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Unraveling India's Economic Tapestry: Analyzing the Convergence of Growth Patterns among Indian States and Prospects for the Future

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Abstract: This study offers an all-encompassing analysis of economic growth and convergence within the Indian States, spanning a period from 1991 to 2020. Through the utilization of the augmented Solow and extended Solow models, this research delves deep into absolute, sigma, and conditional convergence across the Indian States and Union Territories (U.T.). Notably, it is revealed that the initial per capita GDP ratio does not exhibit a significant negative correlation with the average annual growth rate, and suggests the absence of absolute convergence throughout the Indian States and U.T. The outcomes of sigma convergence seamlessly align with those obtained from the absolute convergence model, reinforcing the credibility and robustness of the analysis. However, the exploration of conditional convergence using the augmented Solow model estimates a rate of conditional convergence, as indicated by the coefficient of initial GDP per capita, to be 0.038 among the Indian States and U.T. This compelling statistic considers various influential factors such as GDP per capita, physical and human capital, and population growth. Moreover, the extended Solow growth regression reveals a coefficient of initial GDP per capita of 0.337, demonstrating that factors beyond the initial per capita income make significant contributions to the growth and convergence of Indian States. Conclusively, it can be inferred that economic growth in the Indian States is decisively influenced by a multitude of factors. Notably, prioritizing expenditure on vital social sectors such as health, and education proves instrumental in driving progress. Moreover, to propel economic advancement, India must place great emphasis on accessing new technologies and ideas from around the world, while concurrently bolstering government saving rates and maintaining sound macroeconomic management. Furthermore, heightened investments in human capital formation are crucial for sustainable growth. Prudent budgetary policies must be implemented to ensure efficient resource allocation, with a particular focus on augmenting budgetary resources allocated to the health sector. Simultaneously, incentivizing married couples to curtail fertility rates and ensuring effective monetary policy management is imperative for stability and long-term growth within the Indian States.

Keywords: Convergence; Absolute Convergence; Conditional Convergence; Economic Growth; Augmented Solow Model.

JEL codes: O11, Z32, C01

1. Introduction

The concept of convergence in growth economics refers to the tendency of developing countries/regions to grow at a faster rate compared to developed countries/regions, eventually narrowing the per capita income gaps between different regions. This idea stems from the neoclassical perspective, which assumes diminishing returns to capital. According to this assumption, developing countries/regions with lower capital-labor ratios are expected to experience higher marginal returns on investment compared to rich countries/regions with higher capital-labor ratios. Consequently, all countries/regions should converge to the same steady-state income level over time, assuming constant growth rates in savings, population, and technology across regions. This type of convergence is known as absolute or unconditional β convergence. Empirical evidence for total convergence is typically observed through a statistically significant negative relationship between income growth and the initial level of per capita income. An alternative measure, called Sigma (σ) convergence, focuses on the dispersion of per capita incomes across countries/regions over time. A lower magnitude of income dispersion supports the hypothesis of unconditional convergence.

However, the neoclassical prediction of the elimination of the development gap between poor and rich countries/regions over time lacks strong empirical support, except for certain countries/regions that have made remarkable progress toward reaching the standards of industrialized countries/regions. Sabbaghpoor-Fard, Mina (2013) (1) highlights the significance of the debate on economic growth and convergence, not only due to the existing wide gap between rich and poor countries/regions but also because, for some poor countries, this gap is persistently widening. This debate challenges the neoclassical growth theory and raises questions about the growth model developed by Robert Solow (1956) (2). The two main concerns are the assumption of diminishing returns to capital and the exogenous nature of technology. Technology is treated as a public good accessible to all economies equally. The assumption of diminishing returns to capital suggests that every economy will reach a common steady state regardless of its initial level of income. Once this steady state is reached, growth will be determined by the growth of technology, which is considered exogenous in the model. However, Romer (1986, 1990) (3,4) argues that the Neoclassical Growth Model (NCGM) fails to explain the long-run growth path, especially when considering a larger sample of countries/regions with heterogeneity, where each country/region has different steady-state income levels influenced by its specific factors like savings and population growth rates. This notion of conditional

convergence implies that rich countries/regions may actually grow faster than poor countries/regions, leading to divergences in per capita income. It is important to note that the assumption of unconditional convergence holds true among countries or regions that share common characteristics such as savings preferences, population growth rates, and production functions. Empirical findings support unconditional convergence among homogeneous groups of economies.

