

**SECTION:  
ECONOMETRICS**

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**Socio-Economic Transformation of Post-Soviet States: A Statistical  
Analysis of Azerbaijan, Belarus, and Kyrgyzstan**

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**Abstract**

After the collapse of the Soviet Union, former republics faced the urgent need to restructure their economies and governance systems. Azerbaijan, Belarus, and Kyrgyzstan represent three distinctive paths of socio-economic transformation, shaped by diverse institutional frameworks, natural resource bases, and reform trajectories. This paper provides a comprehensive comparative analysis of macroeconomic and social development in these countries from 1991 to 2024. Using official statistical data, the study evaluates key indicators such as GDP per capita, poverty rates, inflation, employment, and education. The research focuses particularly on the relationship between income and human capital and their impact on poverty reduction. To quantify these effects, we apply multiple linear regression models, where poverty serves as the dependent variable and average wage and education level as independent variables. The statistical results confirm the significance of both factors in explaining poverty dynamics, although with varying intensity across countries. Azerbaijan shows the strongest responsiveness due to consistent economic growth and investment in education. Belarus displays a more state-centered model with stable poverty rates, while Kyrgyzstan's results are moderated by a weaker institutional environment and high dependence on remittances. The findings support the hypothesis that human capital and income are critical to poverty alleviation in post-Soviet contexts. Moreover, the paper demonstrates the utility of econometric modeling as a policy tool for identifying effective strategies for sustainable and inclusive development.

**Keywords:** post-Soviet transformation, macroeconomics, poverty, regression analysis, Azerbaijan, Belarus, Kyrgyzstan

**Introduction**

Following the dissolution of the Soviet Union in 1991, the post-Soviet republics experienced a sharp political, institutional, and economic transition. These nations inherited centrally planned economies, underdeveloped market mechanisms, and significant reliance on state redistribution systems.

Despite these commonalities, each country adopted a distinct developmental trajectory, shaped by its internal resources, political decisions, and degree of integration into the global economy. Among them, Azerbaijan, Belarus, and Kyrgyzstan exemplify markedly different paths of socio-economic reform. Over the past three decades, these countries have encountered numerous challenges, including economic crises, inflation, poverty, institutional deficits, and the imperative for structural reform. Despite their similar starting points, the results and effectiveness of their transformations have varied considerably due to both internal and external factors. In an era of increasing global uncertainty and the need for sustainable development, a comprehensive evaluation of these transformations is essential. A comparative statistical and econometric analysis allows not only for the assessment of quantitative changes but also for uncovering the underlying causes of divergence in outcomes. This is particularly pertinent in evaluating the quality and impact of social policy on living standards. As former Soviet republics transitioned from planned to market economies, they encountered deep crises, institutional shifts, rising poverty, and structural adjustments. Azerbaijan, Belarus, and Kyrgyzstan illustrate three divergent models of post-Soviet development, each reflecting unique internal policies, levels of global economic integration, and reform paces. Despite common historical legacies, their socio-economic trajectories diverge significantly. This study aims to identify similarities and differences in the macroeconomic dynamics of these countries and to quantitatively assess the effects of key factors—particularly average wages and educational attainment—on poverty levels using statistical and econometric methods.

#### Research Objective

To conduct a comparative statistical and econometric analysis of the socio-economic transformations in Azerbaijan, Belarus, and Kyrgyzstan during the post-Soviet period, with a particular focus on the factors influencing poverty levels.

#### Research Tasks

To characterize the stages of socio-economic development in the three countries based on key macroeconomic indicators. To analyze the dynamics of core indicators such as GDP, inflation, poverty levels, employment, and public investment. To compare the structure of the economy and diversification strategies in Azerbaijan, Belarus, and Kyrgyzstan. To construct and interpret an econometric model assessing the relationship between poverty and key determinants such as average wages and educational attainment. To identify differences in the effectiveness of social policies across the selected countries using quantitative data.

