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BASIS FOR DEVELOPING DIGITAL INTEGRATED MODELS FOR THE DEVELOPMENT OF THE RURAL LABOR MARKET IN LABOR-SUFFICIENT REGIONS

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Abstract
The article proposes methodological foundations for the development of digital integrated models for the development of the rural labor market in labor-surplus regions in the conditions of the functioning of a socially oriented market economy. It includes the approved main stages in the development of digital integrated models (DIM) for the development of the rural labor market in labor-surplus regions: defining the goal and a list of problem-optimization tasks to be solved; implementation of the choice of the type of digital economic and mathematical models; development of target integrated models and verification of their consistency; collection, analysis and assessment of the reliability of the necessary information; computer approbation of the proposed DIM, a comprehensive analysis of the obtained computer results. At the same time, on the basis of the developed DIM, forecast indicators for reducing the informal employment of the rural able-bodied population of the Republic of Uzbekistan until 2025 were determined.
Keywords: rural labor market, socially oriented market economy, mathematical economics, digital complex models, optimization models and simulation models.

Introduction

The scientific arsenal of mathematical economics has a fairly rich experience in the development and testing of a system of models in the planning of the national economy and its individual subsystems. It was mostly used in the analysis and forecast of economic and social indicators and in finding their optimal values in the planning period. Then the system of models was developed at the levels of the national economy, intersectoral complex, territorial systems, industries and enterprises based on the principles of central planning [1, 2, 3, 4, 6, 7]. In connection with the transition to a socially oriented market economy, the importance of the latter has significantly decreased.

In this case, there is an urgent need to build digital integrated models (DIM) that reflect the processes of economic, social and demographic development of market economic entities in the analyzed and forecast periods.

In mathematical economics, the rural labor market (RLM) is the least explored part of digital modeling. The main reason for the latter is the multidimensionality (economic, social, demographic, organizational, legal, etc.) and the complexity of modeling relations

between workers and employers in rural areas, especially in labor-surplus regions.

Therefore, in this article, for the first time, the methodological foundations of digital integrated modeling of the main socio-economic processes of development of RLM in labor-surplus regions have been developed.

The rural labor market is a new object of digital economic and mathematical modeling of socio-economic and labor relations regarding the hiring of workers by employers [5, p. 87]. On it, under the influence of many factors and conditions, there is a sale and purchase of "ability to work" of the employed and unemployed able-bodied population on the basis of mutually beneficial individual and collective labor agreements. The mathematical formulation of individual components of the development of the RLM does not lead to an increase in the adequacy of economic and mathematical models.

The development of rural labor markets (RL) and jobs (J) depends not only on the level of demand, supply, price, competition and other elements of the market economy for hiring workers, but also on the availability of economic, demographic and social potentials in the labor surplus region.

At the same time, the effective functioning of various forms of RLM is largely determined by the optimal regulation of the employment of the rural working-age population by the relevant state and territorial management services using the optimal parameters (regulators and mechanisms) of the impact obtained as a result of testing the relevant economic and mathematical apparatus and methodological provisions. Here, state and regional regulation of the reduction of rural unemployment is essential, not only through the rational use of internal reserves to increase the organization of jobs, but also to increase the possibility of organized export of labor.

Materials and methods

The study in the aggregate and the interaction of all factors and conditions is generated by the need to use digital complex modeling in the process of developing RLM based on the optimal use of the achievements of domestic and foreign economic and mathematical modeling and computer technology. Digital integrated modeling is carried out on the basis of interrelated stages of mathematical economics.

At the first stage, the goals and the list of problem-optimization tasks to be solved are determined with the help of the “tree-goals” of the RLM development in labor-surplus regions. The main goal of digital integrated modeling is the development of a scientific concept and optimal options for the development of RLM in the interaction of the main components of a market economy.

The main problem-optimization tasks include: determining the optimal options for the development of RLM (z_{01}); definition, formation of a rational structure of employment (z_{02}); assessment of the scale of labor supply (z_{03}); determining the volume of demand for labor (z_{04}): studying the relationship between demand and supply of labor and optimizing their regulation (z_{05}); study of the proportionality of jobs with labor resources (z_{06}); conducting a multi-criteria assessment of the rational use of rural labor force (z_{07}); system analysis and forecast of unemployment (z_{08}); study of the demosocial basis for the formation of the rural labor market (RLM) (z_{09}); determination of economic indicators of the formation of the rural job market (RJB) (z_{10}), as well as the compilation of intersectoral labor balances (z_{11}).

The above optimization problems can be subdivided into several subtasks (DIM).