The lack of strong empirical evidence supporting the unconditional convergence property of neoclassical growth theory, as demonstrated in the Solow-Swan model (1956) (5), sparked a significant debate among economists in the 1980s, leading to a re-evaluation of economic growth and convergence. This paved the way for the emergence of endogenous growth theory, which aims to provide a satisfactory explanation for the divergences between rich and poor countries/regions worldwide. Endogenous growth models challenge the assumption of diminishing returns to capital and propose constant or even increasing returns, incorporating human capital in the production function to counterbalance diminishing returns. Moreover, these models posit that technological progress depends on the proportion of income allocated to R&D activities, education, and skill development, making growth endogenous in nature. This offers a plausible explanation for the growing development gap between rich and poor countries/regions, suggesting the possibility of divergence rather than convergence.

This study has two main objectives:

(i) to determine whether different growth theories are mutually exclusive, thereby assessing the validity of the convergence hypothesis in the context of the Indian States; and

(ii) to examine the impact of variables such as government role, globalization, and both physical and human capital formation on growth performance.

This investigation is crucial because the Indian States have been exposed to a long period of planning models since their independence of seventy-five years. After functioning within a centrally planned closed economic system for over seven decades, these states have transitioned from various phases of the market economy. Therefore, this study contributes to the existing literature on growth and convergence by focusing on the Indian States, as no previous attempts have been made to investigate these aspects specifically in this context.

The paper is structured as follows:

I) The introduction provides the background of the theme;

(II) The literature review presents both theoretical and empirical studies related to growth and convergence;

(III) The Indian States provide historical and economic performance information about the broader categories of the Indian States;

(IV) Empirical studies on absolute and sigma convergence are presented in the Absolute Convergence and Sigma Convergence sections, respectively;

(V) The estimation and empirical results of augmented Solow and extended Solow models are in the last section.

2. Exploring Economic Growth and Convergence: A Review of Literature

This literature review delves into the ongoing debate among economists regarding the disparities in economic growth rates across countries. It traces the historical perspectives on economic growth, starting with classical economists such as Adam Smith and David Ricardo. The review then examines the evolution of economic growth theories, including the contributions of Harrod, Solow, and the endogenous growth model. It also explores empirical studies on convergence, focusing on various regions and countries, and considers the factors that influence convergence rates. The review concludes by highlighting the importance of investment, human capital, technological progress, and other determinants in understanding long-term economic growth and convergence. Economists have long been engaged in a discourse on the underlying factors that account for differences in economic growth rates across countries. This literature review provides an overview of the historical perspectives on economic growth, examines different growth theories, and analyzes empirical studies on convergence.

2.1. Historical Perspectives on Economic Growth: The review begins by discussing the viewpoints of classical economists, particularly Adam Smith (1776) (6) and David Ricardo (1857) (7). 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.

2.2. Evolution of Economic Growth Theories: The review then explores the evolution of economic growth theories, starting with Harrod's (1939) (9) dynamic theory, which focused on steady-state growth and the role of capital

accumulation and highlighted the issues related to steady-state economic growth. The model explains at what rate investment should increase so that steady growth is possible. In this model, the rate of capital accumulation plays an important role in determining economic growth. The model seeks to determine the rate at which investment and income must grow to achieve a full employment level in the long run. However, with the assumption of fixed 5Ø>Ü/5Ø?Ü and 5Ø>Ü/5ØLÜ, it requires 5Ø?Ü and 5Ø>Ü to grow at the same rate to maintain equilibrium. However, the rigid technical coefficient assumption in the Harrod model gave rise to instability, meaning that any divergence from the full employment equilibrium would lead the economy toward a continuous depression or prolonged inflation (Snowdon & Vane, 2005) (10). However, this model's assumption of fixed technical coefficients led to issues of instability and then introduces Solow's neoclassical growth model (1956) (2), which introduced flexibility in factor prices and factors of production substitutability. Solow's model predicted convergence, with poorer countries growing faster than wealthier ones due to diminishing returns to capital. Therefore, Convergence in the per capita income of countries across the world (Thirlwall, 2011) (8). In this model, the economy will grow for a while but not forever. Over time growth declines as the country approaches a steady state and eventually stops altogether at a steady state (Jones & Vollrath, 2013) (11). However, in a greater sample of countries with large heterogeneity, each country will have different steady-state levels of income and hence no convergence.

2.3. Endogenous Growth Model: The endogenous growth model relaxes the assumption of diminishing returns to capital. They redefined capital by including human capital and R&D expenditure. This board capital either has constant or increasing returns (Romer, 1986) (3). With no diminishing returns to capital, investment becomes important in determining the long-run growth of the economy. With the constant or increasing return, countries' per capita income will not converge. Barro and Salal-i-Martin (1990) (12) examined the data for U.S. states from 1960 to 85. The authors found clear evidence of poor states growing faster than rich states indicating a case of unconditional Convergence. The authors found no such convergence by comparing U.S. states with a cross-country sample of 98 countries from 1960-1985. However, after controlling additional regressors like school enrollment, government consumption, and the difference in steady-state value and technology, the estimated results conform to the Convergence similar to that found in U.S. states. Thus, providing proof of

