

COMPARATIVE ANALYSIS OF INVESTMENT EFFICIENCY IN AZERBAIJAN AND ROMANIA BASED ON ICOR: A MACROECONOMIC PROPORTIONAL APPROACH

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Abstract

In the research, the efficiency of investments directed to the economies of Azerbaijan and Romania was carried out using ICOR, which is considered a classical macroeconomic proportional analysis indicator. Using the quantitative research method, certain answers were found to the research questions posed. Thus, it was determined that investments play an important role in economic growth in both countries. Efficiency was recorded in investments directed to the economies of both Azerbaijan and Romania. However, for a more systematic analysis, it is necessary to take into account the lagged effects of investments, which can act as an important research question for future research. The main limitation of the study is that it requires a wider information base.

Keywords: macroeconomic proportions, investment, efficiency, Azerbaijan, Romania, ICOR

JEL Classification: E00, E22, E6

1. Introduction

Investment is a factor in a country's economic progress which benefits both developing and developed nations. When a country invests, its infrastructure gets stronger, the production capacity increases, and the country advances technologically. All of these benefits help the economy to get better in the run [Égert, Koźluk & Sutherland, (2009); Du, Zhang & Han, (2022)]. People conducted rigorous research which confirms that both public and private investment have a significant positive impact on the economy in countries that are still growing. Investments is key to making the economy strong. The money invested by the public and private companies plays a huge role in a country's economic performance which shows that investment is crucial for a country's development [Ahamed, (2021)]. When investment levels go down economic growth slows down. This shows how closely investment and growth are linked.

For countries like Azerbaijan investment is very important for their strategy. As a developing country that depends strongly on the energy sector, Azerbaijan has relied on investment inflows to improve its infrastructure and to expand its economy beyond oil and gas production. According to research,

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good management of investment is needed for economic growth. It also helps to reduce the country's vulnerability to economic shocks [Azimzadeh, (2025)]. In addition, studies on foreign direct investment in Azerbaijan indicate that the quality of institutions and legal regulations plays a major role in attracting investments and increasing their effectiveness [Salayev et al., (2025)]. Therefore, the importance of investment in Azerbaijan is not only about how much money is invested, but also about how efficiently these investments contribute to economic growth.

Similarly, in Romania investment plays a role in its growth. Investing money directly and building up capital really helps make businesses more productive and makes the economy of Azerbaijan and Romania grow faster. Direct investment is very important, for Azerbaijan and Romania. Empirical studies conducted using time-series methods show that FDI inflows are positively associated with economic expansion and sustainable development in Romania [Drob et al., (2025)]. However, as highlighted in comparative investment studies, the effectiveness of capital utilization may vary across countries depending on structural conditions and economic policies [Taguchi & Lowhachai, (2014)].

Even though investment is good for the economy, countries use their money differently which affects how much economic growth they get from it. A country's economic growth from investment depends on its policies, institutions and economic structure. The quality of institutions and policies, in place also matters. Looking at Azerbaijan and Romania is a way to understand how different things affect how well money is invested in each country. Azerbaijan and Romania are examples of this. Governments and researchers can use the information from Azerbaijan and Romania to make plans so that the money they invest actually does some good and helps the economy in the long.

The research will be directed towards answering the following research questions.

Research Question 1: Are investments made in the economy of Azerbaijan efficient? **Research Question 2:** Are investments made in the economy of Romania efficient?

2. Literature review

In the past many people who study economics have looked at how investments are used and how this affects the economy. One of the commonly used approaches in this area is the Incremental Capital Output Ratio (ICOR), which allows researchers to evaluate how efficiently investment contributes to economic output. Some studies have used a measure to see how capital formation and economic growth are connected in both rich and poor countries. These studies generally focus on identifying how effectively countries transform investment into economic growth and what factors influence this efficiency.

A time ago, Ranadev Banerji (1969) did some research on how capital and output are related. He looked at how the ICOR measure works in countries and

if the usefulness of capital changes over time. Nicholas V. Gianaris (1970) also conducted a study. He found that countries use capital differently depending on their economy and how developed they are. U Tun Wai (1985) conducted another study that showed investment efficiency in countries depends on more than just the amount of money invested. It also depends on the state of the economy. The following table lists some studies that have looked at how well investments are used, capital formation and economic growth.

