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Assessing the middle-income trap in post-Soviet countries: Evidence from unit root tests

Nijat Gasim
Center of Excellence for Research, Development and Innovation, Baku State University, Baku, Azerbaijan
nijatgasim@bsu.edu.az
ORCID 0000-0002-3976-1283

Shahriyar Mukhtarov*
Faculty of Business and International Relations, Vistula University, Warsaw, Poland;
Department of Economics, Korea University, Seoul, 02481, South Korea;
BEU-Scientific Research Center, Baku Engineering University, Baku, Azerbaijan;
UNEC Empirical Research Center, Azerbaijan State University of Economics (UNEC), Baku, Azerbaijan.
s.mukhtarov@vistula.edu.pl
ORCID 0000-0001-6248-6120
**Corresponding Author*

Galib Gafarli
Department of World Economy, Baku State University, Baku, Azerbaijan;
Department of Finance and Accounting, Azerbaijan State Agricultural University, Ganja, Azerbaijan.
qalibqafarli@bsu.edu.az
ORCID 0000-0002-2292-2896

Farid Jabiyev
Department of Economics, Indiana University Bloomington, USA;
Karabakh Economic Research Center, Azerbaijan State University of Economics (UNEC), Baku, Azerbaijan.
fcebiyev@gmail.com
ORCID 0000-0002-6675-0264

Abstract. This study investigates whether post-Soviet countries are caught in the middle-income trap, using the Robertson and Ye (2013) approach. A comprehensive set of unit root tests was employed, including traditional tests (ADF), nonlinear tests (KSS, Kruse, Sollis), and advanced Fourier-based tests (FKPSS, FF-ADF, FADF, FKSS, FKruse, FSollis) to analyze the data spanning from 1990 to 2023. The results revealed a significant heterogeneity in convergence patterns across the countries. It can be concluded that Moldova, Kyrgyzstan, Tajikistan, Armenia, Azerbaijan, Belarus, and Georgia exhibited stationarity in most tests, indicating that these countries are in the middle-income trap. In contrast, Kazakhstan, Uzbekistan, Turkmenistan, Russia, and Ukraine displayed non-stationary results, suggesting that they are not in the trap and are converging toward higher income levels. In addition, the radar chart, coefficient of variation, and three different Multi-Criteria Decision Analysis techniques (Equal Weight Score, Discrimination Weighted Score, and Entropy Weighted Score) were used for robustness check. The results of these tests appear to be consistent with the outcomes of the unit root tests.

Keywords: middle-income trap, unit roots, nonlinear unit roots, Fourier unit roots, post-Soviet Countries, MCDA methods.

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1. INTRODUCTION

In recent years, the concept of the "middle-income trap" has become a point of concern in economic studies. This growing focus is due to the significant role that middle-income countries play in the global economy. If any of these nations experience an economic downturn, it could have a widespread impact on the world economy. For this reason, most studies on the "middle-income trap" have concentrated on countries with a certain level of per capita income. Despite growing attention, economists have yet to reach consensus on a universally accepted definition of the "middle-income trap."

This concept is generally defined as the stagnation of per capita income at the middle-income level and the slowdown of growth after a phase of rapid economic expansion (Gill & Kharas, 2007). Gill and Kharas (2007) emphasized that some countries that have reached middle-income levels exhibit an inability to compete with low-income countries in terms of wages and fail to implement innovation-driven growth strategies to compete with high-income countries. As a result, they experience low growth performance, which leads them into the middle-income trap. In other words, the middle-income trap describes a situation where a country, after quickly reaching middle-income status, experiences slowed growth and fails to transition to a high-income level (Felipe et al., 2012; Aiyar et al., 2013; Tho, 2013). Indeed, while countries can quickly progress to middle-income status, they often encounter structural and economic challenges that prevent them from advancing to high-income levels (World Bank, 2013). This issue typically arises due to factors such as limited technological innovation, an underdeveloped education system, and weak institutional structures. As a result, these nations struggle to transition from an economy driven by low-cost labor and labor-intensive industries to one based on technology and high-value-added sectors (Robertson & Ye, 2013).

For the current 2025 fiscal year, countries with a gross national income (GNI) per capita between $1,146 and $14,005 are considered middle-income nations according to the World Bank. There is a two-way differentiation in such a group, with a lower middle-income countries with a GNI per capita between $1,146 and $4,515, and an upper middle-income countries with a GNI per capita between $4,516 and

$14,005 (World Bank, 2025). Considering the World Bank's classification, the middle-income trap refers to a slowdown in economic growth that typically occurs when a country's per capita income approaches the upper boundary of the middle-income category (set at $14,005) but fails to surpass this threshold. Many countries at this stage fail to implement the structural reforms necessary for progressing to higher levels of development. The World Bank's 2024 World Development Report states that middle-income countries must undergo two key transformations to achieve high-income status. First, rather than simply increasing investments, they must prioritize importing technology and integrating it into their local economies. The second phase requires shifting toward an innovation-driven economic model (World Bank, 2024a). According to the 2024 World Development Report, the chance for middle-income countries to become high-income countries is still relatively low. In 1990 and thereafter, only 34 countries have become high-income countries, having moved out of the stage of being a middle-income country, and such countries represent a small proportion of the population (World Bank, 2024a). The same is seen in post-Soviet nations, for instance, in Kazakhstan and in Russia, a slowdown in growth and a failure to diversify took place when per capita income reached about $10,000–$13,000 (World Bank, 2024a).

Post-Soviet countries underwent a lot of economic sufferings in transitioning from centrally planned economies to economies with a market orientation. Energy-dependent nations, such as Russia, Azerbaijan, and Kazakhstan, developed a lot of their economy in terms of exporting oil and natural gas. Nevertheless, a failure in terms of economic diversification in such countries heightened vulnerability to slipping into a middle-income trap. On the other hand, countries such as the Baltic nations, with quick reform in economies, shunned slipping into such a trap through processes of memberships in European Union. Most post-Soviet countries, during such a period, experienced growth in incomes through exporting energy. Nevertheless, such countries failed to diversify in terms of growth, and therefore, such a model could not stand in terms of long-run survival. Inability in terms of producing low-tech goods and a lack of a strong capacity for innovation could not enable such economies to enjoy long-run growth (Yeldan, 2014). Therefore, this affirms that post-Soviet countries represent a general case of a middle-income trap, according to definitions in the World Bank (World Bank, 2024a).

According to statistics in World Bank, a few post-Soviet countries have been stuck in a state of being a middle-income country for a long duration of years. For instance, Russia's per capita GDP reached $15,941 in 2013, but by 2023, it had declined to $13,817 (World Bank, 2024b). This decline was influenced by fluctuations in oil prices, economic sanctions, and a lack of structural reforms (IMF, 2023). Similarly, Kazakhstan's per capita GDP was approximately $13,478 in 2013, yet it remained at $12,918 in 2023 while Azerbaijan's GDP per capita was approximately $7,875 in 2013, but it had declined to $7,125 in 2023. Meanwhile, Ukraine's per capita GDP stood at $3,054 in 2013, but by 2023, it had only reached $5,069 (World Bank, 2024b).

Taking into account the above-mentioned factors, the main objective of this study will be to analyze the existence of a middle-income trap in the case of post-Soviet countries using the approach developed by Robertson and Ye (2013). To the best of our knowledge, no prior study has comprehensively assessed the presence of a middle-income trap across all post-Soviet countries within a unified empirical framework. In this context, the main contribution of our study is to analyze whether a middle-income trap exists in the case of all post-Soviet countries using various unit root tests within the framework of Robertson and Ye (2013) hypothesis. While previous studies have focused on select countries like the Baltic states, Kazakhstan, and Georgia, no prior research has collectively analyzed all post-Soviet countries within a single framework. The inclusion of all these countries provides a more complete understanding of their economic trajectories and growth dynamics. Secondly, two models were applied to enhance accuracy: the constant (C) model for countries like Moldova, Kyrgyzstan, Tajikistan, and Ukraine, where no clear trend was identified, and the constant and trend (C&T) model for all other countries. Advanced Fourier-based unit root tests, which account for structural breaks and nonlinear trends, provided more reliable

insights than traditional methods. Finally, by analyzing economic dynamics over more than three decades and following the Robertson and Ye (2013) approach, this study contributes to the literature on middle-income trap dynamics. It highlights the diverse growth trajectories of former Soviet Union states and offers policy recommendations for addressing growth challenges. The methodology serves as a valuable tool for assessing the middle-income trap in other regions undergoing similar economic transitions.