conditional Convergence. Dobson and Ramlogan (2002) (13) examine Convergence in Latin America from 1960 to 1990. During this time, Latin America experienced impressive economic and social changes. Between the period 1960 and 1990, there is proof of absolute Convergence. However, there is no proof of sigma convergence for the whole sample. There is additional proof of conditional Convergence in the reported time at a rate lower than in many developed nations. However, the development programs presented by the poor countries and the availability of external finance to support the unutilized resources served to support Convergence among poor nations. Urmas Varblane and Priit Vahter (2005) (14) examined the economic Convergence of transition economies during 1995-2004 and found absolute Convergence and sigma convergence across transition economies during the aforesaid period.

2.4. Empirical Studies on Convergence: The review then delves into empirical studies on convergence across different regions and countries. It discusses research on the convergence of U.S. states, Latin America, transition economies, ASEAN countries, Africa, OIC countries, and German states following reunification. These studies provide evidence of both absolute and conditional convergence, with various factors influencing the speed and extent of convergence. Menbere (2005) (15) examined the degree to which transition economies of Central and Eastern Europe have brought down per capita gaps with the existing members of the European Union during the 1990s. The author used different regression tests to find the empirical results of the given hypothesis. The first was a cross-sectional regression that incorporates the time 1990 – 2000. The outcomes demonstrate no significant convergence in GDP per capita among the transition economies of Central and Eastern Europe and the EU15. However, after controlling various macroeconomic variables like human capital, physical capital, and initial level of capital, there was proof of conditional Convergence among transition economies and the EU15. The results are in line with the predictions of the augmented Solow model. Further, the regression results propose that nations with sound macroeconomic indicators, FDI, financial development, and better structural adjustment will generally have sound economic growth compared to those lacking these indicators. Madhusudan Ghosh (2006) (16) examines regional disparities in agricultural development over 15 states in India during 1960-2002. The author examined the σ and β Convergence (Absolute and Conditional) in land productivity and per capita agricultural output over the states, especially

after adopting new HYV technology and various large-scale economic reforms, and found no significant convergence in land productivity and per capita agricultural output after the initiation of economic reforms during the 1990s. Sigma convergence shows a decrease in land productivity variation while increasing variation in per capita output after the introduction of HYV technology. The author, however, observes a case of conditional Convergence positively impacted by physical capital, human capital, and infrastructure. Ismail (2008) examines the growth and Convergence in the ASEAN countries by utilizing a dynamic, heterogeneous group approach, namely Pool Mean Group Estimation, from 1960 to 2004 and found evidence of absolute and conditional Convergence in ASEAN countries during the aforesaid period. The speed of Convergence ranges from 1.6% to 16.6% per annum. The formation of ASEAN was positively associated with growth. Djennas and Ferouani (2014) (18) conducted a cross-country analysis in Africa incorporating a decomposition approach for absolute Convergence, sigma convergence, and conditional Convergence of GDP growth and its dynamics, using data from 52 African countries from the period 1980 to 2011. Barring a few cases, all nations demonstrate weak proof of absolute Convergence, sigma convergence, and conditional Convergence in Africa. Umut Unal (2014) (19) finds proof of conditional Convergence among 31 OIC countries from 1980-2009. The coefficient of absolute Convergence, although negative is statistically insignificant. By including human capital, a 50 percent cross-country variation in per capita income is explained. However, employing additional variables explains 70 percent of the total variation. The coefficient of conditional Convergence calculated is 1.3 percent per annum, implying that it would take OIC economies almost 55 years to reach half of the study state. Gömleksiz, [a]ahbaz, and Mercan (2017) (20) examined the growth and Convergence of GDP per capita income between German states following the German reunification. The authors apply the neoclassical growth model in a panel approach. The panel regression is modified by including technological progress and a dummy variable to capture the financial crisis. To this basic panel equation, the authors also have labor migration, investment subsidies, and fiscal policies as determinants of economic growth. Authors discover proof of moderate Convergence when technological progress and financial development are included in the model. The coefficients of explanatory variables to explain economic growth are significant, and the marginal impact of variables depends on economic prosperity. Net migration is found to have negatively

affected the economic growth of poor economies and positively affected the growth of advanced economies. Michal, Havrlant, Kuenzel, and Monks (2018) (21) examined economic Convergence in the Czech Republic and Slovakia from the period 1998 -2016 while concentrating on the growth of Gross National Income (GNI) per capita. The empirics show that the Czech Republic and Slovakia saw significant Convergence concerning the E.U. average during the period between 2003 and 2008. Various policy and economic variables like FDI, industrial legacies, and labor market reforms affect the speed of Convergence. Further global crisis adversely affected the speed of Convergence in the Czech Republic and Slovakia.