At the second stage, the choice of the type of digital economic-mathematical models is carried out. The study shows that the most adequate mathematical apparatus for the optimization problem z_{01} is a set of simulation models, z_{02}, z_{05}, z_{06}, z_{07} - optimization; z_{03}, z_{04}, z_{10} and z_{11} - econometric, z_{08} - multifactor and z_{09} - economic-statistical, and z11 intersectoral (balance). At the same time, it should be noted that in solution z_{08} one can apply models of the theory of queuing, which make it possible to determine the parameters for eliminating the queues of the unemployed in the employment of labor-abundant regions.

At the third stage, the DIM and their consistency are developed, which include: economic and statistical models of the demo-social basis for the formation of the RJB (DEMOSOC); intersectoral models of the movement of labor resources and labor costs (ISB-L); econometric models of the main economic indicators of the formation of RLM (ECONOM), demand and supply of labor (DEMAND L, SUPPLY L); optimization models of socio-economic regulation of demand and supply of labor (REG DS), proportionality of jobs with labor resources (PP JLR), formation of rational employment of the rural able-bodied population (RATEMPL) and rational use of labor resources (RUSE LR); multivariate models for the analysis and forecast of rural unemployment (UNEMPL) and a simulation system of models for the development of RLM (RLMD) (see Fig. 1).

The described DIM is developed according to the principle of target orientation of the development of the rural labor market in labor-surplus regions. At the initial stage of development, the DIM closely interacts with models of economic and demosocial development of rural labor-surplus regions, as well as intersectoral models of labor costs.

It is expedient to use a reflex approach in the development of the DIM for the development of RLM [2, p.39]. It fully takes into account the internal (V_i) and external (W_i) conditions for the functioning of RLM subsystems. In the DIM, developed according to the V_iW_i type and based on this approach, the main attention is paid to the internal conditions for the development of RLM subsystems. When it is used in the DIM, a certain subsystem is usually singled out, which is described with the necessary level of detail Vi of its functioning, while other subsystems and their connections between themselves and with the subsystem under study are presented in an aggregated way.

The development of the reflex approach is due to the greatest extent to applied problems, the need to study individual subsystems as part of a single RLM.

The main feature of the reflex approach, as shown above, is a detailed description of the main subsystems and aggregation of the rest of the RLM. When finding the solution of the reflex model for one object, iterative coordination is not required: it is only necessary to establish pairings between the "inputs" and "outputs" of the detailed and aggregated RLM subsystem. A much more complex and little studied problem is the combination of conditions and solutions of several reflex models, in which different objects are described in detail.

In the reflex approach, DIM is consistent with each other in a horizontal connection, i.e., the output of one model serves as input to the next model, and collectively form models for the development of RLM.