Table no.1 Previous Studies on Investment Efficiency and ICOR Analysis

Author(s)	Research name	Who/What Was Analysed	Main Findings	Year
Hiroyuki Taguchi and Suphannada Lowhachai	A revisit to the incremental capital-output ratio	Asian economies and Thailand	Lower ICOR values indicate more efficient investment and higher growth	2014
Anna Yulianita et al.	Analysis of Investment Efficiency by Using ICOR Approach to Economic Growth in All Provinces of Sumatera Island	Provinces of Sumatera Island, Indonesia	The study found that investment efficiency differs between provinces, indicating that the ability of regions to transform investment into economic growth varies significantly	2019
Jeton Mazllami	The Investments Efficiency Toward Economic Growth: ICOR of the Republic of Croatia and Slovenia – Comparative Analysis	Croatia and Slovenia	The results show that ICOR values differ between the two countries, indicating variations in investment efficiency and capital productivity	2021
Zhang Jun	Investment Efficiency and Economic Growth in China	Chinese economy during economic reforms	The results showed that improvements in investment efficiency contributed to China's rapid economic growth	2003
Samia Amin et al.	Does Capital Efficiency Influence Economic Growth in Bangladesh? Application of the Harrod–Domar Model	Bangladesh economy	The study found that higher ICOR values are associated with lower economic growth, reflecting inefficient capital use	2024
Rafid Ahamed	Impact of Public and Private Investments on Economic Growth	39 developing countries	The results indicate that capital formation and investment significantly contribute to economic development	2021

Source: (Amin et al, 2024; Ahamed, 2021; Mazllami, 2021; Yulianita, 2019; Taguchi and Lowhachai, 2014; Jun, 2003; WAI, 1985; Gianaris, 1970; Banerji, 1969).

From all these studies it is clear that investment efficiency is very important for growth. Investment efficiency really matters for growth. It actually helps make the economy grow. The ICOR or Incremental Capital Output Ratio, is one way to see how well countries use investment to get results. A lower ICOR value usually means a country is using investment efficiently. Research has found that investment efficiency can be different from country to country and even within regions. This is because things like the structure and policies it has in place can affect it. Countries with the mix of economic structure and policies tend to have more efficient investment. Investment efficiency is key to making the most of investment. It helps countries get output from their investment. Overall, improving how investments are used can help boost growth, which makes understanding and managing investment efficiency really important for any economy.

3. Material and Methods

This study will employ a quantitative research approach. It should be noted that the study will utilize the statistical software packages GRETL 2026a and IBM SPSS Statistics 27 for data analysis. At the initial stage, it should be noted that the efficiency of investments will be assessed using the Incremental Capital–Output Ratio (ICOR), which is considered a classical macroeconomic proportional indicator for measuring capital productivity and investment efficiency.

$$ICOR = \frac{\Delta K}{\Delta Y} \quad 1]$$

The methodological framework of the study will be based on indicators obtained from the World Bank database. The principal variables include Gross Domestic Product for Azerbaijan and Romania (GDP_AZE and GDP_RO), as well as Gross Fixed Capital Formation for Azerbaijan and Romania (INV_AZE and INV_RO).

Prior to conducting the ICOR analysis, we intend to perform a correlation analysis between the variables. However, before selecting the appropriate correlation method, it is necessary to conduct a normality test. The results of the normality test will determine which type of correlation analysis (e.g., Pearson or Spearman) is most appropriate for the dataset.

Table no.2 Normality test of variables

Tests for GDP_AZE	Result	p value	Tests for INV_AZE	Result	p value
Doornik-Hansen test	10.8071	0.004501	Doornik-Hansen test	3.67083	0.159547
Shapiro-Wilk W	0.858892	0.000369	Shapiro-Wilk W	0.912091	0.008494
Lilliefors test	0.225366	≈ 0	Lilliefors test	0.172562	≈ 0.01
Jarque-Bera test	3.57497	0.16738	Jarque-Bera test	2.12899	0.344901

Source: Authors' calculating

Table no.3 Normality test of variables

Tests for GDP_RO	Result	p value	Tests for INV_RO	Result	p value
Doornik-Hansen test	4.60902	0.099808	Doornik-Hansen test	5.00655	0.081817
Shapiro-Wilk W	0.888395	0.001956	Shapiro-Wilk W	0.886305	0.001729
Lilliefors test	0.191541	≈ 0	Lilliefors test	0.191552	≈ 0
Jarque-Bera test	2.31429	0.314383	Jarque-Bera test	2.4049	0.300457

Source: Authors' calculating

The study covers the period 1990–2024 (sample size = 35). Given the relatively small sample size, the Shapiro–Wilk test will be employed as the primary normality test [Mishra et al., (2019)]. An examination of Table 2 and Table 3 indicates that normality is not observed for any of the variables in either Azerbaijan or Romania [Field, (2013)].