In conclusion, this review highlights the importance of investment, human capital, technological progress, and other determinants in understanding long-term economic growth and convergence. It emphasizes the need for further research to explore the complexities of convergence dynamics across diverse economies.

3. Economic Perspective of the Indian States

India's states have experienced disparate economic growth, resulting in the formation of two distinct groups: high-income clubs and low-income clubs. The high-income club comprises prosperous states like Gujarat, Maharashtra, Punjab, Haryana, Tamil Nadu, and Karnataka. These states have specific drivers of economic growth. For instance, Gujarat and Maharashtra are industrial powerhouses, while Punjab and Haryana serve as the country's primary agricultural regions, producing a significant portion of India's rice and wheat. Tamil Nadu thrives on manufacturing, while Karnataka has developed a self-sustaining growth engine centered around finance and information technology consulting for the international market.

On the other hand, the low-income club encompasses struggling states such as Uttar Pradesh, Rajasthan, Madhya Pradesh, Bihar, Jharkhand, and Odisha. Although these states engage in some agricultural activities, they face immense challenges due to natural calamities, and their contribution to the national GDP remains minimal. Without a strong engine of growth, these states lack the economic mechanisms necessary to connect with and benefit from the spillover effects of high-income states. This situation has worrisome implications for India's overall economic growth and regional development.

While India has experienced remarkably high GDP growth rates in recent years, this growth appears to be fueled primarily by a few sectors of the economy and limited to a handful of states. The growth hubs in India are not

interconnected, either geographically or through a specific engine of growth. Consequently, employment opportunities are highly concentrated in certain states, leaving pockets of poverty in economically disadvantaged regions. This uneven economic growth pattern threatens to worsen regional poverty and exacerbate disparities. The disparities in economic growth across Indian states have long intrigued researchers. Among the myriad of influencing factors, two crucial drivers, namely literacy and per capita private investment, emerge as highly significant contributors to economic progress. Even modest enhancements in literacy rates and private investment demonstrate a substantial positive effect on growth trajectories. Policymaking becomes pivotal, as state governments can exert considerable influence on these factors. However, the realization of growth-enhancing policies faces challenges due to fiscal constraints, primarily stemming from escalating deficits driven by stagnant revenue collections and burgeoning civil service salaries and interest payments. Therefore, a pressing need for fiscal reforms, especially at the state level and concerning fiscal-federal relations, arises to bolster state income levels across the nation. Concurrently, fostering private investment in infrastructure assumes paramount importance. Encouraging strides by certain states in liberalizing private sector participation in the power sector and implementing Build, Operate, and Transfer systems for roads and bridges present promising prospects, further bolstered by central government-level liberalization and deregulation. Nonetheless, significant variations in growth performance remain unexplained by literacy and private investment rates alone. Drawing insights from cross-country studies and anecdotal evidence, investigation of additional factors captured by fixed effects, including the enforcement of the rule of law, bureaucratic efficiency, labor-industry relations, land reform policies, tax regimes, urban regulations, and the diffusion of new technologies and products through foreign investment, fostering competition have been advocated. Moreover, studies by King (1994) (22), Levine and Renelt (1991) (23), and Young (1991) (24) underscore the pivotal role of stable macroeconomic policies and open trade regimes in nurturing robust and inclusive economic growth. These findings underscore the paramount importance of sound policy frameworks and trade openness in unraveling the enigma of state-level economic growth in India.

4. Data Source

All the variables used in the model have been gathered from various sources, whose description is given in Table 3.

Table 3: Description of Variables and Data Sources.

Serial	*Variables*	*Indicators*	*Sources*
1.	Economic Growth	GDP per capita annual growth	MoSPI, GoI.
2.	The initial level of income	lag of GDP per capita	MoSPI, GoI.
3.	Population	Population annual growth rate	RGI
4.	Physical capital	Capital Formation	MoSPI, GoI & the concerned DES.
5.	Human Capital	Percentage of GDP spent on health & education	GoI & the concerned State Government.
6.	Health	Life expectancy	RGI
7.	Government Consumption	Government Consumption as a percentage of GDP	GoI & the concerned State Government

India has 28 states and 9 union territories, but the limitation of comparable data for 1991 to 2020 was restricted to cover only 26 states /UTs, which were: 1. Andhra Pradesh; 2. Maharastra; 3. Arunachal Pradesh;4. Manipur; 5. Assam; 6. Bihar; 7. Nagaland; 8. Meghalaya; 9. Delhi; 10. Orissa; 11. Goa; 12. Pondicherry; 13. Gujarat; 14. Punjab; 15. Haryana; 16. Rajasthan; 17. Himachal Pradesh; 18. Sikkim; 19. J&K; 20. Tamil Nadu; 21. Karnataka; 22. Tripura; 23. Kerala; 24. U.P.; 25. M.P.; 26. West Bengal.

