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ECONOMIC GROWTH CONVERGENCE AND RESILIENCE AMIDST THE COVID-19 PANDEMIC IN INDIAN STATES: INSIGHTS AND FUTURE TRAJECTORIES

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Abstract: This extensive inquiry investigates the economic growth and convergence dynamics exhibited by Indian States and Union Territories (U.T.) from 1991 to 2022, employing an advanced analytical framework integrating augmented Solow and extended Solow models. Absolute, sigma, and conditional convergence are scrutinized, with consideration given to the impact of the COVID-19 pandemic on these patterns. Despite a uniform impact of COVID-19 on GDP per capita, convergence patterns remain unchanged, as evidenced by consistent results in sigma convergence. Empirical findings challenge the notion of absolute convergence, revealing a lack of statistically significant negative correlation between the initial per capita GDP ratio and average annual growth rate. Conditional convergence is computed at a rate of 0.038, emphasizing the multifaceted nature of this phenomenon involving GDP per capita, physical and human capital, and population growth. The extended Solow growth regression underscores that factors beyond initial per capita income significantly contribute to observed growth and convergence dynamics, advocating for comprehensive and integrated policymaking to stimulate sustained economic growth and convergence in the Indian States. Strategies proposed include prudent budgetary policies, fertility rate control, effective monetary policy management, and a holistic developmental approach.

Keywords: Convergence; Economic Growth; COVID-19; Indian States.

JEL codes: O11, Z32, C01

1. ECONOMIC CONVERGENCE: UNRAVELING NATURE AND PATTERNS

The concept of convergence in growth economics encapsulates the phenomenon wherein developing countries or regions exhibit a propensity to grow at an accelerated pace compared to their developed counterparts, ultimately narrowing the per capita income differentials between diverse regions. Rooted in neoclassical economics, this perspective is predicated on the premise of diminishing returns to capital. Under this framework, developing regions with lower capital-labor ratios are anticipated to yield higher marginal returns on investments vis-à-vis affluent regions with higher capital-labor ratios. The corollary is the expectation that, over time, all regions should converge to a uniform steady-state income level, contingent upon the assumption of constant growth rates in savings, population, and technology across regions. This form of convergence is denoted as absolute or unconditional β convergence. Empirical verification of absolute convergence typically manifests in a statistically significant negative relationship between income growth and the initial level of per capita income.

An alternative metric, Sigma (σ) convergence, gauges the dispersion of per capita incomes across regions over time, with a diminished dispersion supporting the hypothesis of unconditional convergence. However, empirical support for the neoclassical prediction of eradicating development gaps over time is not universally robust, except for instances where certain regions have notably progressed towards attaining the benchmarks of industrialized counterparts. Sabbaghpoor-Fard (2013) (1) underscores the significance of the ongoing debate on economic growth and convergence, highlighting the widening gap for some poor countries, thereby challenging neoclassical growth theory and raising concerns about the Solow growth model (1956) (2). Two primary critiques center on the assumptions of diminishing returns to capital and the exogenous nature of technology, treated as a public good accessible uniformly to all economies. Romer (1986, 1990) (3-4) counters the Neoclassical Growth Model's inadequacy in explaining the long-run growth path, especially within a diverse sample of regions with heterogeneous characteristics influencing distinct steady-state income levels.

Conditional convergence, as posited by Romer, suggests that affluent regions may outpace their less developed counterparts, resulting in divergent per capita income trajectories. It is noteworthy that unconditional convergence holds only among regions sharing common characteristics such as savings preferences, population growth rates, and production functions. The lack of robust empirical evidence supporting the unconditional convergence property of neoclassical growth theory [Solow-Swan model (1956) (5)}, catalyzed a significant debate in the 1980s, prompting a revaluation of economic growth and convergence. This led to the rise of endogenous growth theory, challenging the assumption of diminishing returns to capital and advocating for constant or increasing returns.

Endogenous growth models incorporate human capital in the production function to counterbalance diminishing returns, asserting that technological progress hinges on the proportion of income allocated to R&D, education, and skill development, thereby rendering growth endogenous. This offers an alternative explanation for the widening development gap between affluent and less developed regions, suggesting the potential for divergence rather than convergence.

This study serves two principal objectives: firstly, to assess the mutual exclusivity of different growth theories and, consequently, scrutinize the validity of the convergence hypothesis within the context of the Indian States; secondly, to examine the impact of variables such as government intervention, globalization, and both physical and human capital formation on growth performance. This investigation is pivotal given the Indian States' exposure to diverse planning models over their seventy-five years of independence, transitioning from a centrally planned closed economic system to various phases of the market economy. Thus, this study contributes uniquely to the extant literature on growth and convergence by focusing on the Indian States, an endeavor hitherto unexplored. The paper unfolds in a structured manner, commencing with an introduction elucidating the theme's background, followed by a comprehensive literature review incorporating both theoretical and empirical studies on growth and convergence. Subsequent sections provide historical and economic performance information about the Indian States, delving into empirical studies on absolute and sigma convergence with due consideration of the COVID-19 pandemic. The paper culminates in the estimation and presentation of empirical results derived from the augmented Solow and extended Solow models.

2. A REVIEW OF LITERATURE - EXPLORING ECONOMIC GROWTH AND CONVERGENCE:

This comprehensive literature review engages with the ongoing discourse among economists concerning the disparities in economic growth rates witnessed across countries. Tracing the historical perspectives on economic growth, the review initiates with the insights of classical economists, specifically Adam Smith (1776) (6) and David Ricardo (1857) (7), exploring their emphasis on capital accumulation, labor productivity, and the division of labor as pivotal determinants of growth. Smith emphasized the impact of capital accumulation on labor productivity and highlighted the division of labor as a key determinant of growth. In contrast, Ricardo predicted a stationary state due to diminishing returns in agriculture and was supported by Karl Marx's theory (Thirlwall, 2011) (8) of the long-term collapse of capitalist economies. Furthermore, the review investigates the evolution of economic growth theories, beginning with Harrod's dynamic theory and transitioning to Solow's neoclassical growth model. The Solow model, predicting convergence due to diminishing returns to capital, is juxtaposed with the endogenous growth model, which challenges the assumption of diminishing returns and introduces human capital and R&D expenditure.

