(Индекс УДК-2964)

Fazliddin Shamsiev
Head of section "Improving Green budjeting"
Institute of fiscal researches under
Ministry of Economy and Finance of Uzbekistan

Doniyor Raxmonov
Head of section "International Ratings
and Index Strategy Department"
Institute of fiscal researches under
Ministry of Economy and Finance of Uzbekistan

FROM DIVERGENCE TO CATCH-UP: CONDITIONAL GROWTH DYNAMICS ACROSS COUNTRIES

Abstract. *This paper analyzes long-run growth dynamics across countries with a focus on conditional catch-up processes. Using data for 217 economies from 1971 to 2021, the study examines how initial income levels, human capital, macroeconomic conditions, and trade openness shape subsequent growth outcomes. To account for structural changes in the global economy, the analysis is conducted for three periods: 1971–1995, 1995–2021, and the full sample. The results provide consistent evidence that countries with lower initial income levels tend to grow faster once differences in education, inflation, trade exposure, and regional characteristics are controlled for. Human capital, measured by secondary school enrollment, plays a significant role in supporting growth across most specifications. Importantly, the strength of the catch-up effect increases in the post-1995 period, suggesting that globalization and technological diffusion have contributed to faster income convergence in recent decades.*

Keywords: *Economic growth, catch-up dynamics, initial income, human capital; global integration, cross-country evidence.*

Introduction. For much of the twentieth century, global economic development was widely perceived as a process of divergence rather than convergence. Early empirical evidence suggested that income gaps between advanced and developing economies were persistent and, in some cases, widening. For

example, according to D.Patel (2021), in 1950 per capita income in the United States exceeded that of India by a factor of approximately 17 in purchasing power parity (PPP) terms. By 1990, this disparity had increased to nearly 30:1, reinforcing the view that rich and poor countries were evolving along fundamentally separate growth trajectories. Such observations appeared to contradict the predictions of neoclassical growth theory, particularly the Solow (1956) model, which implies convergence of income levels through diminishing returns to capital.

However, the global growth landscape began to change markedly from the mid-1990s onward. By 2017, the ratio of U.S. to Indian per capita GDP had declined to around 9:1 (D.Patel et.al.,2021), This pattern is not unique to India. A growing body of empirical research documents that several developing countries have experienced sustained periods of rapid growth, enabling them to catch up partially with advanced economies.

The experience of Uzbekistan offers a relevant case study within this framework. Until the early 2000s, Uzbekistan's economic structure was dominated by agriculture—particularly cotton production—which accounted for a substantial share of employment and export revenues. This period was characterized by high inflation, limited foreign direct investment, underdeveloped infrastructure, and persistent structural inefficiencies.

Beginning in the 2000s, Uzbekistan initiated a gradual but increasingly comprehensive reform process aimed at liberalizing the economy and fostering long-term growth. Greater engagement in regional economic cooperation, notably through participation in the Shanghai Cooperation Organization (SCO), contributed to increased regional trade turnover. More recently, ongoing efforts to accede to the World Trade Organization (WTO) have strengthened reform credibility and signaled a commitment to deeper integration into the global economy. As a result, both domestic and foreign investment expanded, particularly in manufacturing and extractive industries.

These structural and institutional changes have been accompanied by notable

improvements in Uzbekistan's relative income position. In the early 2000s, per capita income in the United States was approximately 38 times higher than that of Uzbekistan. By 2024, this ratio had declined to about 17:1. It suggests significant degree of income convergence over the past two decades

Against this background, this paper seeks to examine the determinants of conditional convergence with a particular focus on developing and transition economies. By combining theoretical insights from neoclassical and endogenous growth models with empirical evidence from selected country experiences, the study aims to identify the key economic and institutional factors that enable sustained catch-up growth.

Literature review

A central question in the literature on economic convergence is whether observed narrowing of income gaps between rich and poor countries is driven mainly by slowing growth in advanced economies, or accelerated growth in developing countries, or a combination of both. Using cross-country data for two periods (1960–2000 and 2000–2019), Patel, Sandefur, and Subramanian (2021) found that recent convergence reflects both accelerating per capita GDP growth in poorer economies and declining growth in wealthier ones, with the growth acceleration in the Global South being particularly important.

While evidence of convergence has gained traction, some scholars emphasize that apparent convergence patterns may be influenced by differences in institutions, policies, and measurement techniques. Acemoglu and Molina (2021) argue that failure to account for persistent institutional and policy differences across countries — or the influence of unobserved variables — can bias estimates of convergence and potentially create statistical artifacts. Their analysis suggests that institutional heterogeneity and model specification are critical in interpreting convergence results.