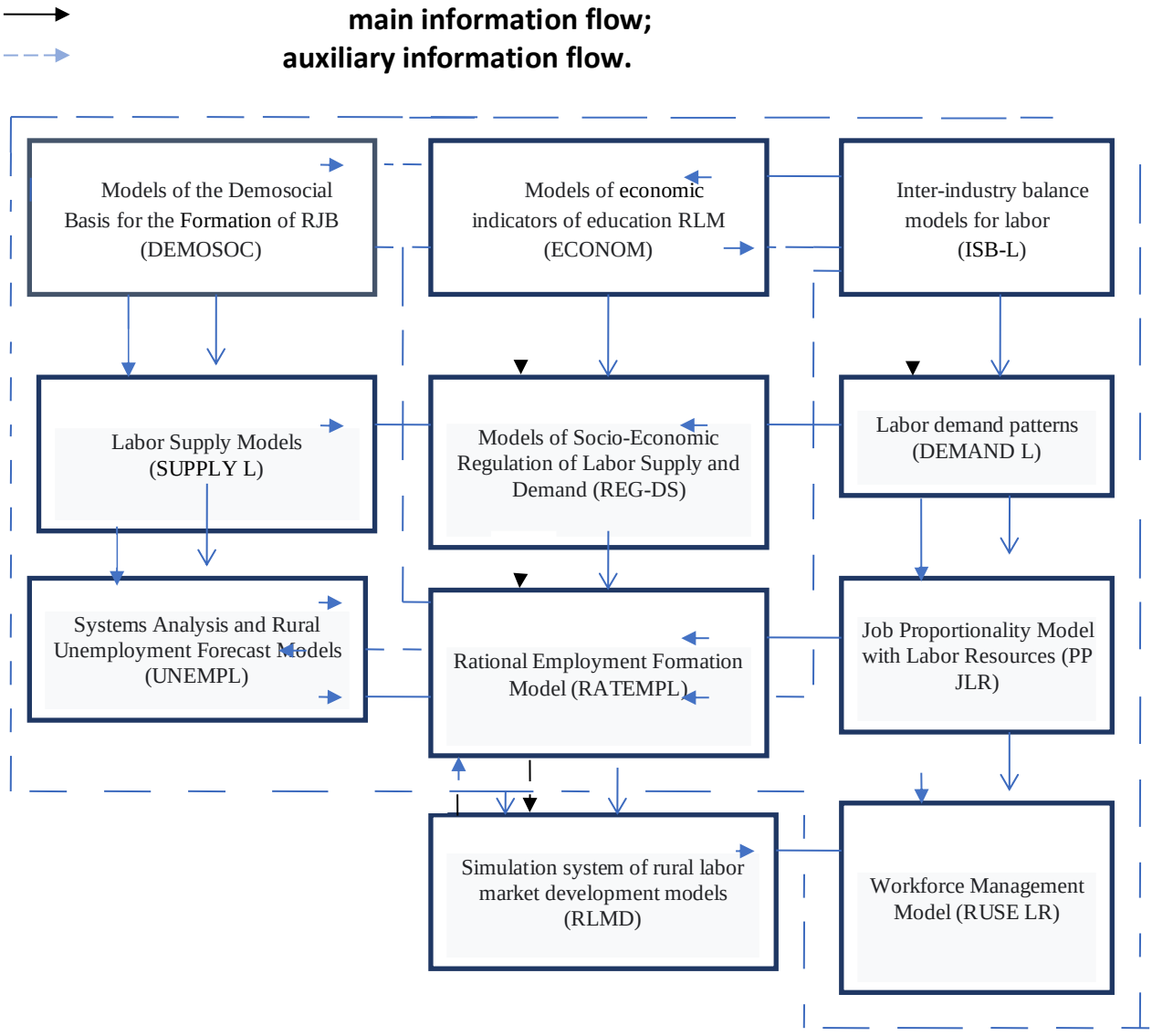

Figure 1. Scheme of information relationships of the integrated digital complex of models for the development of the rural labor market

At the fourth stage, methods for solving the proposed DIM for the development of RLM of labor-surplus regions are determined, which include linear and block programming, machine simulation, correlation-regression analysis, etc. Based on the nature of the problem statement and its corresponding model, one of the listed methods is applied.

The synthesizing (main) simulation digital complex models for the development of RLM form their exogenous parameters due to the output information of models of rational employment, demand and supply of labor and their socio-economic regulation, proportionality of jobs with labor resources, analysis and forecast of unemployment, economic and demo -social development of the labor force, intersectoral balances of labor costs, and they are tested in the object of study by the method of computer simulation.

At the same stage of digital complex modeling, special algorithms are developed for translating the listed models into machine language and the possibilities of using application software packages (APPs) are explored. In case of insufficiency of APPs, new software products are produced and they are modified.

At the fifth stage, the collection, analysis and assessment of the reliability of the

necessary information intended for the implementation of the DIM RLM is carried out. The problems of its information security are successfully solved by specific marketing, statistical and sociological research.

At the sixth stage, a computer approbation of the proposed DIM is carried out, where the existing APPs, the author's software products and reliable information on the economic, demographic and social development of the studied labor-surplus region are optimally used.

At the final stage of digital complex modeling, a comprehensive analysis of the obtained computer results is carried out, on the basis of which a concept for the optimal development of the RLM is developed, which includes optimal options for the formation of a rational employment structure and the achievement of a natural (permissible) level of unemployment in labor-surplus regions.

Now let's consider the process of functioning of the DIM RLM, in other words, the procedure for calculating the models. The calculations start with the DEMOSOC block model. After their approbation, data on fertility, mortality, average life expectancy, qualifications, education, mechanical movement, age structure and size by sex of the rural population are directly transferred to the SUPPLY-L and DEMAND-L model blocks.

Further, using the DEMAND-L and SUPPLY-L model blocks, calculations are carried out to determine the corresponding supply and demand for labor in various sectors and forms of ownership of the economy. These blocks receive calculated indicators on the volume of fixed production assets and the level of their use, wages, prices, labor costs and other necessary economic data obtained as a result of testing the ECONOM and ISB-L model blocks. Models of the ISB-L block make it possible to determine the proportions between the costs of living and materialized labor, which improve the degree of validity of calculations using the models of the DEMAND-L, SUPPLY-L, REG-DS and PP JLR blocks.