The subsequent section of the investigation is delineated as follows: Section 2 presents a literature review grounded on empirical research. Section 3 delineates the methodology and data. Section 4 presents the results from the empirical study. Section 5 delineates the discussions. Section 6 presents the conclusion and policy implications.

2. LITERATURE REVIEW

In recent years, numerous studies have explored whether middle-income countries are caught in the middle-income trap, the underlying causes, and possible strategies for escaping it. This section summarizes studies that examine the middle-income trap in the case of various countries.

Kharas and Kohli (2011) investigated the factors for countries' fall into the middle-income trap and the key channels for countries' escape out of it. According to the estimation results, instability in macroeconomics, weakness in production structure, weakness in institutions, and competitiveness issues have been determined to be key factors for countries' fall into the middle-income trap. Additionally, three main transformation strategies were proposed for Latin American and East Asian countries to overcome the middle-income trap.

Felipe et al. (2012) analyzed historical income transitions, durations, and growth rates of 124 countries over the period 1950–2010 by dividing them into four groups. In the study, countries were classified as follows: low-income (with per capita GDP below $2,000), lower-middle-income ($2,000–$7,250), upper-middle-income ($7,250–$11,750), and high-income (above $11,750). The analysis revealed that for countries to escape the lower-middle-income category, their per capita income must grow by at least 4.7% annually. Similarly, to escape the upper-middle-income trap, countries must have a minimum 3.5% annual per capita growth. It was determined that countries must transition out of the group of lower-middle incomes in a span not exceeding 28 years and out of the group of upper-middle incomes in a span not exceeding 14 years, otherwise, countries will fall into the middle-income trap.

Carnovale (2012), in a 10-year time span analysis of nations in five stages, identified nations with a per capita GDP above a certain threshold relative to U.S. GDP per capita to denote middle-income economies in an empirical study to identify the middle-income trap. This measure was later refined and used in new avenues in analysis by Woo (2012), who specifically formulated and suggested the application of a Catch-Up Index (CUI) in defining and determining nations in a situation of a middle-income trap. Various tests were conducted, and a variety of empirical findings followed. It was determined that the CUI is calculated as the ratio of a country's income level to that of the United States. The index, constructed for the period 1960–2008, classified countries as high-income countries (CUI value above 55%), middle-income countries (CUI between 20% and 55%), and low-income countries (CUI below 20%). According to CUI data, it was found that China became a middle-income country in 2007–2008.

Another study supporting the theory that the middle-income trap is a growth problem was conducted by Eichgreen et al. (2013). In a 1957–2007 analysis of 45 countries, Chow and Probit tests were conducted to evaluate the middle-income trap. In its analysis, according to the study, two incomes at which a country can fall into a trap have been determined: $10,000–$11,000 and $15,000–$16,000 per capita GDP. According to the study, an increase in the proportion of high-tech goods and human capital in exports ranked first in terms of efficiency in escaping the trap of a middle-income trap. Besides, a strong correlation between political regime (the democratization process) and a high probability of an

economic downturn, and, therefore, political stability in escaping a trap, was established in the study. Moreover, Robertson and Ye (2013) analyzed the middle-income trap via break and stochastic tests of structures. In its analysis, the study performed unit root tests such as Augmented Dickey-Fuller, Zivot-Andrews, Lumsdaine, and Papell in testing per capita GDP's series and in testing for the presence of the middle-income trap. In its conclusion, 46 countries out of 189 countries qualified as middle-income, and 23 out of them were trapped in the middle-income level.

Yeldan et al. (2012) examined the economy of Turkey in the framework of middle-income trap at a macro, regional, and sectoral level. The study used the growth accounting method to calculate total factor productivity (TFP). As a result of the analysis, Turkey was divided into three distinct regions in terms of the middle-income trap. Tho (2013) analyzed Indonesia, Malaysia, the Philippines, and Thailand's strategies for escaping the middle-income trap and becoming high-income nations. The results indicated that, a breakthrough out of the middle-income trap entails increased expenditure in terms of R&D, high-quality human development, comparative advantage improvement, and efficiency in economic institutions.

Studies conducted by Egawa (2013), Berliner (2013), and Lee and Li (2014) linked the middle-income trap to the Kuznets curve approach. From this perspective, if appropriate economic policies are not implemented to address income inequality in middle-income countries, inequality will continue to rise. The inevitable consequence of this would be a slowdown in economic growth. Additionally, Lee and Li (2014) argued that rising income inequality would increase demands for resource redistribution while simultaneously reducing investment incentives.

Koçak and Bulut (2014) investigated whether the Turkish economy is trapped in the middle-income trap using data period from 1950 t0 2010. The Lee and Strazicich (2003) and Carrion-i-Silvestre et al. (2009) unit root tests were applied. The key empirical finding of the study was that Turkey is not in the middle-income trap. Besides, Chen and Dai (2014) stated that some economists explain the middle-income trap from a technology-based perspective. According to this approach, less developed countries accelerate their growth processes in the early stages of development by imitating or transferring technology from abroad. However, once their economic development reaches a certain threshold, they must start producing innovation on their own. The researchers emphasized that countries that have previously relied on technology transfer from developed economies face a significant challenge in generating innovation, and in consequence, a key cause of the middle-income trap.

Aiyar et al. (2013) utilized Probit regression, Bayesian models, and Weighted Least Squares (WLS) methods to the data period from 1955 to 2009 in the case of 138 countries. The findings indicated that the scope of government regulation and the rule of law are crucial factors for low-income countries. Furthermore, the establishment and effective enforcement of a legal framework for property rights and contracts can have a significant impact on countries with very low-income levels, particularly during phases of economic growth slowdown.

Zhang et al. (2013) examined China's middle-income trap problem by focusing on education and human capital. The research used survey data from April to July 2010. The findings suggested that the transition to high-income status is highly dependent on skilled human capital. The study also identified income inequality and education as the two biggest challenges in China. Moreover, it highlighted that the movement from middle-income to high-income status is strongly linked to governance and the availability of highly skilled human capital.

Bulman et al. (2014) analyzed the middle-income trap using data from 130 countries for the period 1960–2009. POLS (Pooled OLS) was used in the research, and based on its results, education, industrialization, trade openness, and income inequality have a positive and significant role in economic growth in middle-income countries. In a study by Flaaen et al. (2013), data for India, Singapore, China, and Malaysia for 1982–2006 were analyzed. With a cross-country model, the study considered factors

including per capita GDP, goods and service proportion in merchandise exports, and communications technology factors.

Bozkurt et al. (2016) carried out a study that examined the probability of upper-middle-income nations falling into the middle-income trap and the socioeconomic determinants that can help them escape employing panel data analysis. Based on data from 1982 to 2012, the analysis revealed that 15 countries were approaching high-income status, while 13 countries remained distant from this transition. Furthermore, panel data analyses demonstrated that without structural reforms, even countries progressing toward high-income status may still fall into the middle-income trap. The study concluded that escaping the middle-income trap requires not only income growth but also structural transformation of the economy.

