An Econometric Analysis of Unequal Growth in the G20 Nations: A Regime-Switching Approach Using the Ghosh Factor

Soumadeep Ghosh

Kolkata, India

Abstract

This paper examines GDP per capita growth patterns across 18 major economies during the 2020-2024 period, employing the innovative Ghosh factor methodology to capture regime-dependent asymmetric relationships in economic performance. We implement a piecewise logarithmic transformation framework that exhibits switching properties based on economic state indicators, revealing systematic differences in growth dynamics across loss and gain regimes. Our dual regression analysis demonstrates exceptional explanatory power, with R-squared values exceeding 93% in both directional relationships between average growth rates and performance changes. The findings establish that economic relationships exhibit fundamental asymmetries requiring specialized analytical approaches, with emerging market economies demonstrating distinct growth trajectories compared to developed nations. The regime-switching framework provides enhanced capabilities for international business strategy, investment analysis, and economic forecasting across diverse market conditions.

The paper ends with "The End"

1 Introduction

Economic growth patterns among the world's largest economies demonstrate persistent asymmetries that challenge conventional linear modeling approaches. The period from 2020 to 2024 presents a particularly compelling analytical framework, encompassing the global economic disruption from the COVID-19 pandemic and subsequent recovery phases across diverse economic systems. This study examines GDP per capita growth dynamics across 18 major economies, representing both developed and emerging market classifications, through the application of an innovative regime-switching methodology known as the Ghosh factor.

The Ghosh factor represents a piecewise logarithmic transformation that exhibits regime-switching properties based on the sign of dependent variables, enabling the capture of state-dependent behavioral responses and asymmetric economic relationships. This methodology addresses the empirically documented phenomenon that economic agents respond differently to identical stimuli depending on their current economic state, reflecting fundamental principles including loss aversion, threshold effects, and regime-dependent policy transmission mechanisms.

Our analysis reveals substantial economic disparities among the examined nations, with GDP per capita values ranging from approximately \$9,800 to \$75,500 in 2024. These figures demonstrate clear economic stratification among developed economies, emerging markets, and developing nations, providing a robust foundation for examining how different development stages influence growth dynamics and recovery patterns.

The research contributes to the literature on international economic development by establishing empirical validation for regime-switching approaches in cross-country analysis. Our dual regression framework achieves exceptional explanatory power, with R-squared values of 93.7% and 96.0% respectively, demonstrating that asymmetric economic relationships require sophisticated analytical frameworks beyond conventional linear approaches.

2 Literature Review and Theoretical Framework

2.1 Economic Growth Asymmetries

The theoretical foundation for asymmetric economic relationships extends from established behavioral economics literature demonstrating systematic differences in agent responses to gains versus losses [3]. Economic systems frequently exhibit different behavioral patterns during adverse conditions compared to favorable circumstances, creating regime-dependent relationships that conventional modeling approaches fail to capture adequately.

Business cycle research has documented that economic relationships exhibit different parameters during expansion and contraction phases [2]. These findings support the application of regime-switching methodologies to international growth analysis, particularly during periods characterized by significant economic disruption and recovery.

The concept of threshold effects in economic development suggests that relationships between growth determinants and outcomes may exhibit discontinuous characteristics at critical economic states [4]. This theoretical framework supports the implementation of piecewise transformation approaches that can capture these non-linear dynamics effectively.

2.2 The Ghosh Factor Methodology

The Ghosh factor for an independent variable $X > 0$ is defined as:

$$G_X = \begin{cases} \log(X) & \text{if } y < 0 \\ \log(1 + X) & \text{if } y \geq 0 \end{cases} \tag{1}$$

where y represents the dependent variable that determines the regime state. This specification creates two distinct transformation regimes based on the economic state indicator, reflecting the empirically documented phenomenon that economic agents respond differently to identical stimuli depending on their current economic state.

The mathematical properties reveal important economic insights. For any $X > 0$, we observe that $\log(1 + X) < \log(X)$, indicating that the gain state regime consistently produces lower transformed values than the loss state regime for identical input levels. This characteristic captures the economic reality that favorable conditions typically exhibit more conservative response patterns compared to adverse circumstances.

3 Data and Methodology

3.1 Data Description

Our analysis examines GDP per capita data for 18 major economies spanning the period 2020-2024, encompassing both developed and emerging market classifications. The dataset includes annual GDP per capita measurements alongside calculated five-year averages, statistical deviation measures, and multiple growth rate calculations.

The geographic coverage includes Japan, Australia, South Africa, United Kingdom, Canada, Germany, United States, France, Indonesia, Italy, Turkey, Mexico, Argentina, Brazil, Saudi Arabia, China, India, and Russia. This selection represents a comprehensive mix of economic development stages and regional diversity, enabling robust analysis of growth pattern variations across different economic contexts.

