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Determinants of Economic Growth in D-8 Countries: The Role of Financial Integration, Human Development, and Climate Change

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Abstract:

This study investigates the primary determinants of economic growth in D-8 countries by examining the roles of financial integration, human development, and climate change. Using a panel dataset covering the period from 2002 to 2022, we apply both dynamic system GMM and quantile regression techniques to account for heterogeneity, endogeneity, and distributional differences in growth responses. Our findings indicate that financial integration does not have a consistently significant effect on growth, suggesting that its potential benefits are conditional on domestic absorptive capacities and institutional quality. In contrast, human development emerges as a key driver of economic growth, although its short-term impact appears muted in some specifications. Environmental indicators confirm a nonlinear relationship consistent with the Environmental Kuznets Curve (EKC), wherein emissions initially rise with income but decline beyond a threshold. These results underscore the importance of strategic policy alignment ensuring that financial openness supports productive investment, human capital development is prioritized, and climate policies are integrated into growth agendas.

Key words: Economic Growth; Financial Integration; Human Development ; Climate Change ; D-8 Countries.

JEL Classification Codes: O40, G15,O15, Q54.

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1. Introduction:

Understanding the key drivers of economic growth remains a central concern in development economics, especially for emerging economies striving to balance expansion with social inclusion and environmental sustainability. Among the most salient drivers are financial integration (FI), human development (HD), and climate change (CO2) each a complex, interlinked force with the potential to accelerate or hinder national progress.

For the D8 countries Bangladesh, Egypt, Indonesia, Iran, Malaysia, Nigeria, Pakistan, and Turkey this question carries particular urgency. These economies face demographic pressures, uneven industrial structures, and diverse experiences with financial openness and environmental vulnerability. While financial integration can enhance growth via improved capital allocation, risk diversification, and foreign direct investment (Henry, 2000), its benefits are often conditional on institutional maturity and financial market development. Similarly, human development measured through education, health, and life expectancy underpins labor productivity and innovation, serving as both a cause and effect of economic performance. Climate change, meanwhile, introduces profound long-term risks. Although the Environmental Kuznets Curve (EKC) hypothesis suggests that emissions may decline as incomes rise, the income threshold and policy readiness needed for this transition remain uncertain for many D8 members.

However, despite extensive literature on each dimension individually, few studies have integrated these factors into a unified empirical framework. Even fewer have examined their relative and interactive effects on economic growth in diverse developing contexts. This presents a critical gap: development strategies that emphasize financial openness may fall short if human development lags or climate impacts intensify. Conversely, prioritizing environmental goals without complementary investment in human capital or capital flows may constrain growth.

This study seeks to fill that gap by empirically assessing the relative importance and interactions among financial integration, human development, and climate change in explaining economic growth across the D8 economies. The main questions is:

To what extent do financial integration, human development, and climate change determine economic growth in the D-8 countries?

To answer these, we employ a panel econometric framework covering 2002–2022, incorporating both linear and nonlinear specifications, including threshold and interaction models. This design allows us to test the EKC hypothesis while evaluating how combinations of financial, social, and environmental variables shape growth trajectories. By providing a comparative and integrative analysis, this paper contributes to development policy debates in countries seeking inclusive and sustainable growth.

The organization of the paper is Section 2: reviews the relevant literature. Section 3 describes the data and methodology. Section 4 reports and discusses the findings. Section 5 concludes with policy recommendations tailored to the D8 context.

