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NEW HORIZONS OF ECONOMIC INTEGRATION IN THE EAEU BASED ON EDUCATIONAL AND LABOR MIGRATION: IMPLICATIONS FOR QUALITY MANAGEMENT IN INDUSTRY 4.0

Abstract: The purpose of the article is to define new horizons of economic integration in the EAEU based on educational and labor migration, provided that quality improvement in industry 4.0 is chosen as the key vector of this integration. Using the trend analysis method, changes in the incoming and outgoing migration flow to the EAEU in 2010-2019 have been determined. The influence of migration flows in the EAEU on the product quality in Industry 4.0 has been identified using the regression analysis method. As a result, it has been revealed that economic integration in the EAEU gives a powerful new impetus to the development of migration processes in these countries. The econometric model obtained during the study showed that the quality of Industry 4.0 products in the EAEU improves with an increase in incoming and a decrease in outgoing migration flows. The originality of this study lies in the fact that it proposes a new approach to economic integration in the EAEU, in which the management of educational and labor migration flows is rethought as a tool for the implementation of the common vector of Eurasian integration: quality improvement in industry 4.0 The authors have proposed a framework strategy for improving migration policy in the EAEU until 2025 to icrease the quality in industry 4.0. The implications for migration policy are related to the fact that the developed algorithm for managing educational and labor migration in the EAEU will prevent brain drain, strengthen the culture of the "knowledge society" and attract the best personnel from around the world for Industry 4.0 in the EAEU. The article substantiates new horizons of economic integration in the EAEU for improving migration management to increase quality in industry 4.0, namely: the creation of competence centers, innovation networks and integration associations in industry 4.0.

Keywords: New Horizons of Economic Integration, the EAEU, Educational Migration, Labor Migration, Quality Management, Industry 4.0.

1. Introduction

The Eurasian Economic Union (EAEU) is a promising integration association of countries located in Eastern Europe and Central Asia, which is dictated not only by their geographical proximity, but also by the similarity of cultures, as well as common socio-economic interests. The problem is that despite the fact that the EAEU has received serious development in recent years, the potential of economic integration in the EAEU has not been fully disclosed due to the uncertainty of the key vector of

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this integration.

The best practices of the European Union (EU) as a major integration association of countries serve as a successful example from international practice. The EU has clearly declared and is implementing in practice the "green" vector of its development, introducing high environmental standards and achieving high resource efficiency. This experience is useful for the EAEU, as the choice of the vector of economic integration will strengthen the unifying effect, enhance global competitiveness and bolster the positions of the EAEU on the world stage.

The significant synergetic effect in the EAEU is evidenced not only by the improvement in the indicators of its member countries compared to the period before its formation, but also by a more pronounced improvement in economic indicators. The EAEU began its existence in 2015. The ten-year trend of its development demonstrates the following: in 2021, GDP per capita growth amounted to 34% compared to the period before the formation of the EAEU (2012) (the global average is 32%) and industrial production growth by 20% (compared with 10% in the EU and 8.5% in the OECD) (Eurasian Economic Commission, 2023b).

The noted rapid growth of industry occurred due to the implementation of strategic directions for the development of the Eurasian economic integration until 2025, which were approved on December 11, 2020 by the heads of the EAEU states, among which are "formation of the EAEU digital space", "stimulation of STP", "development of high-performance sectors", "quality assurance", as well as "formation of the EAEU in as one of the most significant centers of development of the modern world" (Eurasian Economic Commission, 2023b).

The disadvantage of the 11 strategic directions of the EAEU development is their fragmentation, which can be overcome by choosing a common direction (vector) that

unites all the others. The marked directions are connected by the fact that all of them can be attributed to industry 4.0. In this regard, the vector of Eurasian integration in the conditions of the Fourth Industrial Revolution may be the improvement of quality in industry 4.0, embodying digitalization, innovation and high-tech production.

Educational and labor migration belong to independent and separate strategic directions, which are "the implementation of cooperation mechanisms in the field of education" and "the completion of the formation of a common labor market", respectively (Eurasian Economic Commission, 2023b). The above determines the relevance of bringing the practice of managing educational and labor migration processes in the EAEU in line with the proposed key vector of Eurasian integration until 2025: improving quality in industry 4.0.

The purpose of this article is to define new horizons of economic integration in the EAEU on the basis of educational and labor migration, provided that quality improvement in Industry 4.0 is chosen as the key vector of this integration.

The originality of this study lies in the fact that it proposes a new approach to economic integration in the EAEU, in which the management of educational and labor migration flows is rethought as a tool for the implementation of the common vector of Eurasian integration: quality improvement in industry 4.0.

The article is organized as follows. After the introduction section, a literature review is presented, which defines the conceptual apparatus of the study, provides its theoretical basis, analyzes gaps and poses a research question. After that, the materials and methodology section provides the methodological and statistical base of the study.

Then the results of the consistent solution of the following three tasks of this study are presented: 1) identification of trends in

educational and labor migration in the EAEU and their impact on product quality in Industry 4.0; 2) development of a framework strategy for improving migration policy in the EAEU until 2025 to increase quality in Industry 4.0; 3) substantiation of new horizons of economic integration in the EAEU for improving migration management to increase quality in industry 4.0

The discussion section provides a comparative analysis of the existing and proposed new approach to economic integration in the EAEU. In the conclusion section, the findings are presented, the limitations of the article are noted and the directions of future research are indicated.

2. Literature Review

2.1 Economic integration and its specifics in the EAEU

Economic integration in this article refers to mutually beneficial cooperation between two or more countries organized in the form of an economic union (Ramirez, 2023). The modern experience of economic integration and its advantages are noted in numerous literature sources. Thus, da Silva et al. (2023) highlighted in their work the important role of technological, organizational and infrastructural factors in the implementation of international investment projects in the context of economic integration (for example, the construction works at subsalt deposits, natural gas exploration and energy production in Brazil under the conditions of economic integration of Latin American countries).