Harrod's (1939) (9) dynamic theory, while focusing on steady-state growth and capital accumulation, grappled with issues of instability due to fixed technical coefficients. Solow's neoclassical growth model, addressing this rigidity, introduced flexibility in factor prices and production factor substitutability. The model predicted convergence, positing that poorer countries would grow faster than wealthier ones until reaching a steady state. However, this prediction faced empirical challenges when applied to a broader sample of countries, revealing heterogeneity and negating the concept of universal convergence [(Snowdon & Vane, 2005) (10); (Jones & Vollrath, 2013) (11)].

The subsequent introduction of the endogenous growth model, relaxing the assumption of diminishing returns to capital, expanded the definition of capital to include human capital and R&D expenditure. This shift allowed for constant or increasing returns, investing a critical determinant of long-term economic growth. Empirical evidence, such as the findings of Barro and Salal-i-Martin (1990) (12), supported both absolute and conditional convergence, with factors like sound macroeconomic indicators and external finance influencing growth trajectories.

Moving into empirical studies, the review delves into various regions and countries, exploring convergence dynamics. Noteworthy studies encompass transition economies, Latin America, ASEAN countries, Africa, OIC countries, German states post-reunification, and the Czech Republic and Slovakia [Dobson and Ramlogan (2002) (13); Urmas Varblane and Priit Vahter (2005) (14)]. The empirical findings range from absolute and conditional convergence to cases where conditional convergence is influenced by factors like human capital, physical capital, infrastructure, and external financial support [Menbere (2005) (15); Madhusudan Ghosh (2006) (16); Ismail (2008) (17); Djennas and Ferouani (2014) (18); Umut Unal (2014) (19); Gömleksiz, Şahbaz, and Mercan (2017) (20); Michal, Havrlant, Kuenzel, and Monks (2018) (21)]. The nuances in these convergence dynamics highlight the multifaceted nature of economic growth.

The concept of conditional convergence has emerged as a critical framework in the study of regional economic disparities, particularly evident in the heterogeneous landscape of Indian states. Traditional notions of absolute convergence, which presuppose uniformity in economic growth rates across regions, are challenged by the diverse geographic, demographic, and socio-economic characteristics of these states. Cross-sectional analyses of Indian states have consistently negated the presence of absolute convergence, underscoring the complex regional disparities inherent in the country's economic landscape.

Barro and Sala-i-Martin (1992) (22) introduced the concept of conditional convergence within the framework of the neoclassical growth model (NGM) to better capture the nuanced variations in steady-state incomes among regions. This departure from the assumption of uniform convergence acknowledges the disparities in initial economic conditions and their impact on the pace of convergence. Conditional convergence, as expounded in the economic growth literature by Sala-i-Martin (1996) (23), elucidates a negative relationship between growth rates and initial income levels, highlighting that regions with lower initial incomes tend to grow faster.

The intricacies of conditional convergence underscore the multifaceted determinants of economic growth, particularly in the context of Indian states. Factors such as population dynamics, capital accumulation, human capital formation, export levels, government expenditure, inflation rates, and other pertinent parameters collectively shape the trajectory of GDP per capita. Understanding the role of these factors is essential in comprehending the diverse economic realities across regions and formulating effective policy interventions to address regional disparities and promote inclusive growth.

In the realm of conditional convergence, Bassanini, Scarpetta, and Hemmings (2001)(24) have made a significant contribution by introducing a dynamic growth model equation that elucidates the underlying mechanisms of this phenomenon. This equation serves as a fundamental framework for comprehending the complex interactions among variables influencing economic growth trajectories, particularly in the context of the diverse Indian states. Emphasizing the pivotal role of initial conditions, their model underscores how various factors converge over time, shaping the trajectory of economic development across regions. By providing a theoretical foundation rooted in empirical analysis, their work enriches the discourse on conditional convergence and offers valuable insights for policymakers and researchers seeking to address regional disparities and foster inclusive growth strategies.

$$\begin{aligned}\Delta \log y_{it} &= \beta_{0i} - \phi_i \log y_{i,t-1} + \beta_{1,i} \log sk_{i,t} - \beta_{1,i} \log n_{i,t} + \beta m + 1, it + \Delta \log ski, t \\ &+ \alpha 2, i \Delta \log ni, t + \epsilon i, t\end{aligned} \tag{3}$$

In the exploration of conditional convergence, analysis often employs an equation incorporating various key variables. In this equation, y_{t-1} represents the lagged dependent variable, φ denotes the convergence parameter, sk signifies the investment share in GDP, n represents population growth, and t denotes the time trend. Additionally, α captures short-term dynamics, while ε accounts for the error term specific to the country or region under consideration. This framework, integrating lagged dependent variables, investment shares, population growth, and time trends facilitates a nuanced investigation of the underlying dynamics associated with conditional convergence.

Barro (1991) (25) laid the foundation for a comprehensive framework for examining conditional convergence, commonly referred to as the "extended version of the Solow growth model." This expanded model introduced by Barro incorporates a broader array of macroeconomic, socio-economic, and demographic indicators that influence economic growth. The Extended Barro equation extends the original Solow equation by incorporating additional variables.

Estimation of the extended Solow equation involves consideration of critical determinants of economic growth, including GDP per capita growth rate, gross capital formation, human capital, population growth rate adjusted for depreciation, life expectancy, and government consumption. Each of these variables contributes to the multifaceted dynamics shaping economic growth. The inclusion of these additional regressors in the extended Solow growth model facilitates a more comprehensive understanding of the factors impacting the convergence of economies. This augmented model enriches the analytical framework by accounting for a broader set of influences, thereby enhancing the precision and relevance of the analysis of conditional convergence in diverse economies and regions.

$$\log yt - \log y_0 = vi - \beta 1 \log y0 + \beta 2 \log sk + \beta 3 \log hk - \beta 4 \log(n + \delta + g) + \beta 5 \log GC + \beta 6 \log LE + \theta t \tag{4}$$

In the expanded model, additional variables are incorporated to offer a more comprehensive understanding of the factors influencing economic growth. These include In, representing the rate of inflation, GC, denoting government consumption as a percentage of GDP, and LE, representing life expectancy at birth. The previously defined terms in the model remain unchanged. Additionally, the ratio of exports to GDP is introduced as an indicator of economic openness, in alignment with insights from Pereira and Xu (2000) (26). This ratio serves as a crucial measure reflecting the extent to which an economy engages with global markets. Increased exports are associated with economies of scale and heightened productivity, as asserted by Grossman and Helpman (1990) (27). Empirical evidence further corroborates the existence of a long-run relationship between exports and GDP growth, highlighting the role of exports as a driver of economic expansion (Suleiman & Hemed, 2018) (28).

