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Mapping inequality: regional income disparities and their determinants in Armenia

ABSTRACT
Relevance. Income inequality, especially in the context of regional development, has become a key focus in academic and policy discussions. For Armenia, which is exposed to continued geopolitical pressures, balanced and sustainable regional development is crucial for national security and economic stability, making it urgent to strengthen its border regions by raising incomes and improving living standards.
Research Objective. This study analyzes regional-level macroeconomic data to identify key factors driving income inequality and propose policy recommendations to address these disparities.
Data and Methods. The study applies statistical and comparative analysis of regional economic data in Armenia, along with a panel regression model with fixed effects. The analysis considered key drivers of income inequality and regional economic weaknesses, focusing on economic growth, wages, poverty, access to education and healthcare, and financial services in Armenian regions.
Results. Most of the factors in question significantly impact income distribution, with the condition of regional education systems being the most important. The decline in educational infrastructure and closure of institutions have clearly contributed to growing income inequality across regions.
Conclusion. The main conclusion is that, in order to reduce income disparities between regions, a priority task should be to improve educational infrastructure, as it plays a key role in economic growth and the overall well-being of regional populations.

KEYWORDS
income level, standard of living, regional development, panel analysis, Armenia

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Картографирование неравенства: региональные различия в доходах и их детерминанты в Армении

АННОТАЦИЯ
Актуальность. Неравенство доходов, особенно в контексте регионального развития, стало ключевым направлением в академических и политических дискуссиях. Для Армении, которая подвергается постоянному геополитическому давлению, сбалансированное и устойчивое региональное развитие имеет решающее значение для национальной безопасности и экономической стабильности, что делает необходимым укрепление ее приграничных регионов за счет повышения доходов и улучшения уровня жизни.
Цель. В этом исследовании анализируются макроэкономические данные на региональном уровне для выявления ключевых факторов, обусловливающих неравенство доходов, и предлагаются рекомендации по политике для устранения этих различий.
Данные и методы. В исследовании применяется статистический и сравнительный анализ региональных экономических данных в Армении,

КЛЮЧЕВЫЕ СЛОВА
уровень доходов, уровень жизни, региональное развитие, панельный анализ, Армения

БЛАГОДАРНОСТИ
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а также панельная регрессионная модель с фиксированными эффектами. Анализ учитывает основные факторы неравенства доходов и региональные экономические слабости, уделяя особое внимание экономическому росту, заработной плате, бедности, доступу к образованию и здравоохранению, а также финансовым услугам в регионах Армении.
Результаты. Большинство рассматриваемых факторов существенно влияют на распределение доходов, причем наиболее важным является состояние региональных систем образования. Сокращение образовательной инфраструктуры и закрытие учреждений явно способствовали росту неравенства доходов в регионах.
Выводы. Основной вывод заключается в том, что для сокращения различий в доходах между регионами приоритетной задачей должно быть улучшение образовательной инфраструктуры, поскольку она играет ключевую роль в экономическом росте и общем благосостоянии населения регионов.

ДЛЯ ЦИТИРОВАНИЯ
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不平等的地域图景：亚美尼亚地区收入差异及其决定因素分析

摘要
现实性： 收入不平等问题——尤其是区域发展背景下的收入差距——已成为学术界和政策讨论的核心议题。对长期承受地缘政治压力的亚美尼亚而言，均衡且可持续的区域发展对国家安全与经济稳定具有决定性意义。这要求该国必须通过提高居民收入和改善生活水平来增强边境地区的综合实力。
目标： 本研究通过分析区域层面的宏观经济数据，旨在识别导致收入不平等的关键因素，并提出政策建议以消除这些差异。
数据与方法： 该研究采用了对亚美尼亚地区经济数据的统计和比较分析，以及固定效应面板回归模型。分析考虑了收入不平等的主要因素和区域经济弱点，特别关注亚美尼亚各地区的经济增长、工资水平、贫困状况、教育和医疗保健的可及性以及金融服务。
研究结果： 在诸多影响因素中，区域性教育体系的完善程度对收入分配格局具有决定性作用。教育基础设施的缩减及教育机构的关闭，已成为加剧地区间收入不平等的重要推手。
结论： 研究结果表明，缩小区域收入差距的首要任务在于完善教育基础设施，因其对地区经济增长和居民整体福祉具有关键性作用。

关键词
收入水平、生活水平、区域发展、面板分析、亚美尼亚

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Introduction

Income inequality is one of the most pressing global issues. Not only does it limit individuals' opportunities to improve their living standards, but it also threatens broader socio-economic development. Persistent income gaps can lead to social tensions and political instability, making it a critical concern for policymakers worldwide.

Income inequality, defined as unequal access to public goods (Kuznets, 2019), exists in all societies, including the most primitive. Since income inequality is detrimental to population well-being, it is essential to assess the extent and patterns of income distribution across the economy. This issue has been extensively covered in research literature.

This study examines income inequality across the regions of the Republic of Armenia, focusing on disparities in economic activity, poverty levels, wages, and access to healthcare, education, and financial services. It employs statistical and comparative analysis, including a panel regression model with fixed effects, to identify the key factors influencing income inequality and challenges in regional development.

Most of the factors are significant in relation to income distribution equality. Among these, the development of the education system in Armenia's regions was found to be the most significant factor. This reflects the ongoing deterioration of educational infrastructure and quality in the country, which has contributed substantial-

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ly to the widening income inequality across regions. The reduction in the number of educational institutions in Armenian regions has intensified income inequality. The study concludes that developing educational infrastructure should be a priority to achieve more equitable income distribution and narrow regional income gaps. Prioritizing investment in education and related infrastructure will also strengthen regional economic growth and improve overall well-being across Armenia.

Theoretical framework

A growing body of research (Mdingi & Ho, 2021; Bathelt et al., 2024) highlights the crucial role of institutions in shaping income distribution and long-term population welfare. In both developing and developed countries, widening income gaps fuel public dissatisfaction and increase the risk of political and social instability. High inequality often leads to political decisions favoring a wealthy minority, deepening divides, eroding trust, and destabilizing societies. This instability raises the likelihood of revolutions, coups, and violence, which threaten property rights, heighten political uncertainty, deter investment, and ultimately slow economic growth (Malikov & Alimov, 2022).

Even developed countries are not immune to uneven regional development and the corresponding disparities in income distribution. For instance, there is evidence that economic policy in the European Union tends to favor large cities and regions with major urban centers (Rauhut & Humer, 2020; Rauhut & Costa, 2021; Vedrin & Le Gallo, 2021), while only a few cities in peripheral regions have managed to benefit from such policies (Nagy & Benedek, 2021). Moreover, many regions are now described as having "no future," effectively rendering them "places that don't matter" (Rodríguez-Pose, 2018; Mattila et al., 2023).

Among the extensive body of research on this topic in Europe, there are noteworthy studies on Italy (Acciari & Mocetti, 2013) and France (Bonnet, d'Albis & Sotura, 2021), which analyzed century-long data sets and concluded that income distribution in these countries is uneven. There are also studies that examine regional income inequality through the lens of crisis impacts, highlighting how such events exacerbate disparities (Branco & Marques da Costa, 2023).

Income inequality remains a central concern for many international organizations, as it impedes sustainable development and poverty reduction. From both theoretical and practical policy-making perspectives, an essential task is to identify the causes of uneven income distribution and explore effective ways to address them.

According to the International Monetary Fund[1], regional inequality has increased in most countries. While there has been substantial progress in reducing global inequality over the past thirty years, regional disparities have widened, particularly in advanced economies. Over the last three decades, more than half of all countries and nearly 90 percent of advanced economies have experienced growing income inequality, with some reporting an increase of over two points in the Gini coefficient.

Academic literature highlights several key factors contributing to the rise in regional income inequality, including technological progress, globalization, fluctuations in commodity prices, and domestic economic policies like redistributive fiscal measures, labor market rules, and product market regulations.