In turn, Zhao et al. (2023) proved the important role of digitalization in promoting sustainable integration of culture and tourism for post-crisis economic recovery (using the example of the COVID-19 crisis against the background of a pandemic in 2020). Kügler et al. (2023) justified the position that in order to derive maximum benefits from the economic integration of countries, the integration of supply chains at the business level is required (using the example of the experience of the European Union, which made it possible to explain the discrepancy in the economic indicators of its member countries). This means that cooperation should be systemic and cover not only the macro- but also the micro-level of the economy.

Raza et al. (2023) showed that the inflow of remittances, investment attributes and regional integration accelerate sustainable economic growth (using the example of integration processes in Asia). This strengthened the evidence base of the advantages of financial and economic integration in comparison with limited economic integration. Meressa (2022) identified the determinants of the inflow of foreign direct investment and proved that they contribute to institutional and socio-economic integration (using the example of cooperation of COMESA member countries). Haiyun et al. (2023) justified the significant impact of integration processes on the economic growth of their member countries (using the example of the Common Market for Eastern and Southern Africa).

The specifics of economic integration in the EAEU, related to its continuity (the EAEU is a continuation of economic integration in the USSR and the CIS), industrial orientationas well, as the conditions of the Fourth Industrial Revolution, are also covered in detail in the available literature by Cieślik and Gurshev (2023), Garashchuk et al. (2023), Kolesnikova et al. (2022), Pishchik et al. (2022).

2.2 Fundamentals of Quality Management in industry 4.0

The theoretical basis of this study was formed by the concept of quality in industry 4.0, presented in the works of Woźniak et al. (2022), Zimon et al. (2022). The content analysis of the existing scientific literature revealed three main directions of quality

management in industry 4.0. The first direction: knowledge management (Gjika and Pano, 2023). High-tech industries of Industry 4.0 have great needs for such human resources as highly qualified and digital personnel, as well as middle-skilled workers with digital competencies for servicing automated production facilities (Chen and Yang, 2022).

The second direction: innovation management. Industry 4.0 assumes high innovation activity, since only it can ensure the global competitiveness of high-tech industries in conditions of intense digital competition.

The third direction: neoindustrialization (transition to industry 4.0) and management of high-tech industries (Thach et al., 2021). The essence of this direction is to increase the high-tech products of industry 4.0 (Grenčíková et al., 2021).

Thus, the quality of products in industry 4.0 is determined by its knowledge intensity, innovation and high-tech. Accordingly, in order to improve quality in industry 4.0, it is necessary to attract and retain the necessary personnel, high innovative activity and dynamic development of high-tech industries.

2.3 Educational and labor migration in the EAEU

Favorable conditions for this have been created in the EAEU: strong university partnerships have been built, similar educational programs based on the post-Soviet model of education are realized, the exchange of students and teachers is actively practiced, and a highly effective practice of mutual recognition of higher education diplomas has been established (Hean et al., 2023).

Labor migration involves the recruitment of foreign personnel by enterprises experiencing a shortage of human resources, or an independent search for the best employment opportunities abroad by

workers who cannot fully unleash their human potential (Sargent, 2023). International migration in the EAEU is largely internal, that is, it occurs within the EAEU and involves the movement of human resources among the EAEU member states.

Thus, the total number of immigrants in Armenia in 2020 amounted to 190,000 people who arrived from the following countries: Russia - 19,000 people (10%), Kazakhstan - 1,000 people (0.53%). The total number of emigrants from Armenia in 2020 amounted to 958,000 people who left for the following countries: Russia - 527,000 people (55.01%), Kazakhstan - 10,000 people (1.04%), Belarus - 6,000 people (0.63%) and Kyrgyzstan - 2,000 people (0.21%) (Migration Policy Institute, 2023).

In Belarus, the total number of immigrants in 2020 amounted to 1,067,000 people who came from the following countries: Russia - 672,000 people (62.98%), Kazakhstan - 69,000 people (6.47%), Armenia - 6,000 people (0.56%), Kyrgyzstan - 5,000 people (0.47%). The total number of emigrants from Belarus in 2020 amounted to 1484,000 people who left for the following countries: Russia - 764,000 people ((51.48%), Kazakhstan - 73,000 people (4.92%), Kyrgyzstan - 10,000 people (0.67%) (Migration Policy Institute, 2023).

In turn, in Kazakhstan, the total number of immigrants in 2020 amounted to 3732,000 people who arrived from the following countries: Russia - 2476,000 people (66.34%), Belarus - 73,000 people (1.96%), Armenia - 10,000 people (0.27%), Kyrgyzstan - 7000 people (0.19%). The total number of emigrants from Kazakhstan in 2020 amounted to 4204,000 people who left for the following countries: Russia - 2559,000 people (60.87%), Belarus - 69,000 people (1.64%), Kyrgyzstan - 13,000 people (0.31%), Armenia - 1,000 people (0.02%) (Migration Policy Institute, 2023).

In Kyrgyzstan, the total number of immigrants in 2020 amounted to 199,000

people who came from the following countries: Russia - 109,000 people (54.77%), Kazakhstan - 13,000 people (6.53%), Belarus - 10,000 people (5.02%), Armenia - 2,000 people (1%). The total number of emigrants from Kyrgyzstan in 2020 amounted to 774,000 people who left for the following countries: Russia - 591,000 people (76.36%), Kazakhstan - 7000 people (0.90%), Belarus - 5000 people (0.65%) (Migration Policy Institute, 2023).

In Russia, the total number of immigrants in 2020 amounted to 11637,000 people who came from the following countries: Kazakhstan - 2559,000 people (21.99%), Belarus - 764,000 people (6.56%), Kyrgyzstan - 591,000 people (5.08%), Armenia - 527,000 people (4.52%). The total number of emigrants from Russia in 2020 amounted to 10757,000 people who left for the following countries: Kazakhstan - 2476,000 people (23.01%), Belarus - 672,000 people (6.25%), Kyrgyzstan - 109,000 people (1.01%), Armenia - 19,000 people (0.18%) (Migration Policy Institute, 2023).