Glawe and Wagner (2020) examined the likelihood of China either being in or falling into the middle-income trap (MIT). They concluded that unless China's economic growth slows to around 3–4%, it is unlikely to become trapped. The most critical factors influencing MIT include human capital, the structure of exports, and total factor productivity (TFP). Bresser-Pereira et al. (2020) determined that between 1980 and 2016, Latin American countries did not experience a middle-income trap but instead became caught in a liberalization trap. Lee (2020) analyzed the economic growth patterns of middle-income economies over the past 50 years, emphasizing instances of successful convergence and the middle-income trap. Examining a sample of 110 economies with available GDP data from 1960 to 2014, the study identified 14 middle-income countries that advanced to high-income status, nine that exhibited strong growth and were classified as convergence successes, and 52 that failed to achieve significant convergence. Islam et al. (2023) explored whether Bangladesh can overcome both the lower-middle-income and upper-middle-income traps. The study applied the "Number of Years Method," a time threshold approach, to evaluate this possibility. The findings suggest that if Bangladesh maintains a per capita Gross National Income (GNI) growth rate of 9.69%, it is expected to escape the lower-middle-income trap by 2029 and the upper-middle-income trap by 2041.

3. METHODOLOGY

The analysis of the middle-income trap in this study follows the Robertson and Ye (2013) approach, where the relative income ratio is expressed as:

$$Y_t = ln\left(\frac{GDP\ Per\ Capita_{Country}}{GDP\ Per\ Capita_{USA}}\right)$$

Here, Y_t represents the natural logarithm of the ratio of a country's per capita GDP to that of the United States at time t. This transformation ensures proportional scaling and focuses on relative differences, making the series suitable for time series analysis. The stationarity of $Y_t$is tested using unit root methods to determine whether a country is in the middle-income trap. A stationary series (Y_t) indicates no convergence toward the United States' income levels and confirms the presence of the trap, while a non-stationary series suggests convergence and the absence of the trap. According to this approach, if a country's per capita income ratio relative to the US is stationary over time — that is, if the basic properties of the series such as mean, variance and covariance remain constant (i.e. the weak stationarity condition is satisfied) — then the relative position of the country remains unchanged and is considered to be non-convergent to the high-income group. Such stationarity is interpreted as empirical evidence that the country is caught in a middle-income trap, reflecting a lack of convergence with high-income benchmarks. It should be noted that stationarity in this instance refers to income stagnation in comparison to the US, not macroeconomic stability. On the other hand, if the series is non-stationary (i.e.,

the weak stationarity condition is not satisfied), i.e., these statistical properties change over time, then the country's income level is converging to that of the United States and it is concluded that it is not in the middle income trap.

To evaluate stationarity, this study employs a wide range of unit root tests, including traditional tests such as the Augmented Dickey–Fuller test (ADF-Dickey and Fuller, 1981), nonlinear tests Kapetanios, Shin, Snell (KSS-Kapetanios et al., 2003), Kruse (2011), Sollis (2009), and Fourier-based ADF test (FADF-Christopoulos and León-Ledesma, 2010), Flexible Fourier-ADF (FFADF-Enders and Lee, 2012), Fourier KPSS (FKPSS-Becker et al., 2006), Fourier KSS (FKSS-Christopoulos and León-Ledesma, 2010), Fourier Kruse (FKruse-Güriş, 2019), Fourier Sollis (FSollis-Ranjbar et al., 2018). Traditional tests like ADF are foundational for stationarity analysis but assume linearity and lack the ability to account for structural breaks or nonlinear trends. As a result, they may fail to capture the complex dynamics of transitioning economies. Nonlinear tests (KSS, Kruse, Sollis) overcome these limitations by modeling asymmetries and smooth transitions, reflecting the effects of policy changes and external shocks. Fourier-based tests further extend the analysis by incorporating Fourier transformations, which detect structural breaks and nonlinearities without requiring prior knowledge of their timing or nature. This allows for a more robust and comprehensive evaluation, particularly in long-term analyses with potential shifts in economic growth trajectories.

The combination of these methods ensures that the limitations of traditional approaches are addressed, providing deeper insights into the growth patterns and convergence dynamics of the countries analyzed. By integrating nonlinear and Fourier-based methods, this study enhances the reliability and accuracy of middle-income trap assessments, making it a valuable contribution to the literature on economic growth and development.

To ensure consistency in the classification of stationarity, we adopted what we refer to as a "dominant test result" approach. Specifically, each country's relative income series was evaluated using ten different unit root tests, covering traditional, nonlinear, and Fourier-based methods. If the majority of these tests indicated that the series was stationary, it was classified as such; conversely, if most tests suggested non-stationarity, the series was treated accordingly. For instance, if six out of ten tests pointed to stationarity and four did not, the series was considered stationary. This rule-based approach is clearly outlined in both the Methodology and Discussion sections of the study. Importantly, we did not treat all tests equally in terms of reliability. In cases where test results conflicted, Fourier-based methods—known for capturing structural breaks and nonlinear patterns without requiring prior information—were given greater weight in interpretation. This decision-making process offers a holistic and transparent framework, balancing methodological diversity with analytical rigor. It also aligns with recent empirical practices, as seen in studies such as Celik et al. (2023), Çelik et al. (2022), and Kızılkaya & Dağ (2021), which have employed similar majority-rule criteria for stationarity assessment.

Furthermore, the assessment of middle-income trap risk was conducted using three distinct Multi-Criteria Decision Analysis (MCDA) techniques: the Equal Weighting Method, the Discriminatory Weighting Method, and the Entropy-Based Weighting Method, each incorporating different weighting schemes to aggregate multiple indicators into a composite risk score. Each of them approaches the results obtained from stationarity tests from a different methodological perspective and provides a multidimensional contribution to the decision process. The Equal Weight Score method provides a simple and transparent risk indicator by averaging the tests for each country under the assumption that the tests are equally effective. This method provides a basic reference for initial assessment and observation of general trends (Booysen, 2002). The Discrimination Weighted Score method evaluates each test with different weights based on its capacity to discriminate the middle income trap. The coefficients obtained through logistic regression analysis represent the "discrimination power" of the tests, and the test results are weighted according to these coefficients. This approach aims to improve the methodological quality of

the stationarity signal, taking into account the scientific reliability of the tests. Thus, the data included in the decision is not only quantitatively but also qualitatively filtered (Hand, 1981). On the other hand, the Entropy Weighted Score method determines the contribution of each test by measuring its statistical information content. These values, calculated with the Shannon entropy formula, reveal how much discriminatory power the tests have between countries. Tests with high information content receive higher weights in the analysis because they make more balanced and variable decisions. This method stands out because it provides a data-driven, unbiased assessment (Hainmueller, 2012).

Using all three methods together allows for a more holistic assessment, taking into account both the reliability, diversity and general tendency of the test results, without relying on a single approach in the decision-making process. This increases the robustness of middle income trap analyses and minimizes the uncertainties arising from methodological diversity in the classification of countries.

4. DATA

We used annual GDP per capita data spanning the years 1990–2023, constrained by data availability, for the 12 post-Soviet countries (Azerbaijan, Armenia, Georgia, Belarus, Moldova, Ukraine, Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, Russian Federation, Uzbekistan). Our study excludes the Baltic countries (Latvia, Lithuania, and Estonia) since they have already transitioned to high-income status, according to the World Bank classification (World Bank Blogs, 2025), and therefore fall outside the scope of middle-income trap analysis. However, long-term growth, competitiveness, and labour market trends remain a source of concern for them. Integration with the European Union, economic diversification, and high human capital have helped them become high-income economies, and they can serve as a model for successful post-Soviet transition economies.

This methodological framework sets the foundation for our empirical investigation. In the following section, we introduce the variables employed in our analysis and explain how they relate to the convergence dynamics discussed above. The variables utilized in our analysis are detailed in Table 1 below. Moreover, the graphs of the used variables are depicted in Appendix, Figure 1.

Table 1

Definition of variable

Variable	Definition	Unit	Period	Source
GDPPC_i	Gross Domestic Product of Per Capita for i.th country	GDP per capita (constant 2015 US$)	1990-2023	World Bank, World Development Indicators
LnY_i	$\frac{GDP\ Per\ Capita_{Country}}{GDP\ Per\ Capita_{USA}}\ of\ i.th\ country$	Ratio	1990-2023	Authors' caltulations

The descriptive statistics of used variable are given in Table 2.

