, they increase competition in the labor market and affect the specialization of indigenous population.

In this article, we consider the contribution of migrants in the development of the Russian economy. After the collapse of the Soviet Union in the early 1990s, a massive migration was observed in Russia and there was a significant inflow and outflow of immigration. The recent immigration occurs mainly due to intensive economic development. About 70% of immigrants in Russia are engaged in construction, trade, production and agriculture. According to the Federal Migration Service (FMS), the focus is on existing legislation, which is aimed at temporary immigrants and the creation of conditions for attracting qualified professionals. Nevertheless, Russia focuses on sustainable growth of internal and external migration in both formal and informal sectors of the economy.

To describe the flow of migration to the main migration areas, we developed a dynamic multi-factor model based on the assumptions of the theory of positional games and allows predicting the behavior of each person depending on economic factors. According to the basic idea of the model, potential migrants have the information about the difference in living and working conditions in countries of origin and migration attraction. This model takes into account several economic theories of migration and describes the migrant's behavior from the point of view of migration barriers absence, which implies the possibility of describing migration for countries with visa-free regime.

The main purpose of qualitative analysis is to assess the impact of the attitude of the local employer and the employment system on the motivation of foreign workers, and then to attract labor migrants to improve the efficiency of the labor market. We analyzed the impact of migrants on GDP growth, using an approach that takes into account the Cobb Douglas production function by linear transformation from a logarithmic form, and showed the positive effects of labor migrants in the Russian economy.

## 2. THEORETICAL FRAMEWORK

Migration is one of the important factors in formation the structure of labor resources in the territory, while distinguishing both age differentiation in the labor market and differences in the level of education and skills of workers. Labor market analysis is the process of identifying the market trends and detecting appropriate labor market for various types of positions. In economics, labor market refers to the dynamics of demand and supply for labor, in which employees provide the supply and employers provide the demand. Labor is one of the major components of production, which can be seen from both micro- and macroeconomic points of view. The theoretical substantiation of migration processes, available to date, has a certain degree of fragmentation, and there is no systematic approach to the economic and social consequences of migration processes.

The neoclassical theory of migration proceeds from the existence of free competition and a perfect market of production factors. This theory was developed to explain labor migration in the process of economic development at both macro- and microeconomic levels. The main idea of this concept is the international difference in the levels of pay. The basis of this concept is the work "The Theory of Wages" (Hicks J.R., 1963), in which migration is viewed as a rational individual decision, based on a complete and reliable information on the labor market situation, but does not take into account the problems of unemployment and relocation costs. The most basic model, originally developed to explain migration in the process of economic development, was presented in the works of Hicks (Hicks J.R., 1963), Lewis (Lewis W.A., 1954) and Harris and Todaro (Harris J.R., Todaro M.P., 1970). These works highlight, that migration results from the difference in the wage levels of potential migrants and the population in the country of migration attraction, which is caused by the uneven distribution of

goods and low efficiency of production factors in these countries.

According to this theory and its extensions, the difference in wage levels should be sufficient to cover the costs of moving. As a result, migration contributes to the equalization of wages and the stabilization of the world labor market by reducing the supply of labor in the country's labor market, which is excessively endowed with manpower and increasing the supply in the country, poor in manpower, and also through cash transfers of migrants. Countries with a large endowment of labor relative to capital have a low equilibrium market wage, while countries with a limited endowment of labor relative to capital are characterized by a high market wage, as depicted graphically by the familiar interaction of labor supply and demand curves. The resulting differential in wages causes workers to move from the low-wage country to the high-wage country. Under the assumption of full employment, it predicts a linear relationship between wage differentials and migration flows (Bauer and Zimmermann 1999; Massey et al. 1993; Borjas 2009).