In the EAEU, migration processes are interpreted as a mechanism for balancing national labor markets in the EAEU countries, as well as facilitating the development and disclosure of human potential (Andronova and Ryazantsev, 2023; Kapsultanova et al., 2022). The essence of state regulation of immigration is related to the creation of favorable and equal conditions for all immigrants from the EAEU countries (Sigareva and Sivoplyasova, 2021).

Regulation of emigration from the EAEU includes only market measures, since it is assumed that natural incentives are sufficient to retain the best personnel (Bokayev et al., 2020). The essence of coordinated migration management based on the economic integration of the EAEU is to provide better conditions for migrants from the EAEU countries compared to migrants from other countries (for example, from the CIS): the

criterion is the migrant's country of origin (Dzhunisbekova et al., 2017; Ryazantsev et al., 2017).

2.4 Gap analysis and research question

Based on the results of the literature review, it can be concluded that the existing approach to economic integration in the EAEU is disclosed in sufficient detail in the available literature. This determines the high degree of elaboration of the problem posed in the article and the reliable theoretical basis of this study. Nevertheless, the relationship of educational and labor migration with quality in Industry 4.0 is poorly understood, and in the EAEU, it is practically not investigated.

The uncertainty of the consequences of educational and labor migration for the product quality in industry 4.0 is a gap in the literature, which this article aims to fill. It poses the following research question. RQ: How to manage international migration to the EAEU in order to maintain the growth of quality in Industry 4.0?

In order to find an answer to the RQ posed in the article, econometric modeling of the impact of the movement of migration flows on the product quality in industry 4.0 in the EAEU is carried out. The scientific novelty of the study lies in the fact that it reveals new horizons of economic integration in the EAEU, which are opening up in the process of bringing educational and labor migration in line with the priority of improving the quality of products in Industry 4.0.

3. Materials and methodology

The article consistently solves three problems. The first task is to identify trends in educational and labor migration in the EAEU and their impact on product quality in Industry 4.0. To solve this problem, the method of trend analysis is used, with the help of which five-year trends of changes in incoming (number of international

immigrants per capita per 1000) and outgoing (number of emigrants per capita per 1000) migration flows in the EAEU are determined based on the statistics of Our World in Data (2023). The data at the level of the integration association as a whole are identified by calculating arithmetic averages of particular values for the EAEU member countries.

The impact of educational and labor migration in the EAEU on the quality of products in Industry 4.0 is determined using the regression analysis method. The components of the Frontier technology readiness index according to UNCTAD.Stat (2023) act as quality management indicators in Industry 4.0: staffing of industry 4.0

(skills), innovation activity in industry 4.0 (R&D) and the development of high-tech industries in industry 4.0 (industry activity).

Since the EAEU includes 5 countries, in order to obtain sufficiently large amounts of data for regression analysis, this study examines statistics for 2010, 2015 and 2020. These statistics are combined into a common data set with 15 observations. This makes it possible to make sufficiently accurate models of multiple linear regression with 14 degrees of freedom. Systematic information on international migration and quality in Industry 4.0 in the EAEU countries in 2010, 2015 and 2020, acting as an empirical basis for this study, is presented in Table 1.

Table 1. Statistics of international migration and quality in Industry 4.0 in the EAEU countries in 2010, 2015 and 2020

Year	Country	Omponent of Frontier technology readiness index			International migration flows	
		Skills (SK)	R&D (RD)	Industry activity (IA)	Number of international immigrants per capita per 1000 (incoming flow, Mim)	Number of emigrants per capita per 1000 (outgoing flow, Mem)
2020*	Armenia	0,45	0,15	0,38	6,42	32,34
	Belarus	0,63	0,18	0,52	11,47	15,70
	Kazakhstan	0,58	0,35	0,48	20,18	22,39
	Kyrgyzstan	0,37	0,07	0,42	3,43	11,87
	Russia	0,67	0,68	0,51	8,03	7,37
2015	Armenia	0,52	0,15	0,35	6,54	32,28
	Belarus	0,72	0,24	0,49	11,29	15,57
	Kazakhstan	0,63	0,25	0,55	19,88	22,11
	Kyrgyzstan	0,40	0,03	0,45	3,05	12,47
	Russia	0,73	0,68	0,54	7,97	7,02
2010	Armenia	0,53	0,15	0,33	7,34	31,87
	Belarus	0,77	0,15	0,44	11,57	15,55
	Kazakhstan	0,64	0,04	0,52	20,52	23,37
	Kyrgyzstan	0,43	0,00	0,49	4,28	13,40
	Russia	0,73	0,63	0,49	7,80	7,05

* statistics of international migration flows are given for 2019.
Source: compiled by the authors based on materials: Our World in Data (2023), UNCTAD.Stat (2023).

The research model has the following form:

The reliability of regression equations is determined using correlation analysis,

$$\left[\begin{array}{l} SK = a_{SK} + b_{Mim(SK)}Mim + {}_{Mem(SK)}Mem, \\ RD = a_{RD} + b_{Mim(RD)}Mim + {}_{Mem(RD)}Mem, \\ IA = a_{IA} + b_{Mim(IA)}Mim + {}_{Mem(IA)}Mem. \end{array} \right. \quad (1)$$

Fisher's (F-test) and Student's t-test. The positive impact of educational and labor migration in the EAEU on the quality of products in industry 4.0 is evidenced by the positive values of regression coefficients (b), and the negative impact – respectively negative values of regression coefficients (b).

The second task is to develop a framework strategy of improving migration policy in the EAEU in the period up to 2025 in order to improve quality in Industry 4.0. The strategy is designed to identify the control values of migration indicators, as well as their expected consequences for quality in industry 4.0, which are predicted by substituting control values of factor variables into regression equations in the research model (1). The strategy also reflects the projected increase in the values of indicators: a five-year trend in 2025 compared to 2020.