#### Research Hypothesis

It is hypothesized that poverty levels in the selected countries are primarily influenced by average wages and the level of education. However, the strength of these effects varies depending on the depth of reforms and the structural characteristics of each economy.

#### Historical and Macroeconomic Overview by Country (1991–2024)

##### Azerbaijan

Following its independence, Azerbaijan faced severe political and economic disruptions. The collapse of production networks, the Nagorno-Karabakh conflict, internal instability, and the shift to a market economy led to a sharp decline in GDP, widespread unemployment, and hyperinflation during the 1990s (World Bank, 1996, 2022). The country was largely isolated financially and lacked strong institutions. However, starting in the 2000s, Azerbaijan entered a phase of sustained economic growth driven by foreign investments and the development of major oil and gas fields in the Caspian Sea (IMF, 2020, 2023). Projects such as the Baku–Tbilisi–Ceyhan and TANAP (TANAP, 2023) pipelines significantly expanded its export capacity (EBRD (European Bank for Reconstruction and Development), 2023, TANAP, 2023).

The focus of economic policy began to shift towards diversification, emphasizing agriculture, infrastructure, digital development, and human capital. This period also witnessed improvements in social indicators: poverty fell from over 60% in the mid-1990s to less than 6% by 2020 (World Bank, 2022). Social programs, job creation initiatives, and education reforms were instrumental. International institutions, including the World Bank and Asian Development Bank, played a key role in supporting reforms and infrastructure projects.

#### Belarus

Belarus adopted a gradual reform path, maintaining many features of a centralized economy. It avoided the "shock therapy" seen elsewhere and emphasized state control and industrial support (UNDP, 2021). This approach ensured macroeconomic stability but limited long-term modernization. The economy was anchored in manufacturing, chemical industries, and the agro-industrial complex (Eurasian Development Bank, 2021). Since the mid-2010s, Belarus faced external economic pressures, sanctions, and the need for structural changes. New focus areas included the IT sector, digitalization, and SME support (OECD, 2021, 2023). Despite challenges, the country maintained social stability and continued rural and industrial development programs (World Bank, 2022, 2023).

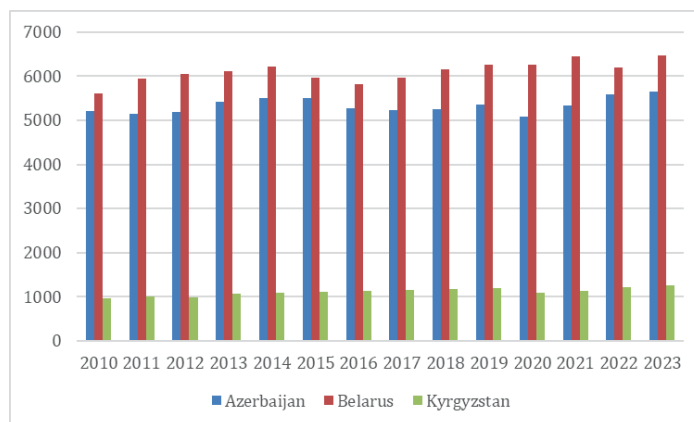
A welfare-state model preserved access to basic services and employment stability. Nonetheless, dependency on Russia and other external actors posed risks to financial sustainability. Since 2020, Belarus has expanded cooperation with China and Asian nations through trade and logistics initiatives such as the Belt and Road Initiative.

#### Kyrgyzstan

Kyrgyzstan undertook rapid economic liberalization in the early 1990s, including privatization, deregulation, and WTO accession. This fostered integration into the global economy (WTO, 2023). However, weak institutions, political instability, and limited resources constrained growth. Per capita GDP remained among the lowest in the CIS. Remittances from migrant workers, primarily in Russia and Kazakhstan, formed a substantial part of the economy (IOM, 2023).