Table 2

Descriptive statistics

Country	Mean	Median	Min	Max	St.dev	JB	Prob
ARM	2605.9	2723.2	791.65	5566.3	1396.8	2.1303	0.3447
AZE	3539.8	3914.1	1102.5	5674.5	1796.3	4.4781	0.1066
BLR	4333.3	4489.6	1886.5	6482.8	1706.0	4.1759	0.1239
GEO	2970.0	2889.2	966.42	6086.4	1467.6	2.0266	0.3601
KAZ	7652.9	8137.9	3700.8	11700	2861.5	3.5556	0.1690
KYR	940.38	966.28	587.31	1263.9	207.64	2.5734	0.2762
MOL	2355.3	2239.2	1316.4	3755.2	788.65	2.5013	0.2863
RF	7701.8	8165.9	4515.5	10421	1971.8	3.4374	0.1793
TJK	804.90	757.51	371.83	1441.3	318.83	2.2089	0.3314
TKM	4260.7	3407.5	1799.6	8906.4	2240.3	3.9201	0.1406
UA	2116.6	2211.1	1317.7	3112.0	461.87	1.0516	0.5911
UZB	2022.9	1721.9	1140.4	3604.1	805.30	3.5949	0.1657

Table 2 presents the descriptive statistics of per capita Gross Domestic Product (GDPPC) values for 12 different countries between 1990 and 2023. This table helps compare the economic performance of these countries and understand how they have changed over the years. In particular, the mean and median values provide a general idea of the income levels of the countries, while the minimum (Min) and maximum (Max) values reflect the economic fluctuations experienced over time. The standard deviation (St.dev) is useful for assessing economic stability, while the Jarque-Bera (JB) statistic and probability (Prob) values indicate the extent to which the series comply with the normality assumption.

Firstly, when examining the average GDPPC values, Kazakhstan (7652.9) and the Russian Federation (7701.8) have the highest levels, whereas Tajikistan (804.90) and Kyrgyzstan (940.38) have the lowest averages. This indicates that Kazakhstan and Russia have stronger economic structures, while countries like Tajikistan and Kyrgyzstan have lower income levels. The median values also provide insights into income distribution among countries. For example, while Turkmenistan's average GDPPC is 4260.7, its median value is 3407.5; this difference suggests that GDPPC significantly increased in certain years, indicating a right-skewed distribution in the dataset.

When examining the minimum and maximum values, some countries show a wide range of GDPPC values. Particularly in countries like Turkmenistan (1799.6 - 8906.4) and Kazakhstan (3700.8 - 11700), substantial fluctuations indicate the effects of economic growth and crises. On the other hand, in countries such as Kyrgyzstan (587.31 - 1263.9) and Ukraine (1317.7 - 3112.0), GDPPC has varied within a narrower range, suggesting either greater economic stability or sustained low growth rates.

The standard deviation (St.dev) values reveal income volatility among countries. Kazakhstan (2861.5) and Turkmenistan (2240.3) have the highest standard deviations, indicating that their GDPPC values have experienced significant fluctuations over the years. In contrast, countries like Kyrgyzstan (207.64) and Ukraine (461.87) have lower standard deviations, suggesting that their GDPPC values have been relatively less volatile over time.

Jarque-Bera (JB) statistics and probability (Prob) values are used to test whether GDPPC distributions adhere to the normality assumption. For most countries, the probability values are greater than 0.05, indicating that the GDPPC series largely conform to the normal distribution assumption. However, deviations from normality can be observed in countries such as Azerbaijan (JB=4.4781, Prob=0.1066) and Turkmenistan (JB=3.9201, Prob=0.1406). This suggests that these countries may have experienced economic shocks or unusual growth/contraction events during certain periods.

Overall, GDPPC values show significant differences across countries, and these variations are influenced by factors such as economic structures, access to natural resources, political stability, and global economic dynamics. While Kazakhstan and the Russian Federation stand out with high GDPPC levels, countries like Tajikistan and Kyrgyzstan have the lowest GDPPC values. In terms of standard deviation,

Turkmenistan and Kazakhstan have been the most exposed to economic fluctuations, whereas countries like Ukraine and Kyrgyzstan have followed a more stable trend. Although GDPPC series generally align with a normal distribution, deviations from normality have been identified in certain countries. These findings indicate that countries exhibit different dynamics in their economic development processes, and some may be more vulnerable to economic instability.

5. EMPIRICAL RESULTS

This section presents the analysis and the findings obtained from the tests mentioned in the methodology section. The existence of middle-income trap has been analyzed within the framework of the Robertson and Ye (2013) approach. For this purpose, the stationarity of per capita GDP levels in the post-Soviet countries has been assessed using the ADF and Fourier-ADF (FADF) tests. The results of both tests are given in Table 3. In addition, we tested the linearity of the series with the Harvey and Leybourne (2007) and Harvey et, al (2008) tests before starting the unit root analysis and the results are presented in Appendix, Table 1. Harvey (2007) should be compared with the chi-square critical value with 4 degrees of freedom, while Harvey et, al (2008) should be compared with the chi-square critical value with 2 degrees of freedom. According to the linearity test results for all countries, the series are non-linear (see Appendix, Table 1). For this reason, we used non-linear and Fourier-based unit root tests in the analysis. In the trend analyses conducted for Moldova, Kyrgyzstan, Tajikistan, and Ukraine, no trend was detected; therefore, only the model with a constant term (C) was considered for these countries (see Appendix, Table 2). For other countries, the model with both a constant and a trend (C&T) was used as the basis.

Table 3

Results of ADF and Fourier ADF

	ADF		FADF					
	C	C&T	C			C&T		
Country	Test stat	Test stat	k	taudfc	F	k	taudft	F
ARM		-5.1518***				1	-7.3075***	16.368***
AZE		-4.8275***				1	-3.7720	13.322***
BLR		-2.7589				1	-2.9011	9.1732***
GEO		-6.5693***				1	-18.609***	15.073***
KAZ		-3.0538				1	-2.1110	3.2980
KYR	-3.5415**		1	-5.9009***	9.2062***			
MOL	-2.8922*		1	-5.2998***	18.378***			
RF		-4.0066**				1	-1.9729	11.242***
TJK	-1.5223		1	-4.7532***	8.3190***			
TKM		-4.6099***				1	-2.0368	4.9376*
UA	-3.1406**		1	-3.0073	6.5626**			
UZB		-6.1356***				1	-3.4027	13.884***

***, ** and * indicate that the null hypothesis is rejected at 1%, 5% and 10% significance level, respectively. The critical values for the equation with constant and trend are obtained from Hepsağ(2022), since the critical values of the Fourier ADF test are generated only for the equation with constant (see Appendix, Table 3).

As a result of the stationarity tests conducted, significant findings have been obtained regarding whether the 12 post-Soviet countries are in the middle-income trap. According to unit root theory, when there is a contradiction between the ADF and FADF tests, the results of the FADF test are considered valid. Within this framework, it is confirmed that Armenia, Georgia, Kyrgyzstan, Moldova, and Tajikistan are in the middle-income trap, as their data are stationary according to both the ADF and FADF tests. On the other hand, for Belarus, Azerbaijan, Russia, Turkmenistan, Ukraine, and Uzbekistan, the FADF test indicates that their data are not stationary. Therefore, it can be concluded that these countries are not in

the middle-income trap. However, for Kazakhstan, the FADF test yielded inconclusive outcomes, possibly due to data irregularities or structural breaks not captured adequately by the test.

Table 4

Results of KSS and Fourier KSS

	KSS		FKSS					
	C	C&T	C			C&T		
Country	Test stat	Test stat	k	taudfc	F	k	taudft	F
ARM		-12.082***				1	-10.606***	11.183***
AZE		-6.8357***				1	-6.7914***	48.628***
BLR		-4.8911***				1	-4.5918**	63.615***
GEO		-14.813***				1	-9.3772***	13.781***
KAZ		-2.5843				1	-2.7129	48.947***
KYR	-3.3247**		1	-2.5430	13.929***			
MOL	-3.4729**		1	-4.7206***	33.946***			
RF		-4.6043***				1	-2.1965	36.311***
TJK	-5.6610***	-	1	-7.4986***	33.975***			
TKM		-3.5624**				1	-2.9730	141.57***
UA	-2.3119		2	-1.9258	13.821***			
UZB		-6.8469***				1	-3.8067	153.01***

***, ** and * indicate that the null hypothesis is rejected at 1%, 5% and 10% significance level, respectively.

As can be seen from Table 4, the unit root tests conducted for post-Soviet countries revealed that these countries exhibit different trends in terms of income levels. According to the KSS test results, all countries except Kazakhstan and Ukraine were found to be stationary. This suggests that these countries are stuck in the middle-income trap. In contrast, the non-stationary results for Kazakhstan and Ukraine indicate that these countries may be converging toward the U.S. income level or are not in the middle-income trap.