Inequality can be understood through several interconnected concepts. Lifetime inequality refers to income disparities in individual experiences over their entire life. Wealth inequality reflects the uneven distribution of assets among households at a given time. Inequality of opportunity captures how factors beyond individual control, such as socioeconomic status, gender, or ethnicity, influence income. Together, these perspectives offer complementary insights into the causes and effects of inequality, helping governments develop more targeted policies[2].

It is important to distinguish between income inequality, which concerns wages and salaries, and wealth inequality, which relates to net asset value.

There are three core aspects highlighted in the literature on inequality:

– high wealth inequality tends to drive income inequality;

– wealth inequality is generally more concentrated globally than income inequality;

– there is a strong correlation between wealth and income inequality.

[1] International Monetary Fund. Income Inequality. An Introduction to Inequality. Retrieved from: https://www.imf.org/en/Topics/Inequality/introduction-to-inequality (date of access: 02.02.2025)

[2] Ibid.

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The facts presented above indicate that wealth inequality is a more serious issue than income inequality and that there is a causal relationship between these two phenomena. Nevertheless, a significant portion of empirical studies analyzing the causes of economic inequality focus on income inequality rather than wealth inequality. Shin et al. (2012) found that income and credit are the main drivers of wealth inequality in South Korea. Fouejieu et al. (2020) showed that financial inclusion reduces both income and wealth inequality. These studies, however, did not explore the relationship between income inequality and overall welfare.

Thus, there is a wide range of factors that influence economic inequality. Let us consider some of them in more detail.

Adam Smith was among the first to examine the relationship between inequality and economic growth. He argued that population welfare and uneven income distribution are directly connected to a country's economic growth. Smith believed that inequality could be balanced by factors such as accessible education, opportunities for personal success, and the prestige of different occupations. Citizens strive to maximize personal welfare, competition arises, and the principle of the "invisible hand" operates, which activates entrepreneurial activity, increases national wealth, and thereby addresses poverty. Consequently, Smith saw no need for government intervention to reduce poverty or redistribute income.

In the 1950s, economic policymakers focused on growth, assuming that any increase in production would raise per capita income in society. However, before production and thus the benefits of economic growth reach low-income or poor individuals, resources must be concentrated in a particular group to be directed toward investment and production. The rationale is that wealthier people save more money than those with less, and the accumulation of savings enables investment and economic growth (Garcilazo et al., 2021).

Kuznets (2019) explored the relationship between economic growth and income inequality through the lens of economic development. He found that the link between growth and income inequality is differential: positive at early stages and negative at mature stages. This phenomenon can be explained by the movement of labor from one sector to another — for example, a worker moving from agriculture to another economic sector. The income level of these workers increases because they are in demand in the new sectors, while the income of those remaining in agriculture stays low and unchanged. Over time, as the movement of workers out of agriculture continues, the supply of agricultural labor falls below demand, causing wages for those remaining to rise in order to retain them. Thus, inequality begins to decline at this stage. Kuznets describes this relationship as the inverted U-hypothesis, which suggests that inequality increases in the early stages of economic development and declines in the later stages.

Ahluwalia (2019) distinguishes between long-term and short-term relationships between inequality and economic growth. Kuznets focuses on the long-term perspective, linking inequality to structural economic changes — for example, the rise in inequality during Brazil's rapid growth in the 1970s. While Kuznets' hypothesis offers a broad explanation, Ahluwalia emphasizes the need to account for short-term factors. He notes that when growth is concentrated in certain sectors or regions, limited labor mobility and rigidities in factor markets can create temporary imbalances, leading to significant income disparities.

On the one hand, inequality motivated low-income individuals to work harder to meet their needs, which contributed to economic growth; on the other hand, inequality hindered human capital accumulation, which in turn impeded growth (Yang & Xin, 2020).

Galor (2024) also examined how income inequality is related to a national or regional level of technological development. In the early stages of technological progress, inequality tends to rise as demand for highly skilled labor increases. Incomes rise for workers engaged in new technologies, whereas workers in traditional technology sectors see little to no increase. Over time, however, inequality tends to decline as the number of workers in outdated sectors falls.

Researchers of the Fourth Industrial Revolution (4IR) have examined technology's role in income inequality (Gomes et al., 2022). The 4IR drives automation through modern technologies, transforming production processes. According to Boeri et al. (2020), this automation tends to widen the income gap between low-skilled and high-skilled workers. Consequently, technological advances may increase both inequality and unemployment.

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Access to credit plays a central role in shaping the economic opportunities of households and businesses and is crucial for recovery from the stagnation caused by the pandemic. It enables individuals to invest in housing, education, and entrepreneurship, thereby promoting upward mobility. As a result, credit access can have significant implications for reducing — or, if unevenly distributed, reinforcing — income inequality.

Problems like adverse selection and moral hazard, caused by asymmetric information between lenders and borrowers, affect how easy it is to get credit. Due to these information gaps, lenders may restrict loans, charge higher interest rates, or often require borrowers to provide collateral. As a result, relatively poor people with limited capital may be denied credit regardless of how good their investment ideas are. This exclusion from credit can limit economic mobility and reinforce income inequality (Delès et al., 2020).

Several studies show a connection between fertility rates and income inequality across different social groups. Kremer and Chen (2002) explored the relationship between inequality and varying fertility rates. Using data from multiple countries, they found that greater inequality tends to come with bigger differences in fertility within a country. Low-income families tend to have higher fertility rates than wealthier families, but they have fewer resources to invest in their children's education and development (Böhm et al., 2021).

Marmot et al. (1991) discovered a link between wages and health: low-skilled workers were four times more likely to suffer from poor health compared to high-skilled workers. Health tends to improve as job status rises, and this pattern holds true regardless of lifestyle factors like smoking or drinking.

Income inequality has harmful effects on physical and mental health, which in turn, also impact important social areas such as crime, social mobility, and education.

The role of education in income inequality remains complicated. Over the past decades, many researchers have explored this topic, but the evidence is still contradictory.

A key contribution to understanding factors affecting income inequality was made by Schultz (1961). He studied how human capital influences economic development and inequality, emphasizing key issues such as gaps in education and skills among the population and pointing out that many people lack access to quality education. This gap can increase inequality, as a large portion of the population cannot gain the skills needed to participate fully in the labor market.

Investments in human capital can contribute to reducing income inequality. The impact of education on uneven income distribution is considered a complex and multifaceted process, depending on numerous factors. An increase in the number of workers with higher education leads to changes in the labor force structure, as unskilled workers become skilled. In the short term, this may increase inequality, but over time, as the number of skilled workers grows, the wage gap between skilled and unskilled labor is likely to narrow, leading to reduced inequality (Chiswick, 1988).

Education aimed at improving qualifications promotes the growth of both personal and social incomes while simultaneously reducing income inequality. The quality of human capital among low-paid workers improves, which helps enhance the quality of life. Psacharopoulos & Woodhall (1991) consider education as an investment that fosters economic development, thereby increasing the assets of low-income populations. However, given that access to educational services is mostly available to wealthier social groups, the question of whether education can reduce inequality remains controversial.

A complicating factor is that inequality depends not only on education investment, but also on how income from non-human capital is distributed and how quickly education grows compared to other forms of capital. These dynamics can either widen or narrow income inequality.

Another important factor is government intervention, particularly through subsidies for higher education, which aim to expand access for children from low-income families. However, Glomm and Ravikumar (2003) argue that the effectiveness of such subsidies and public spending in reducing income inequality remains uncertain.

Public expenditure on education may not reduce the income gap between the rich and the poor, even if everyone has equal access to education, due to differences in individual choices and parental human capital. Furthermore, expanding education will not benefit the poor if they lack sufficient resources to attend school, especially if they are taxed to finance education (Sylwester, 2002).

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Spending on education, particularly higher education, often benefits children from middle- and upper-class families rather than low-income groups, who are expected to be the primary target of redistribution policies.

The current theoretical framework on income inequality does not sufficiently incorporate empirical analysis specific to Armenian regions, particularly multifactor panel regression studies. The role of the education system and access to education in shaping regional income levels is also largely overlooked. This study addresses these gaps by offering a quantitative analysis of key macroeconomic factors affecting income distribution and by applying a fixed effects panel regression model with potential policy relevance.