The third task is to substantiate new horizons of economic integration in the EAEU for improving migration management towards increasing quality in Industry 4.0. New horizons of economic integration are promising institutions of state regulation of educational and labor migration flows, the creation and functioning of which will ensure the achievement of migration benchmarks in the practice of the EAEU in the period up to 2025. In order to systematically present new horizons of economic integration, the authors develop an algorithm for managing educational and labor migration in the EAEU to improve quality in industry 4.0.

4. Results

4.1 Trends of educational and labor migration in the EAEU and their impact on product quality in Industry 4.0

To solve the first task of this study associated to the identification of trends in educational and labor migration in the EAEU and their impact on product quality in industry 4.0, five-year trends of changes in incoming (number of international immigrants per capita per 1000) and outgoing (number of emigrants per capita per 1000) migration flows in the EAEU were determined using the trend analysis method and statistics of Our World in Data (2023) in 2010-2019. (Fig. 1).
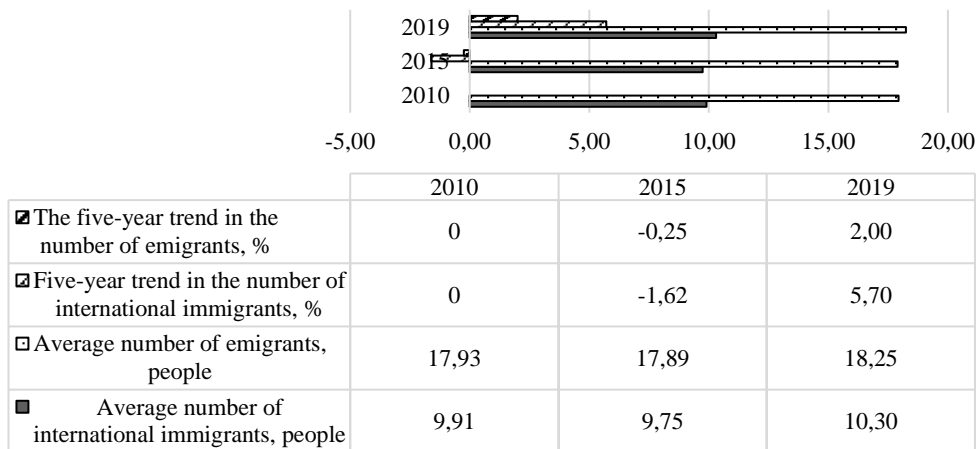

	2010	2015	2019
☑ The five-year trend in the number of emigrants, %	0	-0,25	2,00
☑ Five-year trend in the number of international immigrants, %	0	-1,62	5,70
☐ Average number of emigrants, people	17,93	17,89	18,25
■ Average number of international immigrants, people	9,91	9,75	10,30

Figure 1. Trends of educational and labor migration in the EAEU
in 2010-2019
Source: calculated and constructed by the authors

As shown in Figure 1, the average number of international immigrants per capita per 1000

in the EAEU in 2010 was 9.91 people, and by 2015, it was reduced to 9.75 people. The five-year trend (an increase in 2015 compared to 2010) was -1.62%. The average number of emigrants per capita per 1000 in the EAEU in 2010 was 17.93 people, and by 2015 it decreased to 17.89 people. The five-year trend (an increase in 2015 compared to 2010) was -0.25%.

By 2019, the average number of international immigrants per capita per 1000 in the EAEU was 10.30 people. The trend (four-year growth in 2019 compared to 2015) was 5.70%. The average number of emigrants per capita per 1000 in the EAEU in 2019 was 18.25 people. The trend (four-year growth in 2019 compared to 2015) was 2%.

The obtained results of trend analysis indicate that economic integration based on the EAEU has given a powerful new impetus to the development of migration processes in the member countries of this integration association. Within the framework of solving this task, it is also advisable to assess the consequences of the development of migration processes for quality in industry 4.0. The impact of educational and labor migration in the EAEU on the product quality in Industry 4.0 is determined using regression analysis of data from Table 1, the results are summarized in Tables 2-4.

Table 2. Regression analysis of the impact of educational and labor migration in the EAEU and their impact on the staffing of industry 4.0

Regression statistics					
Multiple R	0,6422				
R-Square	0,4125				
Adjusted R-Square	0,3146				
Standard Error	0,1081				
Observations	15				
ANOVA					
	df	*SS*	*MS*	*F*	*Significance F*
Regression	2	0,0985	0,0492	4,2123	0,0411
Residual	12	0,1403	0,0117		
Total	14	0,2387			
	Coefficients	*Standard Error*	*t-Stat*	*P-Value*	*Lower 95%*	*Upper 95%*
Y-intercept	0,5743	0,0742	7,7405	0,00001	0,4127	0,7360
Number of international immigrants per capita per 1000	0,0128	0,0050	2,5422	0,0258	0,0018	0,0237
Number of emigrants per capita per 1000	-0,0064	0,0033	-1,9350	0,0769	-0,0136	0,0008

Source: calculated and compiled by the authors.

Results from Table 2 indicate that the change in the staffing of industry 4.0 (skills) by 64.22% (Multiple R, and R^2 = 0.4125) is explained by the change in migration flows in the EAEU in 2010-2020. The significance F=0.0411, therefore, the regression statistics correspond to the significance level of 0.05.

At a given significance level for 2 factor variables (m=2) and 15 observations (n=15), that is, for k_1=m=2, k_2=n-m-1=15-2-1=12 critical F=3.8853. The observed F=4,2123, it exceeds the critical one, therefore, the Fischer F-test has been passed.

The critical t for 14 degrees of freedom is 1.76 at a significance level of 0.1 and 2.14 at a significance level of 0.05. The observed t for factor variables were as follows: t_{Mim} =2.54, which exceeds 2.14, therefore, the relationship of the resulting variable with this factor variable is reliable at the significance level of 0.05; t_{Mem} =-1.93, modulo: 1.93, which exceeds 1.76, therefore, the relationship of the resulting variable with this factor variable is reliable at the significance level of 0.1. Therefore, Student's t-test has been passed. The conducted tests allow us to conclude that, in general, regression statistics from Table 1 is credible and reliable at a significance level of 0.1.