However, the FKSS test results present a different picture for some countries. According to FKSS, Kazakhstan, Kyrgyzstan, the Russian Federation, Turkmenistan, Ukraine, and Uzbekistan are non-stationary. This suggests that these countries are not in the middle-income trap or have the potential to progress toward a higher income level. When the KSS and FKSS tests yield conflicting results, the FKSS test is considered more reliable. In this context, instead of the middle-income trap hypothesis suggested by the KSS test, it is more plausible to interpret that Kyrgyzstan, the Russian Federation, Turkmenistan, and Uzbekistan are converging toward higher income levels.

Table 5

Results of Kruse and Fourier Kruse

	Kruse		FKruse					
	C	C&T	C			C&T		
Country	Test stat	Test stat	k	taudfc	F	k	taudft	F
ARM		155.54***				1	111.79***	11.183***
AZE		49.650***				1	45.162***	48.628***
BLR		23.126***				1	23.098**	63.615***
GEO		229.48***				1	170.36***	13.781***
KAZ		6.7961				1	7.8379	48.947***
KYR	10.992**		3	13.530**	16.981***			
MOL	17.084***		3	20.079***	35.849***			
RF		23.324***				1	4.6947	36.311***
TJK	39.398***		3	53.177***	34.081***			
TKM		12.599*				1	10.107	141.57***
UA	5.6098		5	3.7078	22.202			
UZB		48.113***				1	14.039	153.01***

***, ** and * indicate that the null hypothesis is rejected at 1%, 5% and 10% significance level, respectively.

As can be seen from Table 5, The Kruse unit root tests revealed that Armenia, Azerbaijan, Belarus, Georgia, Kyrgyzstan, Moldova, the Russian Federation, Tajikistan, Turkmenistan, and Uzbekistan were found to be stationary. This finding suggests that these countries are trapped in the middle-income trap. On the other hand, the non-stationary results for Kazakhstan and Ukraine indicate that these countries may be converging toward the U.S. income level or are not in the middle-income trap.

However, the results of the FKruse test show that the Russian Federation, Turkmenistan, and Uzbekistan are non-stationary. In this case, the middle-income trap hypothesis does not apply to Russia, Turkmenistan, and Uzbekistan, and it can be interpreted that these countries have the potential to progress toward higher income levels.

In addition, the Sollis and Fourier Sollis (FSollis) unit root tests were applied, and the results are presented in Table 6. The Sollis unit root tests indicated that these countries exhibit different trends in terms of economic growth and income levels. According to the Sollis test, Armenia, Azerbaijan, Belarus, Georgia, Kyrgyzstan, Moldova, the Russian Federation, Tajikistan, Turkmenistan, and Uzbekistan were found to be stationary. This suggests that these countries may be trapped in the middle-income trap. On the other hand, the non-stationary results for Kazakhstan and Ukraine indicate that these countries may be converging toward the U.S. income level or are not in the middle-income trap.

Based on the results presented in Table 6, the FSollis test, which provides a broader perspective, presents different results for some countries. According to the FSollis test, Kazakhstan, Kyrgyzstan, the Russian Federation, Turkmenistan, Ukraine, and Uzbekistan are non-stationary. This finding suggests that these countries are not in the middle-income trap or have the potential to progress toward a higher income level. In cases where the Sollis and FSollis tests yield conflicting results, the FSollis test is considered more reliable. Therefore, for Kyrgyzstan, the Russian Federation, Turkmenistan, and Uzbekistan, the middle-income trap hypothesis does not hold, making it more plausible to conclude that these countries are moving toward higher income levels.

Table 6

Results of Sollis and Fourier Sollis

	Sollis		FSollis					
	C	C&T	C			C&T		
Country	Test stat	Test stat	k	Test stat	F	k	Test stat	F
ARM		76.827***				1	60.054***	11.183***
AZE		25.036***				1	23.447***	48.628***
BLR		11.379***				1	11.493***	63.615***
GEO		117.03***				1	98.334***	13.781***
KAZ		4.0099				1	4.1363	48.947***
KYR	6.1951**		1	6.0444	13.929***			
MOL	7.8837***		1	11.541***	33.946***			
RF		10.677***				1	2.4546	36.311***
TJK	22.994***		1	27.863***	33.975***			
TKM		5.9123*				1	5.1741	141.57***
UA	2.3605		2	1.8025	13.821***			
UZB		23.813***				1	7.8758	153.01***

***, ** and * indicate that the null hypothesis is rejected at 1%, 5% and 10% significance level, respectively.

Finally, the FKPSS and FFADF unit root tests conducted for post-Soviet countries. The findings of tests are presented in Table 7. According to the FKPSS test, only Ukraine was found to be stationary, suggesting that it is trapped in the middle-income trap. In contrast, Armenia, Azerbaijan, Belarus, Georgia, Kazakhstan, Kyrgyzstan, Moldova, the Russian Federation, Turkmenistan, Tajikistan, and Uzbekistan were found to be non-stationary. This implies that these countries are not in the middle-income trap or may be converging toward the U.S. income level.

Table 7

Results of Fourier KPSS and Flexible Fourier ADF

	FKPSS						FFADF					
	C			C&T			C			C&T		
Country	k	Test stat	F	k	Test stat	F	k	Test stat	F	k	Test stat	F
ARM				1	0.082***	11.18***				1	-7.307***	16.37***
AZE				1	0.083***	48.63***				1	-3.772*	13.32***
BLR				1	0.089***	63.62***				1	-2.921	9.173***
GEO				1	0.091***	13.78***				1	-18.61***	15.07***
KAZ				1	0.082***	48.95***				1	-2.111	3.298
KYR	1	0.281***	13.93***				1	-5.901***	9.206***			
MOL	1	0.202**	33.95***				1	-5.300***	18.38***			
RF				1	0.081***	36.31***				1	-1.973	11.24***
TJK	1	0.166*	33.98***				1	-4.753**	8.319***			
TKM				1	0.098***	141.6***				1	-2.037	4.938*
UA	2	0.118	13.82				1	-3.007	6.563**			
UZB				1	0.093***	153.0***				1	-3.403	13.88***

***, ** and * indicate that the null hypothesis is rejected at 1%, 5% and 10% significance level, respectively.

According to the FFADF test, Armenia, Azerbaijan, Georgia, Kyrgyzstan, Moldova, and Tajikistan were found to be stationary, indicating that these countries are in the middle-income trap. On the other hand, Belarus, the Russian Federation, Ukraine, Turkmenistan, and Uzbekistan were found to be non-stationary. These countries may be converging toward higher income levels or may not be in the middle-income trap. Since the FFADF test results for Kazakhstan were invalid, it is not possible to draw a definitive conclusion for this country.

When comparing the results, the FKPSS test is considered more reliable, leading to the conclusion that Kazakhstan is not in the middle-income trap. Overall, Ukraine appears to be in the middle-income trap, while Belarus, the Russian Federation, Turkmenistan, and Uzbekistan are among the countries showing a tendency to increase their income levels. Meanwhile, countries such as Armenia, Azerbaijan, Georgia, Kyrgyzstan, Moldova, and Tajikistan continue to remain in the middle-income trap.

These findings indicate that there is a heterogeneous structure in terms of income levels among post-Soviet countries and that some of these countries have the potential to move up in the global income hierarchy in the long run.