Methods

This study employs statistical and econometric methods to investigate the factors driving income inequality across Armenia's regions. To achieve this, a panel regression model was constructed using regional data. The dependent variable in the final model is the deviation of regional wages from the national average, which allows for consistent income comparisons by controlling for variations in prices and inflation. The primary aim is to identify the determinants of unequal income distribution, rather than to assess income levels per se. The indicator used as the dependent variable was calculated as shown in Equation (1):

$$W_{it} = \frac{Wage_{it}}{Wage_{national,t}} \quad (1)$$

where i represents the region's index, and t, the time period.

The independent variables correspond to the key factors identified in the literature review and are as follows: the number of universities per 1,000 residents; the number of schools per 1,000 residents; the birth rate; regional GDP growth rates; poverty level; and population size. Data for all these indicators were collected at the regional level. The model covers a 7-year period, from 2016 to 2022, because regional GDP data were only available for these years. As part of the regression analysis, all time series were tested for stationarity and normality. Following initial statistical processing, all independent variables, except for GDP growth, were transformed using the first-difference logarithmic method (Δln).

Hypothesis: Access to education and the birth rate have a positive effect on income inequality across regions.

The final specification of the regression model is presented in Equation (2):

$$W_{it} = \alpha + \gamma W_{i,t} + \beta_1 Universities_{it} + \beta_2 Schools_{it} + \\ + \beta_3 Fertility_{it} + \beta_4 GDP_{it} + \mu_i + \varepsilon_{it}, \quad (2)$$

where regions are denoted by i, and years by t. Since poverty level and population size were not statistically significant and worsened the model's fit, they were excluded from the final specification. The coefficients β reflect the impact of the corresponding independent variables on wage inequality across regions. γ indicates the degree of income (wage) persistence over time by region, α is the constant term, ε_{it} is the error term, and μ_i is the individual regional effect. Depending on its characteristics, the coefficients in this specification can be most appropriately estimated using one of the submodels: pooled OLS, fixed effects, or random effects. The total number of observations is 77. Coefficients were estimated using the least squares method, with coefficient covariances calculated using the White cross-section (period cluster) approach, which addresses potential heteroskedasticity in the residuals.

Results

Our results show how the selected factors impact income inequality levels in Armenia's regions and capital. To begin with, the data on regional economic growth in Armenia show considerable variation throughout the given period (Fig. 1). In the crisis years of the COVID-19 pandemic, Syunik, Kotayk, and Yerevan experienced a much smaller economic decline than other regions, which may be explained, in part, by the concentration of resources in Yerevan and Kotayk's proximity to the capital. Another contributing factor is the nature of economic activity in these regions. For example, in Syunik, the mining industry — unlike services and agriculture, which dominate in other regions — suffered a smaller decline during the pandemic. It should be noted that Syunik had the highest economic growth over the given period, which can be linked to the region's economic structure and rising global prices for mineral resources.

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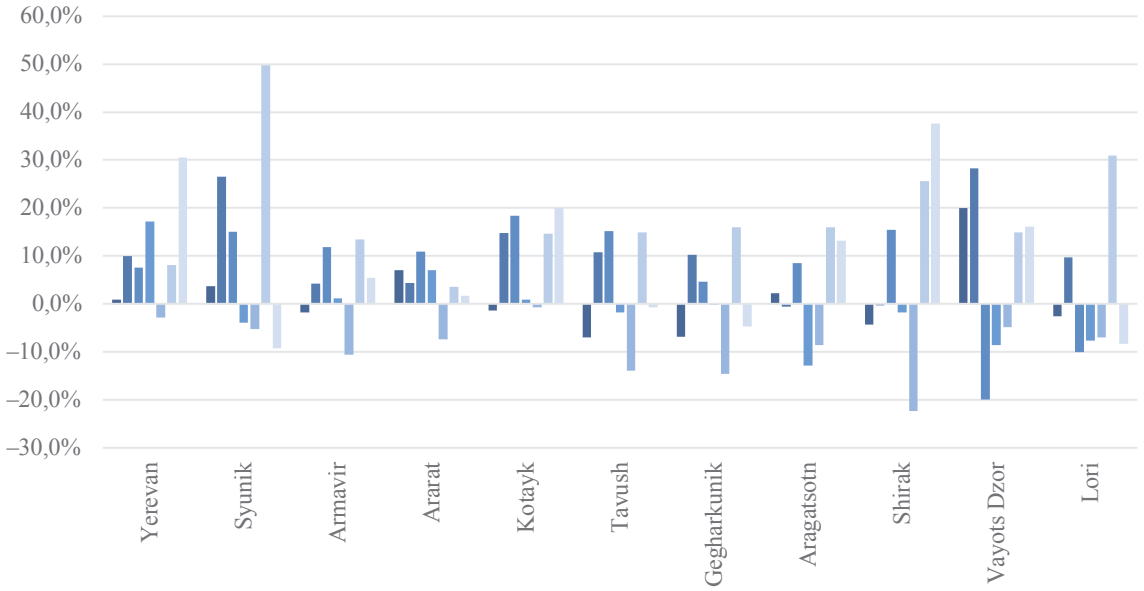

Figure 1. *Economic growth in Armenian regions, 2016–2022*

Source: calculated by the authors by using data from: Collections of Regional Statistics of the Statistical Committee of the Republic of Armenia, Retrieved from: https://www.armstat.am/ru/?nid=651 (date of access: 15.02.2025)

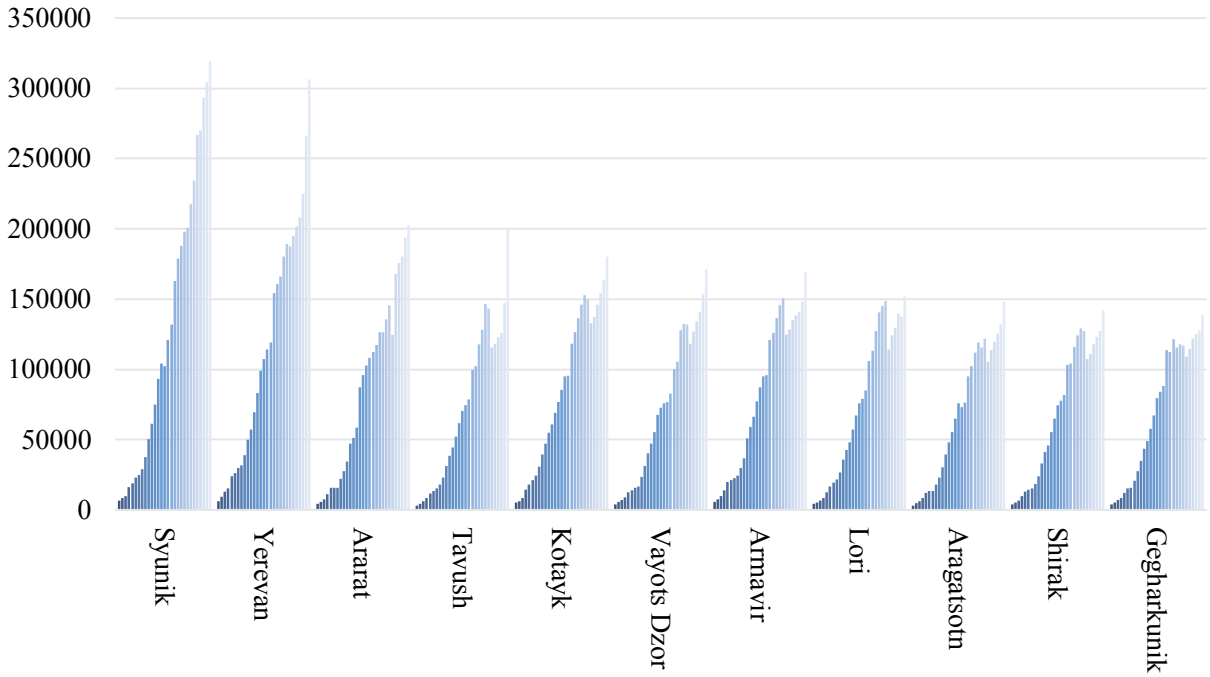

Figure 2. *Average wages in Armenian regions, 1995–2023*

Source: calculated by the authors by using data from: Collections of Regional Statistics of the Statistical Committee of the Republic of Armenia, Retrieved from: https://www.armstat.am/ru/?nid=651, and annual reports "Marzes of the Republic of Armenia in Figures", Retrieved from: https://www.armstat.am/ru/?nid=82 (date of access: 15.02.2025)

Given the uneven economic growth across Armenia's regions and the notably high growth observed in several of them, it is also important to examine regional wages. As shown in Fig. 2, Yerevan and Syunik consistently had significantly higher wage levels compared to other regions throughout most of the given period. In terms of dynamics, it should be noted that in 1995, the gap between the highest and lowest regional wages was a factor of 1.16. By 2023, this gap had increased to

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1.3 times, further highlighting the deepening economic inequality between Armenia's regions.