2. Literature Review and hypothesis development

The importance of regional and global financial integration lies in the adoption by many countries of the world of policies of openness and economic liberalization since the late 1980s, lifting restrictions and easing control over the movement of capital, reducing its costs, raising the efficiency of allocation, diversifying financial investment tools to accumulate savings for the purpose of increasing investment, modernizing trading systems and simplifying portfolio diversification procedures. Settlement and access to finance, especially for micro, small and medium enterprises and boost the real economy by enabling businesses to invest and create jobs. Bong and Premaratne (2019) found that capital inflows enhanced productive efficiency when corruption was low and macroeconomic conditions were stable. Also, (Selvarajan & Ab-Rahim, 2020) noted that the benefits of integration in Asia were more pronounced before the 1997 crisis, highlighting the importance of aligning regional cooperation with domestic policy realities. (Chen & Quang, 2012) contributed to the debate by highlighting the threshold effects of financial integration. Their findings propose that benefits are more likely to materialize in countries with adequate financial sector maturity and macroeconomic resilience. In Turkey, (OZTURK, 2008) pointed out a reverse causality where economic growth led to financial development, indicating that the sequencing of reforms and development strategies plays a vital role.In North African economies such as Algeria, Tunisia, and Morocco, financial openness has been linked to favorable long-run growth trends. (Zenasni, 2015) using an ARDL model, showed that increased integration had a positive effect on economic performance in the long term. For D-8 countries, which share similar structural and institutional features, these findings offer relevant policy insights. Nassani et al. (2025) demonstrated that financial openness, when aligned with renewable energy investment and green technology transfer, supports sustainable growth. Their work, focused on European and Central Asian economies, reveals that effective integration can be a vehicle for climate-resilient development.

***H1**: Financial integration significantly affects economic growth in D-8 countries.*

Human development is measured through several indicators, the most important of which are education, health, and living standards, as a determining factor and result of economic growth. Applied results in this field indicate that human development significantly impacts economic growth, enhancing productivity and increasing human capital, and contributing to increased investment and innovation. When countries invest in human capital, they achieve gains in productivity, innovation, and investment attractiveness. (Kumar , Kaur, Radulescu , Kalaš , & Hagiu , 2025) emphasized the validity of this relationship in BRICS+ economies, as human development has greatly enhanced economic growth, including environmental sustainability.

(RANIS & STEWART, 2000) also proposed a two-way causal relationship framework and stressed the need to focus on initial investments in health and education to promote growth and development. Countries focusing only on economic expansion without considering the necessity of achieving corresponding human development often face stagnation. Looking at the case of developing countries, (Gulcemal, 2020) found a positive long-term impact of the Human Development Index on GDP in 16 developing countries.

***H2**: Human development has a positive impact on economic growth.*

The environmental Kuznets curve (EKC) assumes an inverted U-shaped relationship between economic growth and environmental degradation where emissions rise in the early growth stages and fall after reaching a certain income level. Empirical evidence from Africa and Asia supports the EKC hypothesis but also reveals the complexity of the interactions between climate and the economy; Therefore, talking about environmental sustainability has become an essential dimension of economic development, especially in light of the increasing impact of climate change. The results of Rice and (iman & mourad, 2022) showed that a 1° warming decreased GDP per capita by 1.68% in the short term and 2.45% in the long term in 34 African countries. Hence, these findings highlight the deep economic vulnerabilities posed by climate change, especially in agriculture-dependent economies. (Akram, 2012) asserted that climate variability, including temperature and precipitation fluctuations, negatively affected economic performance in many Asian countries. Although factors such as urbanization and human development mitigated some of the negative impacts, the overall impact remained significant, underscoring the importance of tailor-made adaptation policies. (Nassani, Imran, M, Khan, S, Haroon , & Mohamed , 2025)

examined the effects of renewable energy and green technology investments in upper-middle-income economies. The results reaffirmed the inverted U-shaped relationship between emissions and growth, while also showing that a lack of sustainable infrastructure and weak financial systems limit long-term gains.

***H3**: Climate change indicators significantly influence economic growth.*

3. Materials and methods

This study examines six D-8 countries, excluding Nigeria and Iran, over the period 2002 to 2022. These countries were selected based on their shared aspirations for economic progress, while showing significant differences in levels of financial integration, environmental vulnerability, and human development achievements. By excluding Nigeria and Iran, the sample gains greater institutional and macroeconomic consistency and reduces data limitations, thereby enhancing the robustness of cross-country comparisons. The study period was chosen from 2002 to 2022 to study structural transformations, especially those related to global financial instability, increased awareness of climate risks, and the development of comprehensive development policies. This timeframe includes critical events, such as the global financial crisis of 2008 and the increased focus on sustainable development and regional integration, that have shaped economic strategies across the D8 region. Focusing on D8 members provides a useful perspective on regional economic strategies and the nature of cooperative frameworks among countries with compatible development priorities.