States/UT that could not be included were: Puducherry; Lakshadweep; Ladakh; D& N Haveli; Chandigarh; Andaman & Nikobar; Uttarakhand; Telangana; Mizoram; Jharkhand; Chattisgarh.

5. Examining Convergence among Indian States

5.1. Absolute Convergence

Absolute Convergence based on cross-sectional regression is estimated using the following equation

$$GR = \alpha_0 + \alpha_1 \, log \, y_{i0} + \varepsilon_{it} \tag{1}$$

In the context of analyzing the growth rate of a country/region, denoted as *GR*, along with the initial level of income represented by *logyi*0 and the error term ε_{it}, the concept of convergence arises. For convergence to occur, it is crucial for the coefficient α_1, which pertains to the initial level of income, to exhibit a significantly negative value. To examine the presence of absolute convergence, an empirical analysis was conducted using the OLS econometric technique, and the findings are presented in Table 1. The regression results, based on data from 1991 to 2020, indicate that the coefficient associated with the initial level of GDP per capita is negative but lacks statistical significance. Consequently, the absence of absolute convergence can be inferred. The absence of absolute

convergence among the Indian states suggests that the steady-state level of income differs across these regions. This divergence may stem from variations in investment rates, population growth rates, and levels of technology among the states. Consequently, it is not generally expected that these states will converge toward the same steady-state target.

Table 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

Source: Author's processing

5.2. Sigma Convergence

Grier and Grier (2007) (25) and Streissler (1979) (26) utilized linear regression analysis to investigate sigma convergence, focusing on cross-sectional variances of countries. Building upon their methodology, the assessment of sigma convergence involves examining a linear trend equation, which can be expressed as follows:

$$\sigma_t^s = \gamma_0 + \gamma_1 t + u_t \tag{2}$$

In the context of studying sigma convergence, dispersion is measured using the standard deviation of the logarithm of income, denoted as σ^s. The presence of sigma convergence is indicated by a negative coefficient γ_1. The outcomes of the analysis on sigma convergence are presented in Table 2, with t-statistics calculated using the Newey-West (HAC) consistent standard errors {The Newey–West (1987) (27) variance estimator is an extension that produces consistent estimates when there is autocorrelation in addition to possible heteroskedasticity. The Newey–West variance estimator handles autocorrelation up to and including a lag of m, where m is specified by stipulating the lag () option.}. The table reveals that the time series coefficient of the standard deviation is positive and statistically significant. Consequently, **no evidence of sigma convergence is observed**. Therefore, the disparity in GDP per capita income among the Indian states has increased over the analyzed period, suggesting a widening gap.

5.3. Conditional 5Ø7ß Convergence

Considering the diverse geographic, demographic, and socio-economic characteristics of the Indian states, the notion of absolute convergence becomes

Table 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*
γ_1	-0.0029***	0.0113	2.70	-0.0059 to -0.0053
γ_0	-5.1913**	2.2641	-2.30	-9.8997 to-4.8283

***, ** *indicates significance at the 1 % and 5% levels of significance, respectively.*
γ_0 *is the intercept and* γ_1 *is the time coefficient.*
Source: Author's processing

implausible. The cross-sectional analysis of the states rejects the presence of absolute convergence. To account for variations in steady-state incomes among countries, Barro and Salal-i-Martin (1992) (28) introduced the concept of conditional convergence within the framework of the neoclassical growth model (NSGM). By incorporating these steady-state income differences, the notion of conditional convergence emerged in the literature on economic growth. Conditional convergence refers to the negative relationship between the growth rate and the initial level of income, taking into account the disparities in steady-state incomes across countries (Salali-Martin, 1996) (29). Consequently, differences in GDP per capita among countries/regions can be attributed to various underlying factors, such as population, capital stock, human capital formation, exports, government consumption, inflation, and other relevant parameters that shape a country's GDP.

Bassanini, Scarpetta, and Hemmings (2001) (30) presented the following dynamic growth model equation of conditional Convergence:

$$\Delta \log y_{it} = \beta_{0i} - \phi_i \log y_{i,t-1} + \beta_{1,t} \log sk_{i,t} - \beta_{1,i} \log n_{i,t} + \beta_{m+1,i} t + \Delta \log sk_{i,t} + \alpha_{2,i} \Delta \log n_{i,t} + \epsilon_{i,t} \quad (3)$$

