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Modeling Real Income Indicators in the Russian Federation and the European Union Countries

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ABSTRACT

This paper presents the results of a factor analysis of real income indicators in the Russian Federation and the European Union based on an original evaluation algorithm. Using the least squares method, the authors propose models for assessing real income in Russia and European countries. The findings of these models are compared, leading to recommendations aimed at increasing real income levels in Russia, the EU and globally.

Keywords: Environment 1, European Union 7, Factor analysis 2, Least squares method 3, Model 5, Principal component analysis 4, Russian Federation 6.

INTRODUCTION

Real income levels and their assessment methods are of particular relevance. This indicator not only allows for an analysis of the current economic situation but also serves as a foundation for forecasting future trends, which ultimately determines the trajectory of sustainable environmental development for any country.

Real income refers to the total amount of goods and services that individuals can purchase with their nominal income, i.e., income generated by financial flows over a specific period (Bobkov et al., 2022).

Studies on real income require the application of various statistical methods. One of the most accurate methods, according to the authors of this paper, is factor analysis. Factor analysis is a class of multivariate statistical analysis procedures aimed at identifying latent variables (factors) responsible for the presence of latent statistical relationships (correlations) between observed variables. The outcome of factor analysis is the identification of hidden variables affecting real income levels and the construction of a mathematical model in which each variable is expressed as a linear combination of common and unique factors (Fomina, 2017).

Another effective approach to studying and modeling real income is the least squares method (LSM). LSM is a mathematical method applied to solve various problems based on minimizing the sum of squared deviations of certain functions from experimental input data (Kostin, 2004). This method establishes relationships between real income and other socio-economic indicators, enabling the identification of the most significant factors and forecasting income dynamics based on changes in these factors (Mazurov et al., 2017).

The topic of this study is particularly relevant, as the level of real income is a key indicator reflecting a country's financial well-being. Research in this area is especially important in the context of global economic turbulence, as increasing real income contributes to improving people's quality of life.

The objective of this study is to analyze the concept of real income, conduct an econometric analysis to identify key factors influencing real income levels, and develop recommendations for improving this indicator.

The scientific novelty of the research lies in the development of original models for evaluating real income using factor analysis and the least squares method. The study identifies factors that negatively and positively influence real income and provides recommendations for their optimization.

The hypothesis of the study suggests that despite the deterioration of the socio-economic climate, the application of factor analysis and the least squares method will help identify key variables affecting real income, develop an appropriate forecast, and create a strategy for its growth.

The real income indicator of the population analysis has been the subject of works by many well-known economists. The authors of this article have examined theoretical approaches to defining the concept of real income of the population, as well as developed an algorithm for conducting factor analysis to study this indicator. The algorithm consists of six stages: data collection, correlation analysis, cumulative variance calculation, determination of the optimal number of factors, calculation of weighting coefficients, and model construction. This methodology makes it possible to identify hidden variables that influence the level of real income, and the analysis algorithm allows structuring the process and determining key variables that form the studied indicator (Maksimtsev et al., 2025).

Economist José Javier Caloca Martinez also analyzes the real income indicator using factor analysis in his work. During the analysis, the author identified that in the United States, factors such as education level, employment, social programs, and investments influence the level of real income. The author emphasizes that it is necessary to develop an individualized socio-economic policy to improve these factors, which, in turn, will lead to an increase in real income and sustainable economic growth (Caloca Martinez, 2020).

European economists Fagerberg, J. and Verspagen, B. in their work study the factors influencing the growth of real income in European countries using the least squares method. The article examines such factors as investments and innovative technologies. The authors conclude that to raise the level of real income, it is necessary to improve economic policy aimed at increasing the level of new technologies, which, in turn, will contribute to the growth of real income (Fagerberg, 2002).

METHODOLOGY

As previously noted, the authors selected the factor analysis method to analyze the dynamics of the real income indicator in Russia. The application of this statistical method will allow for the identification of key factors that can be utilized in further analysis of the real income indicator and for the discovery of new patterns (Lee Chun-Chang et al., 2024).

A crucial step in conducting factor analysis is data collection. The study utilized data from the website of Rosstat (Federal State Statistics Service, General Provisions) and the World Bank.

Next, it is necessary to conduct an analysis of paired correlation coefficients, which allows for the study of relationships between two economic indicators and the identification of potential patterns that may be useful for further analysis. Then, the cumulative variance indicator must be calculated. After this, it is necessary to assess the degree of influence of each variable on the formation of the corresponding factor using weighting coefficients.