Accordingly, the Spearman's rank correlation, the formula of which will be presented below, will be used for the correlation analysis [Song and Park, (2020)].

$$r_s = 1 - \frac{6 \sum d_i^2}{n(n^2 - 1)} \quad 2]$$

The Spearman rank correlation coefficient ranges between +1 and -1. A coefficient value closer to 0 indicates a weak association between the variables, whereas a value closer to ± 1 reflects a strong monotonic relationship [Li et al., (2022)].

Within the framework of this study, it should also be noted that a key limitation concerns the unavailability of monthly data for some of the variables. This constraint restricts the possibility of conducting an analysis with a larger sample size and, consequently, limits the scope of the empirical investigation.

4. Result and Discussion

Since normality was not detected for the variables of Azerbaijan and Romania, the Spearman rank correlation coefficients are presented in the tables below.

Table no.4 Spearman's rank correlation matrix for GDP_AZE and INV_AZE

			GDP_AZE	INV_AZE
Spearman's rho	GDP_AZE	Correlation Coefficient	1.000	.929**
		Sig. (2-tailed)	.	.000
		N	35	35
	INV_AZE	Correlation Coefficient	.929**	1.000
		Sig. (2-tailed)	.000	.
		N	35	35

** . Correlation is significant at the 0.01 level (2-tailed).

Source: Authors' calculating

As shown in Table 4, there is a very strong correlation between GDP and GFCF in the case of Azerbaijan. Specifically, the correlation coefficient between the variables was determined to be 0.929, which indicates a strong relationship [Hair et al., (2017)].

Table no.5 Spearman's rank correlation matrix for GDP_RO and INV_RO

			GDP_RO	INV_RO
Spearman's rho	GDP_RO	Correlation Coefficient	1.000	.963**
		Sig. (2-tailed)	.	.000
		N	35	35
	INV_RO	Correlation Coefficient	.963**	1.000
		Sig. (2-tailed)	.000	.
		N	35	35

** . Correlation is significant at the 0.01 level (2-tailed).

Source: Authors' calculating

A similar result was obtained for Romania. Specifically, the Spearman rank correlation coefficient between the variables was calculated as 0.963, indicating a very strong positive correlation between GDP and GFCF in the case of Romania [Hair et al., (2017)].

The existence of a strong correlation between GDP and GFCF in both countries suggests that GFCF has a measurable impact on economic growth. This finding indicates that employing the classical macroeconomic proportional indicator, ICOR, to assess investment efficiency is theoretically and economically justified.

In order to address the research questions posed in this study, it is necessary to conduct an ICOR analysis for both Azerbaijan and Romania.

Table no. 6. Changes in GFCF, GDP and ICOR in Azerbaijan

Years	K*	Y*	ΔK	ΔY	ICOR
1990	1,80	8,88	-	-	-
1991	0,61	5,34	-1,19	-3,54	0,34
1992	0,10	0,44	-0,51	-4,90	0,10
1993	0,33	1,57	0,23	1,13	0,20
1994	0,31	1,19	-0,02	-0,38	0,05
1995	0,38	2,42	0,07	1,23	0,06
1996	0,92	3,18	0,54	0,76	0,71
1997	1,47	3,96	0,55	0,78	0,71
1998	1,58	4,45	0,11	0,49	0,22
1999	1,31	4,58	-0,27	0,13	-2,08
2000	1,22	5,27	-0,09	0,69	-0,13
2001	1,31	5,71	0,09	0,44	0,20
2002	2,13	6,24	0,82	0,53	1,55

2003	3,85	7,28	1,72	1,04	1,65
2004	5,01	8,68	1,16	1,40	0,83
2005	5,47	13,25	0,46	4,57	0,10
2006	6,23	20,98	0,76	7,73	0,10
2007	7,07	33,05	0,84	12,07	0,07
2008	9,08	48,85	2,01	15,80	0,13
2009	8,34	44,29	-0,74	-4,56	0,16
2010	9,61	52,91	1,27	8,62	0,15
2011	13,31	65,95	3,70	13,04	0,28
2012	15,65	69,68	2,34	3,73	0,63
2013	19,13	74,16	3,48	4,48	0,78
2014	20,64	75,24	1,51	1,08	1,40
2015	14,77	53,08	-5,87	-22,16	0,26
2016	9,48	37,87	-5,29	-15,21	0,35
2017	9,73	40,87	0,25	3,00	0,08
2018	9,75	47,11	0,02	6,24	0,00
2019	10,18	48,17	0,43	1,06	0,41
2020	9,68	42,69	-0,50	-5,48	0,09
2021	8,90	54,83	-0,78	12,14	-0,06
2022	9,47	78,81	0,57	23,98	0,02
2023	12,60	72,43	3,13	-6,38	-0,49
2024	12,48	74,32	-0,12	1,89	-0,06