`The following space was deliberately left blank.`

Table 1: GDP Per Capita Summary Statistics (2024)

Economic Tier	Countries	Mean GDP	Min GDP	Max GDP
Developed (≥$45,000)	6	$62,450	$46,097	$75,492
Emerging ($15,000-$44,999)	8	$28,750	$15,234	$42,940
Developing (<$15,000)	4	$11,200	$9,817	$13,456

The dataset demonstrates substantial economic diversity, with 2024 GDP per capita values ranging from $9,817 to $75,492. This variation provides sufficient heterogeneity to examine how different economic development levels influence growth dynamics and regime-switching behavior patterns.

3.2 Empirical Specification

Our analytical framework implements dual regression specifications to examine bidirectional relationships between average growth rates (R_{Avg}) and changes in average performance (Δ_{Avg}) through the Ghosh factor transformation methodology.

The first regression specification examines how performance changes respond to growth dynamics:

$$\Delta_{Avg} = \alpha_1 + \beta_1 R_{Avg} + \gamma_1 G_{R_{Avg}} + \epsilon_1 \tag{2}$$

The second regression specification analyzes how growth rates respond to performance changes:

$$R_{Avg} = \alpha_2 + \beta_2 \Delta_{Avg} + \gamma_2 G_{\Delta_{Avg}} + \epsilon_2 \tag{3}$$

where $G_{R_{Avg}}$ and $G_{\Delta_{Avg}}$ represent the Ghosh factor transformations applied to the respective variables based on the regime-switching criteria established through the dependent variable signs.

4 Empirical Results

4.1 Regime Classification Analysis

Our analysis reveals a balanced distribution of economic regimes across the examined countries. The first regression model identifies 9 countries operating in loss state conditions ($\Delta_{Avg} < 0$) and 9 countries in gain state conditions ($\Delta_{Avg} \geq 0$). This balanced regime distribution validates the theoretical framework's applicability to diverse economic conditions.

Loss state economies include Japan, Germany, France, United Kingdom, Italy, South Africa, Russia, Turkey, and Saudi Arabia. These countries experienced negative changes in average GDP per capita performance during the analysis period, reflecting various structural and cyclical economic challenges.

Gain state economies comprise Australia, United States, Canada, Brazil, China, India, Mexico, Argentina, and Indonesia. These countries demonstrated positive performance changes, indicating successful navigation of the global economic disruption and effective implementation of recovery strategies.

4.2 First Regression Results: Performance Change Analysis

The first regression specification examining performance changes yields exceptional explanatory power with the following results:

$$\Delta_{Avg} = -0.009462 + 1.040188 \cdot R_{Avg} + 0.005671 \cdot G_{R_{Avg}} \tag{4}$$

Table 2: First Regression Results: Performance Change Model

Variable	Coefficient	Std. Error	t-Statistic	p-Value
Intercept	-0.009462	0.002145	-4.411	0.000
R_{Avg}	1.040188	0.087234	11.924	0.000
$G_{R_{Avg}}$	0.005671	0.001892	2.997	0.009
R-squared		0.9371		
Adjusted R-squared		0.9287		
F-statistic		111.67		

The intercept coefficient of -0.009462 represents baseline structural adjustment in economic performance when growth momentum factors are absent, suggesting inherent economic headwinds requiring positive growth to overcome. The R_{Avg} coefficient of 1.040188 demonstrates strong positive correlation between average growth rates and performance changes, with the coefficient exceeding unity indicating amplification effects in the economic system.

The Ghosh factor coefficient of 0.005671 captures differential impact of growth rates across economic regimes, validating the theoretical prediction that regime-switching transformations provide additional explanatory power beyond conventional linear relationships.

4.3 Second Regression Results: Growth Rate Analysis

The second regression specification examining growth rate responses achieves even superior explanatory power:

$$R_{Avg} = 0.017367 + 13.087858 \cdot \Delta_{Avg} - 12.629093 \cdot G_{\Delta_{Avg}} \tag{5}$$

Table 3: Second Regression Results: Growth Rate Model

Variable	Coefficient	Std. Error	t-Statistic	p-Value
Intercept	0.017367	0.001834	9.470	0.000
Δ_{Avg}	13.087858	0.945237	13.848	0.000
$G_{\Delta_{Avg}}$	-12.629093	0.967541	-13.052	0.000
R-squared		0.9602		
Adjusted R-squared		0.9549		
F-statistic		181.45		

The intercept of 0.017367 establishes baseline growth momentum of approximately 1.74% independent of performance change factors. The Δ_{Avg} coefficient of 13.088 demonstrates extraordinary sensitivity of growth rates to performance changes, indicating dynamic system responses to performance signals.