The purpose of neoclassical theory is to maximize behavior of agents and a flexible wage, which, using the supply and demand forces, cleans the market and leads to an equilibrium. A person continues to look for work if the expected income is less than or equal to the search costs. When a person finds a job with a higher salary, migration begins. Since the alternative is cheaper, then it is not optimal to accept the first job offer (Stigler G.J., 1961)

Unit-labor cost is the most important factor in determining the price level in a closed economy (Herr H., 2009). Due to insufficient goods demand in the overall economy, any level of unemployment can be occurred. In a positive economic condition, nominal wage increases according to trend productivity growth as well as the target inflation rate of the central bank, discretionary monetary policy geared towards growth and anti-cyclical fiscal policy. The basic assumption of the microeconomic model of individual choice (Todaro M., 1969) is the decision to migrate by a rational individual, based on the information on the full picture of the consequences of the move, related to costs and profits, thus the assessment of the expected benefit from the differentiation of earnings by territories. Within the framework of the individual choice model, migration processes appear as investments in human capital. In this case, the territory of arrival is chosen by the migrant in order to maximize his productivity, taking into account his qualification level.

The concept of a new migration economy (Stark O., Bloom DE, 1985) in determining the purpose of migration, first, minimizes the potential risks of income fluctuations through diversification, and secondly, provides a sufficient financial base for effective production processes. At the same time, the income level of the family environment, whose members make a decision on migration, is important. The importance of this factor is explained by the fact, that often a person agrees the decision on migration with members of his family, who, in most cases, do not change their place of residence and work. The basis for the decision on migration is the

desire to maximize household incomes. According to the human capital theory, therefore, migrants tend to be relatively more skilled, because this increases the chances of their success. Borjas (Borjas G.J., 1987) investigated this assumption in respect to the immigrants in the US labor market and analyzed, in particular, the relationship between the income distribution and the skills of migrants.

A synthetic theory of migration, also known as the theory of migration networks, was proposed by the sociologist Douglas Massey (Massey D.A., 2002). This theory explains international migration by the prevalence of financial relations in non-market societies. Massey included in the basis of this theory the positions of the classical theory of migration. According to Massey's theory, in the process of making a decision on the migration and selection the country for migration, the employee faces the problem of incomplete information about the working conditions in other countries. The solution for this problem is provided by migration networks, which are understood as a set of interpersonal links between migrants, former migrants and potential migrants.

The Russian labor market development is strongly affected by the initial conditions in the country along with complete economy, political reforms institutional development and social dynamics. The Russian transition differs in many aspects from those observed in most Central and Eastern European countries. According to Gimpelson and Lippoldt (Gimpelson V., Lippoldt D., 2001), although radical and positive changes were made in establishing key elements of a market-oriented framework for the Russian labor market, this reform was neither coherent nor sufficient.

The modeling of the general dynamics of migration processes between the CIS countries and the regions of the Russian Federation suggests a combination of the assumptions of a number of classical theories: neoclassical concept of migration, synthetic theory of migration, theory of human capital for explaining the socioeconomic factors of labor migrants attraction.

### 3. LABOR MIGRATION DYNAMIC MODELING

In accordance with the model structure in migration, a rational individual takes a decision to migrate from the country of departure to the region of the country of attraction, comparing the expected income level  $w_i$  with the current  $w_j$ . The decision on migration will be made, if the difference between earnings in the country of origin and the final region of the migration is positive, i.e.  $w_j - w_i > 0$ . The model is based on the assumption, that there are no barriers for labor migration (Vasilyeva A.V., Tarasyev A.A., 2012). Using this model it is possible to describe migration between countries with visa-free regime. Given the specifics of the functions, describing the dynamics of wage levels with dependence on the influx of migrants, this model simulates an increase in the level of competition in the centers of migrants attraction and the reduction of competition in countries of origin.

When choosing a region for migration, each participant of the migration process, in addition to maximizing the expected income, will try to minimize its expenses, including the direct

and indirect costs of moving. As a result, when considering the case of migration to regions with identical levels of expected revenues and a comparable level of development of regional socio-economic systems, a rational individual will choose for migration a region, which is closer to the country of departure, or a region, in which he can get his earnings at the lowest cost of the movement. Information on regional labor markets obtained through migration networks will also have a significant impact on the decision making.