Following the calculation of weighting coefficients, all variables must be distributed across factors based on their magnitudes. This distribution will determine the contribution of each variable to the formation of factors and assess the degree of their influence on the studied process.

The final stage of the analysis is the construction of a model, using the variables obtained during the analysis, and the interpretation of the final results (Fragoso et al., 2023).

The second method used by the authors is the least squares method (LSM), which also requires strict adherence to an algorithm (Masayuki et al., 2009).

The first step also involves collecting data from reliable sources.

The second step is testing for stationarity using the augmented Dickey-Fuller test (Masudul, 2024).

Next, an analysis of paired correlation coefficients must be conducted. Based on the correlation matrix and the analysis of causal relationships, a number of dependencies can be identified.

The final stage of the analysis is the construction of an econometric model and its interpretation.

RESULTS

Factor Analysis of Indicators Characterizing Real Income of the Population in Russia

Conducting a factor analysis of the data requires adherence to a strict algorithm previously proposed by the authors (Maksimtsev et al., 2025). An important step in performing factor analysis is the calculation of correlation (Bobkov et al., 2022; Mishchenko et al., 2023).

For the analysis, six socio-economic indicators were selected, each assigned a unique variable index by the authors: x_1^{ϕ} – Consumer Price Index (CPI) for the Russian Federation, x_2^{ϕ} – unemployment rate, x_3^{ϕ} – fixed goods basket cost, x_4^{ϕ} – real income of the population by region, x_5^{ϕ} – poverty level and x_6^{ϕ} – the discount rate (Naumik et al., 2019). The data were obtained from the Rosstat website for the period 1997–2023 (Federal State Statistics Service, General Provisions). The results of the correlation analysis are presented in **Table 1**. The selection of these indicators was based on data availability, as provided on the Rosstat website (Federal State Statistics Service, General provisions).

Table 1. Matrix of paired correlation coefficients with factor analysis variables.

Indicators	x_1^{ϕ}	x_2^{ϕ}	x_3^{ϕ}	x_4^{ϕ}	x_5^{ϕ}	x_6^{ϕ}
x_1^{ϕ}	1,00	0,18	-0,55	-0,09	0,30	0,82
x_2^{ϕ}	0,18	1,00	-0,25	-0,01	0,78	0,18
x_3^{ϕ}	-0,55	-0,25	1,00	-0,21	-0,33	0,68
x_4^{ϕ}	-0,09	-0,01	-0,21	1,00	0,01	0,37
x_5^{ϕ}	0,30	0,78	-0,33	0,01	1,00	0,22
x_6^{ϕ}	0,82	0,18	0,68	0,37	0,22	1,00

Based on the correlation analysis, it was concluded that (x_1^{ϕ}) – the Consumer Price Index for goods and services in the Russian Federation, (x_2^{ϕ}) – the unemployment rate, and (x_3^{ϕ}) – the fixed goods basket cost display weak negative correlation with the real income (x_4^{ϕ}) indicator due to regional differences. The poverty level indicator (x_5^{ϕ}) and the discount rate (x_6^{ϕ}) – have a moderate positive correlation (0,01 и 0,37 accordingly) with the real income indicator according to Chaddock's scale.
Now, we determine the cumulative variance indicator using the R software. The corresponding results are presented in (**Table 2**).

Table 2. Cumulative variance indicator.

Component	PC_1	PC_2	PC_3	PC_4	PC_5	PC_6
Standard Deviation	1,54	1,11	1,02	0,86	0,61	0,35
Proportion of Variance	0,39	0,21	0,17	0,12	0,06	0,02
Cumulative Proportion	0,39	0,61	0,77	0,91	0,96	1,00

(Table 2) presents the following data: standard deviation, proportion of variance, and cumulative proportion. It is evident that the optimal number of factors is 4, as these four factors: PC_1, PC_2, PC_3 and PC_4 explain 91% of the variance in the studied indicators. This is a good result, as a high percentage of explained variance indicates that the selected factors significantly influence the studied indicators and allow for data analysis with a high degree of reliability.

(Table 3) presents the results of the calculation of weighting coefficients for determining the assignment of corresponding variables to factors.

Table 3. Weighting coefficients for determining whether a variable belongs to a factor.