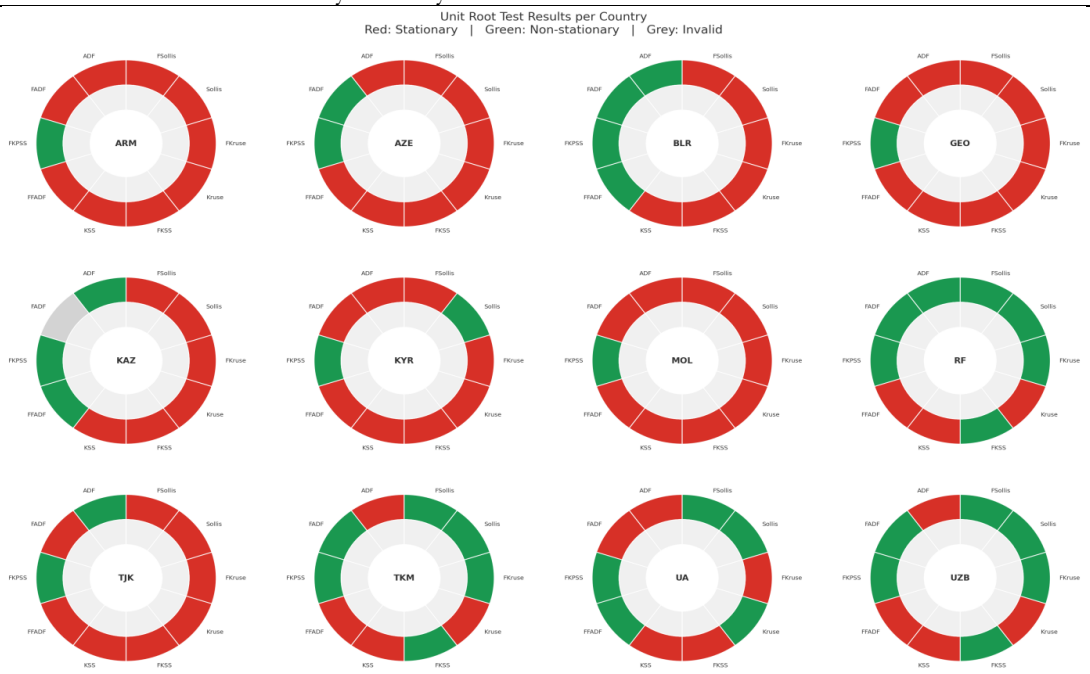
6. DISCUSSION

Ten different unit root tests have been applied to analyze the presence of the middle-income trap in post-Soviet countries. These tests help uncover the dynamics of economic growth and the evolution of income levels in these economies. The outcomes provide important insights into whether these countries are likely to be trapped in the middle-income range. In this analysis, countries have been classified as Stationary or Non-stationary based on the dominant rule, which refers to the majority outcome across ten different unit root tests. Rather than presenting the test outcomes in a traditional tabular format, the complete set of results is visualized through two-level donut charts, offering a clear and intuitive representation for each country. Furthermore, to support the scoring methodology, the results of the three weighting approaches—Equal Weight, Discrimination Weighted, and Entropy Weighted—are presented as a heatmap. These visualizations are provided in Figure 1, Panel A (donut charts) and Panel B (scoring heatmap).

According to the unit root tests results, Armenia, Azerbaijan, Belarus, Georgia, Kyrgyzstan, Moldova, and Tajikistan have been identified as stationary. The fact that the majority of these countries were found to be stationary in the tests. It can be concluded that they are trapped in the middle-income trap. The

middle-income trap is defined as the inability of countries to transition to the high-income group after reaching a certain level of economic growth. The main reasons for these countries remaining in the middle-income trap include a lack of industrial diversification, dependence on low-tech production, weaknesses in the investment environment, and low productivity. In particular, countries such as Armenia, Azerbaijan, Georgia, and Moldova rely heavily on foreign trade and investments in specific sectors (such as agriculture and energy) for economic growth. The underdevelopment of industrial policies has limited the economic progress of these countries.

Panel A: Unit Root Test Results by Country



Panel B: Middle-Income Trap Risk Score by Country

Country	Equal Weight Score	Discrimination Weighted	Entropy Weighted	MCDA Results
Armenia	0.9	1.9	7	Strong
Georgia	0.9	1.9	7	Strong
Moldova	0.9	1.9	7	Strong
Kyrgyzstan	0.8	1.8	6	Strong
Azerbaijan	0.8	1.7	6	Strong
Tajikistan	0.8	1.6	6	Strong
Belarus	0.6	1.1	4.2	Moderate
Ukraine	0.5	1.3	3.8	Moderate
Uzbekistan	0.4	0.97	2.2	Weak
Russia	0.3	0.65	1.2	Weak
Turkmenistan	0.3	0.65	1.2	Weak
Kazakhstan	0.2	0.36	0.41	Weak

Figure 1. Stationarity-based classification and risk scoring of post-soviet countries

Source: Authors' caltulations

Additionally, Belarus and Tajikistan also appear to be stuck in the middle-income trap. Although Belarus has a strong industrial base, it has not fully implemented institutional reforms to sustain economic growth. Tajikistan, despite having a low income level, has been classified as stationary in most tests, placing it among the countries at risk of falling into the middle-income trap. In general, the main reasons for these countries being in the middle-income trap can be attributed to dependence on natural resources, low levels of innovation and technology, deficiencies in human capital, and institutional weaknesses. To accelerate their growth processes, these countries need to implement reforms that attract foreign direct investment, enhance productivity, and prioritize industrialization. Furthermore, investing in innovation and digital transformation to develop high-value-added sectors will play a critical role in escaping the middle-income trap.

On the other hand, Kazakhstan, the Russian Federation, Turkmenistan, Ukraine, and Uzbekistan have been identified as non-stationary. It can be interpreted that they are not in the middle-income trap or are tending to converge toward the U.S. income level. Kazakhstan was classified as non-stationary in most tests, and its overall result was also determined as non-stationary. This indicates that the country has been making progress in terms of economic growth and income level. Kazakhstan's rich natural resources, economic reforms, and ability to attract foreign investments are among the key factors that distance it from the middle-income trap. However, its heavy dependence on the energy sector poses a risk to sustainable growth. Expanding its industrial structure and increasing investments in the services sector could further enhance its income level. Besides, the Russian Federation, despite showing mixed results in different tests, was generally found to be non-stationary. This suggests that the country has the capacity to sustain its economic growth. However, Russia's economic growth is highly dependent on energy exports, making it vulnerable to sanctions and global economic fluctuations. To avoid the middle-income trap in the long run, the country needs to focus more on innovation and industrial transformation. Ukraine was found to be non-stationary in most tests, placing it among the countries that are not in the middle-income trap. Ukraine's economic integration process with the European Union and the implementation of certain reforms have created a favorable environment for economic growth. However, geopolitical risks and political instability pose uncertainties for sustainable long-term growth. Turkmenistan and Uzbekistan were also identified as non-stationary. These countries have demonstrated growth primarily driven by energy and natural resource revenues. However, their economic structures need to be diversified. The development of the industrial and services sectors could facilitate their transition to the high-income group in the long run.