Government consumption, expressed as a percentage of GDP, exerts a dual impact on economic growth. On one hand, taxes diminish the marginal product of capital, exerting a negative influence. On the other hand, government services and spending contribute positively to the marginal product. The dynamic interplay between these factors results in a nuanced relationship. Initially, at lower levels of public spending, the positive effect dominates, leading to increased growth rates. However, beyond a certain threshold, the negative impact becomes predominant, as observed by Robert Barro (1990) (29). Notably, studies by Connolly & Cheng (2016) (30) and Grier and Tullock (1989) (31) reveal a statistically significant negative relationship between the GDP growth rate and the growth rate of government consumption.

The influence of money on economic growth depends on the effect of inflation on the steady-state equilibrium level of output. This impact can manifest as neutral, positive (Tobin's effect), or negative (anti-Tobin's effect). Sidrauski (1967) (32) posits a neutral impact of money, while Tobin (1965) (33) considers it a substitute for capital, leading to a positive impact on economic growth. In contrast, Stockman views money as complementary to capital, resulting in a negative impact on economic growth.

The impact of life expectancy on economic growth is multifaceted. Cervellati and Sunde (2009) (34) suggest that lower mortality rates increase resource productivity but may decrease per capita output. On the other hand, Lorentzen, McMillan, and Wacziarg (2008) (35) find a robust and positive relationship between GDP growth and life expectancy, indicating a beneficial effect on economic growth. This intricate interplay of variables adds depth to the analytical framework, enriching the understanding of the determinants shaping economic growth within the considered model.

Barro and Sala-i-Martin (1992) (22) and Mankin, Romer & and Weil (1992) (36) utilized a cross-sectional approach to investigate the convergence hypothesis. However, the cross-sectional estimation approach has inherent limitations as it overlooks time series variations and fails to explain the heterogeneity among different cross-sectional units. To overcome these drawbacks, the study employs panel data estimation, a method that incorporates data for multiple cross-sections over a specified period. Panel data analysis, essentially combining both cross-sectional and time series dimensions, offers several advantages over traditional time series and cross-sectional analyses. These advantages include increased variability, reduced collinearity among variables, higher degrees of freedom, and enhanced efficiency. Moreover, panel data analysis enables a more robust assessment of the impact of economic, political, institutional, and social policies and programs by observing the same cross-sectional units across different periods.

Several methods can be employed for panel data estimation. The pooling method (PM) assumes homogeneity among countries and estimates a common constant for all countries. In contrast, the fixed effect (F.E.) method allows for the inclusion of different dummies or indicators for each country, providing a distinct constant for each one. The random effect (RE) method assumes that each country exhibits variations in its error term. Importantly, the fixed effect estimator remains consistent even when the estimator is correlated with individual effects.

The literature review underscores the pivotal role of investment, human capital, technological progress, and other determinants in comprehending long-term economic growth and convergence. The synthesis of historical perspectives, growth theories, and empirical evidence accentuates the need for ongoing research to unravel the intricacies of convergence dynamics across diverse economies. This comprehensive review contributes to the understanding of the complexities inherent in economic growth and convergence, providing a foundation for further exploration and analysis in this crucial area of economic research.

4. REGIONAL DISPARITIES IN INDIA'S ECONOMIC LANDSCAPE

India's economic landscape exhibits significant disparities in growth trajectories among states, forming distinct high-income and low-income clusters. This study analyzes the economic dynamics of states such as Gujarat, Maharashtra, Punjab, Haryana, Tamil Nadu, and Karnataka, and those facing challenges, including Uttar Pradesh, Rajasthan, Madhya Pradesh, Bihar, Jharkhand, and Odisha. The disparities in growth patterns have profound implications for overall economic growth and regional development. Despite commendable overall GDP growth rates, this growth is concentrated in specific sectors and limited to select states, resulting in uneven distribution of employment opportunities and perpetuating regional disparities. Insights from studies on the role of government policies in influencing capital accumulation, including research by King (1994) (37), Levine and Renelt (1991) (38), and Young (1991) (39), underscore the critical connection between stable macroeconomic policies, trade openness, and robust economic growth. As India addresses regional disparities, targeted policy interventions and efforts to foster interconnectedness between high and low-income states become imperative. This study explores the multifaceted impact of the COVID-19 pandemic on India's economy, utilizing data from sources such as the International Monetary Fund and the Centre for Monitoring the Indian Economy. The analysis covers disruptions in various sectors, unemployment trends, and government interventions, offering insights into the ongoing economic trajectory and providing a foundation for future policy considerations aimed at achieving balanced regional development and equitable prosperity.

5. DATA SOURCE

The model employed for analysis incorporates variables sourced from diverse origins, as delineated in Table 4.1. It is pertinent to note that India comprises 28 states and 9 union territories; however, for the temporal scope spanning 1991 to 2022, data comparability constraints dictated the inclusion of data only from 26 states/union territories. The selected entities are enumerated as follows:

1. Andhra Pradesh; 2. Maharashtra; 3. Arunachal Pradesh; 4. Manipur; 5. Assam; 6. Bihar; 7. Nagaland; 8. Meghalaya; 9. Delhi; 10. Odisha; 11. Goa; 12. Puducherry; 13. Gujarat; 14. Punjab; 15. Haryana; 16. Rajasthan; 17. Himachal Pradesh; 18. Sikkim; 19. Jammu & Kashmir; 20. Tamil Nadu; 21. Karnataka;22. Tripura; 23. Kerala; 24. Uttar Pradesh; 25. Madhya Pradesh; 26West Bengal.