Recent years have seen efforts to develop hydropower, e-governance, educational reforms, and agricultural support (ADB (Asian Development Bank), 2022). The informal sector remains dominant, especially in rural areas engaged in subsistence farming. International aid supports infrastructure improvements, but budget constraints limit large-scale investment. Employment, healthcare, and education access remain challenges, though government actions aim to enhance social protection and investment inflows. Kyrgyzstan continues to balance external dependence with efforts toward internal resilience.

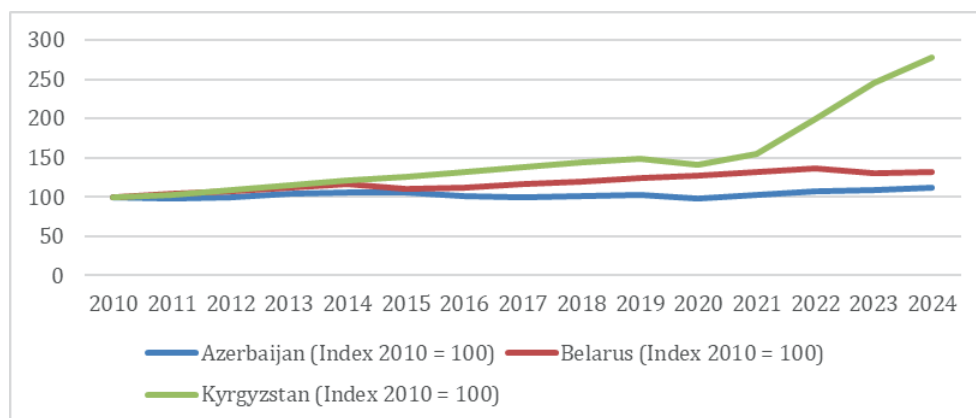
The agricultural sector continues to play a significant role, particularly in rural areas where the majority of the population is engaged in subsistence farming and small-scale commodity production. Financial support from international organizations has contributed to the improvement of basic infrastructure; however, budget constraints hinder the implementation of large-scale investments. Issues related to employment, access to healthcare, and education persist, although the government has undertaken measures to enhance social protection and attract investment into key sectors. Kyrgyzstan remains a country with high migration potential and is striving to balance external dependence with internal economic resilience. Figure 1 below illustrates the dynamics of GDP per capita across the three countries during the period from 2010 to 2024.



**Figure 1. Dynamics of GDP per Capita in Azerbaijan, Belarus, and Kyrgyzstan (2010–2024)**

*Source: Author's own calculations based on official statistics (IMF,2023, World Bank,2023, National Statistics Committees*

As illustrated in the figure, Azerbaijan and Belarus maintain significantly higher levels of GDP per capita compared to Kyrgyzstan throughout the entire period. Azerbaijan exhibits notable growth during 2014–2015, followed by a decline likely linked to the oil crisis and currency devaluation. Belarus demonstrates a more stable, though moderate, upward trajectory, with a slight slowdown observed after 2020. Kyrgyzstan starts from a substantially lower base but shows steady growth, particularly from 2020 onward. A different picture emerges when analyzing the base indices (2010 = 100), as presented in



**Figure 2. Dynamics of the Base Index of GDP per Capita in Azerbaijan, Belarus, and Kyrgyzstan (2010–2024, %)**

*Source: Author's own calculations based on official statistics (IMF,2023, World Bank,2023, National Statistics Committees*

Taking 2010 as the base year for comparison, it becomes evident that Kyrgyzstan demonstrates the fastest relative growth—nearly 2.5 times higher by 2024. In contrast, the GDP indices for Azerbaijan and Belarus in 2024 range approximately between 110 and 130, indicating positive but less dynamic growth. The sharp increase observed in Kyrgyzstan between 2021 and 2024 reflects post-crisis recovery and a notable revitalization of the domestic economy, despite starting from a low base.