	Variable	PC_1	PC_2	PC_3	PC_4
Factors	x_1^{ϕ}	0,3883	0,3775	0,5492	0,0362
	x_2^{ϕ}	0,5081	-0,2828	-0,3052	0,3567
	x_3^{ϕ}	-0,4083	-0,5678	-0,1245	0,0468
	x_4^{ϕ}	0,0114	0,5278	-0,7288	-0,2890
	x_5^{ϕ}	0,5564	-0,2124	-0,2285	0,2126
	x_6^{ϕ}	-0,3384	0,3621	-0,0781	0,8953

From (Table 3), it is evident what weighting coefficient each factor variable PC_n has. As a result, the variables were distributed as follows (Table 4).

Table 4. Distribution of variables by principles' component factors.

	Variables			
Variables	PC_1 - «Social Economic Burden» factor	PC_2 – «Fixed Goods Cost» factor	PC_3 – «Purchasing Power Index» factor	PC_4 – «Discount rate» factor
	1. Unemployment; 2. Poverty Level	1. Fixed Goods Basket Cost	1. CPI; 2. Real Income	1. Discount rate

Thus, the first factor (PC_1) reflects the influence of social and economic conditions on the life and well-being of the population. The factor (PC_3) represents the consumer's ability to purchase a certain amount of goods and services at current prices. Through factor analysis, two comprehensive indicators were formed, allowing for tracking the current socio-economic situation in the region.

Modeling the Real Income Indicator in Terms of the Socio-Economic Burden on the Population in the Russian Federation

As previously noted, selecting and constructing an optimal statistical model is of great importance in many fields, including science, business, technology, housing, and others (Lukyanova et al., 2013).

For modeling the indicator of households that have obtained housing and improved their living conditions in the Russian Federation, the following variables were selected: socio-economic burden factor – x_1^{M}, x_2^{M} – fixed goods basket cost factor, x_3^{M} – real purchasing power index, and x_4^{M} – discount rate factor. These factors take into account the overall economic and social situation in the country.

When constructing the model, the following multiple regression equation was determined:

$$y = 93{,}33 - 0{,}45x_1^{\text{M}} - 0{,}22x_2^{\text{M}} - 0{,}18x_3^{\text{M}} - 1{,}08x_4^{\text{M}}$$

where:

$y -$ is the dependent variable;

$93{,}33 -$is the intercept (const), representing the value of y, when all variables in the model are equal to 0;

$-0{,}45x_1^{\text{M}} -$ is the coefficient for variable (x_1^{M}), indicating how the dependent variable changes with a change in the socio-economic burden factor;

$-0{,}22x_2^{\text{M}} -$ is the coefficient for variable (x_2^{M}), indicating how the dependent variable changes with a change in the fixed goods basket cost factor;

$-0{,}18x_3^{\text{M}} -$ is the coefficient for variable (x_3^{M}), indicating how the dependent variable changes with a change in the real purchasing power index;

$-1{,}08x_4^{\text{M}} -$is the coefficient for variable (x_4^{M}), indicating how the dependent variable changes with a change in the discount rate.

The verification results of the model are presented in (**Table 5**).

Table 5. Verification of the degree of dependence of the indicator of the households that received housing and improved their living conditions in the Russian Federation.

Statistics	Statistical Value	Conclusion
p-value (x_1^{M})	1,99E-015	The indicator is significant (***)
p-value (x_2^{M})	0,0030	The indicator is significant (***)
p-value (x_3^{M})	0,0075	The indicator is significant (***)
p-value (x_4^{M})	0,4028	The indicator is significant (**)
p-value (F)	5,88E-25	The regression model is statistically significant at both 5 % and 1 % significance levels.
R^2	0,7555	The variation in the number of households that received housing and improved their living conditions is explained by the variation of the factors included in the model by 75,55%

Based on the obtained *p-value* and *F*-statistic values, it can be concluded that there is a significant relationship between the number of households that have obtained housing and improved their living conditions and the factors included in the model.

Thus, based on the analysis of the results and the derived regression equation, it can be concluded that in the presented model, the target indicator (*y*) depends on all four considered factors.

Construction of an Econometric Model of Real Income and Analysis of Regressors in the Russian Federation

To forecast the real income indicator of the population in the Russian Federation, the authors selected the following indicators: unemployment, poverty level, fixed goods basket cost, cconsumer price index, and employment level. The authors obtained data from the Rosstat website for six indicators over the period from 1997 to 2023 (Federal State Statistics Service).

(**Table 6**) presents the set of variables for constructing the econometric model. Each variable has been assigned a unique index and an abbreviated name in English.

Table 6. A set of variables for constructing an econometric model.