An important place in the approbation of the DIM RLM is given to the calculated data on the release of workers from agricultural production and other sectors of the rural economy, obtained as a result of approbation of the models of the UNEMPL block. The output parameters of the last block characterize the number, structure and types of rural unemployment.

In the event of a change in the price, supply and demand for labor, economic and social regulation of the main components of the formation of rural labor markets and jobs is carried out based on the output information obtained from the calculations of the models of the REG-DS block.

The output data of the listed models are first fed into the summary models of the rational employment formation block (RATEMPL), then into the models of the rational use of labor resources (RUSE LR).

Approbation of the DIM is completed when, with the help of the main and auxiliary information flows, computer simulation calculations are made according to the RLMD model to determine the optimal options for the development of various RLM subsystems in the studied labor-surplus region.

DIM RLM is intersecting. This means that a number of indicators is the result of a calculation using two or more models, each of which enhances one or another aspect of reality. For example, the input parameters of the models of the DEMAND L block are mainly formed as a result of the calculations of the models of its four sub-blocks. In the

process of harmonizing the indicators, the probability of correct reflection by the models of the actual state and dynamics of the RLM development increases.

DIM allows to carry out calculations for the intended purpose. In particular, according to the given targets and indicators that reflect the formation of a rational structure of employment with an acceptable level of unemployment in the conditions of effective development of the RLM in labor-surplus regions, it is possible to find a number of optimal options for socio-economic development or their combination, with the help of which it will be achieved. For this purpose, a wide range of instrumental model parameters is used.

The DIM forms a certain integrity, which means that calculations on it make it possible to obtain something more than calculations for each model separately.

Approbation of the DIM RLM enriches the information base of other models of a socially oriented market economy. For example, in the model of the UNEMPL block, the output can be the number of trained unemployed in certain professions, which is one of the main conditions for the formation of models of the RATEMPL block.

An important advantage of the DIM is the relative ease of its software and mathematical support. The difficulties associated with algorithmization and programming of large non-linear models are well known; their implementation is often difficult even for modern computer technology. DIM RLM allows to eliminate these difficulties. It allows fast algorithmization and programming of models, some of which are non-linear.

Results

The DIM development process is presented in the form of steps to be performed, but in practice such a logical sequence is not maintained. Forecasting here precedes the formulation of goals. However, both in setting goals and in the subsequent stages of development, it is advisable to pay special attention to forecasting.

It is expedient to use the proposed methodology, the development of the DIM, in labor-surplus rural regions of our republic and other countries of Central Asia.

As a result of testing the DIM, we calculated predictive indicators for reducing the informal employment of the rural able-bodied population of the Republic of Uzbekistan until 2025 by increasing the organization of jobs in agricultural clusters, cooperatives, farms and personal subsidiary plots.

The effective organization of agricultural clusters and cooperatives will have a direct positive impact on increasing the share of employment in this sector of the economy in the future and reducing the level of informal employment of the able-bodied population.

In 2021, 99,524 new jobs were created under the program in the agricultural sector. According to our calculations, an increase in the number of new jobs created in this sector of the economy is expected in the near future. That is, by 2025 the number of new jobs in agriculture will reach 112,713 units.

The share of clusters in the structure of job creation in agriculture is high, and the number of jobs created in them will increase from 74010 in 2021 to 88940 in 2025. During this period, the number of jobs created in agricultural cooperatives will increase from 4909 to 5302, respectively, and the number of jobs created in private and farm enterprises and other organizations will increase from 24822 to 27971 (see Table 1).

During the forecast period, the number of jobs created in the non-agricultural sector will increase from 206,744 in 2021 to 259,874 in 2025.

Table 1. Forecast of new jobs and employment in agricultural clusters and cooperatives and other sectors of the rural economy of the Republic of Uzbekistan