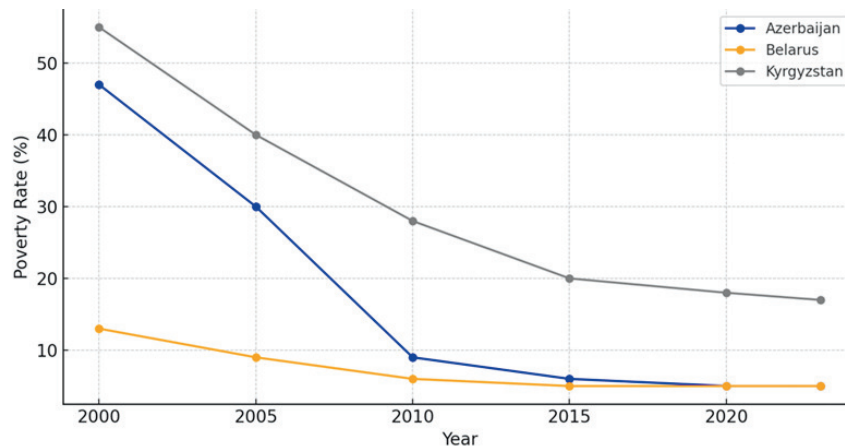
## 2. Comparative Analysis of Macroeconomic Indicators (1991–2024)

A comparison of the socio-economic trajectories of Azerbaijan, Belarus, and Kyrgyzstan reveals persistent differences in growth strategies, sectoral structures, and levels of social resilience. Although all three countries transitioned from centrally planned economies to market-oriented systems, the directions and pace of these transformations have varied significantly.

One of the key indicators of macroeconomic development is GDP per capita. Azerbaijan experienced the most substantial increase, primarily driven by the development of hydrocarbon resources and the export of raw materials to international markets. Compared to early 2000s levels, its GDP per capita more than quadrupled. Belarus followed a more gradual path, maintaining a balance between industrial development and agricultural support. Kyrgyzstan, constrained by limited natural resources and high external vulnerability, displayed an uneven pattern of growth, alternating between expansion and contraction—reflecting both domestic structural barriers and reliance on foreign remittances (National Statistical Committee of the Kyrgyz Republic).

The dynamics of poverty levels also serve as an indicator of the social outcomes of economic processes. In Azerbaijan, a steady decline in the share of the population living below the national poverty line has been observed—from over 60% in the 1990s to just 5.4% by 2020. This trend was supported by large-scale infrastructure investments, increasing domestic demand, and active employment programs implemented by the state.

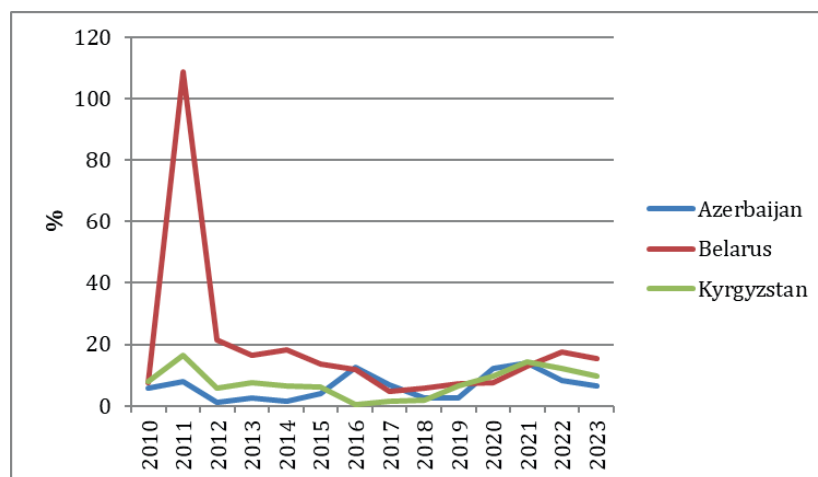
In Belarus, poverty levels remained relatively stable and low—ranging from 4% to 6% in various years—due to the existence of an extensive social protection system and universal access to basic healthcare and education (Belstat, (National Statistical Committee of the Republic of Belarus, 2023)). In Kyrgyzstan, despite efforts to enhance social protection, the poverty rate has fluctuated between 18% and 22% in recent years, particularly in rural, agrarian regions (see Figure 3).