№	Variable Name	Variable Abbreviation
1	Real household income (*y*)	(*inc*)

2	Unemployment rate (x_3^1)	(*unempl*)
3	Poverty rate (x_3^2)	(*pov*)
4	Cost of a fixed basket (x_3^3)	(*fix*)
5	Gross Domestic Product (x_3^4)	(*GDP*)
6	Consumer Price Index (x_3^5)	(*cpi*)
7	Discount rate (x_3^6)	(rir)

(Calculated by the authors).

The next step is to conduct the Augmented Dickey-Fuller test. The test results are presented in (**Table 7**).

Table 7. Checking data for stationarity.

Indicator	*p-value*	*p-value* (first differences)	*p-value* (second differences)
inc	0,04284	0,01555	1,088e-10
unempl	0,7472	0,002378	
pov	0,3936	0,04014	5,94e-07
fix	0,001582		
GDP	0,9947	0,0003863	
cpi	0,001582		
rir	0,6320	1,2884e-03	

(Table 7) presents the values of the Augmented Dickey-Fuller test. The stationarity conditions are met for all indicators, with *p-value* < 0.005.

Next, it is necessary to construct a matrix of paired correlation coefficients (Fomina, 2017). (Figure 1) presents the matrix of paired correlation coefficients.

	inc	*unempl*	*pov*	*fix*	*GDP*	*cpi*	*rir*
inc	1						
unempl	-0,87809	1					
pov	-0,80579	0,838713	1				
fix	0,832844	-0,90821	-0,76418	1			
GDP	0,876202	-0,92854	-0,8407	0,972076	1		
cpi	0,436255	-0,36209	-0,4338	0,164713	0,26198	1	
rir	-0,4379	-0,73705	-0,75875	0,72764	0,755606	0,204	1

Figure 1. Matrix of pair correlation coefficients.

The real income indicator (*inc*) has a strong inverse relationship with the unemployment rate (*unempl*) at -0.88. The poverty level (*pov*) and real income (*inc*) also show a strong inverse relationship at -0.81. GDP (*GDP*) and real income (*inc*) have a strong direct relationship at 0.88. The fixed goods basket cost (*fix*) and real income (*inc*) show a correlation of 0.83, while the discount rate (rir) and real income (*inc*) have a moderate negative correlation of -0.44. A moderate correlation is observed between real income (*inc*) and the Consumer Price Index (*cpi*) at 0.44.

Summarizing the analysis, it can be concluded that to achieve sustainable economic growth, it is necessary to focus on job creation and implement a balanced fiscal policy.

Thus, the real income model for the Russian Federation takes the following form (1).

$$inc = 41{,}881 - 1{,}2991unempl + 0{,}0003GDP - 2{,}5133rir - 0{,}3227fix \quad (1)$$

where,

inc- dependent variable;

41,881- intercept (*const*), representing the value of inc when all variables in the model are equal to 0;

$-1{,}2991unempl$- coefficient for variable ($unempl$), indicating how the dependent variable changes with a change in the unemployment rate;

$0{,}0003GDP$- coefficient for variable (GDP), indicating how the dependent variable changes with a change in GDP;

$-2{,}5133rir$- coefficient for variable (rir), indicating how the dependent variable changes with a change in the employment rate;

$-0{,}3227fix$- coefficient for variable (fix), indicating how the dependent variable changes with a change in the fixed goods basket cost.

The model verification results are presented in (Table 8).

Table 8. Verification of the model for the indicator of real income of the population of the Russian Federation.

Statistic	Statistical Value	Conclusion
p-value (unempl)	0,0000	The indicator is significant (***)
p-value (GDP)	0,0006	The indicator is significant (***)
p-value (rir)	0,0543	The indicator is significant (**)
p-value (fix)	0,0621	The indicator is significant (*)
R^2	0,8475	The variation in Real income of the population is explained by the variation in the factors included in the model by 84,75%.

Based on the obtained *p-value* values, it can be concluded that there is a relationship between the studied indicator and the corresponding factors included in the model.

As a result of the least squares method (LSM) analysis conducted for the Russian Federation, the regression model was obtained. The modeling results are presented in (Table 9).

Table 9. Comparative characteristics of LMS models.

Country	MNC model
Russian Federation	$inc = 41{,}881 - 1{,}2991unempl + 0{,}0003GDP - 2{,}5133rir - 0{,}3227fix$

From (Table 9), it can be seen that both models include four variables and a constant term. In the Russian Federation, real income levels are influenced by indicators such as unemployment, GDP, discount rate, and the fixed goods basket cost. The situation in European Union countries is different, as the following indicators influence income levels in the EU: unemployment, health index, CPI and GDP.