Regrettably, certain states/union territories were excluded due to the unavailability of comparable data for the stipulated period. The omitted entities are as follows:

1. Puducherry; 2. Lakshadweep; 3. Ladakh; 4. Daman & Diu and Dadra & Nagar Haveli; 5. Chandigarh; 6. Andaman & Nicobar Islands; 7. Uttarakhand; 8 Telangana; 9. Mizoram; 10. Jharkhand; 11. Chhattisgarh.

This delineation is essential for maintaining precision in data selection and ensures a robust foundation for the analytical procedures applied to elucidate patterns and trends in the specified economic contexts across the included states and union territories during the defined timeframe.

Table 4.1: Description of Variables and Data Sources

Serial	*Variables*	*Indicators*	*Sources*
1.	Economic Growth	GDP per capita annualgrowth	MoSPI, GoI.
2.	The initial level of income	lag of GDP per capita	MoSPI, GoI.
3.	Population	Population annual growthrate	RGI
4.	Physical capital	Capital Formation	MoSPI, GoI & the concerned DES.
5.	Human Capital	Percentage of GDP spenton health and education	GoI and the concerned State Government.
6.	Health	Life expectancy	RGI
7.	Government Consumption	Government Consumption as a percentage of GDP	GoI & and the concerned State Government
8.	Covid	Case Rate for States averaged for the wave period (Daily new cases normalized by the population)	GoI and the concerned State Government

6. MODELS FOR CONVERGENCE AMONG INDIAN STATES

(a) Absolute Convergence

Absolute Convergence, a pivotal concept in growth economics, is scrutinized through cross-sectional regression employing the specified equation:

$$GR = \alpha_0 + \alpha_1 \cdot \log y i_0 + \alpha_2 . D_1 + \varepsilon it \quad (1)$$

The growth rate equation, GR, is expressed as a function of the initial income level (logyi0) and the error term εit. The investigation into convergence focuses on the significance of the coefficient α1 associated with the initial income level. For convergence to be substantiated, α1 must exhibit a significantly negative value. To address the impact of COVID-19, a Dummy Variable (D1) is introduced. In response to the discernible repercussions of adversities, a nuanced approach involves the introduction of a dummy variable, denoted as D1, capturing the unique challenges posed by years marked by high negative growth rates during COVID-19. D1 takes a value of 1 for these specific years, signaling adverse conditions, while for other years, D1 is 0, indicative of normal conditions. This inclusion enriches our analytical framework, offering a more nuanced understanding of the economy. The interpretation of the dummy variable coefficient in multiple regression aligns with the expectation of the average difference in the dependent variable between instances with a value of 1 and those with a value of 0, holding other variables constant. This methodological sophistication ensures a robust interpretation of the economic dynamics, effectively capturing the impact of COVID-19.

(b) Sigma Convergence

The examination of sigma convergence, as conducted by Grier and Grier (2007) (40) and Streissler (1979) (41), employs linear regression analysis, focusing on cross-sectional variances of countries. Extending their methodology, the assessment of sigma convergence involves the scrutiny of a linear trend equation articulated as:

$$\sigma_s = \gamma_0 + \gamma_{1\,t} + \gamma_2\, D_2 + u_t \tag{2}$$

Within the domain of sigma convergence analysis, the metric for measuring dispersion is denoted as the standard deviation of the natural logarithm of income (ós). The presence of sigma convergence is discerned through the coefficient (ã1), with a negative value indicative of such convergence.

To account for the impact of the COVID-19 pandemic, a dummy variable (D2) has been introduced into the analytical framework. The binary nature of D2 assigns a value of 1 for the years 2020-21 and 2021-22, corresponding to a period marked by monetary and fiscal stimuli impacting the economy. Conversely, D2 assumes a value of 0 for all other years, representing periods devoid of such specific initiatives. Through the incorporation of this dummy variable, the model endeavors to capture the unique dynamics and effects engendered by the COVID-19 pandemic, thereby enriching our comprehension of its contribution to the broader economic landscape. In essence, this augmentation of the analytical framework with D2 allows for a more nuanced examination of sigma convergence, offering insights into how the specific circumstances surrounding the pandemic have influenced income distribution dynamics. This methodological refinement enhances the model's capacity to disentangle the distinct effects attributable to the COVID-19 period, thereby contributing to a more comprehensive understanding of the intricate interplay between external shocks and economic convergence.

(c) Conditional β Convergence

The growth regression, representing the equation of convergence in the dynamic panel, takes the following form:

$$Y_{it} = \alpha + \beta_1 X_{it} + \beta_2 Yi,\ t{-}1 + \gamma Zi + \lambda t\ D_3 + \varepsilon it,$$

where Y_{it} denotes the dependent variable, α is the intercept, X_{it} represents the independent variable, Yi, t–1 is the lagged dependent variable, Zi comprises additional control variables, and λt represents time-specific effects. To comprehensively address the intricate influence of monetary and fiscal stimuli on the economy, our analytical framework incorporates a dedicated dummy variable, denoted as D3. This variable assumes significance during the fiscal years 2020-21 and 2021-22, corresponding to the implementation of specific monetary and fiscal measures explicitly designed to mitigate the impact of COVID-19 on the economy. Importantly, no independent variable within the equation explicitly represents these effects, underscoring the necessity for a tailored approach to capture the nuanced dynamics at play. In response, the dummy variable (D3) is assigned a value of 1 for the years 2020-21 and 2021-22, indicating the period when the consequential monetary and fiscal stimuli influenced the economy. Conversely, for all other years, D3 takes on a value of 0, representing periods devoid of these specific initiatives.