**Figure 3. Poverty Rate in Azerbaijan, Belarus, and Kyrgyzstan (% of population), 2000–2023**

Source: Author's own calculations based on official statistics (IMF,2023, World Bank,2023, National Statistics Committees

Inflationary risks took a sharp form during the initial phase of the transformation period, particularly in Azerbaijan and Kyrgyzstan, where annual price growth rates exceeded 1000% (IMF,2023). In Belarus, inflation was also significant but stabilized comparatively faster due to managed monetary policies. In subsequent years, all three countries achieved relative price stability, although certain periods were marked by deviations from target parameters—mainly due to volatility in external markets and fluctuations in exchange rates (Figure 4).



**Figure 4. Inflation Dynamics in Azerbaijan, Belarus, and Kyrgyzstan (year-on-year, %), 2010–2023**

Source: Author's own calculations based on official statistics (IMF,2023, World Bank,2023, National Statistics Committees



Labor markets show varying degrees of organization and population engagement across the three countries. In Belarus, a high share of the population remains formally employed, largely due to the continued operation of large industrial enterprises and support for agricultural organizations. In Azerbaijan, the development of small businesses and the construction sector in regional areas has created opportunities to reduce unemployment. Kyrgyzstan is characterized by a high level of informal employment, with a significant portion of the working-age population engaged in temporary or long-term employment abroad. According to international sources, over one million Kyrgyz citizens work outside the country, and their remittances play a critical role in shaping domestic consumption and maintaining foreign currency reserves (IOM Kyrgyzstan).

A comparison of GDP structure highlights the distinctive development models. In Azerbaijan, the oil and gas sector remains dominant; however, in recent years, there has been a gradual shift toward non-resource-based sectors, including logistics, agriculture, and services. The Belarusian economy is based on manufacturing industries—such as mechanical engineering, chemicals, and food production—which form a significant part of its export potential (Belstat, 2023). Due to natural and geographic constraints, Kyrgyzstan maintains a predominantly agro-service economy, with agriculture, trade, and domestic services accounting for the bulk of GDP.

The external economic strategies of the three countries have been shaped by differing priorities. Azerbaijan has focused on developing its export-oriented energy infrastructure and strengthening economic ties with partners in the region and Europe. Belarus actively participates in interstate trade and production initiatives within the Eurasian economic space. Kyrgyzstan has consistently expanded multilateral economic cooperation, including participation in international development programs aimed at enhancing economic resilience and investment attractiveness.

Thus, the macroeconomic comparison reveals that differences in institutional environments, sectoral specialization, and external economic orientations have led to divergent development trajectories. These factors provide a valuable empirical foundation for further analysis of the relationships between macroeconomic parameters and social outcomes such as employment, poverty, and living standards.

To identify structural differences among the countries in terms of socio-economic development, a cluster analysis was conducted based on data from the year 2023. The variables selected for clustering were gross domestic product per capita (GDP per capita, USD) and the unemployment rate (%).

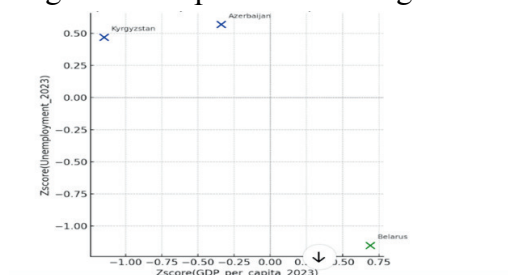
Prior to clustering, the data were standardized (converted into Z-scores) to account for scale differences between variables. The clustering was performed using the k-means method with the number of clusters set to  $k = 2$ , implemented via SPSS software.