Table 1: List of variables

Variables	Symbol	Unit	Source
Dependent variable			
Real economic growth	REG	Constant 2015 US$	World Bank
Independent variables			
Financial integration			
Financial integration as port-folio investment	FINT	Current US$	Our world in data
Trade policy	TPOL	% of GDP	Our world in data
Climate change factor			
Carbon emissions	CO2	Metric tonnes annual	Our world in data
Square of carbon emissions	SQCO2	Square of Metric tonnes annual	Author's estimate
Human development		-	
Human development index	HDI		Human development Reports
Interaction terms			
Foreign direct investment	FDI	Foreign direct investment, net inflows (% of GDP)	World Bank

Source: Author's estimate.

The study adopts a model grounded in established economic growth theory. The analytical foundation is based on the frameworks proposed by Barro (1990) and Mankiw et al. (1992), which underscore the importance of human capital, policy factors, and institutional structures in shaping long-term growth differences across nations. By using the Generalized Method of Moments (GMM) estimator, methodological challenges, such as endogeneity, are addressed by incorporating insights from (Bond, Hoeffler, & Temple, 2001).

Given the potential for two-way causality between variables such as financial integration, climate change, and human development, a dynamic panel data model is used. By including lagged values of GDP, the GMM method improves the reliability of estimated transactions and captures the evolving nature of economic growth processes. The drivers of growth in the D-8 context can be understood more precisely and policy-related using this approach.

This study aims to estimate how human development, financial integration, and environmental pressures interact to influence economic growth in the selected countries over time.

$$REG_{i,t} = C + \beta_1 REG_{t-1} + \beta_2 FINT_{i,t} + \beta_3 TPOL_{i,t} + \beta_4 CO2_{i,t} + \beta_5 SQCO2_{i,t} + \beta_6 HDI_{i,t} + \beta_7 FDI_{i,t} + \epsilon t$$

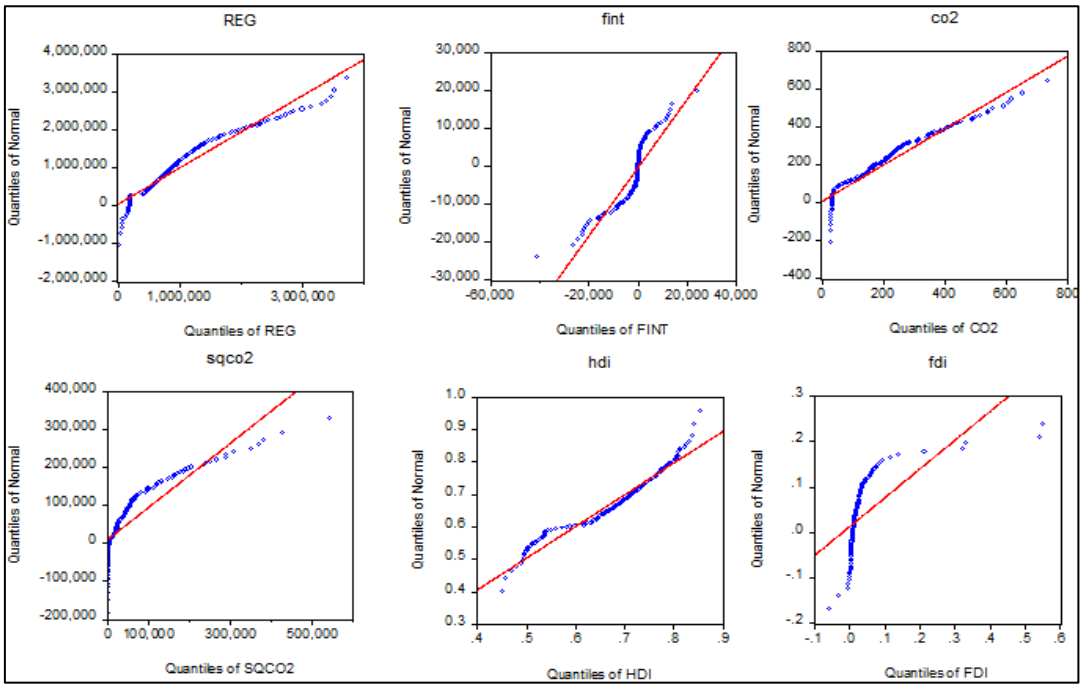
Where: C is the intercept term, i denotes cross-section countries,t denotes the time period of the sample, ϵt is the error term.