In the context of studying conditional convergence, where y_{t-1} represents the lagged dependent variable, ϕ denotes the convergence parameter, *sk* represents the investment share in GDP, *n* denotes population growth, and *t* represents the time trend. Additionally, α captures short-term dynamics, while ϵ represents the country/region-specific error term. Barro (1991) (31) introduced a comprehensive framework for studying conditional convergence, often referred to as the "extended version of the Solow growth model." In this extended version, Barro incorporated additional macroeconomic, socio-economic, and demographic indicators that influence economic growth. The Extended Barro equation is derived by augmenting the equation with various additional variables. To estimate the extended Solow equation, variables such as GDP per capita

growth rate, gross capital formation, human capital, population growth rate (adjusted for depreciation), life expectancy, and government consumption are considered crucial determinants of economic growth. By including these additional regressors, the extended Solow growth model provides a more comprehensive understanding of the factors influencing the convergence of economies.

$$\log y_t - \log y_0 = v_i - \beta_1 \log y_0 + \beta_2 \log s_k + \beta_3 \log h_k - \beta_4 \log(n + \delta + g) + \\ + \beta_5 \log G_C + \beta_6 \log LE + \theta_t \quad (4)$$

In the equation, additional variables are introduced: *ln* represents the rate of inflation, *GC* denotes government consumption as a percentage of GDP, and *LE* denotes life expectancy at birth. The previously defined terms remain the same.

The ratio of exports to GDP serves as an indicator of an economy's openness, as highlighted by Pereira and Xu (2000) (32). An increase in exports leads to economies of scale and enhanced productivity (Grossman and Helpman, 1990) (33). Empirical evidence supports the existence of a long-run relationship between exports and GDP growth, indicating that exports drive economic expansion (Suleiman & Hemed, 2018) (34).

Government consumption has a dual impact on economic growth. On one hand, taxes reduce the marginal product of capital, exerting a negative influence. On the other hand, government services and spending contribute positively to the marginal product. Initially, at lower levels of public spending, the positive effect dominates, resulting in increased growth rates. However, beyond a certain threshold, the negative impact dominates (Robert Barro, 1990) (35). Connolly & Cheng (2016) (36) and Grier and Tullock (1989) (37) find a statistically significant negative relationship between the GDP growth rate and the growth rate of government consumption.

The impact of money on economic growth is determined by the effect of inflation on the steady-state equilibrium level of output. This impact can be neutral, positive (known as Tobin's effect), or negative (referred to as anti-Tobin's effect). Sidrauski (1967) (38) finds a neutral impact of money, while Tobin (1965) (39) considers it a substitute for capital, thus having a positive impact on economic growth. Stockman, on the other hand, views money as complementary to capital, resulting in a negative impact on economic growth.

Regarding life expectancy, its impact on economic growth is complex. Cervellati and Sunde (2009) (40) suggest that lower mortality increases resource productivity but may decrease per capita output. Lorentzen, McMillan, and

Wacziarg (2008) (41) find a strong and positive relationship between GDP growth and life expectancy, indicating a beneficial effect on economic growth.

5.4. Estimation of Conditional Convergence

Barro and Sala-i-Martin (1992) (28) and Mankin, Romer & Weil (1992) (42) employed a cross-sectional approach to analyze the convergence hypothesis. However, cross-sectional estimation overlooks time series variations and fails to explain heterogeneity among different cross-sectional units. To address these limitations, panel data estimation is utilized, which allows the incorporation of data for multiple cross-sections over a specific time period. In essence, panel data analysis combines both cross-sectional and time series dimensions, offering several advantages over time series and cross-sectional analyses. It provides greater variability, reduced collinearity among variables, increased degrees of freedom, and enhanced efficiency (Gujarati, 1995) (43). Furthermore, panel data enables a better assessment of the impact of economic, political, institutional, and social policies and programs, as it observes the same cross-sectional units across different time periods (Wooldridge, 2011) (44).

Various methods can be employed for panel data estimation. The pooling method (PM) assumes homogeneity among countries and estimates a common constant for all countries. The fixed effect (F.E.) method allows for different dummies or indicators for each country, thereby providing a distinct constant for each country. On the other hand, the random effect (RE) method assumes that each country exhibits variations in its error term. The fixed effect estimator remains consistent even when the estimator is correlated with individual effects. The growth regression, i.e., the equation of convergence in the dynamic panel takes the form as follows:

$$y_{it} = \alpha_1 y_{t-1} + \Sigma\eta_1 x_{it} + \delta_t + \mu_t + u_{it} \quad (5)$$

where y_{t-1} is a lag of per capita GDP, the dependent variable, and the second term of equation (5) represents the sum of regressors. The third and fourth terms of equation (5) are the time effect and state-specific effect respectively, and the last term is the error term.