Table 3. Regression analysis of the impact of educational and labor migration in the EAEU and their impact on innovation activity in Industry 4.0

Regression statistics						
Multiple R	0,5254					
R-Square	0,2760					
Adjusted R-Square	0,1554					
Standard Error	0,2136					
Observations	15					
ANOVA						
	df	*SS*	*MS*	*F*	*Significance F*	
Regression	2	0,2089	0,1044	2,2878	0,1440	
Residual	12	0,5477	0,0456			
Total	14	0,7566				
	Coefficients	*Standard Error*	*t-Stat*	*P-Value*	*Lower 95%*	*Upper 95%*
Y-intercept	0,4306	0,1466	2,9370	0,0124	0,1112	0,7501
Number of international immigrants per capita per 1000	0,0070	0,0099	0,7025	0,4958	-0,0147	0,0286
Number of emigrants per capita per 1000	-0,0139	0,0065	-2,1265	0,0549	-0,0281	0,0003

Source: calculated and compiled by the authors.

The results from Table 3 indicate that the change in innovation activity in Industry 4.0 (R&D) by 52.54% (Multiple R, and R^2 =0.2760), which is explained by the change in migration flows in the EAEU in 2010-2020. The significance F=0.1440, therefore, the obtained regression statistics correspond to the significance level of 0.15. At a given significance level for 2 factor variables (m=2) and 15 observations (n=15), that is, for k_1=m=2, k_2=n-m-1=15-2-1=12 critical F=2.2313. The observed F=2.2878, it exceeds the critical one, therefore, the Fischer F-test has been passed.

The critical t for 14 degrees of freedom is 1.52 at a significance level of 0.15. The observed t for factor variables were as follows: t_{Mim}=0.7025 (the t-test was not passed for this factor variable), t_{Mem}= -2.1265, modulo: 2.1265, which exceeds 1.52. Therefore, the relationship of the resulting variable with this factor variable is reliable at the significance level of 0.15. Thus, the Student's t-test has been passed only for the Mem variable. The conducted tests allow us to conclude that, in general,

the regression statistics from Table 1 are credible and reliable at a significance level of 0.15, but the relationship of innovation activity in industry 4.0 (R&D) with the incoming migration flow to the EAEU is unstable.

Table 4. Regression analysis of the impact of educational and labor migration in the EAEU and their impact on the development of high-tech industries in industry 4.0

Regression statistics					
Multiple R	0,9040				
R-Square	0,8172				
Adjusted R-Square	0,7867				
Standard Error	0,0314				
Observations	15				

ANOVA					
	df	SS	MS	F	Significance F
Regression	2	0,0528	0,0264	26,8167	0,00004
Residual	12	0,0118	0,0010		
Total	14	0,0646			

	Coefficients	Standard Error	t-Stat	P-Value	Lower 95%	Upper 95%
Y-intercept	0,4966	0,0215	23,0718	0,00000000003	0,4497	0,5435
Number of international immigrants per capita per 1000	0,0075	0,0015	5,1514	0,0002	0,0043	0,0107
Number of emigrants per capita per 1000	-0,0060	0,0010	-6,2280	0,00004	-0,0081	-0,0039

Source: calculated and compiled by the authors

The results from Table 4 indicate that the change in the level of development of high-tech industries in Industry 4.0 (industry activity) by 90.40% (multiple r, and R2 = 0.8172) is explained by the change in migration flows in the EAEU in 2010-2020. The significance F=0.00004, therefore, the obtained regression statistics correspond to the significance level of 0.01. At a given significance level for 2 factor variables (m=2) and 15 observations (n=15), that is, for k_1=m=2, k_2=n-m-1=15-2-1=12 critical F=6.9266. The observed F=26.8167, it exceeds the crititcal one, therefore, the Fischer's F-test has been passed.

The critical t for 14 degrees of freedom is 2.98 at a significance level of 0.01. The observed t for factor variables were as follows: t_{Mim}=5.15, which exceeds 2.98. Therefore, the relationship of the resulting variable with this factor variable is reliable at the significance level of 0.05; t_{Mem}=-6.2280, modulo: 6.2280, which exceeds 2.98. Hence, the relationship of the resulting variable with this factor variable is reliable at the significance level of 0.1. Therefore, Student's t-test has been passed. The conducted tests allow us to conclude that, in general, regression statistics from Table 1 is credible and reliable at a significance level of 0.01.

Taken together, the regression analysis results obtained in Tables 2-4 allow us to refine the research model (1) and set up the following system of equations (2):

$$\left[\begin{array}{l} SK=0{,}5743+0{,}0128Mim-0{,}0064Mem, \\ RD=0{,}4306+0{,}0070Mim-0{,}0139Mem, \qquad (2) \\ IA=0{,}4966+0{,}0075Mim-0{,}0060Mem. \end{array}\right.$$

The system of equations (2) indicates that with an increase in the number of international immigrants per capita per 1000 per 1 person, the staffing of industry 4.0 (skills) increases by 0.0128, innovation activity in industry 4.0 (R&D) - by 0.0070, and the development of high-tech industries in industry 4.0 (industry activity) - by 0.0075. When increasing the number of emigrants per capita per 1000 per 1 person, the staffing of industry 4.0 (skills) is reduced by 0.0164, innovation activity in industry 4.0 (R&D) - by 0.0139, and the development of high-tech industries in industry 4.0 (industry activity) - by 0.0060.

Thus, the quality of products in industry 4.0 in the EAEU improves as the incoming migration flow (international immigration) increases and as the outgoing migration flow

(emigration) decreases. Therefore, in order to improve the product quality of indutry 4.0 in the EAEU, it is advisable to stimulate the incoming flow and limit the outgoing flow of international migration.