In summary, it can be concluded that the studied countries require the implementation of individualized socio-economic policies, including labor market improvements, healthcare system enhancement, and trade optimization.

Factor Analysis of Indicators Characterizing Real Income of the Population in the European Union Countries

To analyze the dynamics of real income in the European Union countries, the authors also applied the factor analysis method (Maksimtsev et al., 2025).

The first step is to analyze paired correlation coefficients. In conducting the correlation analysis, data from the World Bank Group, Data section on the World Bank Group website for the period 1997–2023 were used. For the analysis, nine socio-economic indicators were selected, each assigned a unique variable index by the authors: x_1^{ϕ}– real income of the population in Germany, France, Italy, and Spain, x_2^{ϕ} – unemployment rate, x_3^{ϕ} – Gini coefficient, x_4^{ϕ} – healthcare index, x_5^{ϕ} – safety index, x_6^{ϕ} – Consumer Price Index (CPI), x_7^{ϕ} – Gross Domestic Product (GDP), and x_8^{ϕ} – real interest rate. The selection of these indicators was based on their significance for the socio-economic development of EU countries.

It should be noted that the indicator sets for the analysis of Russia and the EU differ; however, common and related categories can be identified among them.

The next step is to conduct a correlation analysis. (Table 10) presents the results of the correlation analysis.

Table 10. Matrix of paired correlation coefficients with factor analysis variables.

Indicators	x_1^{ϕ}	x_2^{ϕ}	x_3^{ϕ}	x_4^{ϕ}	x_5^{ϕ}	x_6^{ϕ}	x_7^{ϕ}	x_8^{ϕ}
x_1^{ϕ}	1,00	-0,42	0,62	0,81	0,85	0,96	0,87	-0,54
x_2^{ϕ}	-0,42	1,00	-0,04	-0,41	-0,35	-0,37	-0,35	0,26
x_3^{ϕ}	0,62	-0,04	1,00	0,57	0,64	0,69	0,69	-0,43
x_4^{ϕ}	0,81	-0,41	0,57	1,00	0,81	0,87	0,75	-0,55
x_5^{ϕ}	0,85	-0,35	0,64	0,81	1,00	0,90	0,76	-0,50
x_6^{ϕ}	0,96	-0,37	0,69	0,87	0,90	1,00	0,93	-0,58
x_7^{ϕ}	0,87	-0,35	0,69	0,75	0,76	0,93	1,00	-0,56
x_8^{ϕ}	-0,54	0,26	-0,43	-0,55	-0,50	-0,58	-0,56	1,00

Based on the data analysis obtained from the correlation analysis, the authors concluded that several indicators exhibit significant relationships. In particular: (x_1^{ϕ}) – real income of the population in Germany, France, Italy, and Spain and (x_6^{ϕ}) – Consumer Price Index (CPI) have a strong positive correlation (0,96); (x_1^{ϕ}) – real income of the population in Germany, France, Italy, and Spain and (x_5^{ϕ}) – safety index also have a strong correlation (0,85); (x_4^{ϕ}) – healthcare index is closely correlated with (x_5^{ϕ}) – safety index (0,81) and (x_6^{ϕ}) – Consumer Price Index (0,87); (x_5^{ϕ}) – safety index and (x_6^{ϕ}) – Consumer Price Index also have a strong correlation (0,90). While (x_2^{ϕ}) – unemployment rate has a negative correlation with (x_1^{ϕ}) – real income of the population in Germany, France, Italy, and Spain (-0,42).

The next step is to determine the cumulative variance indicator. The corresponding results are presented in (Table 11).

Table 11. Cumulative variance indicator.

Components	PC_1	PC_2	PC_3	PC_4	PC_5	PC_6	PC_7	PC_8
Standard Deviation	2,35	0,78	0,69	0,57	0,51	0,33	0,31	0,09
Proportion of Variance	0,61	0,06	0,05	0,03	0,02	0,01	0,01	0,01
Cumulative Proportion	0,61	0,85	0,92	0,94	0,97	0,98	0,99	1,00

In (Table 11), the cumulative variance indicators have been calculated. It is evident that the optimal number of factors is 4, as these four factors: PC_1, PC_2, PC_3 and PC_4 explain 94% of the variance in the studied indicators.

The next step is to assess the influence of each variable on the formation of the corresponding factor using weighting coefficients. The corresponding results are presented in (Table 12).