A more illustrative indicator of income inequality across Armenia's regions is the coefficient of wage variation, shown in Fig. 3. Although this coefficient began to decline in the 2000s, indicating a reduction in income inequality, since 2018 it has risen significantly, highlighting a rise in regional income disparities.

Considering regional poverty levels in the context of wealth inequality, we can see that Yerevan has historically had the lowest poverty rate.

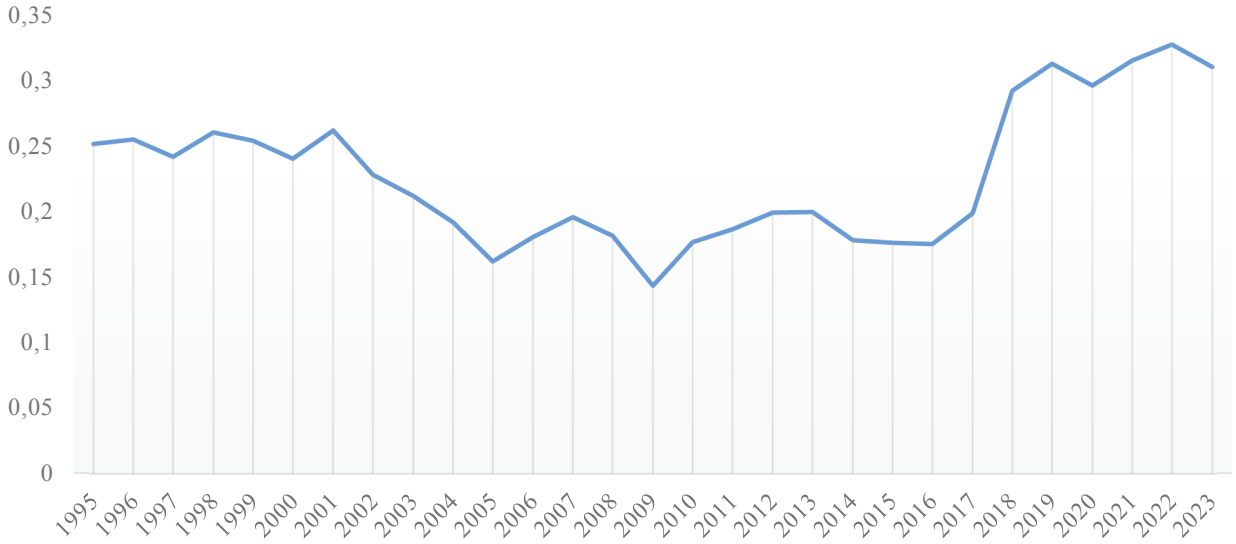

Figure 3. *Wage variation coefficient in Armenian regions, 1995–2023*

Source: calculated by the authors by using data from: Collections of Regional Statistics of the Statistical Committee of the Republic of Armenia, Retrieved from: https://www.armstat.am/ru/?nid=651, and annual reports "Marzes of the Republic of Armenia in Figures", Retrieved from: https://www.armstat.am/ru/?nid=82 (date of access: 15.02.2025)

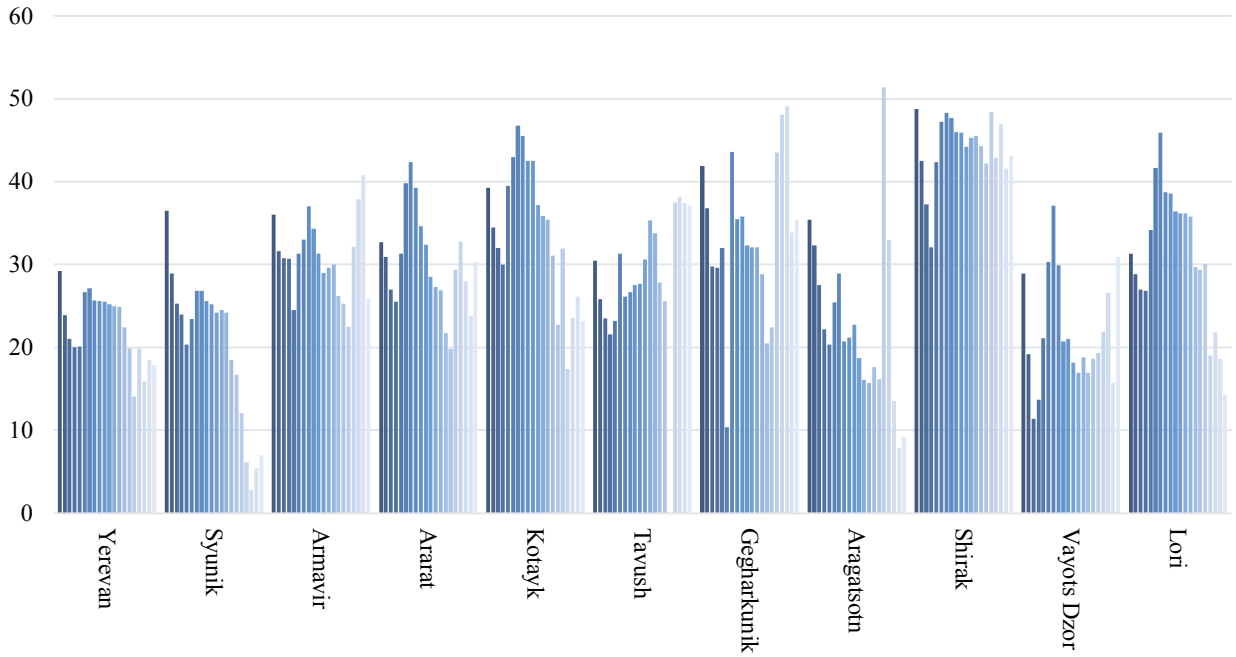

Figure 4. *Poverty levels in Armenian regions, 2004–2023.*

Source: calculated by the authors using data from: Collections of Regional Statistics of the Statistical Committee of the Republic of Armenia, Retrieved from: https://www.armstat.am/ru/?nid=651, and annual reports "Marzes of the Republic of Armenia in Figures", Retrieved from: https://www.armstat.am/ru/?nid=82 (date of access: 20.02.2025)