However, Panel data estimation also faces several challenges, including serial correlation, correlated individual effects, inaccurate standard errors, and endogeneity issues. The dynamic nature of panel data introduces a correlation between the error terms and the lagged dependent variable, 5ØfÜ5ØaÜ”1, leading to bias and underestimation of the convergence coefficient. Consequently, the random effect regression is unsuitable for estimation as it assumes an exogeneity of variables, implying no correlation between the error term and the

regressors. To address these problems, Arellano and Bond (1991) (45) developed the first-differenced generalized method of moments (GMM). This approach utilizes 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 become weak when differencing is applied, leading to correlation with the error term (Sabbaghpoor-Fard, 2013) (1). To overcome the drawbacks of the first-differenced GMM, Blundell, and Bond (1998, 2000) (46) 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 the problems of 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 states that the instruments are valid and not correlated with the error term. If the null hypothesis is rejected, it indicates that the instruments are not valid. Additionally, the AR (1) and AR (2) tests are used 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 (Roodman, 2006) (47).

6. Results and Discussions

The convergence hypothesis suggests that if the coefficient of the initial level of GDP per capita in a state/UT is negative and statistically significant, convergence is observed. To account for heteroscedasticity and nonlinear trends, all variables are transformed into natural log form (Iyoboyi, 2014) (48).

The regression results for the first Augmented Solow Model and Extended Solow Model are presented in Table 4. Accurate estimation requires addressing endogeneity, validating instruments, absence of autocorrelation {AR (2)}, and individual significance of coefficients. The Sargen test indicates the validity of instruments, while the model exhibits first-order autocorrelation but no second-order autocorrelation, indicating no autocorrelation issue.

According to the model, the coefficient of the log of initial GDP per capita (-0.0378) is significantly and negatively related to the real GDP per capita growth of the Indian states/UT. This implies the presence of conditional convergence across the region, controlling for investment, human capital, and population

growth. Consequently, poorer states in India are experiencing faster economic growth compared to wealthier ones.

Analyzing the impact of regressors on economic growth in the augmented Solow model, it becomes evident that physical capital stock has a positive and significant influence on economic growth in the 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 found to be significantly conducive to economic growth at the 1% level. Additionally, population growth is positively and significantly associated with economic growth in the Indian States/UT. It is worth mentioning that most Indian states/UT have experienced increasing population growth rates. Therefore, these states should consider formulating policies to incentivize lower fertility rates among married couples to harness the benefits of the demographic dividend.

Expanding the augmented Solow model, we control for additional variables such as government final consumption (% of GDP), and life expectancy (number of years). Similar to the previous analysis, the validity of instruments, absence of autocorrelation {AR (2)}, and individual significance of coefficients are confirmed. The Sargen test indicates the validity of instruments, and while first-order autocorrelation is present, second-order autocorrelation is absent, suggesting no overall autocorrelation problem in the model.

Table 4: Testing Conditional Convergence of Indian 26 States/ UT (1991-2020)

Variable	*Augmented Solow Model*	*Extended Solow Model*
£Ln(y_{it-1})	0.4181***(0.0257)	0.5636***(0.0041)
Ln(y_{it-1})	-0.0378***(0.0356)	-0.4337***(0.0014)
Ln (s_k)	0.0217* (0.0068)	0.0435***(0.0009)
Ln (h_k)	0.2266***(0.0266)	0.0241***(0.0009)
Ln(n+ä)	0.0825*(0.0483)	0.2238***(0.0029)
Ln(Gc)	-	-0.0649***(0.0008)
Ln(LE)	-	1.0384***(0.0163)
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, and LE is the life expectancy at birth.

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.

After accounting for other macroeconomic indicators such as government consumption, and life expectancy, the coefficient of the initial level of per capita income demonstrates a significant negative relationship. This provides evidence of conditional convergence, indicating that lower-income states/UT in India are growing at a faster rate compared to wealthier States/UT. The convergence coefficients in the augmented Solow model for the Indian States are lower than those in the Solow extended growth model, highlighting the importance of additional variables in explaining economic growth. These results suggest that the extended Solow-type income growth framework better captures the phenomena of growth and convergence. Moreover, the marginal impact of different macroeconomic variables varies.

The study by MRW (1992) (42) emphasizes the significant role of physical capital in explaining differences in output per capita across countries. Growth theory considers the accumulation of physical capital as a key driver of economic growth. Similarly, in the case of the Indian states/UT, we find a positive and significant relationship between economic growth and physical investment.

Human capital, another variable in the regression equation, has been widely recognized as a crucial factor for economic growth. It influences production through labor productivity (level effect) and contributes to increased competitiveness through innovation and technology transfer (rate effect). Consistent with Elena Pelinescu (2014) (49) and other research, we find a strong and positive relationship between economic growth and human capital.

Life expectancy, with a coefficient of 1.04, exerts the greatest positive and significant effect. This underscores the importance of health in determining economic growth rates.