Table 12. Weighting coefficients for determining whether a variable belongs to a factor.

	Variables	PC_1	PC_2	PC_3	PC_4
Factors	x_1^{ϕ}	0,4011	-0,0001	-0,1477	0,0434
	x_2^{ϕ}	-0,1962	0,5590	-0,0680	-0,7596
	x_3^{ϕ}	0,3041	0,4029	-0,1109	0,0043
	x_4^{ϕ}	0,3841	-0,1156	-0,0755	-0,3093
	x_5^{ϕ}	0,3828	0,0876	-0,1722	0,1223
	x_6^{ϕ}	0,4170	0,0512	-0,1270	-0,0514
	x_7^{ϕ}	0,3904	0,0768	-0,0775	0,0149
	x_8^{ϕ}	-0,2805	-0,0462	-0,9470	0,1027

From (Table 12), it is evident what weighting coefficient each factor variable PC_n has. As a result, the variables were distributed as follows (Table 13).

Table 13. Distribution of variables by principle component factors.

	Variables			
Variables	**PC_1 - «Socio-Economic Sustainability Indicators» factor**	**PC_2 – «Gini coefficient» factor**	**PC_3 – «Real Interest Rate» factor**	**PC_4 – «Unemployment Rate» factor**
	1. Real income of the population in Germany, France, Italy and Spain; 2. Healthcare level; 3. Security index; 4. Consumer Price Index 5. Gross Domestic Product	1. Gini coefficient	1. Real interest rate;	1. Unemployment rate

Thus, the first factor (PC_1) reflects differences in social and economic conditions affecting the quality of life in Germany, France, Italy, and Spain.

In summary, it can be concluded that through factor analysis, a comprehensive indicator was formed: PC_1 – the «Socio-Economic Stability Indicators» factor, which allows tracking the current socio-economic situation in the region and assessing the state of household incomes.

For modeling the «Housing Cost Index in EU Countries» the «Socio-Economic Stability Indicators» factor was used.

When constructing the model, the following multiple regression equation was determined (2)

$$y = 5{,}5591 - 1{,}8853x_2^{\text{M}} + 5{,}7134x_3^{\text{M}} + 0{,}3570x_4^{\text{M}} + 1{,}0538x_5^{\text{M}}$$

where:

y – is the dependent variable (real income);

5,5591 – is the intercept (*const*) representing the value of y when all variables in the model are equal to 0;

$1{,}8853x_2^{\text{M}}$ – is the coefficient for variable (x_2^{M}), indicating how the dependent variable changes with a change in the level of unemployment in Germany, France, Italy, and Spain;

$5{,}7134x_3^M$ – is the coefficient for variable (x_3^M), indicating how the dependent variable changes with a change in the healthcare index;

$0{,}3570x_4^M$ – is the coefficient for variable (x_4^M), indicating how the dependent variable changes with a change in the safety index;

$1{,}0538x_5^M$ –is the coefficient for variable (x_5^M), indicating how the dependent variable changes with a change in GDP.

The verification results of the model are presented in (Table 14).

Table 14. Verification of the degree of dependence of the indicator of the Housing cost ratio in EU countries.

Statistics	Statistical Value
p-value (x_2^M)	0,0006
p-value (x_3^M)	0,0341
p-value (x_4^M)	0,0001
p-value (x_5^M)	0,0857
p-value (F)	6,91E-22
R^2	0,9755

Based on the obtained *p-value* and *F*-statistic values, it can be concluded that there is a significant relationship between the housing cost index and the factors included in the model, and that 97% of the variation in the housing cost index is explained by the variation of the factors included in the model.

As a result of the factor analysis conducted separately for Russia and the European Union countries: Germany, France, Italy, and Spain the authors arrived at the following conclusion. The analysis showed that in the Russian Federation, the level of real income is influenced by two factors: PC_1 – the «Socio-Economic Burden on the Population» factor and PC_3 – the «Real Purchasing Power Index» factor. In the EU, one explanatory factor was identified: PC_1 – the «Socio-Economic Stability Indicators» factor.

The results of the factor comparison between Russia and the EU are presented in (Table 15).

Table 15. Comparative characteristics of factors in the Russian Federation and the countries of the European Union.