Source: Authors' calculating

Note: * - billion US dollar

As shown in the table, the ICOR indicator in Azerbaijan is generally below 1, which may suggest potential efficiency in invested capital. However, in recent years the ICOR value has turned negative, casting doubt on conclusions regarding investment efficiency. Specifically, in 2023 the negative value was driven by changes in GDP, while in 2024 it resulted from movements in GFCF. This may indicate the presence of lag effects in the relationship between investment and output. Therefore, relying solely on ICOR may be insufficient, and incorporating lag analysis in future research would be important for a more comprehensive assessment.

To address the next research question, it is necessary to analyze the ICOR for Romania.

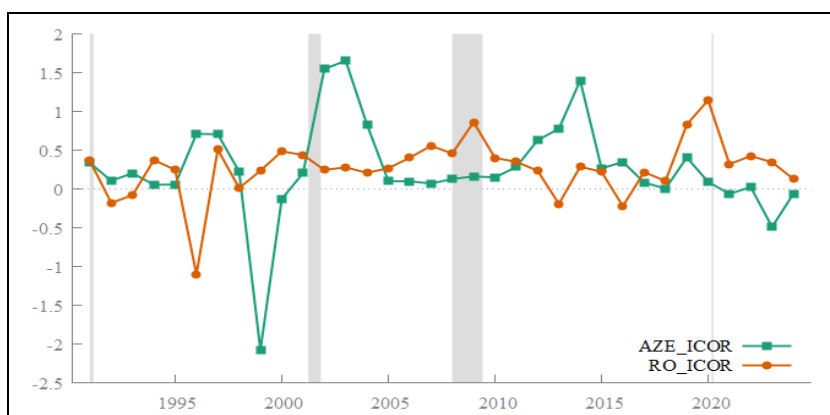
Table no.7 Changes in GFCF, GDP and ICOR in Romania

Years	K*	Y*	ΔK	ΔY	ICOR
1990	7,57	38,25	-	-	-
1991	4,15	28,85	-3,42	-9,40	0,36
1992	4,82	25,12	0,67	-3,73	-0,18
1993	4,72	26,36	-0,10	1,24	-0,08
1994	6,10	30,07	1,38	3,71	0,37
1995	7,92	37,43	1,82	7,36	0,25
1996	8,46	36,94	0,54	-0,49	-1,10
1997	7,77	35,58	-0,69	-1,36	0,51
1998	7,84	41,70	0,07	6,12	0,01
1999	6,49	35,95	-1,35	-5,75	0,23
2000	7,12	37,25	0,63	1,30	0,48
2001	8,50	40,40	1,38	3,15	0,44
2002	9,89	46,07	1,39	5,67	0,25
2003	13,15	57,81	3,26	11,74	0,28
2004	16,72	74,97	3,57	17,16	0,21
2005	23,00	98,45	6,28	23,48	0,27
2006	32,48	122,02	9,48	23,57	0,40
2007	61,70	174,59	29,22	52,57	0,56
2008	79,91	214,32	18,21	39,73	0,46
2009	45,28	174,11	-34,63	-40,21	0,86
2010	43,66	170,06	-1,62	-4,05	0,40
2011	51,56	192,62	7,90	22,56	0,35
2012	48,38	179,12	-3,18	-13,50	0,24
2013	46,32	189,80	-2,06	10,68	-0,19
2014	49,16	199,72	2,84	9,92	0,29
2015	44,33	177,89	-4,83	-21,83	0,22
2016	42,69	185,29	-1,64	7,40	-0,22
2017	48,08	210,15	5,39	24,86	0,22
2018	51,29	241,79	3,21	31,64	0,10
2019	58,17	250,08	6,88	8,29	0,83
2020	58,80	250,63	0,63	0,55	1,15
2021	69,85	285,07	11,05	34,44	0,32
2022	74,20	295,32	4,35	10,25	0,42
2023	92,32	347,76	18,12	52,44	0,35
2024	96,76	382,56	4,44	34,80	0,13

Source: Authors' calculating

*Note: * - billion US dollar*

The analysis for Romania also indicates that investments have generally been efficient. However, an interesting observation is that in 2020, according to the ICOR indicator, investments in Romania appeared inefficient, whereas Azerbaijan demonstrated efficiency. This suggests that the structure of investments and the lag effects differ across countries. For a clearer comparative assessment, it is necessary to examine the graph below.