By integrating this specialized dummy variable into our model, our analytical framework expands to accommodate the unique dynamics and consequences stemming from the monetary and fiscal stimuli on the economy. This strategic inclusion offers illuminating insights into the distinctive contribution of COVID-19 to the overall economic landscape. Moreover, it is essential to highlight that the incorporation of D3 contributes to providing a more nuanced understanding of the economic landscape across various states, where õit represents the error term. This dynamic panel structure facilitates a more comprehensive understanding of convergence dynamics by considering both cross-sectional and time-dependent variations.

$$y_{it} = \alpha_1\, y_{t-1} + \Sigma\eta_1\, x_{it} + \delta_t + \mu_t + u_{it} \tag{5}$$

The dynamic panel data regression model is expressed as:

$$y_{it} = \beta_0 + \beta_1 X_{it} + \beta_2\, y_{i,t-1} + \lambda_t D_3 + \alpha_i + \varepsilon_{it},$$

where y_{it-1} is the lag of per capita GDP, the dependent variable, and the second term represents the sum of regressors. The third and fourth terms denote the time and state-specific effects, respectively, and the last term is the error term.

The application of panel data estimation encounters various challenges, including issues such as serial correlation, correlated individual effects, inaccurate standard errors, and endogeneity. The dynamic nature of panel data introduces a correlation between the error terms and the lagged dependent variable, yi,t"1, leading to bias and underestimation of the convergence coefficient. Consequently, the random effect regression is deemed unsuitable for estimation, as it assumes the exogeneity of variables, implying no correlation between the error term and the regressors.

To address these challenges, Arellano and Bond (1991)(42) developed the first-differenced generalized method of moments (GMM). This approach employs lagged levels of variables as instruments, assuming specific moment conditions and the absence of serial correlation in the error term before differencing the regression equation. However, the first-differenced GMM method has limitations, particularly in cases where time series exhibit persistence, as the lagged values of variables used as instruments weaken when differencing is applied, resulting in correlation with the error term.

To overcome the drawbacks of the first-differenced GMM, Blundell, and Bond (2000) (43) introduced the dynamic system generalized method of moments (sysGMM). This approach estimates a system of equations in both levels and first differences, with the first differences serving as instruments. As a result, the sysGMM method mitigates problems related to omitted variable bias and endogeneity.

In the dynamic system GMM, the Sargen test is employed to examine the correlation between the error term and instruments. The null hypothesis posits that the instruments are valid and not correlated with the error term. Rejection of the null hypothesis indicates that the instruments are not valid. Additionally, the AR (1) and AR (2) tests are utilized to assess residual serial correlation. The null hypothesis suggests that the test should reject the presence of first-order serial correlation while not rejecting second-order serial correlation.

6. RESULTS AND DISCUSSIONS

6.1. Absolute Convergence

In this empirical investigation, we employ the Ordinary Least Squares (OLS) econometric technique to scrutinize the phenomenon of absolute convergence among Indian states during the period spanning 1991 to 2022. The analysis reveals a negative coefficient associated with initial GDP per capita, albeit lacking statistical significance. This observation leads to the inference that there exists an absence of absolute convergence among the Indian states under consideration.

Furthermore, the examination of the impact of the COVID-19 pandemic on GDP per capita indicates a statistically significant negative effect. Despite this, the absence of statistical significance in the coefficient associated with initial GDP per capita persists, reinforcing the conclusion of the non-existence of absolute convergence. Consequently, the implication is that the steady-state income levels across Indian states do not converge over the specified time frame.

The identified negative influence of COVID-19 on GDP per capita, while statistically significant, does not alter the overall conclusion of the absence of absolute convergence. This finding suggests that factors other than the pandemic, such as investment rates, population growth, and technological disparities, play pivotal roles in shaping the steady-state income levels of Indian states.

In light of these results, it is evident that the examined states exhibit divergence in their steady-state income levels. This divergence is influenced by multifaceted dynamics, underscoring the intricate interplay of investment patterns, demographic shifts, and technological disparities across the diverse landscape of Indian states. The absence of a universal convergence toward a common steady-state target underscores the need for a nuanced understanding of economic dynamics within the regional context. This applied econometric analysis conclusively contributes valuable insights into the economic landscape of Indian states, emphasizing the non-uniform nature of development trajectories and prompting further investigation into the diverse array of factors influencing economic growth across regions.

Table 6.1: Absolute Convergence based on Cross-sectional Regression Analysis: Indian States

Dependent variable: GDP per capita growth rate.

Variable	*Coefficient Interval*	*Standard Error*	*t-value*	*95% confidence interval*
α_1	-0.2817	1.5687	-0.21	-3.7723 to 3.2788
α_0	5.7565	4.8991	1.18	-5.2108 to 16.7486
α_2	- 0.1267	1.9982	1.45	- 1.1773 to 5.6243

Source: Author's processing

6.2. Sigma Convergence

The results of the sigma convergence analysis are succinctly presented in Table 6.2, featuring t-statistics calculated using the Newey-West (HAC) consistent standard errors. Implementing the Newey–West (1987) (44) variance estimator ensures the robustness of estimates in the presence of autocorrelation and potential heteroskedasticity. Autocorrelation is addressed up to and including a lag of m, where the specific lag value (m) is determined by the chosen (m) option. Examination of the findings in the table reveals a statistically significant positive time series coefficient associated with the standard deviation. Consequently, the empirical evidence points to the absence of sigma convergence among Indian states over the analyzed period. Despite the dampening effect of COVID-19 on GDP per capita, it has not altered the non-existent sigma convergence among the states. This observation implies that the disparity in GDP per capita income has widened over time, signaling an expanding economic gap among these states. The meticulous application of linear regression analysis, fortified by the utilization of robust statistical techniques such as Newey-West standard errors, contributes to a nuanced understanding of the dynamics of sigma convergence among Indian states. The identified lack of convergence underscores the escalating economic divergence among these states, prompting a deeper inquiry into the factors driving this widening gap. Additionally, the results bear implications for potential policy measures aimed at fostering regional equity and economic stability in light of the observed disparities. Further investigation into the nuanced determinants of economic divergence would contribute to a more informed and targeted approach to addressing regional economic disparities.

Table 6.2: Sigma Convergence with Newey-West Standard Errors: Indian States

Dependent variables: Standard Deviation of GDP per capita

Variables	*Coefficient*	*Standard Error (Newey- West)*	*t-value*	*95% Confidence Interval*
γ1	-0.0029***	0.0113	2.70	-0.0059to -0.0053
γ0	-5.1913**	2.2641	-2.30	-9.8997 to-4.8283
γ_2	-0.5943***	0.02135	2.37	-0.4623 to 2.4122

***, ** indicates significance at the 1% and 5% levels of significance, respectively.

γ_0 is the intercept and γ_1 γ_2 & are the time coefficient.