	Countries	
	Russian Federation	**European Union**
Factors	1. PC_1 - «Socio-Economic Burden on the population» factor — Unemployment rate; — Poverty level 2. PC_3 – «Real Purchasing Power Index» factor — Consumer Price index; — Real income	1. PC_1 - «Socio-Economic Sustainability Indicators» factor — Real income of the population in Germany, France, Italy and Spain; — Healthcare level; — Security index — Consumer Price Index; — Gross Domestic Product

From (Table 15), it can be seen that two factors have been identified in the Russian Federation that characterize the real income of the population, while in the European Union countries, a single factor influences the socio-economic situation of the population.

Construction of an Econometric Model of Real Income and Analysis of Regressors in European Union Countries

To forecast real income indicators, data from the following countries were used: Germany, France, Italy, and Spain. These countries were selected by the authors based on the criterion of economic significance within the EU.

The analysis utilized data from the World Bank Group for the period from 1997 to 2023. (Table 16) presents the set of variables used for constructing the econometric model.

Table 16. A set of variables for constructing an econometric model.

№	Variable Name	Variable Abbreviation
1	Real income of the population (*y*)	(*inc*)
2	Unemployment rate ($x_э^1$)	(*unempl*)
4	Gini coefficient ($x_э^2$)	(*gin*)
5	Gross Domestic Product ($x_э^3$)	(*GDP*)
6	Healthcare level ($x_э^4$)	(*heal*)

7	Safety index ($x_э^5$)	(*saf*)
8	Consumer Price Index ($x_э^6$)	(*cpi*)
9	Real interest rate ($x_э^7$)	(*rir*)

The model includes 9 variables, including the dependent variable: real income of the population (*y, inc*), unemployment rate ($x_э^1$, *unempl*), Gini coefficient ($x_э^2$, *gin*), Gross Domestic Product ($x_э^3$, *GDP*), healthcare index ($x_э^4$, *heal*), safety index ($x_э^5$, *saf*), Consumer Price Index ($x_э^6$, *cpi*), and real interest rate ($x_э^7$, *rir*). Each variable has been assigned a unique index and an abbreviated name in English.

During the study, the authors conducted a stationarity test on the time series using the Augmented Dickey-Fuller test. The test results are presented in (Table 17).

Table 17. Checking data for stationarity.

Indicator	*p-value*	*p-value* (first differences)	*p-value* (second differences)
inc	0,4866	3,664e-08	
unempl	0,2951	0,0486	2,391e-06
gin	0,1839	2,114e-08	
GDP	0,6841	0,0003	
heal	0,9298	0,0269	5,598e-37
saf	0,9577	0,6235	1,011e-05
cpi	0,8995	0,0461	1,218e-09
rir	0,0001		

Table 17 presents the values obtained after conducting the Augmented Dickey-Fuller test. The stationarity conditions are met. Therefore, based on the test results, all variables conform to the stationarity requirement.

The stationarity check allows for the construction of a matrix of paired correlation coefficients—a matrix whose elements are paired correlation coefficients (Fomina, 2017). (**Figure 2**) presents the matrix of paired correlation coefficients.

	inc	***unempl***	***gin***	***heal***	***saf***	***cpi***	***gdp***	***rir***
inc	1							
unempl	-0,420495	1						
gin	0,6174061	-0,035629	1					
heal	0,8141637	-0,414563	0,5713801	1				
saf	0,8463716	-0,354847	0,6386194	0,8109506	1			
cpi	0,9587971	-0,369076	0,6907876	0,8727653	0,8977489	1		
gdp	0,8736686	-0,352135	0,6896444	0,7523137	0,7623804	0,9335226	1	
rir	-0,537438	0,2633984	-0,431548	-0,553134	-0,503879	-0,579382	-0,558337	1

Figure 2. Matrix of pair correlation coefficients.

Based on the correlation matrix and the analysis of causal relationships, several dependencies were identified. The real income indicator (*inc*) has a strong correlation with the healthcare index (*heal*) at 0,81, the safety index (*saf*) at 0,85, the Consumer Price Index (*cpi*) at 0,96 and GDP (*gdp*) at 0,87. A moderate correlation is observed with the Gini coefficient (gin) at 0,62. Meanwhile, the unemployment rate (*unempl*) and the real interest rate (*rir*) show a moderate inverse correlation of (-0,42) and (-0,54), respectively.

Summarizing the conducted analysis, it can be concluded that for sustainable economic development, it is important to create new jobs to reduce the unemployment rate and implement a balanced fiscal policy.