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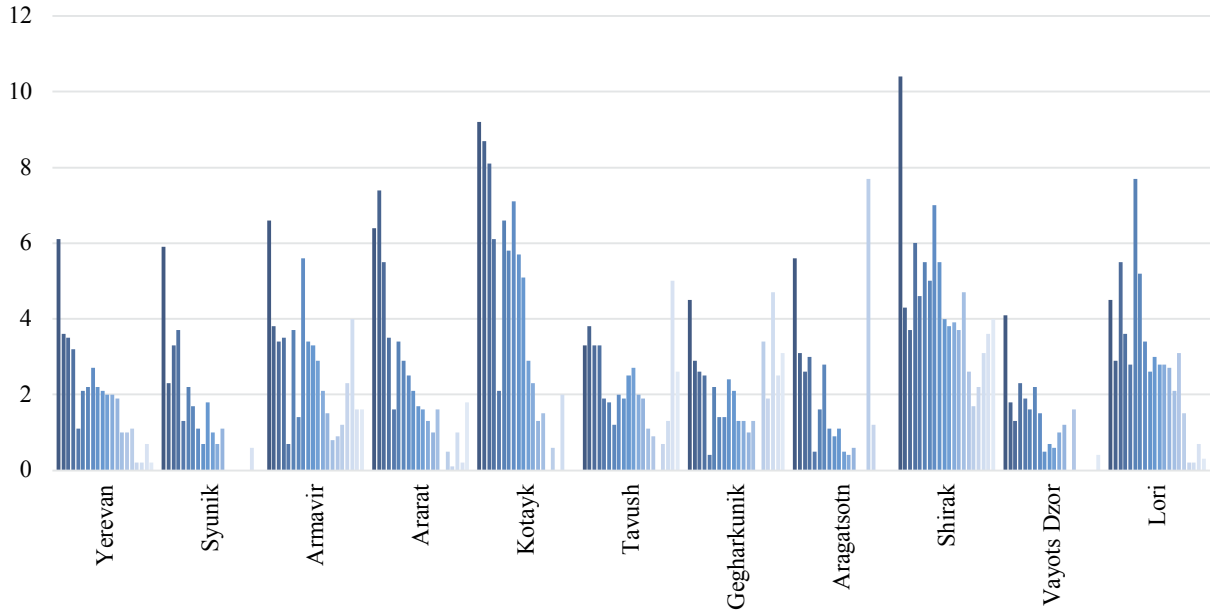

Figure 5. *Extreme poverty levels in Armenian regions, 2004–2023.*

Source: calculated by the authors using data from: Collections of Regional Statistics of the Statistical Committee of the Republic of Armenia, Retrieved from: https://www.armstat.am/ru/?nid=651, and annual reports "Marzes of the Republic of Armenia in Figures", Retrieved from: https://www.armstat.am/ru/?nid=82 (date of access: 20.02.2025)

However, in recent years, Syunik and Aragatsotn have made significant progress in reducing poverty. In 2023, for instance, the poverty rate in Syunik was just 7 %, while in Yerevan it stood at 17.9 %. By contrast, Shirak region has continued to struggle. Since the 2008 financial crisis, poverty in the region has remained consistently high. Between 2008 and 2023, the average poverty rate in Shirak was 45.1 % (Fig. 4).

If we look at the level of extreme poverty, Shirak once again stands out with the highest rate among all regions, indicating the severity of poverty in the area (Fig. 5).

Regarding the accessibility of financial institutions in the regions, it is important to note that the concentration of banks in Yerevan has only increased over the past 30 years. In 1998, out of 30 banks, only one had its headquarters in Shirak region[3], whereas by 2025, all 18 bank headquarters are located in Yerevan[4]. Table 1 shows that the proportion of bank branches in Yerevan grew from 26.5 % in 1998 to 50.4 % today.

Table 1

Distribution of bank branches by Armenian regions, number, 1998–2025

Region	1998	2025
Yerevan	44	268
Syunik	13	28
Armavir	11	27
Ararat	12	26
Kotayk	16	41
Tavush	9	20
Gegharkunik	16	26
Aragatsotn	9	17
Shirak	12	35
Vayots Dzor	7	10
Lori	17	34

Source: compiled by the authors using data from the official websites of the banks of Armenia and the Reference of the Statistical Committee of the Republic of Armenia "Marzes of the Republic of Armenia in Figures, 1999", Retrieved from: https://www.armstat.am/ru/?nid=81&id=78 (date of access: 22.02.2025)

As for birth rates, it should be noted that the number of births per capita is lowest in the capital, Yerevan, which may be related to its higher level of development compared to the rest of the regions. In the other regions, the overall birth rate reflects both urban and rural areas, with higher

[3] Marzes of the Republic of Armenia in Figures, 1999. Retrieved from: https://www.armstat.am/ru/?nid=81&id=78 (date of access: 15.02.2025)

[4] The Central Bank of the Republic of Armenia. Retrieved from: https://www.cba.am/am/sitepages/fscfobanks.aspx (date of access: 15.02.2025)

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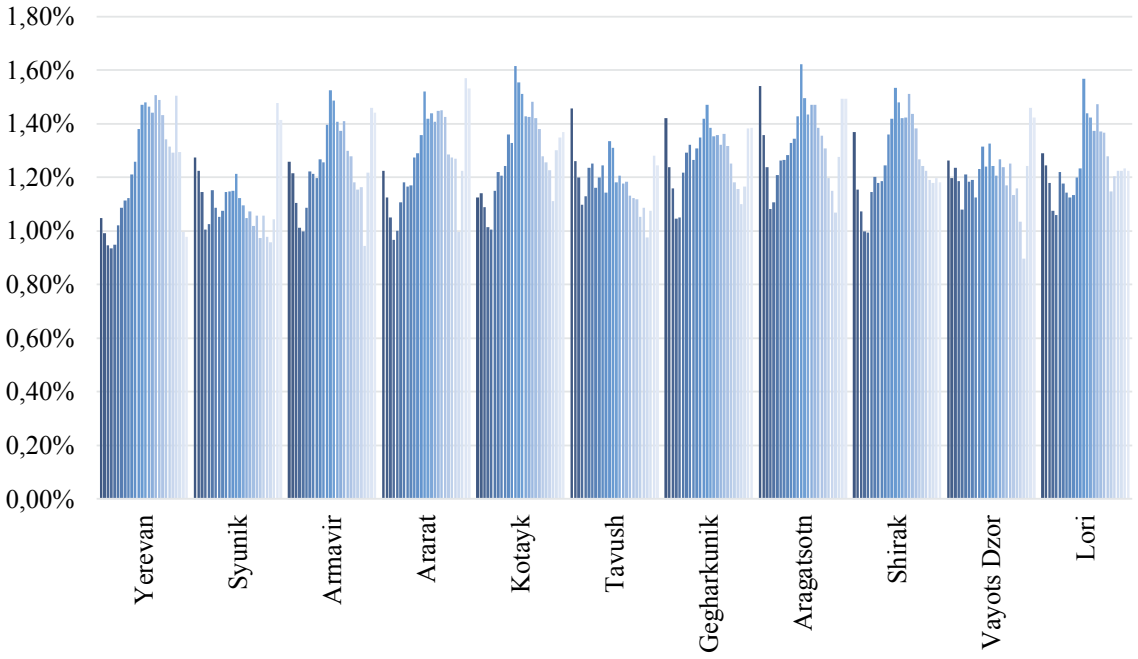

Figure 6. *Birth rate per capita, 1998–2023*

Source: calculated by the authors by using data from Collections of Regional Statistics of the Statistical Committee of the Republic of Armenia, Retrieved from: https://www.armstat.am/ru/?nid=651, annual reports "Marzes of the Republic of Armenia in Figures", Retrieved from: https://www.armstat.am/ru/?nid=82, and Demographic Collections of Armenia, Retrieved from: https://www.armstat.am/ru/?nid=81&pthid=demo&year=&submit=%D0%9F%D0%BE%D0%B8%D1%81%D0%BA (date of access: 22.02.2025)