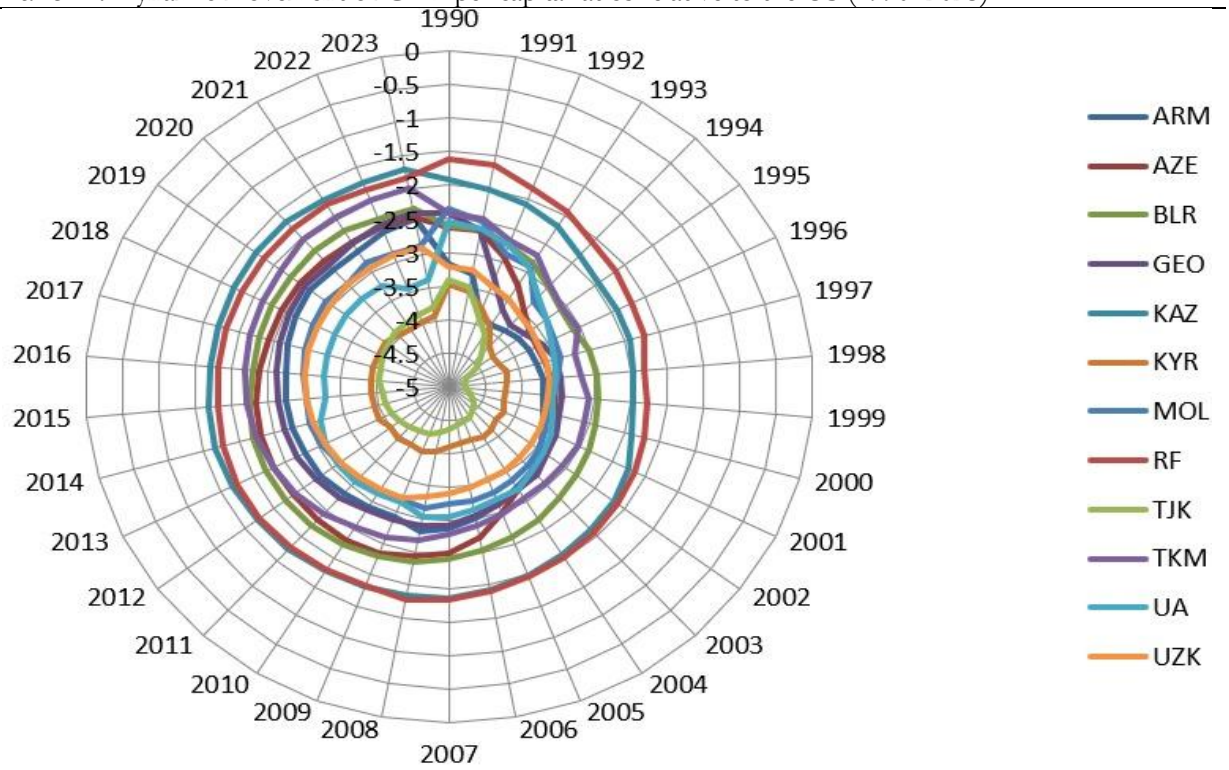
Although Kyrgyzstan and Belarus were identified as stationary in the tests, some economic indicators suggest that these countries are at high risk of being trapped in the middle-income trap. In particular, despite having a strong industrial base, Belarus has failed to implement the necessary reforms to sustain its economic growth. Kyrgyzstan, on the other hand, is largely dependent on foreign aid, and its growth potential is limited due to a lack of economic diversification.

Overall, the economic growth dynamics of post-Soviet countries follow different paths, with some countries being trapped in the middle-income trap while others have the potential to surpass this threshold. For countries identified as being in the middle-income trap, structural reforms are essential; otherwise, economic growth will not be sustainable. On the other hand, for countries not in the middle-income trap, establishing long-term policies is a critical necessity to ensure the continuity of economic growth (Gasimov et al., 2023; Jabiyev et al., 2022).

In addition, a radar chart was used to support the results of the unit root tests, and the results are presented in Figure 2, Panel A. The unit root test results and the radar chart provide two different approaches to analyzing the economic growth dynamics of post-Soviet countries. While unit root tests determine whether a country's income series is stationary, analyzing how income levels will evolve in the long run, the radar chart visualizes economic variability over time, highlighting the growth dynamics of

different countries. Both analytical methods offer important insights into whether countries are trapped in the middle-income trap.

Panel A: Dynamic movement of GDP per capita ratios relative to the US (1990–2023)



Panel B: Coefficient of Variation of GDP per capita series by country

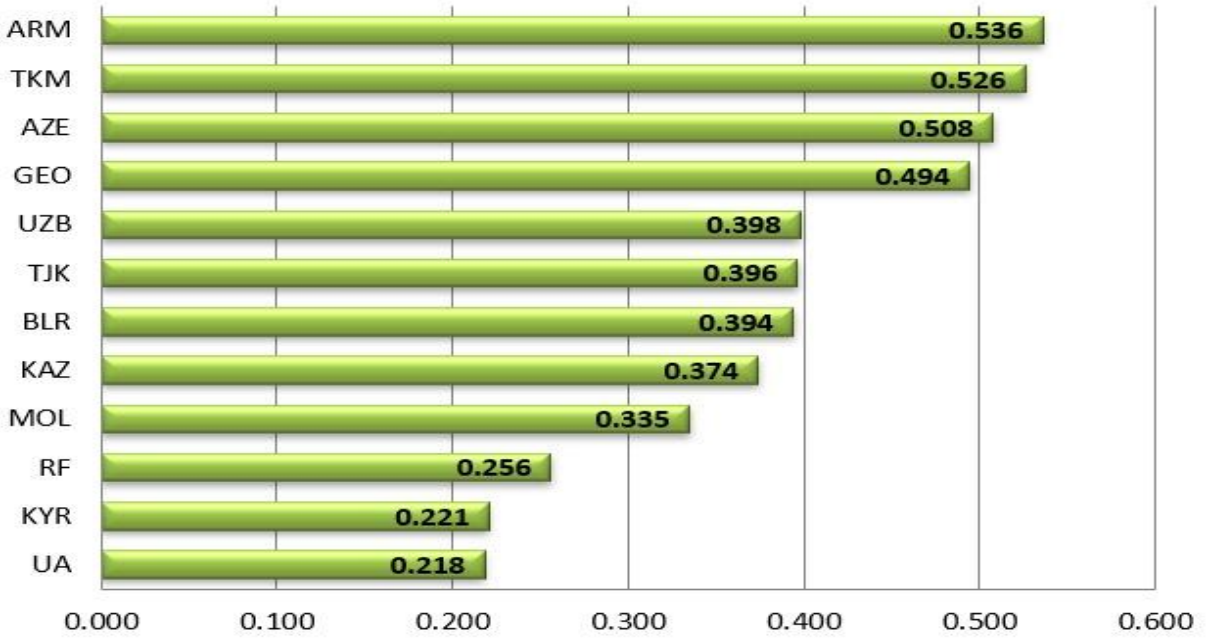


Figure 2. Relative Income Dynamics and Variation in Post-Soviet Countries

Source: Authors' caltulations

The radar chart illustrates the economic growth trends of countries over time. Countries identified as stationary in unit root tests generally exhibit limited variations in their growth rates, while non-stationary countries display greater fluctuations in their growth dynamics. According to the unit root tests, Armenia, Azerbaijan, Georgia, Kyrgyzstan, Moldova, and Tajikistan were classified as stationary. The radar chart shows that these countries exhibit more stable growth trends with limited economic fluctuations. This suggests that countries in the middle-income trap tend to experience slower growth after reaching a certain income level, without significant fluctuations.

On the other hand, countries such as Kazakhstan and Ukraine were identified as non-stationary in unit root tests and exhibit a wider distribution in the radar chart. These countries demonstrate a more dynamic economic growth structure, experiencing significant fluctuations over time. Notably, Kazakhstan and Russia Federation's economic data distinctly diverge from those of other countries in the radar chart, with growth rates following different trends over different periods. This finding aligns with the unit root test results, reinforcing that Kazakhstan and Russia Federation are not in the middle-income trap and continues its growth trajectory. Although unit root tests and the radar chart generally align in terms of overall trends, there are significant differences for some countries. For instance, while unit root tests indicate that Belarus and Tajikistan are stationary, the radar chart suggests the presence of economic fluctuations. Despite Belarus and Tajikistan exhibit considerable income fluctuations, unit root tests suggest stationarity, implying a persistent income stagnation in the long run. Overall, the general results from the unit root tests are largely consistent with the radar chart findings. Countries identified as stationary tend to be more compressed inward in the radar chart, exhibiting limited growth tendencies. In contrast, non-stationary countries display greater economic variability and more dynamic growth patterns over time.

In conclusion, although the radar chart does not directly provide information on the middle-income trap, it serves as an important complementary tool for analyzing growth stability and income fluctuations. When used alongside unit root tests, it enables a more comprehensive assessment of economic growth trends, leading to a deeper understanding of whether countries are in the middle-income trap.