4. Empirical results

4.1. Quantile–quantile distribution:

Figure 2 shows plots of quantile–quantile (Q–Q) for the variables under study, providing a graphical comparison between their empirical distributions and the normal distribution. The results shown in the figure above indicate that many variables, most notably real economic growth (REG), financial integration (FINT), and foreign direct investment (FDI), show significant deviations from the normal situation, especially in the tails of the distribution. The observed deviations in environmental variables, such as carbon dioxide emissions (CO2) and its squared term (SQCO2), suggest skewness or heavy tail behavior. In contrast, the human development index (HDI) demonstrates a distribution that more closely approximates normality. These findings underscore the non-normal nature of much of the dataset and justify the application of the dynamic panel GMM estimator, which is well-suited for addressing such statistical irregularities and for correcting potential endogeneity, thus enhancing the reliability of the empirical results.

Figure 2: Quantile–quantile distribution plots



Source: Author's illustrate

4.2. Unit root test:

Table 2 summarizes the outcomes of the Phillips–Perron Fisher unit root test, alongside the panel cointegration and cross-sectional dependence assessments. The results reveal that most variables are non-stationary in their level form but attain stationarity upon first differencing, indicating they are integrated of order one, I(1). For instance, real economic growth (REG), trade policy (TPOL), CO_2 emissions (CO2), and the Human Development Index (HDI) all exhibit unit root behavior at level but become stationary after differencing. However, financial integration (FINT) and foreign direct investment (FDI) appear to be stationary in levels, suggesting they may follow a trend-stationary process.

The Pedroni residual cointegration test does not provide evidence of a stable long-run relationship among the study variables, as the Augmented Dickey–Fuller statistic (–0.226) is statistically insignificant (p = 0.436). Additionally, Pesaran's cross-sectional dependence test yields a CD statistic of –0.107 with a p-value of 0.914, indicating that cross-sectional interdependence is not a concern in this panel. This implies that the countries under study behave relatively independently in terms of economic dynamics, supporting the appropriateness of the econometric methodology.

Taken together, these diagnostic results support the use of the dynamic panel Generalized Method of Moments (GMM) approach. Given the presence of mixed integration orders and the absence of cointegration, the system GMM estimator is

particularly suitable, as it effectively addresses potential endogeneity and heterogeneity across countries, ensuring robust inference in the context of panel data.

Table 2: Phillips-Perron Fisher Unit Root Test, Panel Cointegration Estimates, and Cross-Sectional DependenceTest

Variables	Level		First Difference	
	PP—Fisher Chi-square	PP—Choi Z-stat	PP—Fisher Chi-square	PP—Choi Z-stat
REG	1.67547	7.1856	75.6705***	– 5.43671***
FINT	47.9318***	- 4.74928***	219.568***	– 13.1752***
TPOL	13.1326	1.60924	74.7153***	– 6.21335***
CO2	9.33098	2.92581	115.968***	– 8.82219***
HDI	19.2555	0.999905	51.8128***	-4.96313
FDI	48.6572***	-3.45856***	211.929***	– 9.93533***

Pedroni residual cointegration test estimates				
ADF (t-statistics)	- 0.226	Prob.value	0.436	Not cointegrated
Cross-section dependence test				
Pesaran CD	-0.107	Prob.value	0.914	No cross-section
Dependence				

Source : Author's estimate. ***, **, and * indicates 1%, 5% and 10% significance level.

4.3. Panel GMM Estimates

Table 3 reports the dynamic panel Generalized Method of Moments (GMM) estimates, using real economic growth (REG) as the dependent variable. The coefficient on the lagged dependent variable REG(–1) is positive and highly significant, confirming the persistence of economic growth and the dynamic nature of the growth process in D8 countries. This aligns with the convergence theory, where past income levels influence current growth rates, as emphasized in (Barro & Sala-i-Martin, 2004) and confirmed by recent panel data studies (Roodman, 2009).