As a result of the analysis, the countries were grouped as follows:

Cluster 1 includes Azerbaijan and Kyrgyzstan, which are characterized by relatively higher unemployment rates and lower levels of GDP per capita (particularly low in the case of Kyrgyzstan).

Cluster 2 consists solely of Belarus, distinguished by the highest GDP per capita and an almost negligible unemployment rate.

A visualization of the clustering results is presented in Figure 5.



**Figure 5. Country Clustering Results Based on GDP per Capita and Unemployment Rate (2023)**

Source: Author's calculations based on data from official statistics and international organizations (IMF, World Bank, Belstat, State Statistics Committee of Azerbaijan, National Statistical Committee of the Kyrgyz Republic).

Thus, the results of the cluster analysis provide grounds to conclude that, despite their shared post-Soviet legacy, the macroeconomic trajectories of Azerbaijan, Belarus, and Kyrgyzstan differ significantly in terms of both economic efficiency and social resilience. These differences must be taken into account when formulating future economic strategies, conducting cross-country comparisons, and developing policy recommendations within the framework of regional development initiatives.

#### Research Methodology and Data Description

This study employs quantitative analytical methods aimed at identifying the relationships between macroeconomic indicators and poverty levels in three post-Soviet countries: Azerbaijan, Belarus, and Kyrgyzstan. The primary objective is to assess the influence of key factors—namely, average wages and educational attainment—on poverty dynamics. Multiple linear regression was selected as the core analytical tool.

The models were built using official statistical data obtained from publicly accessible sources, including national statistical agencies, the International Monetary Fund (IMF, 2023), the World Bank (World Bank, 2023), and the United Nations Development Programme (UNDP, 2021). The time frame covers the years 1991 to 2024, depending on data availability for each country. The choice of variables is grounded in both theoretical approaches to poverty analysis and empirical studies in the field of social economics. The dependent variable is the poverty rate (as a percentage of the total population). The independent variables include:

Average wage (expressed either in national currency or in USD adjusted for purchasing power parity);

Education level (percentage of the population with complete secondary or higher education).

The general form of the regression model is:

$$\text{POVERTY} = \beta_0 + \beta_1 \times \text{WAGE} + \beta_2 \times \text{EDUCATION} + \varepsilon$$

where:

POVERTY — poverty rate;

WAGE — average wage;

EDUCATION — level of education;

$\beta_0, \beta_1, \beta_2$  — model coefficients;

$\varepsilon$  — error term.

The models were estimated using standard statistical analysis tools, including Python (pandas, statsmodels libraries) and EViews. The statistical significance of coefficients, presence of autocorrelation (Durbin–Watson test), heteroskedasticity (Breusch–Pagan test), and multicollinearity (via correlation matrix and Variance Inflation Factor, VIF) were tested. To improve model accuracy, variables exhibiting high intercorrelation were excluded in the preliminary stage. All data were standardized and, where necessary, smoothed using moving averages and normalized for comparability. The methodology is designed not only to provide a quantitative assessment of factor influence but also to facilitate interpretation of results for the development of evidence-based social policy recommendations.

#### Econometric Analysis of Factors Influencing Poverty Levels

Based on the methodology outlined in the previous section, multiple linear regression models were constructed for the three countries—Azerbaijan, Belarus, and Kyrgyzstan. The goal of the analysis is to quantify the impact of average wages and educational attainment on the poverty level. Model estimation was performed using time series data spanning from 1991 to 2024.