The negative Ghosh factor coefficient of -12.629 reveals that the logarithmic transformation creates moderating influence, tempering direct linear relationships and capturing diminishing marginal impacts at extreme performance changes.

`The following space was deliberately left blank.`

5 Discussion

5.1 Economic Interpretation and Policy Implications

The analysis reveals fundamental asymmetries in economic relationships that have significant implications for policy development and international business strategy. The regime-switching framework demonstrates that countries experiencing different economic states exhibit systematically different sensitivity patterns to growth and performance stimuli.

The superior explanatory power of the growth rate model (96.0% versus 93.7%) suggests that economic growth represents a more fundamental driver of system dynamics than performance changes. This relationship structure supports growth-focused policy interventions as potentially more predictable in their outcomes compared to performance-targeting strategies.

The balanced distribution of countries across loss and gain regimes during the 2020-2024 period reflects the complex global economic environment characterized by both recovery successes and persistent structural challenges. Emerging market economies demonstrate particular resilience, with countries like China, India, and Brazil achieving sustained positive performance changes despite global disruption.

5.2 International Business Applications

The regime-switching framework provides enhanced analytical capabilities for multinational business operations and investment portfolio management. Organizations can leverage these insights to optimize resource allocation and strategic positioning across different economic environments, with the Ghosh factor providing quantitative measures of how performance improvements translate into sustainable growth momentum.

The analysis supports sophisticated approaches to international market entry strategies, enabling businesses to better understand how economic conditions influence growth trajectories in target markets. The regime classification system provides early warning indicators for potential economic transitions that could affect business operations and investment returns.

5.3 Methodological Contributions

The exceptional statistical performance validates the Ghosh factor's theoretical foundations while demonstrating practical applicability to real-world economic analysis. The framework successfully captures complex non-linear relationships that traditional modeling approaches might overlook, providing enhanced analytical precision for business intelligence and strategic planning applications.

The dual regression approach reveals important bidirectional relationships between economic variables, with different explanatory power in each direction indicating the complex interdependencies that characterize modern economic systems. This methodology offers valuable enhancements to existing econometric capabilities for international development research.

6 Conclusion

This study establishes the Ghosh factor methodology as a valuable enhancement to international economic analysis, providing sophisticated capabilities for examining asymmetric growth relationships across diverse economic development stages. The analysis of 18 major economies during the 2020-2024 period demonstrates exceptional explanatory power through regime-switching approaches, achieving R-squared values exceeding 93% in both directional relationship specifications.

The findings reveal systematic differences in economic behavior across loss and gain state regimes, with emerging market economies demonstrating particular resilience during the analyzed period. The balanced distribution of countries across economic regimes validates the theoretical

framework's applicability to diverse economic conditions while providing enhanced analytical tools for business strategy and policy development.

The regime-switching framework offers significant advantages over conventional linear approaches by capturing the fundamental asymmetries that characterize real economic relationships. These capabilities support more sophisticated approaches to international business strategy, investment analysis, and economic risk management across varying market conditions.

Future research should focus on extending this methodology to longer time series analysis and incorporating additional economic indicators to further validate the regime-switching framework's predictive capabilities. The theoretical foundation established through this analysis provides a robust platform for enhanced econometric modeling in international development research.

References

[1] Ghosh, S. The Ghosh factor, Kolkata, India.

[2] Hamilton, J. D. (1989). A new approach to the economic analysis of nonstationary time series and the business cycle. *Econometrica*, 57(2), 357-384.

[3] Kahneman, D., & Tversky, A. (1979). Prospect theory: An analysis of decision under risk. *Econometrica*, 47(2), 263-291.

[4] Krugman, P. (1991). Increasing returns and economic geography. *Journal of Political Economy*, 99(3), 483-499.

[5] Akerlof, G. A. (1970). The market for "lemons": Quality uncertainty and the market mechanism. *The Quarterly Journal of Economics*, 84(3), 488-500.

[6] Ball, L., & Mankiw, N. G. (1994). Asymmetric price adjustment and economic fluctuations. *The Economic Journal*, 104(423), 247-261.

[7] Bernanke, B. S., & Gertler, M. (1989). Agency costs, net worth, and business fluctuations. *The American Economic Review*, 79(1), 14-31.

[8] Cover, J. P. (1992). Asymmetric effects of positive and negative money-supply shocks. *The Quarterly Journal of Economics*, 107(4), 1261-1282.

[9] Lucas Jr, R. E. (1976). Econometric policy evaluation: A critique. *Carnegie-Rochester Conference Series on Public Policy*, 1, 19-46.

The End