Source: Author's processing

6.3. Conditional β Convergence

The convergence hypothesis posits that a negative and statistically significant coefficient for the initial level of GDP per capita in a state/UT indicates the occurrence of convergence. To address heteroscedasticity and nonlinear trends, all variables undergo logarithmic transformation following the approach outlined by Iyoboyi (2014) (45). The regression outcomes for both the first Augmented Solow Model and Extended Solow Model are presented in Table 6.3.

Ensuring precise estimation involves mitigating endogeneity, validating instruments, checking for autocorrelation (AR (2)), and verifying the individual significance of coefficients. The Sargen test affirms the validity of instruments, and while the model exhibits first-order autocorrelation, second-order autocorrelation is absent, suggesting an overall lack of autocorrelation issues. In the model, the coefficient (-0.0378) of the logarithm of initial GDP per capita is significantly and negatively associated with the real GDP per capita growth of Indian states/UT. This implies the presence of conditional convergence across the region, controlling for investment, human capital, and population growth. Consequently, economically disadvantaged states in India are undergoing more rapid economic growth compared to affluent ones.

A closer examination of the impact of regressors on economic growth in the augmented Solow model reveals that physical capital stock has a positive and significant influence on economic growth in Indian states, with a coefficient of 0.021, significant at the 10% level. Human capital, represented by the elasticity coefficient of 0.22, is also significantly conducive to economic growth at the 1% level. Furthermore, population growth is positively and significantly associated with economic growth in Indian states/UT. Given the escalating population growth rates in most Indian states/UT, policy formulations should prioritize measures to encourage lower fertility rates among married couples, leveraging the potential benefits of the demographic dividend.

Table 6.3: Testing Conditional Convergence of Indian 26 States/ UT (1991-2022)

Variable	*Augmented Solow Model*	*Extended Solow Model*
£Ln(yit-1)	0.4181***(0.0257)	0.5636***(0.0041)
Ln(yit-1)	-0.0378***(0.0356)	-0.4337***(0.0014)
Ln (sk)	0.0217* (0.0068)	0.0435***(0.0009)
Ln (hk)	0.2266***(0.0266)	0.0241***(0.0009)
Ln(n+δ)	0.0825*(0.0483)	0.2238***(0.0029)
Ln(Gc)	-	-0.0649***(0.0008)
Ln(LE)	-	1.0384***(0.0163)
Ln (C_d)	-	- 1.0543***(0.0236)
AR(1) p-value	0.0921	0.0701
AR(2) p-value	0.2261	0.1201
Sorgan test p-value	0.5030	0.3240

*, *** shows significance level at 10% &1% respectively. Source: Own processing

y i, t–1 is lag of GDP per capita, s_k *is physical capital,* h_k *is the human capital. (n + δ) is population growth plus 0.5% depreciation.* G_c *is the government consumption as a percentage of GDP, LE is the life expectancy at birth, and Cd is the Covid-19 cases during 2020-21 & 2021-22.*

AR (1) is significant hence the rejection of first-order correlation, but AR (2) is insignificant. The Sargan test is insignificant and confirms instruments are valid.

Expanding the augmented Solow model to incorporate additional variables such as government final consumption (% of GDP) and life expectancy (number of years) reiterates the validity of instruments, the absence of autocorrelation (AR (2)), and the individual significance of coefficients. The Sargen test reaffirms instrument validity, and although first-order autocorrelation is present, second-order autocorrelation is absent, suggesting an overall absence of autocorrelation issues in the model. This comprehensive analysis contributes to a refined understanding of the factors influencing economic convergence in Indian states/UT, informing potential policy interventions for promoting regional equity and sustainable economic development.

Upon incorporating additional macroeconomic indicators such as government consumption, COVID-19, and life expectancy into the analysis, the coefficient associated with the initial level of per capita income reveals a significant negative relationship. This finding substantiates the existence of conditional convergence, indicating that lower-income states/UT in India are experiencing faster economic growth compared to their wealthier counterparts. Notably, the convergence coefficients in the augmented Solow model for the Indian States are lower than those in the Solow extended growth model, underscoring the significance of additional variables in elucidating economic growth. These outcomes imply that the extended Solow-type income growth framework provides a more comprehensive understanding of the dynamics of growth and convergence, with varying marginal impacts observed for different macroeconomic variables.

The seminal study by MRW (1992) (46) underscores the pivotal role of physical capital in elucidating variations in output per capita across countries. Growth theory posits the accumulation of physical capital as a fundamental driver of economic growth. Correspondingly, in the context of Indian states/UT, we identify a positive and significant relationship between economic growth and physical investment.

Human capital, another integral variable in the regression equation, is widely acknowledged as a critical factor for economic growth. It exerts influence on production through labor productivity (level effect) and contributes to heightened competitiveness through innovation and technology transfer. In alignment with Elena Pelinescu (2014) (47) and other pertinent research, we establish a robust and positive relationship between economic growth and human capital.

Life expectancy, with a coefficient of 1.0384, exerts the most substantial positive and significant effect, underscoring the pivotal role of health in determining economic growth rates.

The association between population growth and economic output growth has been extensively explored in the growth literature. In our study, we observe a negative and significant impact of population growth on economic growth in the Indian States/UT.

The government consumption ratio, a policy variable frequently scrutinized in the context of long-run income growth, has generated opposing arguments: the crowd-out hypothesis and the government expenditure multiplier. In our analysis, as evidenced in Table 5.4, the government consumption ratio is found to be negatively and significantly correlated with economic growth in the Indian States/UT. This aligns with the observed negative impact of government spending on economic growth in developing countries.

The economic impact of the 2020 coronavirus epidemic in India has been profound. India's development in the fourth quarter of the financial year 2020 declined to 3.1% according to the Ministry of Statistics. Service-oriented economies were particularly negatively affected, with job losses and salary cuts. As the disruption from the virus continues, we must prioritize addressing the consequences of COVID-19 rather than solely focusing on economic recovery Barclays (2020) Pragyan Deb and TengTeng Xu1(2021) PARANDHAMAN & SAGAYADOSS (2020) & Srinivas & Singh (2023) (49-52).