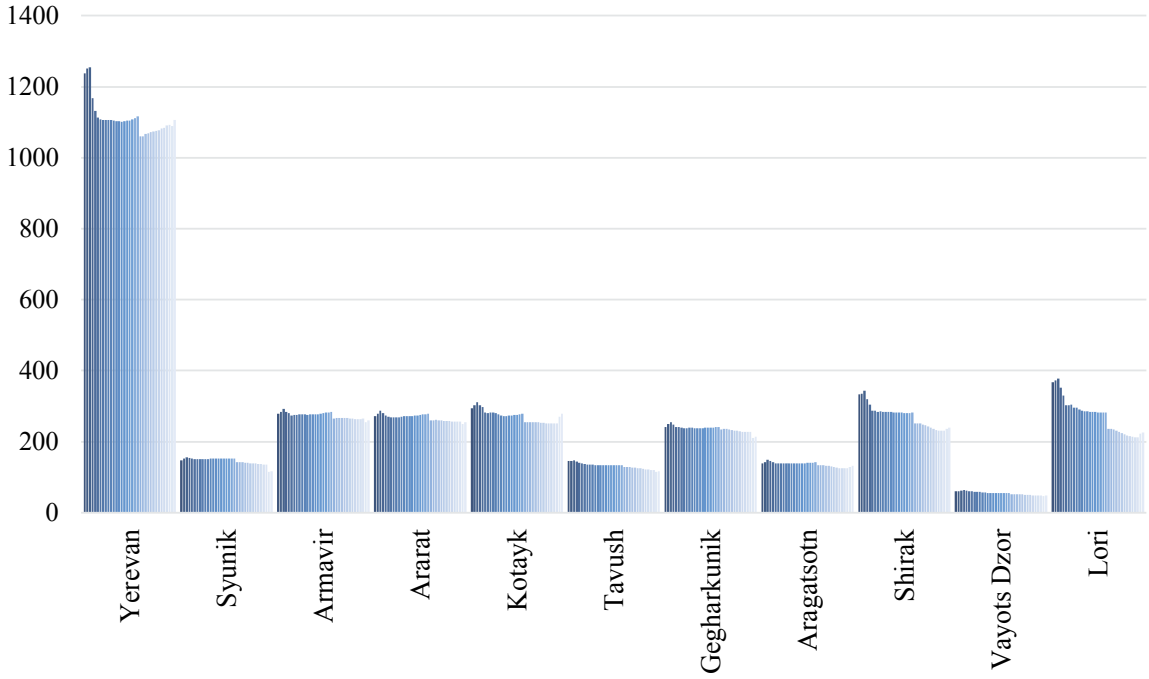

Figure 7. *Population of Armenian regions, thousand people, 1989–2023*

Source: calculated by the authors by using data from Collections of Regional Statistics of the Statistical Committee of the Republic of Armenia, Retrieved from: https://www.armstat.am/ru/?nid=651, annual reports "Marzes of the Republic of Armenia in Figures", Retrieved from: https://www.armstat.am/ru/?nid=82, and Demographic Collections of Armenia, Retrieved from: https://www.armstat.am/ru/?nid=81&pthid=demo&year=&submit=%D0%9F%D0%BE%D0%B8%D1%81%D0%BA (date of access: 22.02.2025)

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birth rates in rural communities boosting the average. Yerevan, however, lacks this averaging effect. At the same time, the birth rate is roughly similar across all regions of Armenia (Fig. 6).

Despite similar birth rates, if we look at the overall population in the regions, it becomes clear that while all of them follow the general trend of population decline, the rate of decline varies significantly. For example, from 1989 to 2023, Aragatsotn's population decreased by 5.4 %, whereas Lori's population fell by 39 %, and Shirak's by 29 % (Fig. 7). This variation may be linked to negative natural population growth, indicating migration flows in these regions.

As for education, it is important to note that resource concentration in Yerevan has increased over time. While there were 26 universities in the regions in 2001, this number had decreased to 11 by 2023. In terms of the number of universities and their branches per 1,000 residents, Yerevan, Syunik, and Shirak stand out sharply compared to other regions (Fig. 8). Thus, in this context, poverty levels and wages do not show a clear correlation with the number of higher education institutions in the regions.

As for schools, we see that the number of schools per 1,000 people is higher in regions with smaller populations (Fig. 9), which likely indicates that school openings were not proportional to population size but were driven by political goals to maintain a large number of operating schools. As a result, regions with fewer people end up with a relatively high number of schools per capita.

Unlike schools, outpatient clinics are distributed roughly evenly per capita across all regions (Fig. 10). The only exception is Yerevan, which has the much larger population and well-developed infrastructure and thus can serve a high number of patients with fewer outpatient facilities.

It should be noted that our analysis of the key factors related to the uneven distribution of income in Armenian regions had some data gaps, which is why only relevant data were used in this study, and some factors that could provide a more accurate picture were not fully considered.

Nevertheless, the overall picture is quite clear. In the next stage of our research, we are going to assess the impact of the various factors discussed above on the uneven distribution of income across Armenia's regions. These include institutions and the financial system, which can be assessed at the national level but are difficult to evaluate regionally.

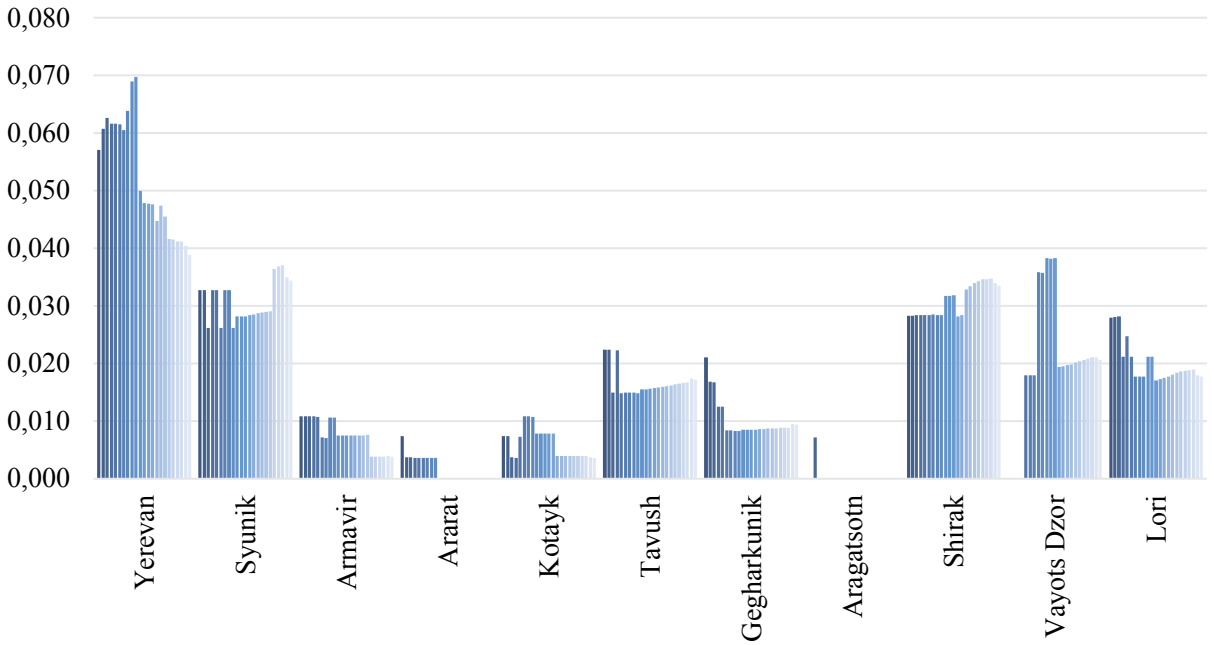

Figure 8. *Number of universities and university branches per 1,000 people in Armenian regions, 2001–2023*

Source: calculated by the authors using data from Collections of Regional Statistics of the Statistical Committee of the Republic of Armenia, Retrieved from: https://www.armstat.am/ru/?nid=651, and annual reports "Marzes of the Republic of Armenia in Figures", Retrieved from: https://www.armstat.am/ru/?nid=82 (date of access: 22.02.2025)