Thus, the real income model for Europe takes the following form (3)

$$inc = 17{,}79 - 1{,}1unempl + 3{,}09heal - 1{,}59cpi + 0{,}02gdp$$

where:

inc – is the dependent variable;

$17{,}79$ –is the intercept (*const*), representing the value of *inc*, when all variables in the model are equal to 0;

$-1{,}1unempl$ – is the coefficient for variable ($unempl$), indicating how the dependent variable changes with a change in the unemployment rate;

$3{,}09heal$ – is the coefficient for variable ($heal$), indicating how the dependent variable changes with a change in the healthcare index;

$-1{,}59cpi$ – is the coefficient for variable (cpi), ndicating how the dependent variable changes with a change in the CPI;

$0{,}02gdp$ –is the coefficient for variable (gdp), indicating how the dependent variable changes with a change in GDP.

The model verification results are presented in (Table 18).

Table 18. Verification of the model for the indicator of real income of the population of the European Union countries

Statistics	Statistical Value
p-value (unempl)	0,0073
p-value (heal)	0,0071
p-value (cpi)	0,0000
p-value (gdp)	0,0312
R^2	0,9166

Based on the obtained *p-value* values, it can be concluded that there is a relationship between the studied indicator and the corresponding factors included in the model. The variation in the Real Income of the Population indicator is explained by 91.66% of the variation in the factors included in the model.

Summarizing the study on real income in European countries, it can be concluded that it is advisable to implement a set of measures aimed at improving the state of the European economy, specifically: reducing unemployment, improving the healthcare system, and controlling inflation.

Comparison of Real Income Models for Russia and Europe. Recommendations for Increasing the Real Income Indicator in Russia

As part of the study, two models were developed to model the real income indicator of the population in Russia and European countries. Two forecasting methods were used for model construction—factor analysis and the least squares method (Mathieson, 2018).

Using factor analysis, real income was forecasted considering the socio-economic burden. This indicator was used to forecast the "Number of Households That Obtained Housing and Improved Living Conditions" in Russia and the "Housing Cost Index in EU Countries" for EU nations.

Using the least squares method (LSM), the real income indicator for the population was forecasted based on the example of EU countries. The results showed that the level of real income is influenced by CPI, GDP, unemployment, and the healthcare index in the EU, while in Russia, key factors include the unemployment rate, GDP, employment level, and the cost of the minimum goods basket.

The model validation results are as follows: since real income largely determines the socio-economic climate in a country, the key task of the government should be its increase. Similar conclusions were reached by other researchers (Del Aguila Paredes et al., 2025; Faramarzi et al., 2021): since real income reflects the socio-economic climate in all countries, it must be increased.

Thus, the working hypothesis proposed by the authors at the beginning of the study has been confirmed.

DISCUSSION

The article examines the concept of real income from a theoretical perspective and analyzes the works of leading economists on the topic of real income.

The authors present the results of a statistical analysis, constructing two models based on factor analysis and the least squares method (LSM). A comparative analysis of the two models was conducted, leading to relevant conclusions and the development of a set of measures to improve the real income indicator.

The results of the factor analysis and LSM for the Russian Federation identified key socio-economic factors, based on which the following models were developed:

$$y = 93{,}33 - 0{,}45x_1^{\text{м}} - 0{,}22x_2^{\text{м}} - 0{,}18x_3^{\text{м}} - 1{,}08x_4^{\text{м}}$$

$$inc = 41{,}881 - 1{,}2991unempl + 0{,}0003GDP - 2{,}5133work - 0{,}3227fix$$

From this, it can be assumed that the government should focus on stimulating economic growth, increasing the purchasing power index, regulating the cost of the fixed goods basket, and improving employment levels.

The results of the factor analysis and LSM for the European Union countries also identified key factors, which formed the basis for the following models:

$$y = 5{,}5591 - 1{,}8853x_2^{\text{м}} + 5{,}7134x_3^{\text{м}} + 0{,}3570x_4^{\text{м}} + 1{,}0538x_5^{\text{м}}$$

$$inc = 17{,}79 - 1{,}1unempl + 3{,}09heal - 1{,}59cpi + 0{,}02gdp$$

From this, it follows that the government should focus on reducing the unemployment rate, increasing employment levels, and finding an optimal balance between GDP and the cost of the fixed goods basket.

This study not only reveals the challenges and prospects of real income dynamics but also supports the argument that new effective methods must be sought to improve the socio-economic sphere, which largely determines the quality and standard of living.

Thus, the working hypothesis stated at the beginning of the study has been confirmed.

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Abbreviations:

The following abbreviations are used in this manuscript:

EU	European Union
LMS	Least squares method
GDP	Gross domestic product
CPI	Consumer price index

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