7. CONCLUSIONS

This comprehensive study rigorously examines the complexities of economic growth and convergence across the diverse landscape of Indian States. Spanning a dataset from 1991 to 2022, encompassing 27 states/Union Territories (UTs), the analysis reveals nuanced insights. No statistically significant negative correlation between the initial per capita GDP ratio and the average annual growth rate is observed, indicating the absence of absolute â convergence across the Indian States' economies over the study period. Despite the severe repercussions of COVID-19 on GDP per capita, the relative convergence level remains unaffected. Results from the sigma convergence analysis, considering the impact of COVID-19, align seamlessly with those derived from the absolute convergence model, reinforcing the robustness of the findings.

To address inherent heterogeneity among Indian States, both the augmented Solow model and the extended Solow growth regression frameworks are employed. The augmented Solow model integrates crucial control variables—such as physical capital, human capital, and population growth rate—into the convergence equation, consistent with MRW. The extended Solow regression model further incorporates variables such as exports as a percentage of GDP, inflation, life expectancy, and government consumption as a percentage of GDP to capture the multifaceted heterogeneity of the Indian States/UT.

Estimation processes for both models utilize the Dynamic System Generalized Method of Moments (DSGMM), known for its effectiveness in handling endogeneity and providing robust parameter estimates. In the augmented Solow model estimations, a rate of conditional â-convergence is observed among Indian states/UT, with a coefficient of 0.037 associated with the initial GDP per capita. This implies that beyond the influence of the initial GDP per capita, variables such as physical and human capital, along with population growth, play significant roles in shaping growth and convergence dynamics.

Moving to the extended Solow growth regression, the coefficient of the initial GDP per capita is found to be 0.43. This indicates that in addition to the initial per capita income level, factors such as physical and human capital, population growth, and other incorporated variables significantly contribute to observed growth and convergence in the Indian States/UT. These results underscore the complexity of the economic growth process, emphasizing the importance of a comprehensive approach that considers multiple variables to understand the intricate dynamics of regional convergence in India.

8. POLICY IMPLICATIONS

The pursuit of robust and sustainable economic growth stands as a paramount policy objective for the Indian States. Policymakers are tasked with comprehending the determinants of growth and the ramifications of policies on economic performance to establish and uphold a high growth trajectory. Real GDP growth has evolved into a focal point for policy initiatives across almost all states/Union Territories (UTs). In accordance with the findings of this research, several key conclusions emerge:

1. **Positive Influences on Economic Growth:** Economic growth is propelled positively by various factors, including the expansion of the labor force, investments in both physical and human capital, and judicious government consumption. The prioritization of expenditures in social sectors, particularly health and education, assumes a pivotal role in fostering overall economic growth.
2. **Advantages of Open Economies:** Open economies benefit from accessing novel technologies and ideas globally. Furthermore, they capitalize on greater specialization in production processes based on comparative advantages, contributing substantively to accelerated economic growth.
3. **Significance of Government Saving Rates:** The savings rate of the central government serves as a crucial policy indicator. States with higher government saving rates tend to experience elevated levels of investment and, consequently, faster growth. Moreover, higher government savings signal sound macroeconomic management overall.
4. **Role of Government Spending in Human Capital Formation:** The study underscores a significant and positive relationship between government spending on education and health (as a percentage of GDP) and per capita

income growth in Indian states/UTs over the specified time frame. This emphasizes the imperative for governments to augment investments in human capital formation for enhanced growth performance.

5. **Prudent Budgetary Policies:** The coefficient of government consumption as a percentage of GDP manifests a negative and statistically significant relationship with per capita income growth. Hence, there is a need for policymakers to formulate prudent budgetary policies to efficiently allocate resources for optimal economic outcomes.
6. **Impact of Life Expectancy on Economic Growth:** Life expectancy exhibits a positive and statistically significant effect on the economic growth rate among Indian States/UTs. Theoretically, higher levels of productivity growth are expected to correlate positively with health levels, particularly where average life expectancy serves as a proxy variable. Consequently, governments are urged to allocate increased budgetary resources to the health sector to foster economic growth.
7. **Population Growth Dynamics:** Population growth contributes positively and significantly to economic growth in Indian States/UTs. Given the observation of negative population growth rates in most countries in the region, policies should be devised to incentivize married couples to reduce fertility rates, thereby harnessing the potential benefits of the demographic dividend.
8. **Role of Effective Monetary Policy Management:** Effective management of monetary policy remains crucial for ensuring stability and fostering sustained economic growth. This underscores the necessity for policymakers to employ prudent monetary measures to support overall economic objectives.
9. **Fiscal & Monetary Dynamics:** Public spending on healthcare in India is 1.1 percent of GDP. The crisis that emerged from the coronavirus spread has pulled down investment and consumption demand. Conventionally, the demand side components of GDP account for 72.1 percent of consumption, out of which government consumption is barely 11.9 percent. An anxiety-induced reluctance to spend is the main threat to the economic growth rate. The government needs to increase spending to boost demand. Support to different sectors needs to be given as a measure to boost investment demand. Repo Rate has been reduced by 75 basis points, as part of a loose monetary policy. Monetary policy is less effective in dealing with a pandemic because the problem is not liquidity alone. The disruption of economic activity and the uncertainty of the future bring down the investment sentiment. An anxiety-induced frugality among firms and investors wipes out the investment demand.

10. **Rethink on Developmental Paradigm for India:** The Oxford Committee for Famine Relief (OXFAM) report on 'Income Inequalities in India', 2021 (48), brought forth some eye-opening findings on the asymmetrical developmental paradigm in India. The report mentioned that in 2017–2018, the richest 1 percent of the population owned 73 percent of the wealth generated in the country. The wealth of this group increased by [1] 20913 billion, which is equivalent to the total budget of the central government in the same year. The richest 1 percent in the country hold more than four times the wealth held by 953 million (bottom 70% of the country's population). Six hundred and seventy million Indians who comprise the poorer half of the population saw a 1 percent increase in their wealth in 2017–2018. The benefits of development have been claimed by a few people in the society. Stark income inequities in the country explain why a large part of the population that belongs to the subsistence sector does not demand anything more than subsistence needs of food and shelter.
11. **Pandemic Effect:** An economic shock resulting from a natural calamity or a pandemic pushes many others back to the subsistence sector. The COVID-19 pandemic has brought forth lopsided development in the country to the forefront. Loss of daily wages has forced a large segment of society to struggle with hunger unless a relief measure is provided to them.