Table 3: Panel GMM Estimates

Dependent variable: REG				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob**
REG(-1)	1.19E – 06	1.38E – 07	8.605659	0.0000
FINT	3.63E – 07	3.05 E -06	0.119080	0.9054
TPOL	0.156629	0.094467	1.658036	0.0997
CO2	0.004624	0.000679	6.806613	0.0000
SQCO2	-9.53E – 06	8.02E – 07	-4.591564	0.0000
HDI	-1.440769	0.313786	-4.591564	0.0000
FDI	-2.883080	0.352234	-8.185125	0.0000
C	12.99268	0.179807	72.25918	0.0000
Statistical Test				
R^2	0.917910	S.E. of regression	0.2772636	
	0.272636			
Adjusted R-squared	0.913556	Instrument rank	8	8

Source: Author's estimate

The coefficient associated with financial integration (FINT) is positive yet lacks statistical significance. This outcome could imply that the influence of cross-border capital flows on economic expansion in emerging markets may be indirect or subject to delays. As suggested by (Eswar S, Kenneth , Wei, & Kose, 2007) and more recently by (Almekinders, Fukuda, Mourmouras, Zhou, & Zhou, 2015), the gains from financial openness are typically realized in economies with strong domestic institutions, prudent macroeconomic policies, and a sufficient level of absorptive capacity—conditions that are not uniformly present among D-8 nations.

Trade policy (TPOL) appears to exert a positive influence on economic growth, with significance at the 10% level. This result implies that trade liberalization measures, such as reducing tariff and non-tariff barriers, could enhance economic outcomes. Although the statistical significance does not persist across all model specifications, the general finding aligns with (Irwin, 2020), who emphasizes that trade liberalization in developing countries can yield positive outcomes, particularly when accompanied by supportive domestic policy frameworks.

Regarding environmental indicators, the relationship appears non-linear. Carbon dioxide emissions (CO_2) are positively and significantly associated with economic growth, whereas the squared term (SQCO2) shows a strong negative significance. This suggests the presence of an inverted U-shaped Environmental Kuznets Curve (EKC), where pollution initially increases with income but declines after surpassing a critical income level. These results are consistent with prior findings from (Rongrong , Qiang , & Jiale , 2024), who observed similar patterns in emerging and middle-income economies.

Unexpectedly, the Human Development Index (HDI) coefficient became significantly negative. This may indicate that, in the short term, increased investment in social sectors such as health and education could be associated with lower growth, due to delayed returns or structural challenges in economies that rely on low-productivity sectors. (Ranis & Stewart , 2020) emphasize that the positive impact of human development is often reversed over time, especially in environments constrained by institutional and labor market inefficiency.

Results show that foreign direct investment (FDI) has a strong and statistically significant negative impact on growth. Although foreign direct investment is generally viewed as a channel for technology diffusion and capital accumulation, the negative relationship in this context may reflect the dominance of investment in low-value or resource-based industries, which provide only limited spillover effects, a result that deviates from conventional economic theory but aligns with the perspective of (Gunby, Jin, & Robert Reed, 2017), who emphasize that the effectiveness of FDI depends critically on sectoral allocation, institutional quality, and governance structures. The GMM system model used in the analysis shows high explanatory power, with an R^2 value of 0.918. The rank of the tool (8) indicates a well-designed model specification.

4.4. Median Quantile Regression

Table 4 summarizes the median 50% quantile regression results, offering a robust depiction of how explanatory factors influence real economic growth (REG) while accounting for heterogeneity across the data distribution. Unlike traditional mean-based approaches such as OLS, quantile regression minimizes the influence of outliers and skewed data, enabling a more detailed analysis of how variables behave at different points within the growth distribution (Koenker & Hallock, 2001).

Table 4 : Median Quantile Regression Estimates

Dependent variable: REG				
Method: quantile regression (Median)				
Variables	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob**
FINT	3.38E – 06	1.80E – 06	1.879941	0.0622
TPOL	-0.315849	0.088741	-3.559231	0.0005
CO2	0.007169	0.001421	5.045862	0.0000
SQCO2	-5.18E – 06	1.55E -06	-3.349127	0.0010
HDI	-0.019034	0.633678	-0.030038	0.9761
FDI	-3.061531	0.371754	-8.235363	0.0000
C	12.81763	0.163753	78.27394	0.0000
Statistical test				
Pseudo R^2	0.685159	Quasi-LR statistic		526.0022
Adjusted R^2	0.671666	Prob(Quasi-LR stat)		0.00000

Source: Author's estimate.