##### Azerbaijan

The regression model for Azerbaijan is as follows:

$$\text{POVERTY} = 122.13 - 0.0200 \times \text{WAGE} - 1.0322 \times \text{EDUCATION}$$

The regression results indicate a high level of statistical significance for both independent variables ( $p < 0.0001$ ). The coefficient of determination ( $R^2 = 0.93728$ ) suggests that the model explains nearly all variations in poverty levels. Diagnostic tests confirmed the model's reliability: the Durbin–Watson statistic ( $DW = 2.26$ ) showed no evidence of autocorrelation, and the Breusch–Pagan test ( $p = 1.000$ ) indicated the absence of heteroskedasticity, validating the standard error estimates.

Thus, an increase of 1 manat in the average wage corresponds to a 0.02 percentage point decrease in the poverty rate, while a 1% rise in the share of the population with formal education leads to a reduction in poverty of more than one percentage point.

Belarus

The regression model for Belarus is specified as follows:

$$\text{POVERTY} = 45.78 - 0.0185 \times \text{WAGE} - 0.8673 \times \text{EDUCATION}$$

Both independent variables were found to be statistically significant. However, the coefficient of determination ( $R^2 \approx 0.93$ ) is slightly lower than that observed in the Azerbaijani model. This may reflect Belarus's institutional characteristics, such as a substantial level of social support and strict government regulation, which also affect poverty levels but were not explicitly included in the model. Nevertheless, the impact of education is also pronounced: a 1% increase in educational attainment is associated with a nearly 0.87 percentage point reduction in poverty, while the contribution of wages mirrors the pattern observed in Azerbaijan. This resilience may be attributed to well-developed social policy mechanisms and a regulated system of income redistribution.

Kyrgyzstan

The regression model for Kyrgyzstan is:

$$\text{POVERTY} = 67.42 - 0.0141 \times \text{WAGE} - 0.7534 \times \text{EDUCATION}$$

A notable feature of this model is the relatively lower sensitivity of poverty levels to changes in wages and education, compared to Azerbaijan and Belarus. This can be attributed to a weaker institutional framework, a large informal sector, and significant external influences such as remittances and labor market instability. The model's  $R^2$  value is approximately 0.921, indicating a satisfactory level of explanatory power. The reduced sensitivity may result from several factors:

A high share of informal and self-employment, especially in rural areas;

Significant reliance on external remittances (up to 30% of GDP in some years);

Limited access to quality education in certain regions;

Institutional instability and weak social policies.

Table 1 summarizes the key evaluation metrics of the regression models. In all three cases, the  $R^2$  exceeds 0.92, indicating strong explanatory power. The Durbin–Watson statistics show no signs of autocorrelation in the residuals. All coefficients for the variables WAGE and EDUCATION are statistically significant at the 5% level or lower, confirming the robustness of the relationships between poverty, education, and income. Durbin–Watson values range from 2.12 to 2.72, within acceptable limits, affirming the correctness of parameter estimates.

<b>Indicator</b>	<b>Azerbaijan</b>	<b>Belarus</b>	<b>Kyrgyzstan</b>
$R^2$ (Coefficient of Determination)	0.93728	0.95614	0.92142
Durbin–Watson Statistic	2.26	2.72	2.12
Significance of WAGE (p-value)	< 0.001	< 0.05	< 0.05
Significance of EDUCATION (p-value)	< 0.001	< 0.05	< 0.05
Autocorrelation Presence	Her	Her	Her
Model Significance Conclusion	All coefficients are significant	All coefficients are significant	All coefficients are significant

**Table 1. Evaluation of the quality of regression models**

*Source: Author's calculations based on data from official statistics and international organizations (IMF,2023, World Bank,2023, Belstat, State Statistics Committee of Azerbaijan, National Statistical Committee of the Kyrgyz Republic).*



The models were constructed by the author using data, part of which was obtained through time series interpolation due to gaps in official sources.

#### Comparative Summary

A comparison of the three models reveals that, in all cases, both wages and education have a negative effect on poverty levels—meaning that increases in these variables contribute to poverty reduction. However, the strength of this influence varies. The most robust and explanatory model was developed for Azerbaijan, where reforms aimed at enhancing human capital and increasing income levels have shown the highest effectiveness. While the models for Belarus and Kyrgyzstan also demonstrate statistically significant impacts of these factors, the effects are comparatively weaker due to different institutional and structural characteristics.