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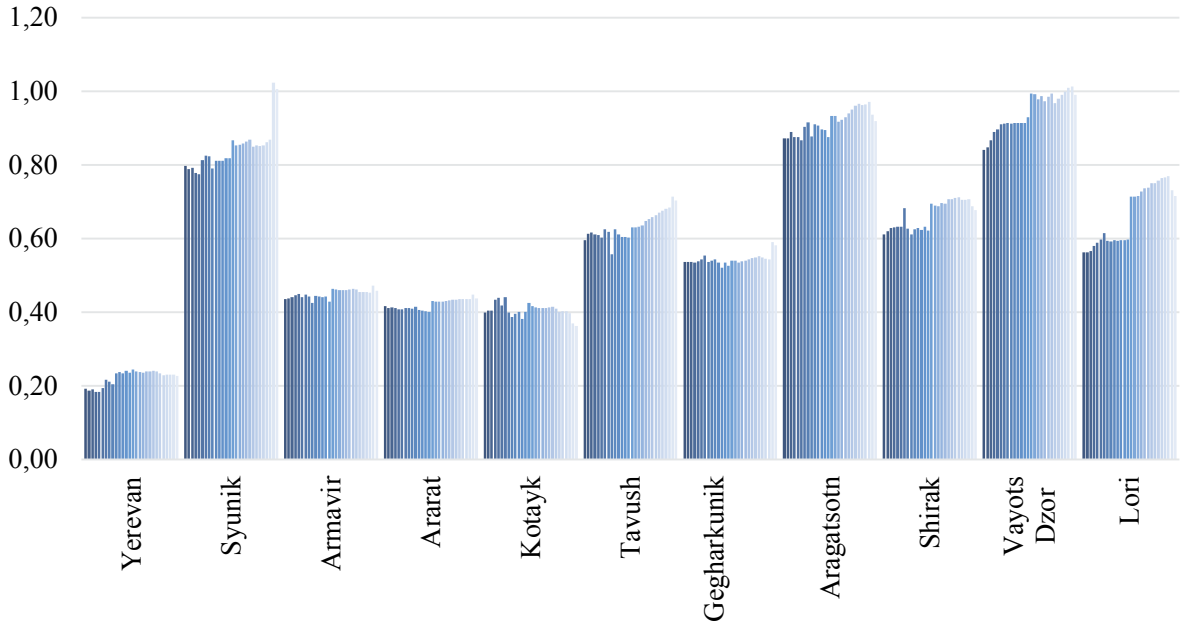

Figure 9. *Number of schools per 1,000 people in Armenian regions, 1996–2023*

Source: calculated by the authors using data from Collections of Regional Statistics of the Statistical Committee of the Republic of Armenia, Retrieved from: https://www.armstat.am/ru/?nid=651, and annual reports "Marzes of the Republic of Armenia in Figures", Retrieved from: https://www.armstat.am/ru/?nid=82 (date of access: 22.02.2025)

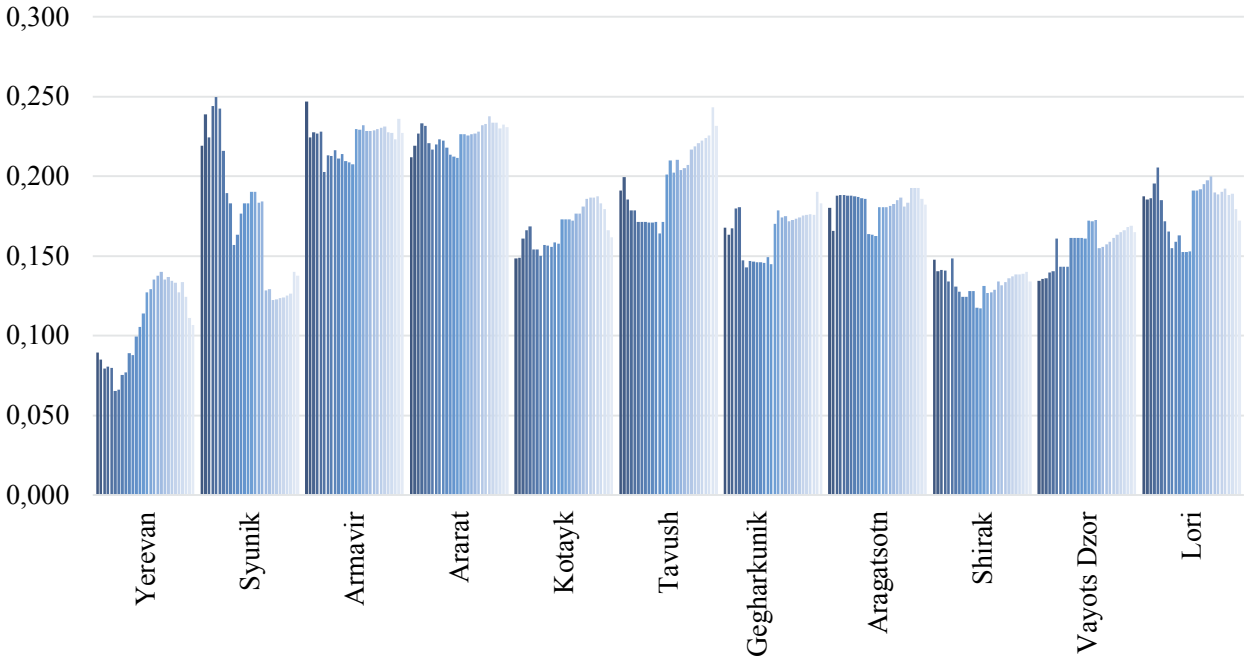

Figure 10. *Number of outpatient clinics per 1,000 people in Armenian regions, 1996–2023*

Source: calculated by the authors using data from Collections of Regional Statistics of the Statistical Committee of the Republic of Armenia, Retrieved from: https://www.armstat.am/ru/?nid=651, and annual reports "Marzes of the Republic of Armenia in Figures", https://www.armstat.am/ru/?nid=82 (date of access: 22.02.2025)

Panel regression model

The results of the panel regression model estimation are presented in Table 2. The left part of the table shows the results of the Pooled OLS submodel, the middle part presents the results of the fixed effects submodel, and the right part shows the results of the random effects submodel.

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Table 2

Results of coefficient estimation for the panel regression model

	Pooled OLS		Fixed effects (FEM)		Random effects (REM)	
Regressor	**Coeff.**	**Prob.**	**Coeff.**	**Prob.**	**Coeff.**	**Prob.**
Wage (-1)	0.917	0.0000	0.331	0.0096	0.869	0.0000
Universities	15.993	0.3279	12.619	0.0162	27.221	0.0328
Schools	0.552	0.1803	0.652	0.0064	0.632	0.1460
Fertility	–0.007	0.8419	–0.065	0.0214	0.036	0.6094
GDP	–0.06	0.0022	–0.042	0.0111	–0.099	0.0620
C	0.071	0.2508	0.679	0.0005	0.126	0.2564
R-square	0.856		0.911		0.8097	
R-square adj.	0.844		0.885		0.7939	
DW statistic	1.978		1.814		2.327	
Root MSE	0.112		0.089		0.117	
F-stat	71.321		34.192		51.087	
Prob (F-stat)	0.000		0.000		0.000	

Source: calculated by the authors

Table 3

Lagrange multiplier (LM) test

Null (no rand. effect) Alternative	Cross-section One-sided	Period One-sided	Both
Breusch-Pagan	29.0384	1.0492	13.3958
	(0.0000)	(0.3057)	(0.0002)
Honda	–5.3887	–1.0243	–11.052
	(0.0000)	(0.8472)	(0.0000)
King-Wu	–5.3887	–1.0243	–11.475
	(0.0000)	(0.8472)	(0.0000)

Source: calculated by the authors

Table 4

Hausman test & redundant fixed effects

Null (no rand. effect) Alternative	Statistic	Degrees of freedom	Prob.
Cross-section random	25.7462	5	0.0001
Cross-section F	3.9927	(10.5)	0.0005

Source: calculated by the authors

To select the optimal model for estimating the coefficients, two main tests were applied: the Lagrange multiplier (LM) test and the Hausman test. The LM test compares which method is better — ordinary least squares (OLS) or a model with effects. According to the test results (Table 3), the p-values for all tests are below 0.05, so at the 5 % significance level, it can be concluded that panel effects are present in the model.

To identify whether the effects are fixed or random, the Hausman test was used. This test's null hypothesis assumes no correlation between the random effects and the independent variables. The results show that, at the 5 % significance level, the null hypothesis can be rejected. Therefore, the fixed effects model is better suited for estimating the coefficients in this panel regression (see Table 4).