In summation, these findings provide a nuanced understanding of the multifaceted factors influencing economic growth in the Indian States, offering actionable insights for policymakers to craft informed and effective strategies for long-term economic development.

9. SUGGESTIONS FOR FURTHER RESEARCH

The exploration of economic growth and convergence is an intricate and dynamic domain within the realm of economic research. Various econometric techniques have been employed by researchers to delve into the effects of different determinants of economic growth, often accounting for unobserved factors. In our research, we utilized the dynamic system Generalized Method of Moments (GMM). While our study contributes valuable insights, several avenues for further investigation could enhance the robustness of the results and broaden the understanding of economic growth dynamics.

Firstly, extending the time series and incorporating additional determinants of economic growth, where data is available, would significantly benefit the comprehensiveness of the study. The application of Mean Group Estimators (MGE) or Pooled Mean Group Estimators (PMGE) could potentially provide more reliable and robust results, offering a more nuanced understanding of the long-term patterns and determinants of economic growth in the context of Indian States/ UTs.

A second promising area for future research involves testing the convergence hypothesis by examining multiple independent variables that capture different facets of economic growth, such as labor productivity and institutional factors. This approach would contribute to a more holistic understanding of the convergence dynamics among the Indian States/UT and provide insights into the interplay of diverse factors shaping regional economic development.

Furthermore, the classification of states based on their distance from the national per capita income, considering higher GDP and per capita income, could offer valuable insights into convergence dynamics. By categorizing states/UT in this manner, the convergence hypothesis could be rigorously tested with the inclusion of additional explanatory variables, helping discern whether the observed results hold when states/UT are grouped based on their GDP per capita.

Lastly, for a more meaningful analysis of the convergence hypothesis, it is advisable to include all states/UT in the study. The incorporation of all entities would enable a more comprehensive assessment of convergence patterns, providing a broader perspective and enhancing the generalizability of the findings.

In conclusion, by addressing these avenues for future research, scholars can further enrich our understanding of economic growth and convergence dynamics. This, in turn, would lead to more nuanced insights into the determinants and patterns of economic development, contributing to the international body of knowledge in the field of economics.

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NOTE

A Comprehensive Examination of Dummy Variables in Regression Analysis: An Application in the Context of Sectoral Impact on Economic Output:

This note elucidates the strategic application of dummy variables in regression analysis, specifically addressing their utility in accommodating outliers and exceptional cases. The study employs three distinct dummy variables in three separate regression equations to systematically address exceptional situations pertinent to the respective equations. Each dummy variable is meticulously introduced to encapsulate nuanced factors affecting the dependent variables under scrutiny.

Introduction: Dummy variables serve as indispensable tools in statistical modeling, particularly when addressing outliers or unique situations that may significantly influence the observed data. This note focuses on the incorporation of dummy variables in regression models, with a particular emphasis on their application in studying the economic output of different sectors.

Background: The utilization of dummy variables becomes imperative when confronted with atypical scenarios that may exert a notable impact on the dependent variable. In the present study, six dummy variables (D_1-D_3) are judiciously employed to account for specific contextual nuances in the regression analyses.

Specific Applications of Dummy Variables: The following sections detail the introduction and interpretation of each dummy variable in the context of the regression equations employed in the study:

3.1. D1 - A Dummy Variable (D_1) is introduced to address the impact of COVID-19. In response to the discernible repercussions of these adversities, a nuanced approach within our analysis involves the introduction of a dummy variable, denoted as D_1. This dummy variable assumes a pivotal role in capturing the unique challenges posed by years marked by high negative growth rates during COVID-19. Within the analysis, D_1 takes a value of 1 for these specific years, effectively signaling the presence of adverse conditions attributable to the pandemic period. In contrast, for all other years, D_1 assumes a value of 0, indicative of normal conditions devoid of such extreme negative growth rates. By Sincorporating this bespoke dummy variable into our model, we can comprehensively account for the distinct challenges encountered by COVID-19 in the Indian states during these specific years. This strategic inclusion enriches our analytical framework, affording a more nuanced and holistic understanding of the economy.

3.2. D2 - To account for the impact of COVID-19, a dummy variable (D_2) has been introduced. The dummy variable (D_2) takes a value of 1 for the years 2020-21 and 2021-22, indicating the period of monetary and fiscal stimuli that influenced the economy. For all other years, the dummy variable (D_2) assumes a value of 0, representing periods without such specific initiatives. By incorporating this dummy variable, the model considers the unique dynamics and effects resulting from COVID-19, enhancing our understanding of its contribution to the overall economic scenario.

3.3. D3 - To comprehensively account for the intricate influence of monetary and fiscal stimuli a strategic addition to our analytical framework involves the incorporation of a dedicated dummy variable, denoted as D3. This distinctive variable assumes significance from the fiscal years 2020-21 and 2021-22, coinciding with the implementation of specific monetary and fiscal measures explicitly designed to impact of Covid-19 on the economy. Notably, no independent variable within the equation explicitly represents these effects, emphasizing the need for a tailored approach to encapsulate the nuanced dynamics at play. In response, the dummy variable (D3) assumes a value of 1 for the years 2020-21 and 2021-22, signifying the period when the consequential monetary and fiscal stimuli exerted their influence on the economy. Conversely, for all other years, D3 adopts a value of 0, designating periods devoid of these specific initiatives. By integrating this specialized dummy variable into our model, our analytical lens widens to accommodate the unique dynamics and consequences stemming from the monetary and fiscal stimuli on the economy. This strategic inclusion provides illuminating insights into the COVID-19 distinctive contribution to the overall tapestry of the economy. Moreover, it is pivotal to highlight that the incorporation of D3 contributes to providing a more nuanced understanding of the various states' economic landscape, and *õit* is the error term.

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