Taking into account the above main criteria, a dynamic equation was developed for the description of the migration process from the country of departure  $i$  to the region of attraction  $j$  at time  $t$ :

$$x_{ij}^k(t+1) = x_{ij}^k(t) + \frac{\alpha_j^k (M_i^k - x_i^k(t))(w_j^k(t) - w_i^k(t))}{W_j^k(t)} dt, (1)$$

where  $x_{ij}^k(t)$  - migration flow from country  $i$  to region  $j$  of the receiving country;

$k$  - migrant's qualification level;

$M_i^k$  - amount of potential migrants in the chosen qualification group;

$(w_j^k(t) - w_i^k(t))$  - wages gap between country of origin and region of migration attraction;

$W_j^k(t)$  - average salary level at the country of migration attraction;

$\alpha_j^k$  - migration attractiveness of the region.

To obtain in the Nash equilibrium in the model we developed functions describing the dynamics of changes in the wage levels of migrants depending on the level of competition for jobs (Nikonov O.I., Tarasyev A.A., 2015). Forecasting the dynamics of the wages level in the region of attraction  $j$  for the migratory flux  $x_i(t)$  at time  $t$  is performed in accordance with equation:

$$w_j(t) = w_j(t_0) \cdot \frac{E_j(t_0) + V_j(t_0)}{E_j(t_0) + U_j(t_0) + x_j(t)}, (2)$$

where  $w_j(t)$  is the average wage of migrants in the region of attraction  $j$  at time  $t_0$ ;

$E_j(t_0)$  - number of employees in the region of attraction  $j$  at time  $t_0$ ;

$V_j(t_0)$  - the number of vacancies in the attraction region  $j$ ;

$U_j(t_0)$  - the number of unemployed in the region of attraction  $j$  at time  $t_0$ ;

$x_j(t_p) = \sum_{i=1}^m x_{ij}(t_p)$  - the number of labor migrants from  $m$  countries of departure located in the region of attraction  $j$ .

Model forecasting of wage level dynamics in the country of origin  $i$  at  $x_i(t)$  at time  $t$  is performed in accordance with the function:

$$w_i(t) = w_i(t_0) \cdot \frac{E_i(t_0) + V_i(t_0)}{E_i(t_0) + U_i(t_0) - x_i(t)}, \quad (3)$$

where  $w_i(t)$  is the average wage of migrants in the country of origin  $i$  at time  $t_0$ ;

$E_i(t_0)$  - number of employees in the country of origin;

$V_i(t_0)$  - the number of vacancies in the country of origin  $i$ ;

$U_i(t_0)$  - the number of unemployed in the country of origin  $i$ ;

$x_i(t_p) = \sum_{j=1}^n x_{ij}(t_p)$  - the number of labor migrants from  $m$

countries of departure located in the region of attraction  $j$ .

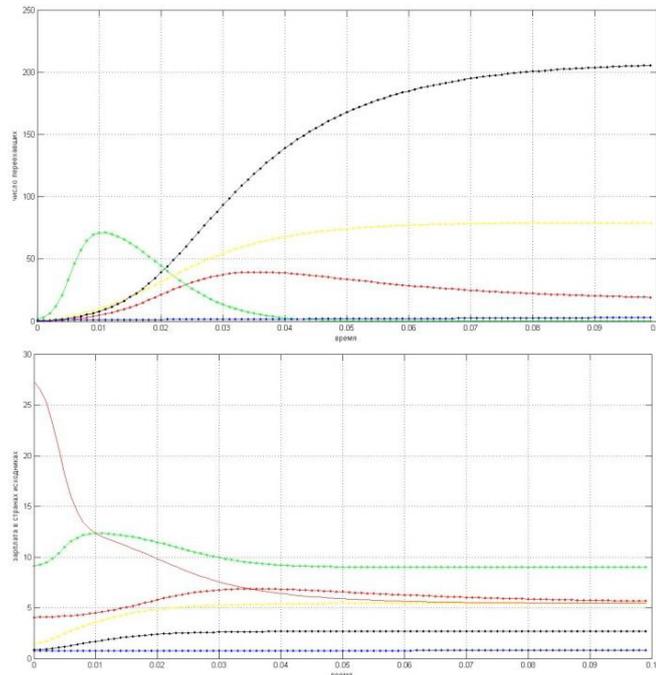


Fig. 1. Interdependent dynamics of migratory flows and salary levels in a dynamic model