Thus, the results of the econometric analysis confirm the central role of education and income in fostering social resilience and underscore the need for an integrated approach to poverty reduction in post-Soviet countries.

#### Discussion of Results

The conducted econometric analysis revealed patterns characteristic of social dynamics in the post-Soviet space. The models for Azerbaijan, Belarus, and Kyrgyzstan confirmed the hypothesis that increases in income and educational attainment contribute to poverty reduction. However, variations in coefficient magnitudes and model statistics indicate differing degrees of sensitivity to these social factors across the three economies.

The strongest explanatory power was observed in the model for Azerbaijan. This can be attributed to consistent educational reforms, large-scale infrastructure investments, and active human capital development. A systematic link is evident between income growth, educational coverage, and improvements in social indicators. The energy sector has provided a financial foundation for implementing social policy, while recent diversification efforts have enhanced the country's resilience to external shocks.

The model for Belarus also demonstrates a high, though slightly lower, explanatory capacity. This reflects the nature of the Belarusian socio-economic model, which is characterized by state regulation, subsidies, fixed tariffs, and targeted support for vulnerable groups. Consequently, poverty levels are influenced not only by market-based factors but also by administrative decisions. Nevertheless, the statistical significance of income and education confirms the importance of continued investment in human capital.

The model for Kyrgyzstan exhibits the lowest elasticity of poverty with respect to changes in wages and educational attainment. This reflects the structural specifics of the Kyrgyz economy, including a large informal sector, limited fiscal capacity, dependence on external financial inflows (particularly remittances), and weak institutional resilience. Even with rising wages and education levels, systemic constraints limit the effectiveness of these factors in reducing poverty.

It is also important to note that all models include a limited set of explanatory variables. Poverty is a multidimensional phenomenon and may be influenced by a broader range of factors, such as healthcare quality, infrastructure access, income inequality, and political stability. Nonetheless, focusing on two fundamental structural determinants allowed for a clear evaluation of the foundational drivers of social well-being.

In conclusion, the findings underscore the necessity of a comprehensive approach to social policy. In countries with strong institutions and resource bases (such as Azerbaijan), investments in education and income growth yield measurable outcomes. In economies with limited capacity (such as Kyrgyzstan), structural reforms, institutional strengthening, and improved conditions for private sector development are essential to achieving sustained poverty reduction.

## **Conclusion**

This study provided a comprehensive examination of the socio-economic transformation in Azerbaijan, Belarus, and Kyrgyzstan during the post-Soviet period. The use of statistical and econometric methods allowed for the identification of key patterns in the relationship between income levels, educational attainment, and poverty reduction across the three countries.

The comparative analysis showed that, despite starting from relatively similar economic conditions following the dissolution of the USSR, each country pursued a distinct development trajectory. Azerbaijan focused on the energy sector followed by diversification; Belarus relied on state regulation and economic stability; and Kyrgyzstan implemented liberal reforms under limited institutional support. These strategic choices influenced both the pace of economic growth and the success of social policy outcomes.

Regression analysis confirmed that increases in average wages and education levels significantly contribute to poverty reduction. However, the effectiveness of these factors varies depending on the institutional context. Azerbaijan demonstrated the highest sensitivity of poverty to these variables, while Kyrgyzstan showed a weaker effect due to structural and external economic constraints.

These findings underscore the importance of long-term investments in human capital, educational reforms, and the creation of conditions for sustainable income growth. To strengthen social resilience, countries must address not only economic but also institutional reforms, reduce inequality, and ensure equitable access to basic services. The study highlights the practical value of statistical analysis for informing evidence-based social policy and may serve as a foundation for further comparative research across the post-Soviet region.

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