4.2 Framework strategy for improving migration policy in the EAEU until 2025 to increase quality in industry 4.0

To solve the second task of this study, which is to develop a framework strategy for improving migration policy in the EAEU until 2025 to increase quality in industry 4.0, the authors have made a forecast of quality increase in industry 4.0 with the improvement of migration policy in the EAEU until 2025, which is presented in Fig. 2.
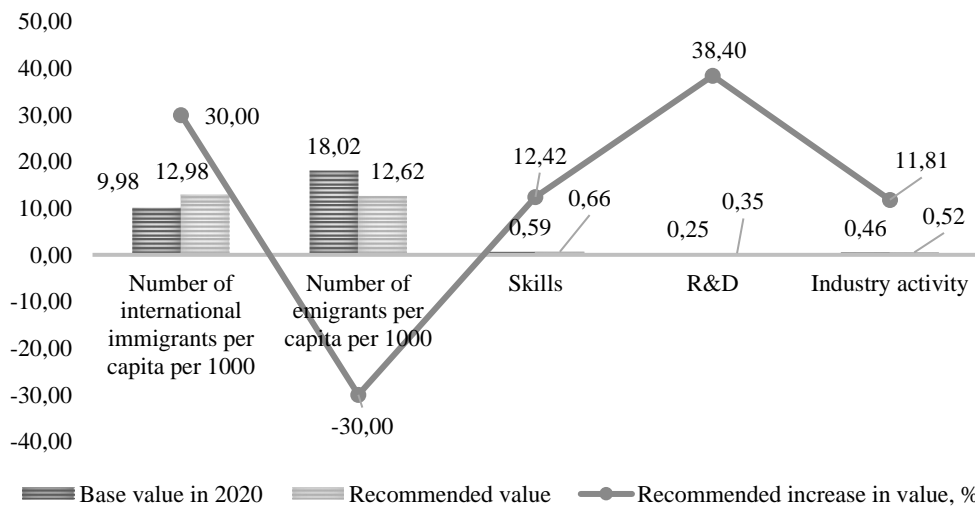

Figure 2. Forecast of quality increase in industry 4.0 with the improvement of migration policy in the EAEU in the period up to 2025
Source: calculated and constructed by the authors

As shown in Figure 2, in the proposed strategy, the control values of migration indicators are an increase of 30% in the incoming flow of international migration in the EAEU and a reduction in the outgoing migration flow by 30%. To do this, it is recommended to increase the number of international immigrants per capita per 1000 from 9.98 people on average in the EAEU in 2019 to 12.98 people by 2025. It is also recommended to reduce the number of emigrants per capita per 1000 from 18.02 people on average in the EAEU in 2019 to 12.62 people by 2025.

By substituting the control values of factor variables into the system of regression equations (2), the expected consequences (the five-year prediction trend in 2025 compared to 2020) for quality in industry 4.0 were revealed: an improvement in the staffing of industry 4.0 (skills) by 12.42% from 0.59 in 2020 to 0.66 in 2025; an increase in innovation activity in industry 4.0 (R&D) by 38.40% from 0.25 in 2020 to 0.35 in 2025; development of high-tech industries in industry 4.0 (industry activity) by 11.81% from 0.46 in 2020 to 0.52 in 2025.

4.3 New horizons of economic integration in the EAEU for improving migration management to increase quality in industry 4.0

To solve the third task of this study related to the justification of new horizons of economic integration in the EAEU for improving migration management to increase quality in industry 4.0, promising institutions of state regulation of educational and labor migration flows have been identified, the creation and functioning of which will ensure the achievement of migration benchmarks in the practice of the EAEU in the period up to 2025.

To improve the staffing of industry 4.0 (skills), it is proposed to create competence centers in the EAEU, whose activities are related to the coordination of knowledge management in the member countries of this integration association. To increase innovation activity in industry 4.0 (R&D), it is proposed to create innovation networks in the EAEU, whose activities are related to joint R&D in the member countries of this integration association.

For the development of high-tech industries in industry 4.0 (industry activity), it is proposed to create integration associations of the EAEU in industry 4.0 (for example, clusters and special economic zones). The authors' algorithm for managing educational and labor migration in the EAEU to improve quality in industry 4.0, presented in Fig. 3, systematically reflects the indicated new horizons of economic integration.

The algorithm in Figure 3 assumes a three-level system for filtering migration flows in the EAEU. When international immigrants arrive in the EAEU, at the first level of filtration, the integration associations of the EAEU in industry 4.0 (clusters, special economic zones) determine whether immigrants are in demand in industry 4.0. In-demand immigrants are attracted to industry 4.0. Then, at the second level of filtration, innovation networks in the EAEU determine whether immigrants are useful for R&D. Useful immigrants are attracted to R&D.