Additionally, the coefficient of variation (CV) measures the level of economic fluctuations, providing insights into the stability of economic growth. The results of the coefficient of variation are presented in Figure 2, Panel B. In this study, the coefficient of variation results were compared with the unit root test findings to evaluate the relationship between economic stability and the middle-income trap.

According to the unit root test results, countries classified as stationary are considered to be in the middle-income trap, while non-stationary countries are either converging toward the U.S. income level or are not in the middle-income trap. Analyzing the coefficient of variation (CV), it is observed that countries with high CV values are largely stationary, while those with low CV values tend to be non-stationary. For example, Armenia (0.536), Turkmenistan (0.526), Azerbaijan (0.508), and Georgia (0.494) are among the countries with the highest CV values. These countries have also been identified as being in the middle-income trap according to unit root tests. In other words, these countries, which experience high income fluctuations, struggle to sustain economic growth and appear to be stuck at the middle-income level.

On the other hand, the lowest CV values belong to countries such as Kyrgyzstan (0.221), Ukraine (0.218), and Russia (0.256). Compared to unit root tests, Ukraine and Russia are classified as non-stationary, consistent with its low CV value. Similarly, Kazakhstan's CV value (0.374) is relatively low compared to other countries, and it has also been classified as non-stationary in unit root tests. This data suggests that lower CV values are generally associated with a tendency toward being non-stationary.

It is difficult to claim that the coefficient of variation alone is a definitive determinant of the middle-income trap. However, in general, countries with high CV values are more likely to be in the middle-income trap, while those with low CV values tend to show income convergence. Economic growth

stability is an important indicator for exiting the middle income trap, but other factors such as structural reforms, investment climate and industrialization processes also play an important role.

In conclusion, while the coefficient of variation is a significant indicator for measuring economic stability and growth fluctuations, it does not perfectly align with the middle-income trap. However, when analyzed alongside unit root tests, it provides a more comprehensive understanding of the long-term income trends of countries.

7. CONCLUSION AND POLICY RECOMMENDATIONS

This study investigates whether post-Soviet Union are caught in the middle-income trap by assessing the stationarity of their economic growth from 1990 to 2023. The analysis adopts the Robertson-Ye (2013) approach, which evaluates the stationarity of GDP per capita ratios relative to the United States. If these ratios are stationary, it implies that the country is in the middle-income trap, as it fails to converge toward U.S. income levels. Conversely, non-stationary ratios indicate ongoing convergence and the absence of the trap. To obtain the robustness of the findings, a broad set of unit root tests was applied, including traditional approaches (ADF), nonlinear methods (KSS, Kruse, Sollis), and advanced Fourier-based tests (FKPSS, FF-ADF, FADF, FKSS, FKruse, FSollis). In addition, the radar chart, coefficient of variation, and three different MCDA methods (Equal Weight Score, Discrimination Weighted Score and Entropy Weighted Score) were used for robustness check. The results of unit root tests highlight significant variation among countries. Most tests confirm stationarity for Moldova, Kyrgyzstan, Tajikistan, Armenia, Azerbaijan, Belarus, and Georgia, suggesting these nations are stuck in the middle-income trap. In contrast, Kazakhstan, Russia, Uzbekistan, Turkmenistan, and Ukraine show non-stationary results, indicating they are not in the trap and are progressing toward higher income levels.

Achieving sustainable economic growth and overcoming the middle-income trap necessitate a strategic blend of structural reforms, economic diversification, investments in human capital, technological innovation, and the establishment of robust institutions. In this context, post-Soviet countries should consider following policy recommendations:

(a) Post soviet countries should increase investment in human capital. Investment in human capital, as a well-educated and healthy workforce is fundamental for sustainable economic growth. Modernizing education systems by prioritizing STEM (science, technology, engineering, and mathematics) education, vocational training, and digital literacy will better prepare the labor force for a rapidly evolving economy. Additionally, increasing access to higher education and healthcare services will enhance productivity and ensure a more competitive workforce. (b) Another critical factor is economic diversification. To build more resilient economies, countries should develop competitive manufacturing sectors, expand the services industry, and modernize agriculture. (c) Infrastructure development and connectivity are also key drivers of long-term economic expansion. Investments in transportation networks, renewable energy, and smart cities can improve productivity and trade efficiency. Additionally, integrating into global markets through free trade agreements, promoting export-oriented industries, and strengthening regional cooperation can enhance economic competitiveness. (d) Innovation and technology play a crucial role in economic transformation. For this post-Soviet economies should invest heavily in research and development (R&D). Allocating a larger share of GDP to R&D, fostering university-industry collaborations, and promoting digital transformation can drive economic competitiveness. Supporting startups, encouraging entrepreneurship, and implementing technology transfer policies will also help countries transition toward knowledge-based economies and high-tech industries. (e) Beyond economic and technological progress, institutional reforms are essential for ensuring sustainable growth. Post-Soviet countries should strengthen governance, enhance transparency and accountability, reduce corruption, and uphold the rule of law to create a stable business environment. These factors may attract foreign direct

investment. Furthermore, improving financial institutions, streamlining bureaucratic procedures, and increasing public sector efficiency will further contribute to economic stability and growth. (f) Inclusive growth policies such as strengthening social policies, reducing inequality, and ensuring gender equality will lead to a more balanced and sustainable economy. Implementing social safety nets, investing in underdeveloped areas, and fostering inclusive economic participation will help reduce disparities and create a more resilient society. Therefore, these will be cause for avoiding the middle-income trap and achieving sustainable economic growth in post-Soviet countries.

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APPENDIX

Table 1

Trend analysis results

Panel A: Trend Analysis Results by Country		
Countries	**C**	**Trend**
ARM	-3.838***	0.043***
AZE	-3.429***	0.036***
BLR	-2.969***	0.025***
GEO	-3.499***	0.032***
KAZ	-2.350***	0.023***
KYR	-4.043***	0.002
MOL	-3.238***	0.007
RF	-2.057***	0.008**
TJK	-4.411***	0.001
TKM	-3.120***	0.003***
UA	-3.097***	-0.007
UZB	-3.659***	0.002***

,* denote 5% and 1% significance level, respectively.

Figure 1. Time Series Graphics by Country
Source: World Bank, (2024a).

Table 2

Linearity Test Results

Countries	Harvey and Leybourne (2007)			Harvey et al(2008)
	W*_1%	W*_5%	W*_10%	W_lam
ARM	17.53***	17.13***	16.91**	13.32***
AZE	16.28***	15.27***	13.65***	12.45**
BLR	33.42***	33.18***	33.04***	14.07***
GEO	24.12***	23.82***	23.62***	8.614**
KAZ	10.72*	10.63*	10.62*	11.32**
KYR	10.71*	10.55*	10.21*	19.25***
MOL	12.93**	11.92*	11.54**	12.71**
RF	17.52***	13.62***	10.73*	13.52***
TJK	30.38***	28.67***	27.75**	14.86***
TKM	11.63**	11.48**	11.39**	8.231**
UA	32.13***	31.92***	31.72***	14.94***
UZB	35.62***	35.13***	34.83***	24.23***

***, ** and * indicate that the null hypothesis of linearity is rejected at 1%, 5% and 10% significance levels, respectively.

Table 3

Critical values for the constant and trended equation of the FADF test

	k	**1%**	**5%**	**10%**
T=100	1	-5.11	-4.46	-4.15
	2	-4.83	-4.16	-3.79
	3	-4.50	-3.83	-3.49
	4	-4.39	-3.70	-3.36
	5	-4.37	-3.63	-3.28
T=250	1	-4.93	-4.34	-4.06
	2	-4.72	-4.04	-3.72
	3	-4.44	-3.80	-3.45
	4	-4.26	-3.67	-3.33
	5	-4.22	-3.59	-3.25
T=500	1	-4.86	-4.30	-4.02
	2	-4.64	-4.02	-3.69
	3	-4.39	-3.77	-3.46
	4	-4.24	-3.64	-3.32
	5	-4.13	-3.59	-3.27

Source: This table was obtained from Hepsag (2022).