The above model design describes the process of external labor migration for migrants of different qualification groups. Model dynamics (figure 1) reflects the impact of migration on the competition at the labor market in the country of migration attraction. So, under the condition of reduced salaries, the migration inflow will decrease and switch to another region of attraction. It is necessary to mention, that in case of low profit for migrants, the immigration will stop and the trend will switch to the opposite one. The labor market of migrants in the developed model reacts on the impact of external parameters, which is accomplished by specifying the dynamics of natural growth and population loss, and increases the permissible limit of the model forecast. According to the modeling results, main migration flows will be observed between Tajikistan, Uzbekistan, Kyrgyzstan and Russian regions, which is explained by a sufficient gap in

socio-economic development of these countries and Russian regions.



Fig. 2. The influx of labor migrants in the Sverdlovsk region

The wage gap between Russia and CIS countries will diminish, while the wages in the Moscow region will go downward. This tendency however may call for attention to the negative effects on wages and employment due to immigration, where the arguments are that immigrants may compete in labour markets with native-born workers.

#### 4. PRODUCTION FUNCTION FOR MIGRATION IMPACT ASSESSMENT

The study primarily applied a production function approach to estimate the impact of migrant workers on Russia's economic growth from 2000 to 2014 using data on Gross Domestic Product (GDP), total labor including migrants in Russia and Gross Fixed Capital. Productivity essentially indicates the effectiveness of a company or country that can transform resources into a potential number of products from fewer resources; that is why economists mostly look into the measures of productivity within a given system to determine how different factors of production affect the overall output. The reason behind using production function is that it describes the relation between the production outcome and quantity of factors, used for this production (Cobb & Douglas, 1928). For both micro and macroeconomics, the production functions are non-constant, that specifies the output of a firm or an entire economy of a country for all combination of inputs.

This study consider the basic form of production function which has two production factors- labor and capital and those are interchangeable. In this research, it is proposed to modify this production function in labor input.

The reason for using the production function is that it is an important tool for modeling and analyzing the relationship between the dynamics of production factors and the change in output. For micro- and macroeconomics production functions are impermanent.

In the Cobb-Douglas function, if the sum of the coefficients  $(\alpha + \beta)$  is 1, the function shows a constant return on production scale. To assess the contribution of foreign human capital, the production function has been changed to account for labor costs. Since it is necessary to calculate the contribution of migrants to the formation of GDP, it is

necessary to separate the overall labor of migrants from the total labor of the local population. The formula for the modified production function is as follows:

$$Y = A \cdot (L + M)^\alpha \cdot K^\beta, \quad (4)$$

where  $Y$  - is the real GDP with a constant assessment of national prices;

$L$  - total employment in Russia (excluded migrants), actively working per hour;

$M$  - all foreign workers, actively working per hour, in Russia;

$K$  - gross fixed capital formation in Russia;

$A$  - is the overall performance factor.

Estimation of equation (4) with the help of the generalized least squares method leads to the case, when one of the two variables has a significantly larger value. To solve this problem, it is necessary to scale independent variables to the proper extent. When elaborating the model, it is assumed that the parameter, determining the number of the employed population of the Russian Federation, will be used as a labor force in the production function. For migrant workers we used the data on work on the patent and the work permission for foreign citizens employed in the Russian Federation. Thus, changes in labor can be defined as:

$$\Delta L = (L + M) - L = M. \quad (5)$$

After scaling the basic parameters to simplify the evaluation, it is necessary to linearize the function from the nonlinear form. At this stage, the control parameters of the model are calibrated. As a result, the function will be expressed as follows:

$$Y = \ln Y = \ln A + \alpha \ln(L + M) + \beta \ln K + u_i. \quad (6)$$

To evaluate this function, we use the generalized least-squares method in the framework of the econometric approach. After linearization, the GDP, designated as  $Y$ , is estimated with input factors of labor and capital. After that, GDP is calculated without taking into account foreign workers. The equation, describing the impact of the country's labor resources on the formation of GDP ( $Y^*$ ) without considering the impact of labor migration, is as follows:

$$\frac{\Delta Y}{\Delta L} = \frac{\Delta Y}{M}$$

$$Y = \ln Y = \ln A + \alpha \ln L + \beta \ln K + u_i \quad (7)$$

$$\Delta Y = Y - Y^*$$

Thus, the changes between  $Y$  and  $Y^*$  calculated through ( $\Delta Y$ ) show the gross national income generated by foreign workers in the Russian Federation. The percentage of  $\Delta Y$  in Russia's real GDP shows the potential share of the income that has been generated by migrant workers. The developed function of the Cobb-Douglas type is a convenient tool for calculating coefficients and economic factors on the basis of statistical data, while the output of  $Y$  allows to estimate the influence of

the components on the country's GDP. In the developed model, using a more general production function, the link between gross domestic product and labor is not monotonous, as the function factors can vary in different ways.

The reason for calculating the regression results for the two equations is to elucidate the contribution of migrant workers to the Russian Federation. Subtracting equation (7) from equation (6), we deduce  $\Delta Y$ , which showed the income, received from the labor of migrants in the Russian Federation. Changes in  $Y$  give us very significant results, as additional labor supply by migrants adds a large number of results in the country. The diagram below shows the difference in output, using the total labor force and the volume of the local employed population separately from migrants, and the difference means the contribution of migrant workers with a positive trend (figure 3).

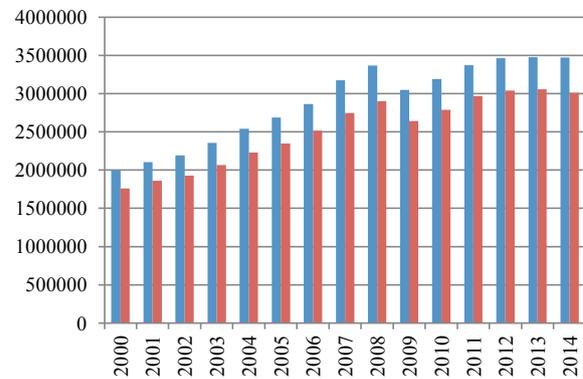


Fig. 3. Difference of output by total labor and migrant labor in Russia

The main reason behind calculating regression results for two equations was to find out the contribution of migrant labors in the Russian Federation. By subtracting equation (3) from the equation (2),  $\Delta Y$  was found, which showed the income generated by the migrant labors in the Russian Federation. The changes of  $Y$  gave us very significant results, because additional labor supply by migrants added a good number of outputs of this country, which cannot be denied. The chart, given above, shows the difference of output from total labor and output from only native labor in Russia, which reflects the contribution of migrants labor.

## 5. CONCLUSIONS

Migration of the population is one of the most important socio-demographic processes that allows the redistribution of human capital between labor markets in order to optimize the development of regional economic systems and improve the efficiency of the functioning of regional labor markets.

In Russia, migrants are, in most cases, employed in jobs that are not claimed by the local population. These are heavy, not prestigious and low-paid jobs, jobs that are temporary or seasonal, or informal jobs in the sphere of shadow employment. In accordance with the proposed model, the main pushing and pulling factor of migration is the level of

income, the values of which are converging in the countries of origin and destination with the growth of migration flows. To assess the impact of migrant workers on Russia's economic growth from 2000 to 2014, a Cobb-Douglas-type production function was applied using data on the GDP and the number of employed people, including migrants in Russia.

It should also be noted, that attempts to strictly restrict the access of migrants to the labor markets of migration attraction centers through the introduction of quotas or the visa regime will lead to the growth of the shadow economy through the development of shadow forms of migrant employment. Under current conditions it is necessary to develop programs for interaction with potential migrants, taking into account their education, qualification level, language knowledge and personal preferences, which will attract qualified labor resources, necessary for sustainable proportional economic growth.

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