s/n	Name of the agricultural sector	Indicators and units	2021 (report)	Forecast period				Change in 2025 compared to 2021	
				2022	2023	2024	2025	+ ; -	%
I.	**Total for the agricultural sector, including:**	new jobs, pcs.	99524	102161	104798	107435	112713	+13189	113,3
		employed population, people	115789	119136	122483	125830	132525	+16736	114,5
1.1.	By agricultural clusters – total, including:	new jobs, pcs.	74010	76995	79980	82965	88940	+14930	120,2
		employed population, people	82854	88195	93536	98877	109563	+26709	132,2
1.1.1.	Cotton-textile	new jobs, pcs.	38028	40384	42739	45095	47450	+9422	124,8
		employed population, people	44235	47070	49905	52740	55575	+11340	125,6
1.1.2.	Grain growing	new jobs, pcs.	3118	3192	3266	3341	3415	+297	109,5
		employed population, people	3563	3627	3690	3753	3816	+253	1,07,1
1.1.3.	animal husbandry	new jobs, pcs.	10721	11067	11413	11759	12552	+1831	117,1
		employed population, people	12474	12907	13340	13773	14639	+2165	117,4
1.1.4.	fruit and vegetable	new jobs, pcs.	17249	17890	18532	19173	20556	+3307	119,2
		employed population, people	20071	20866	21662	22457	24048	+3977	119,8
1.1.5.	Sericulture	new jobs, pcs.	1936	2047	2158	2269	2490	+554	128,6
		employed population, people	2255	2390	2524	2659	2928	+673	129,8
1.1.6.	Fishing	new jobs, pcs.	1204	1212	1221	1229	1245	+41	103,4
		employed population, people	1400	1413	1426	1439	1464	+64	104,6
1.1.7.	Agritourism	new jobs, pcs.	871	910	949	988	1067	+196	122,5
		employed	1013	1061	1110	1158	1255	+242	123,9

		population, people							
1.1.8.	medicinal plants	new jobs, pcs.	589	609	630	650	712	+123	120,9
		employed population, people	651	682	713	744	837	+186	128,6
1.2.	Agricultural cooperatives	new jobs, pcs.	4909	5008	5106	5204	5302	+393	108,0
		employed population, people	5401	5509	5617	5725	5942	+541	110,0
1.3.	Private and subsidiary farms	new jobs, pcs.	24822	25452	26081	26711	27971	+3149	112,7
		employed population, people	26663	27624	28586	29547	31470	+4807	118,0
II.	Non-agricultural industries	new jobs, pcs.	206744	217370	227996	238622	259874	+53130	125,7
		employed population, people	252349	265980	279611	293242	320504	+68155	127,0
In the countryside – total		new jobs, pcs.	306269	319533	332796	346060	372587	+66318	121,7
		employed population, people	373797	393605	413413	433221	453029	+79232	121,2

Particular attention is paid to the creation of new jobs in agricultural clusters and cooperatives of the country, the adoption in the future of special state programs in these sectors of the economy will lead to an increase in employment of the rural working-age population.

The increase in the number of new jobs in agricultural clusters and cooperatives in the Republic of Uzbekistan, in turn, will lead to a reduction in the number of informal employment in rural areas (see Table 2).

Table 2. Forecast of informal employment in rural areas of the Republic of Uzbekistan, in thousand people

№	Name of indicators	2021 (report)	Forecasting period				In 2025 to 2021, %
			2022	2023	2024	2025	
1	The number of people employed in rural areas – total	10442,9	10651,8	10864,8	11082,1	11303,7	108,2
1.1	Including: in the informal sector	6109,1	6060,9	5943,0	5884,6	5753,6	94,2
1.1.1	Share of the informal sector, in percentage	58,5	56,9	54,7	53,1	50,9	x

From Table 1 it can be seen that the number of people employed in rural areas in 2021 amounted to 10442,9 thousand people, and by 2025 this figure will reach 11303,7 thousand people. Due to the special attention paid to the organization of agricultural clusters and cooperatives in the country, as well as the development of private farms, there is a decrease in the number of informal employments by 355,5 thousand people. In particular, 58.5% of the employed population in rural areas in 2021 were employed in the informal sector and this figure will reach 50.9% by 2025.

Discussion

At the same time, the limitations inherent in the developed DIM should also be noted. Although it simultaneously implements resource and target approaches, the latter is represented in it much weaker. This is expressed, firstly, in an insufficient degree of substantiation of social needs, since the system does not include models for determining the living standards and poverty of the rural population; secondly, in the impossibility of identifying and solving on its basis all the socio-economic problems that arise in the conditions of the formation and development of market relations in rural areas of labor-surplus regions. The limitation of the developed DIM is also in the predominance of cost indicators in it to the detriment of natural. The above

shortcomings in digital complex modeling are eliminated by developing additional models for the social and economic development of rural labor-abundant regions.

Conclusion

Thus, the proposed methodology for the development of the DIM makes it possible to determine specific measures, deadlines, performers and financial sources for the implementation of effective solutions to reduce the supply of labor and increase its demand, the formation of an optimal proportion between the labor force and job markets, the formation of rational employment and the reduction of unemployment to an acceptable level. level in rural areas of labor-surplus regions in the Republic of Uzbekistan.

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