The results of the fixed effects model show that all selected independent variables are significant at the 5 % significance level (p-value below 0.05). The models' explanatory power is about 90 %, which is a very high figure. The Durbin-Watson statistic indicates the absence of autocorrela-

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tion in the residuals. The low RMSE level (0.089) demonstrates a low error in predictions made by the estimated coefficients of this model.

The model results show that the availability of education has a positive effect on reducing income inequality. Both the increase in the number of universities (coefficient 12.619) and the increase in the number of schools (coefficient 0.652) have a strong positive impact on the wage level in the region compared to the average wage in the economy. Interesting are the coefficient estimates for the birth rate (coefficient –0.065) and the growth rate of the gross regional product (coefficient –0.042). The negative impact of the birth rate on income inequality in the region is associated with an increased burden on households in the short term, while a positive effect may only be observed in the long term. On the other hand, the negative influence of the gross regional product growth rate suggests that income generated in the

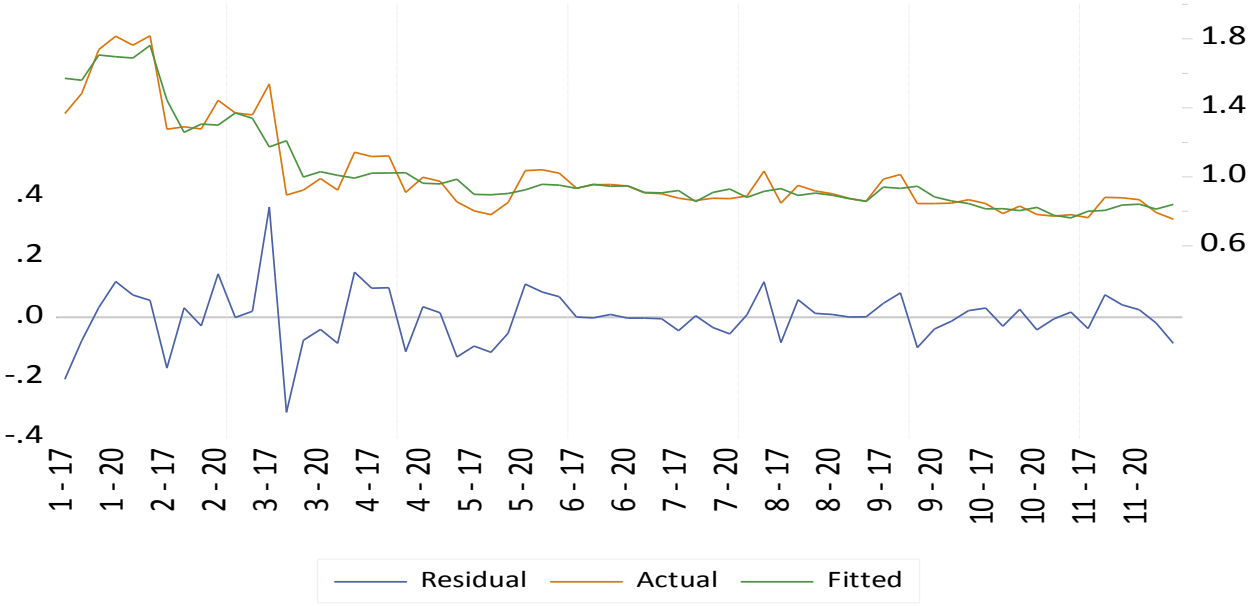

Figure 11. *Actual values, estimated values, and residuals.*
Source: calculated by the authors

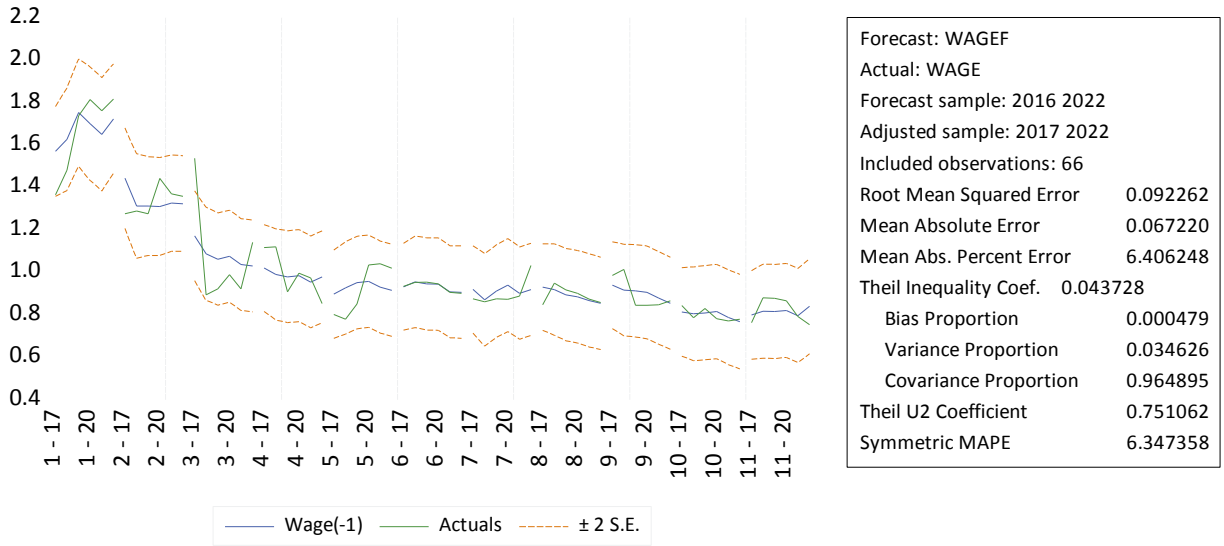

Figure 12. *Actual values, predicted values, and confidence intervals*
Source: calculated by the authors

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region mostly either flows to other regions (for example, Yerevan) or leaves the country (for example, in the form of dividends).

To evaluate the quality of the model, let us consider its ability to predict the dependent variable. As shown in Fig. 11 and 12, the model fits the results quite well, and the residual values are relatively small.

Moreover, the root mean square error (RMSE, 0.092) and the mean absolute error (MAE, 0.067) are very low, indicating a high-quality model. The mean absolute percentage error is 6.4% (below 10%), which points to high forecasting accuracy, while the low Tail inequality coefficient (0.044) indicates an excellent model approximation.

Thus, we can conclude that the panel regression model demonstrates a high predictive ability with a very low level of bias errors and well-balanced errors. The Jarque-Bera test (0.9, p-value 0.64) indicates a normal distribution of the model's residuals.

Conclusions

Regional development, especially fair income distribution, is vital for Armenia's national security. Since the country faces military risks, it is even more urgent to boost economic growth and improve living standards in its regions. This, in turn, will help maintain population levels in the regions — especially in border areas, where risks are higher and low living standards may lead to increased migration to the capital or even beyond Armenia's borders. In this sense, the issue of equitable income distribution across Armenia's regions is of paramount importance.

Our results reveal significant disparities in the development of nearly all factors theoretically linked to equitable income distribution. This situation is typical of many post-Soviet countries, both small open economies and larger ones, and can be explained by low institutional development, which hinders the fair allocation of resources between regions. At the same time, the education system clearly stands out as a key factor in this matter. The study's main conclusion is that education is the key factor shaping fair income distribution across regions, an insight that we believe is likely true worldwide.

In this context, a key recommendation is to develop the infrastructure of regional education systems at all levels — primary, secondary, higher, and continuing education. Currently, most universities are concentrated in Yerevan, which naturally attracts the younger generation to the capital. As the socio-economic conditions in the regions are deteriorating, there is little reverse migration. More effective policies are needed to develop educational systems in the regions. These measures may include relocating some universities, training qualified academic staff in the regions themselves, and increasing government funding for regional universities. Together, these measures could make the regional education system more effective and, in the medium term, be conducive to a more balanced income distribution across the regions.

Other factors that affect income distribution in the longer term should not be overlooked and need to be integrated into a comprehensive national program for regional development, requiring a forward-looking approach from the government.

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