At the final third level of filtration, competence centers in the EAEU determine whether they have gaps in competencies. Immigrants who are in demand in Industry 4.0 and/or useful for R&D fill their gaps in competencies that are necessary for their activities in industry 4.0. Those immigrants who are attracted to industry 4.0 are offered the most favorable conditions, including state housing subsidy programs, employment assistance, long-term employment contracts with favorable wage conditions, career building and additional social support for industry 4.0 workers. For the rest (those who are not in demand in industry 4.0 and are not useful for R&D) immigrants, the conditions of arrival in the EAEU are less attractive.
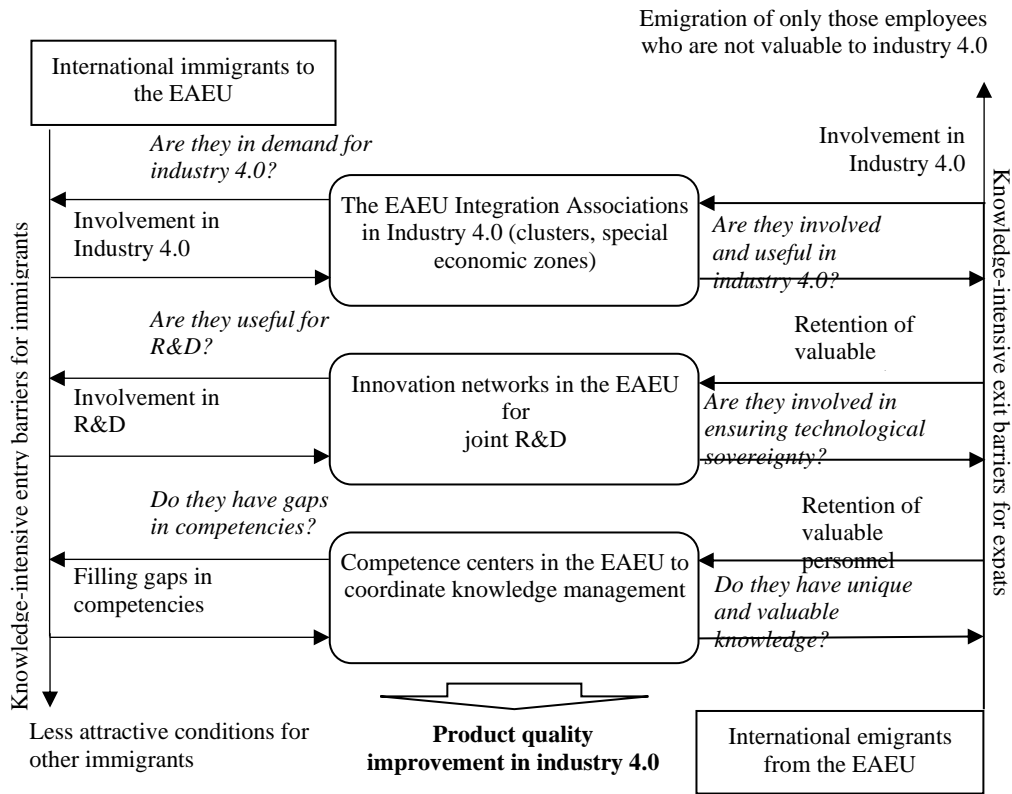
Emigration of only those employees
who are not valuable to industry 4.0

International immigrants to
the EAEU

*Are they in demand for
industry 4.0?*

Involvement in
Industry 4.0

Involvement in
Industry 4.0

The EAEU Integration Associations
in Industry 4.0 (clusters, special
economic zones)

*Are they involved
and useful in
industry 4.0?*

*Are they useful for
R&D?*

Retention of
valuable

Involvement in
R&D

Innovation networks in the EAEU
for
joint R&D

*Are they involved in
ensuring technological
sovereignty?*

*Do they have gaps
in competencies?*

Retention of
valuable
personnel

Filling gaps in
competencies

Competence centers in the EAEU to
coordinate knowledge management

*Do they have unique
and valuable
knowledge?*

Knowledge-intensive entry barriers for immigrants

Knowledge-intensive exit barriers for expats

Less attractive conditions for
other immigrants

**Product quality
improvement in industry 4.0**

International emigrants
from the EAEU

Figure 3. Algorithm for managing educational and labor migration in the EAEU to improve
quality in industry 4.0
Source: developed and built by the authors

When emigrants leave the EAEU, at the first level of filtration, the competence centers in the EAEU determine whether they have unique and valuable knowledge that is in demand in industry 4.0. The procedure of retention of valuable personnel is carried out. Then, at the second level of filtration, innovation networks in the EAEU determine whether those who leave the Union participate in ensuring the technological sovereignty of the EAEU. Valuable personnel capable of high innovation activity, as well as researchers are retained.

At the final third level of filtering, the integration associations of the EAEU in the field of Industry 4.0 (clusters, special economic zones) determine whether those who leave the EAEU are involved in industry 4.0. In-demand emigrants are attracted to industry 4.0, and those already involved in it are retained through lucrative job offers and career growth opportunities. As a result, only those employees who are of no value to industry 4.0 will emigrate.

The proposed algorithm will provide the following advantages:

- The brain drain will be prevented and will become impossible in the EAEU, since the list of criteria for customs control will no longer be limited only to access to state secrets, but will be supplemented by the criterion of the value of potential emigrants for industry 4.0;

- The culture of the "knowledge society" will be strengthened, industry 4.0 personnel will realize their value and receive a well-deserved high position in society, which will serve as a mechanism to keep them from emigrating;
- Immigrants who are not in demand in industry 4.0 and potentially destabilizing society and the economy will lose interest in coming to the EAEU;
- Powerful incentives will be provided for the influx of valuable personnel who are in demand in industry 4.0, the influx (immigration) of which will increase in the EAEU.

5. Discussion

The contribution of the article to the literature consists in the development of scientific provisions of the concept of quality in industry 4.0 by clarifying the implications of educational and labor migration for the product quality in Industry 4.0. The new approach to economic integration in the EAEU proposed by the authors makes it possible to optimize migration flows in the interests of maximizing the product quality of Industry 4.0. Table 5 presents a comparative analysis of the existing and proposed new approach to economic integration in the EAEU.

Table 5. Comparative analysis of the existing and proposed new approach to economic integration in the EAEU

Criteria for comparing approaches	Existing approach	Proposed new approach
Interpretation of migration processes in the EAEU	balancing national labor markets in the EAEU countries, promoting the development and disclosure of human potential (Kapsultanova et al., 2022)	changing the strategic staffing of industry 4.0
The essence of state regulation of immigration	creating favorable and equal conditions for all immigrants from the EAEU countries (Sigareva and Sivoplyasova, 2021)	providing incentives for the influx of personnel for industry 4.0, selection and filtration of immigrants from the EAEU countries
Measures necessary and sufficient to regulate emigration from the EAEU	only market measures: natural incentives to retain the best staff (Bokayev et al., 2020)	additional measures of state regulation are needed
The essence of coordinated migration management based on the economic integration of the EAEU	ensuring better conditions for migrants from the EAEU countries compared to migrants from other countries (for example, from the CIS): the criterion is the migrant's country of origin (Dzhunisbekova et al., 2017)	creating better conditions for migrants who are in demand in industry 4.0 compared to others: the criterion is the value of the migrant for industry 4.0

Source: developed and compiled by the authors.