The results show a significant direct relationship between financial integration (FINT) and economic growth at the level of 10% (p = 0.0622), which means a modest correlation between financial openness and average economic growth. This suggests that increased capital mobility, financial market liberalization and cross-border investment will contribute incrementally to enhancing productivity. This interpretation is in line with the results of (Ayhan Kose, Prasad , & Taylor, 2011) and (Almekinders, Fukuda, Mourmouras, Zhou, & Zhou, 2015), who highlight that the potential of growth-enhancing financial globalization often unfolds gradually. However, the relatively low statistical power of the relationship points to institutional weaknesses and insufficient absorptive capacity within the D-8 countries, which may constrain the wider gains expected from financial integration. While trade policy (TPOL) shows a statistically significant negative impact on growth ($p < 0.01$), suggesting that recent trade policy actions in the sample have exerted deflationary effects at the average level. This may reflect structural trade barriers, non-optimal policy implementation or mismatch between trade strategies and national development agendas. These findings are consistent with (Rodrik, 2018), who warns of the negative aspects of early-stage trade liberalization in economies lacking diversified industrial bases or competitive export sectors.

Carbon dioxide emissions $_2$ (CO2) and (SQCO2) confirm a statistically significant nonlinear relationship with economic growth, which appears as an inverted U-shaped environmental Kuznets curve (EKC). An initial positive correlation with emissions, followed by a negative impact at higher levels, suggests that environmental degradation can stimulate growth until a tipping point, after which its negative consequences outweigh the benefits. This pattern reflects the theoretical framework developed by (Gene M & Alan B, 1995).

In the case of human development (HDI), the regression reveals a negligible and close to zero coefficient, indicating no measurable short - to medium-term impact on economic growth at the median quantity. This can be attributed to the lagged nature of the returns on investments in health, education and social welfare. As noted by (Ranis, Stewart, & Ramirez, 2000), the relationship between human development and economic performance is complex and is often shaped by structural and institutional conditions, which may delay or mask the effects of their growth in developing economies. Unexpectedly, foreign direct investment (FDI) exhibits a significantly negative coefficient ($p < 0.01$), implying that increased FDI inflows may be linked to lower growth outcomes at the median. This may reflect a dominance of investments concentrated in resource-extractive or capital-intensive sectors with limited integration into the domestic economy. The findings are consistent with (Gunby, Jin, & Robert

Reed, 2017), who emphasizes that without strategic policy direction and careful sectoral targeting, FDI can displace domestic enterprises or exacerbate structural vulnerabilities rather than contribute to inclusive growth.

The model's explanatory capacity is substantial, as evidenced by a pseudo R^2 of 0.685, indicating that nearly 69% of the variation in median growth is accounted for by the selected variables. The highly significant Quasi-LR statistic ($p < 0.001$) affirms the collective relevance of the model, and the adjusted R^2 of 0.671 further underscores its empirical robustness and suitability for capturing median growth dynamics in the D-8 context.

5. Conclusion :

This study explored the relative impact of financial integration, human development, and environmental pressures on economic growth in D-8 countries between 2002 and 2022. Using both system GMM and quantile regression approaches, we found mixed evidence across methods and indicators. Financial integration showed weak or insignificant effects on growth, reinforcing the idea that capital inflows alone are insufficient without strong institutions and strategic allocation mechanisms. Human development displayed inconsistent results positive in some cases, negligible or negative in others highlighting the long-term nature of its returns and the role of underlying structural conditions. Climate change effects followed an inverted U-shaped pattern, confirming the EKC hypothesis: economic growth initially correlates with higher emissions, but beyond a certain income threshold, environmental degradation slows or reverses.

These findings suggest that no single factor unilaterally drives economic performance. Instead, growth outcomes depend on the complex interaction between institutional capacity, investment quality, social inclusion, and environmental policy. To foster sustainable development, D-8 countries should pursue coordinated strategies that:

- Prioritize long-term investments in education and healthcare;
- Strengthen financial governance and domestic market development before deepening external integration;
- Encourage sectorally targeted, value-added foreign direct investment;
- Integrate green growth and climate resilience into national economic strategies.

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