A large body of literature explores structural determinants of convergence. One important channel is technological diffusion: prior to the 2000s, limited access to advanced technologies constrained growth in less developed countries,

contributing to divergence. However, increased globalization, digitalization, and expanded access to international flows of information and technology have facilitated faster adoption of modern technologies in lagging economies. Technology spillovers — especially through trade and foreign direct investment (FDI) — can enhance productivity growth in developing countries, thereby contributing to convergence. (Neto, 2013)

Trade liberalization has also been identified as a driver of convergence. Ben-David (1993, 1996) and Sachs and Warner (1995) shows that countries with greater trade openness experienced faster income growth and reduced income dispersion among trading partners, suggesting that liberalized markets create conditions conducive to convergence.

Additionally, human capital accumulation, investment in infrastructure, and FDI inflows are widely recognized as factors that can accelerate growth in poorer countries. Empirical research indicates that FDI has a disproportionately positive impact on economic growth in low-income countries and is associated with faster convergence in per capita income across groups of countries. (Jawaid, 2012)

Finally, recent work highlights that while some forms of convergence (e.g., GDP per capita growth) may be observable, convergence in institutional quality and structural characteristics does not necessarily follow at the same pace. For example, Safdar (2025) found that institutional convergence is slower than income convergence, implying that financial, legal, and governance differences can continue to shape long-term growth outcomes.

Methodology

The study tests the conditional convergence hypothesis by examining the relationship between initial income levels, human capital, and subsequent economic growth across countries. Three periods are considered: 1971–2021, 1971–1995, and 1995–2021, capturing long-term, pre-globalization, and post-globalization dynamics.

All relevant data for 217 countries were obtained from the World Bank World

Development Indicators (WDI) database, including GDP per capita (constant 2015 USD), secondary school enrollment (SE), inflation, trade openness, and regional classifications.

1. Basic Model. The basic model analyzes the effect of initial GDP per capita and initial human capital on subsequent economic growth. Human capital is proxied by the secondary school enrollment ratio. Growth is measured as the average annual growth rate of per capita GDP over each period. The model is specified as

follows:

1) Long-term period (1971–2021): $GRp1 = \beta_0 + \beta_1 lnGDP_{pc1971} + \beta_2 lnSE71 + \mu$,

here $GRp1 = \frac{lnGDP\ pc\ 2021 - lnGDP\ pc\ 1971}{51}$

2) Pre-globalization (1971–1995): $GRp2 = \beta_0 + \beta_1 lnGDP_{pc1971} + \beta_2 lnSE71 + \mu$,

here $GRp2 = \frac{lnGDP\ pc\ 1995 - lnGDP\ pc\ 1971}{25}$

3) Post-globalization (1995–2021): $GRp3 = \beta_0 + \beta_1 lnGDP_{pc1995} + \beta_2 lnSE95 + \mu$,

here $GRp3 = \frac{lnGDP\ pc\ 2021 - lnGDP\ pc\ 1995}{27}$

lnSE means natural log of School enrollment, secondary (% gross). β_1 captures the convergence effect, and β_2 represents the impact of initial human capital on growth.

2. Extended model

To account for additional determinants of economic growth, the extended model incorporates macro-structural variables and regional dummies such as inflation measured by the average annual growth rate of the Consumer Price Index (CPI), Trade openness defined as the ratio of exports plus imports to GDP and three categorical variables representing major world regions to control for unobserved regional heterogeneity.

4) $GRp1 = \beta_0 + \beta_1 lnGDP_{pc1971} + \beta_2 lnSE71 + CPIp1 + TOp1 + EAP + LAC + SSA + \mu$

5) $GRp2 = \beta_0 + \beta_1 lnGDP_{pc1971} + \beta_2 lnSE71 + CPIp2 + TOp2 + EAP + LAC + SSA + \mu$

6) $GRp3 = \beta_0 + \beta_1 lnGDP_{pc1995} + \beta_2 lnSE95 + CPIp3 + TOp3 + EAP + LAC + SSA + \mu$

here:

$GRp1 = (\ln GDP_{pc2021} - \ln GDP_{pc1971})/51$,

$GRp2 = (\ln GDP_{pc1995} - \ln GDP_{pc1971})/25$

$GRp3 = (\ln GDP_{pc2021} - \ln GDP_{pc1995})/27$

$CPIp1 = (\log \text{ of } CPI_{2021} - \log \text{ of } CPI_{1971})/51$

$CPIp2 = (\log \text{ of } CPI_{1995} - \log \text{ of } CPI_{1971})/25$

$CPIp3 = (\log \text{ of } CPI_{2021} - \log \text{ of } CPI_{1995})/27$

EAP – East Asia & Pacific, LAC – Latin America & Caribbean,

SSA – Sub-Saharan Africa

This approach allows the study to isolate the conditional convergence effect, controlling for human capital, macroeconomic stability, trade exposure, and regional characteristics. All variables are expressed in natural logarithms where appropriate to reduce heteroskedasticity and interpret coefficients as elasticities.