As shown in Table 5, the interpretation of migration processes in the EAEU, in contrast to the existing approach, which involves balancing national labor markets in the EAEU countries, promoting the development and disclosure of human potential (Kapsultanova et al., 2022), in the new approach is associated with a change in the strategic staffing of industry 4.0.

The essence of state regulation of immigration, in contrast to the existing approach, which assumes the creation of favorable and equal conditions for all immigrants from the EAEU countries

(Sigareva and Sivoplyasova, 2021), in the new approach is related to providing incentives for the influx of personnel for industry 4.0, the selection and filtration of immigrants from the EAEU countries.

Measures necessary and sufficient to regulate emigration from the EAEU, in contrast to the existing approach, which is limited to market measures: natural incentives to retain the best personnel (Bokayev et al., 2020), in the new approach is associated with additional measures of state regulation.

The essence of coordinated migration management based on the economic integration of the EAEU, in contrast to the existing approach, which assumes providing better conditions for migrants from the EAEU countries compared to migrants from other countries (for example, from the CIS), in the new approach is associated with creating better conditions for migrants who are in demand in industry 4.0 compared to the others. That is, the criterion for ensuring the best conditions for migrants is not their origin (Dzhunisbekova et al., 2017), but the value of migrants for industry 4.0.

6. Conclusion

Summing up the research, it should be noted that the goal has been achieved, the following results have been obtained and the following conclusions have been made: 1) It has been revealed that economic integration in the EAEU gives a powerful new impetus to the development of migration processes in these countries. If before the formation of the EAEU in 2015, the five-year migration trend was negative (-1.62% for foreign immigrants and -0.25% for emigrants), a positive migration trend was formed during the four years of the EAEU's existence: +5.70% for immigrants and +2% for emigrants. This provided an evidence base for the positive impact of economic integration on migration processes in the EAEU.

The authors obtained an econometric model that includes a system of equations that reveals the nature and scale of the impact of educational and labor migration in the EAEU on the quality of products in industry 4.0. The change in migration flows in the EAEU in 2010-2020 determines the change in the staffing of industry 4.0 (skills) by 64.22%, the change in innovation activity in industry 4.0 (R&D) - by 52.54%, the change in the level of development of high-tech industries in industry 4.0 (industry activity) - by 90.40%. The model has shown that the product quality of industry 4.0 in the EAEU improves with an increase in the incoming migration flow (international immigration) and with a decrease in the outgoing migration flow (emigration) (the first task of the study has been solved).

2) The article proposes a framework strategy for improving migration policy in the EAEU until 2025 to increase quality in industry 4.0. The control values of migration indicators in the framework strategy are an increase of 30% (up to 12.98 people) in the number of international immigrants per capita per 1000 in the EAEU and a reduction of 30% (up to 12.62 people) in the number of emigrants per capita per 1000. The strategy also includes the aauthors' forecast of quality increase in industry 4.0 with the improvement of migration policy in the EAEU in the period up to 2025.

The forecast is based on an econometric model and assumes that the implementation of the strategy will ensure by 2025 (a five-year trend compared to 2020): improvement of staffing of industry 4.0 (skills) by 12.42% to 0.66 in 2025; growth of innovation activity in industry 4.0 (R&D) by 38.40% to 0.35 in 2025; development of high-tech industries in industry 4.0 (industry activity) by 11.81% to 0.52 in 2025 (the second task of the study has been solved).

3) New horizons of economic integration in the EAEU to improve migration management to increase quality in industry 4.0 have been substantiated: promising

institutions of state regulation of educational and labor migration flows, the creation and functioning of which will ensure the achievement of migration benchmarks in the practice of the EAEU in the period up to 2025. These new horizons are associated with the creation of competence centers, innovation networks and integration associations in industry 4.0 in the EAEU.

The authors have developed a promising algorithm for managing educational and labor migration in the EAEU, contributing to quality improvement in industry 4.0, as well as the systematic achievement of all three horizons. The novelty of the algorithm is that it provides three-level filtering of both outgoing and incoming migration flows, retention of the best personnel and stimulation of the influx of personnel in demand in industry 4.0 of the EAEU (the third task of the study has been solved).

The key conclusion of the study is that in order to improve the product quality of industry 4.0 in the EAEU, it is advisable to stimulate the incoming flow and limit the outgoing flow of international migration (this is the answer to the RQ posed in the article). The theoretical significance of the authors' conclusions is that they clarified the scientific vision of the prospects for optimizing migration flows in the EAEU for quality management in industry 4.0, and also proposed new horizons for economic integration.

The practical significance of the article is due to the fact that the new approach to economic integration in the EAEU developed in it supports the systematic and highly effective practical implementation of strategic directions for the development of Eurasian economic integration until 2025 due to the choice of quality improvement in

industry 4.0 as a key vector of this integration.

Quality management implications consist in the fact that it is recommended to increase the incoming and reduce the outgoing migration flow to the EAEU by 30%, which will improve the quality of products in industry 4.0 by an average of 20.88% in the period up to 2205. Implications for migration policy in the EAEU are related to the fact that the developed algorithm for managing educational and labor migration in the EAEU to improve quality in Industry 4.0 will prevent brain drain, strengthen the culture of the "knowledge society", limit the arrival of immigrants who are not in demand in industry 4.0 and attract the best personnel from around the world for industry 4.0 of the EAEU.

In conclusion, it should be noted that the results obtained during the study are limited to the period of 2019-2020. The latest events related to the pandemic and the COVID-19 crisis in 2020-2021, as well as the aggravation of the international sanctions crisis in 2022-2023, could radically change the nature of migration flows and their impact on quality of industry 4.0. in the EAEU. As the latest official statistics become available, it is advisable to clarify the results obtained and, possibly, revise the proposed recommendations and finalize them taking into account the latest migration trends. It is proposed to devote future research on migration in the EAEU countries to these tasks.

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