Figure no.1 ICOR Dynamics in Azerbaijan and Romania

Source: Authors' calculating

The comparative analysis indicates that the average ICOR in both countries suggests investment efficiency. However, during the NBER-defined recession periods, which are marked in grey on the graph, the two countries exhibited different responses. This highlights differences in their economic development cycles and the lag structures of investments. In the long run, further research focusing specifically on these dynamics may provide a more precise and meaningful understanding of investment efficiency patterns.

5. Conclusion

Investments constitute a core component of countries' economic development strategies. Therefore, analyzing their efficiency is essential within the framework of strategic planning to ensure the optimal use of resources. The findings of this study further confirm that investments have had a positive impact on economic growth in both Azerbaijan and Romania.

Within the scope of the research questions, it has been determined that investments in both economies are generally efficient. However, the economic development cycles and investment lag structures differ between the two countries.

Moreover, to obtain more comprehensive results, it is necessary to conduct a sectoral, lag-based analysis of investment efficiency in these economies. This direction may serve as a key research question for future studies and contribute to more robust and insightful conclusions.

References

Taguchi, H., & Lowhachai, S. (2014). A revisit to the incremental capital-output ratio: the case of Asian economies and Thailand. *International Journal of Economic Policy in Emerging Economies*, 7(1), 35-54.

Ahamed, F. (2021). Impact of public and private investments on economic growth of developing countries. *arXiv preprint arXiv:2105.14199*.

Azimzadeh, A. (2025). The Analysis of the Investment-Output Proportion in Azerbaijan's Mining Industry: Lag-Based Approach. *International Journal of Sustainable Development and Planning*, 20(9), 4025-4032.

Salayev, E., Maharramov, R., & Idziak, E. (2025). Analysis of Foreign Direct Investments in Azerbaijan and Directions for Improving the Legal Attraction Mechanism in Local Self-Government Bodies. *Journal of Economics and Management Advances*, 1(2), 21- 33.

Drob, C., Plescau, I., & Zichil, V. (2025). Foreign Direct Investments and Economic Growth in Romania: A Time-Series Approach for Sustainable Development. *Sustainability*, 18(1), 343.

Égert, B., Kozluk, T., & Sutherland, D. (2009). *Infrastructure and growth: empirical evidence* (No. 2700). CESIFO working paper.

Du, X., Zhang, H., & Han, Y. (2022). How does new infrastructure investment affect economic growth quality? Empirical evidence from China. *Sustainability*, 14(6), 3511.

Banerji, R. (1969). An experiment with incremental capital-output ratio. *Weltwirtschaftliches Archiv*, 274-277.

Gianaris, N. V. (1970). International Differences in Capital-Output Ratios. *The American Economic Review*, 60(3), 465-477.

Yulianita, A., Marissa, F., Widyanata, F., Fitriyah, A., & Marcheline, M. (2019). Analysis of investment efficiency by using ICOR approach to economic growth in all provinces of Sumatera Island. In *Proceedings of the 4th Sriwijaya Economics, Accounting, and Business Conference(SEABC)* (pp. 708-704).

Wai, U. T. (1985). Study of ICOR in developing countries. *Savings and development*, 9(3), 225-263.

Mazllami, J. (2021). The investments efficiency toward economic growth: Icor of the republic of croatia and slovenia-comparative analysis. *Journal of Economics and Social Studies*, 8(1).

Amin, S. B., Samia, B. I., & Khan, F. (2024). Does capital efficiency influence economic growth in Bangladesh? Application of the Harrod-Domar model. *Journal of Economics, Finance and Administrative Science*, 29(58), 326-345.

Jun, Z. (2003). Investment, investment efficiency, and economic growth in China. *Journal of Asian Economics*, 14(5), 713-734.

Field, A. (2024). *Discovering statistics using IBM SPSS statistics*. Sage publications limited.

Mishra, P., Pandey, C. M., Singh, U., Gupta, A., Sahu, C., & Keshri, A. (2019). Descriptive statistics and normality tests for statistical data. *Annals of cardiac anaesthesia*, 22(1), 67-72.

Song, H. Y., & Park, S. (2020). An analysis of correlation between personality and visiting place using Spearman's rank correlation coefficient. *KSII Transactions on Internet and Information Systems (TIIS)*, 14(5), 1951-1966.

Li, H., Cao, Y., & Su, L. (2022). Pythagorean fuzzy multi-criteria decision-making approach based on Spearman rank correlation coefficient. *Soft Computing*, 26(6), 3001-3012.

Hair, J. F., Wolfinbarger, M. F., Ortinau, D. J. & Bush, R. P. (2017). *Essentials of Marketing Research* Fourth Edition McGraw-Hill Education, 2 Penn Plaza, New York