Results. We can see from the result in Table 1 that all models show a negative relationship between the initial GDP per capita and subsequent growth rates.

Table 1. Basic model results

VARIABLES	model 1	model 2	model 3
GDP per capita (log), 1971	-0.00700***	-0.00629***	
	(0.001)	(0.002)	
Secondary School Enrollment (log), 1971	0.01177***	0.01361***	
	(0.002)	(0.003)	
GDP per capita (log), 1995			-0.00808***
			(0.001)
Secondary School Enrollment (log), 1995			0.01318***
			(0.003)
Constant	0.03404***	0.02100*	0.03481***
	(0.007)	(0.011)	(0.008)
Observations	95	95	107
R-squared	0.342	0.244	0.272

*Standard errors in parentheses.*** p<0.01, ** p<0.05, * p<0.1*

For example, -0.007 for model 1 (1971-2021), -0.006 for model 2 (1971-1995), and -0.008 for model 3 (1995-2021). This suggests that countries with higher initial GDP per capita tend to grow more slowly. This is consistent with the

concept of conditional convergence, where poorer countries grow faster than richer ones, all else being equal.

The coefficients for secondary school enrollment are positive and significant across all models, it means that higher levels of secondary school enrollment are associated with higher growth rates. This suggests that investment in human capital (education) positively impacts economic growth.

Comparison Between Model 1 (1971-2021) and Model 2 (1971-1995):

The coefficient decreases slightly from -0.00629 in Model 2 to -0.00700 in Model 1. This suggests that the negative impact of initial GDP per capita on growth is somewhat stronger when considering the longer period (1971-2021). It implies that over a longer horizon, the convergence effect might become more pronounced.

Model 1 (1971-2021) vs. Model 3 (1995-2021). The coefficient in Model 3 is -0.00808, which is larger in magnitude than -0.00700 in Model 1. This indicates that the negative relationship between initial GDP per capita and growth was stronger in the more recent period (1995-2021) than over the entire period from 1971 to 2021.

Model 2 (1971-1995) vs. Model 3 (1995-2021). The coefficient increases from -0.00629 in Model 2 to -0.00808 in Model 3. This significant increase suggests that the negative impact of initial GDP per capita on growth has become more pronounced in the recent period (1995-2021) compared to the earlier period (1971-1995).

The stronger negative relationship in the more recent period (1995-2021) could indicate a strengthening of the convergence process. As globalization and technological diffusion have accelerated, poorer countries may be catching up more rapidly with richer countries.

Table 2 demonstrates results of extended model.

Table 2. Results of extended models

VARIABLES	model 4	model 5	model 6
GDP per capita (log), 1971	-0.00664***	-0.00475**	
	(0.001)	(0.002)	
Secondary School Enrollment (log), 1971	0.00578***	0.00770**	
	(0.002)	(0.003)	
CPI Growth Rate, 1971-2021	-0.01437		
	(0.018)		
Trade Openness avg, 1971-2021	0.00006**		
	(0.000)		
East Asia & Pacific	-0.00091	0.00862	0.00043
	(0.004)	(0.006)	(0.004)
Latin America & Caribbean	-0.00489	-0.00214	-0.00531
	(0.003)	(0.005)	(0.004)
Sub-Saharan Africa	-0.01609***	-0.01448**	-0.01479**
	(0.004)	(0.006)	(0.006)
CPI Growth Rate, 1971-1995		-0.03335***	
		(0.011)	
Trade Openness avg, 1971-1995		0.00008	
		(0.000)	
GDP per capita (log), 1995			-0.00812***
			(0.001)
Secondary School Enrollment (log), 1995			0.00638*
			(0.004)
CPI Growth Rate, 1995-2021			0.03673
			(0.030)
Trade Openness avg, 1995-2021			0.00005*
			(0.000)
Constant	0.05258***	0.03099**	0.06206***
	(0.010)	(0.014)	(0.014)
Observations	64	67	87
R-squared	0.514	0.517	0.444

*Standard errors in parentheses.*** p<0.01, ** p<0.05, * p<0.1*

All three models show negative coefficients for GDP per capita, which indicates

conditional convergence.

Model 4: -0.00664 (1971-2021)

Model 5: -0.00475 (1971-1995)

Model 6: -0.00812 (1995-2021)

The coefficients vary slightly, with Model 6 showing a stronger negative relationship compared to Model 5 and Model 4, suggesting a more pronounced convergence effect in the recent period (1995-2021).

Positive coefficients across all models indicate that higher secondary school enrollment is associated with higher growth rates. (0.00578, 0.00707 and 0.00638 respectively) The significance levels vary, but the positive impact of education on growth is consistently evident.

Mixed results for CPI growth rate indicate varying impacts on growth. The negative coefficient in Model 5 suggests that higher inflation rates could negatively impacted growth in the 1971-1995 period.

Positive coefficients for trade openness indicate that greater openness is associated with higher growth rates.The results suggest that trade openness positively impacts growth, though significance varies.

Regarding regional dummy variables:

East Asia & Pacific: Mixed and not significant across models.

Latin America & Caribbean: Negative but not significant across models.

Sub-Saharan Africa: Consistently negative and significant, indicating lower growth rates compared to other regions.

Conclusion. The empirical analysis carried out in this study lends strong support to the conditional convergence hypothesis. Across both the baseline and extended model specifications, a stable and negative relationship is observed between initial GDP per capita and subsequent economic growth. This pattern suggests that economies starting from lower income levels tend to grow faster than richer ones, and this result remains consistent regardless of the model framework or period under consideration.

Human capital also plays a meaningful role in shaping growth outcomes.

Secondary school enrollment is found to have a positive association with economic growth in all estimations, although the size and statistical strength of this effect vary slightly across models. Even so, the overall results confirm that improvements in educational attainment contribute to higher growth rates over time. This result is consistent with earlier studies emphasizing education as a key driver of long-run growth, including Barro (1991), Mankiw, Romer, and Weil (1992), and Benhabib and Spiegel (1994), all of whom highlight the contribution of human capital accumulation to productivity and income growth.

An important finding of the study is that convergence appears to have become more pronounced in the period from 1995 to 2021. The stronger negative coefficient on initial income during this later period points to faster catch-up dynamics, which may reflect increased globalization, structural changes in economies, and broader access to education and technology.

Finally, extending the model to include additional controls—such as inflation, trade openness, and regional characteristics—does not alter the main conclusions. While these variables influence the estimated coefficients to some degree, the fundamental relationships between initial income, education, and growth remain intact. Taken together, the results indicate that income convergence and human capital accumulation continue to be central factors in explaining long-term economic growth patterns.

References:

1. Dev Patel, Justin Sandefur, and Arvind Subramanian, 2021. The New Era of Unconditional Convergence. Journal of Development Economics, Volume 152, September 2021. https://doi.org/10.1016/j.jdeveco.2021.102687

2. Daron Acemoglu, Carlos A. Molina, 2021 “Converging to converge? A comment”. National Bureau of Economic Research. July, 2021
DOI 10.3386/w28992

3. Solow, R. M. (1956). A contribution to the theory of economic growth

4. Dev Patel, Arvind Subramanian, and Justin Sandefur. 2021. “The New Era of

Unconditional Convergence". Journal of Development Economics, 152. https://doi.org/10.1016/j.jdeveco.2021.102687.

5. Delfim Gomes Neto, Francisco José Veiga. Financial globalization, convergence and growth: The role of foreign direct investment, 2013. Journal of International Money and Finance. Volume 37, October 2013, Pages 161-186. https://doi.org/10.1016/j.jimonfin.2013.04.005

6. Jawaid, Syed Tehseen, Raza, Syed Ali, 2012. Foreign Direct Investment, Growth and Convergence Hypothesis: A Cross Country Analysis. MPRA Paper No. 39000. https://mpra.ub.uni-muenchen.de/39000/

7. Muhammad Safdar, Ahmad Nawaz. Convergence in economic growth and institutional quality: Does convergence of institutions matter to catch-up rich economies?, Research in Economics, Volume 79, Issue 3, September 2025, 101079. https://doi.org/10.1016/j.rie.2025.101079

8. Barro, R. J., Sala-i-Martin, X. (2004). Economic growth (2nd ed.). MIT Press.

9. Mankiw, N. G., Romer, D., & Weil, D. N. (1992). A contribution to the empirics of economic growth. The Quarterly Journal of Economics, 107(2), 407–437. https://doi.org/10.2307/2118477

10. Benhabib, J., & Spiegel, M. M. (1994). The role of human capital in economic development: Evidence from aggregate cross-country data. Journal of Monetary Economics, 34(2), 143–173. https://doi.org/10.1016/0304-3932(94)90047-7