The relationship between population growth and economic output growth has been extensively studied in the growth literature. Some analysts predict relatively slow economic growth in transition economies, including India, due to anticipated population growth. Others argue that population growth poses challenges as it strains finite resources and limits long-term growth potential. 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 analyzed in the context of long-run income growth, has generated two opposing arguments: the crowd-out hypothesis and the government expenditure multiplier. In our analysis (as shown in Table 5.4), the government consumption ratio is found to be negatively and significantly related to economic growth in the Indian States/

UT. This aligns with the negative impact of government spending on economic growth observed in developing countries, as validated by Guseh (1997) (50).

7. Conclusions

This study thoroughly examines the issue of economic growth and convergence in the Indian States, encompassing 27 states/UT over a 30-year period from 1991 to 2020. The analysis reveals that there is no significant negative correlation between the initial per capita GDP ratio and the average annual growth rate, indicating the absence of absolute â convergence across the Indian States' economies during the study period. The findings from the sigma convergence analysis align with the results obtained from the absolute convergence model.

To account for the heterogeneity among Indian States, both the augmented Solow model and the extended Solow growth regression frameworks are employed for estimation. The augmented Solow model incorporates control variables such as physical capital, human capital, and population growth rate (variables used by MRW) in the convergence equation. The extended Solow regression model further includes additional variables like exports as a percentage of GDP, inflation, life expectancy, and government consumption as a percentage of GDP to capture the heterogeneity of the Indian States/UT. Estimations for both models are conducted using the Dynamic System Generalized Method of Moments (DSGMM).

In the estimations of the augmented Solow model, we observe a rate of conditional â-convergence (coefficient of initial GDP per capita) of 0.037 among the Indian states/UT. This implies that, in addition to the initial level of GDP per capita, factors such as physical and human capital, as well as population growth, play significant roles in the growth and convergence of these states.

In the extended Solow growth regression, the coefficient of initial GDP per capita is found to be 0.43. This indicates that, apart from the initial level of per capita income, factors such as physical and human capital, population growth, and other variables included in the model, contribute significantly to the growth and convergence of the Indian States/UT.

8. Policy Implications

Achieving high and sustainable economic growth has been a primary policy objective for the Indian States. Policymakers must understand the determinants of growth and the impact of policies on economic performance to attain and maintain a high growth rate since real GDP growth has become a focal point for policy initiatives in almost all states/ UT. Consistent with the findings of this research, it can be concluded that:

1) Economic growth is positively influenced by factors such as expansion in the labor force, investment in physical and human capital, and prudent government consumption. Prioritizing spending on social sectors like health and education also plays a vital role in fostering growth.
2) Open economies have advantages in terms of accessing new technologies and ideas from around the world. Additionally, they tend to benefit from greater specialization in production processes based on their comparative advantages, which contributes to faster economic growth.
3) The savings rate of the central government serves as an important policy indicator. Higher government saving rates have two positive effects on aggregate economic growth: firstly, states with higher saving rates tend to have higher investment levels and, consequently, experience faster growth; secondly, higher government savings indicate sound macroeconomic management overall.
4) This study reveals a significant and positive relationship between government spending on education and health (measured as a percentage of GDP) and per capita income growth in the Indian states/ UT during the specified period. This implies that governments must increase investments in human capital formation to achieve higher growth performance.
5) The coefficient of government consumption as a percentage of GDP exhibits a negative and statistically significant relationship with per capita income growth. Therefore, prudent budgetary policies must be formulated to allocate resources efficiently.
6) Life expectancy also exhibits a positive and statistically significant effect on the economic growth rate among the Indian States/UT. Theoretically, productivity growth should be positively correlated with health levels, particularly with average life expectancy serving as a proxy variable. Consequently, governments should allocate increased budgetary resources to the health sector.
7) Population growth contributes positively and significantly to economic growth in the Indian States/ UT. It is worth noting that most countries in the region have experienced negative population growth rates. Therefore, policies should be formulated to incentivize married couples to decrease fertility rates and harness the potential benefits of the demographic dividend.

8) Effective monetary policy management remains crucial for stability and growth.

9. Suggestions for Further Research

The study of economic growth and convergence is a complex and evolving field. Researchers have employed various econometric techniques to explore the effects of different determinants of economic growth, often considering unobserved factors. In our research, we utilized the dynamic system GMM. However, there are several avenues for further investigation that could enhance the robustness of the results.

Firstly, extending the time series and incorporating additional determinants of economic growth, for which data is available, would be beneficial. Applying Mean Group Estimators (MGE) or Pooled Mean Group Estimators (PMGE) could provide more reliable and robust results.

A second area for future research involves testing the convergence hypothesis by examining multiple independent variables that capture different aspects of economic growth, such as labor productivity and institutional factors. This would offer a more comprehensive understanding of the convergence dynamics among the Indian States/ UT.

Furthermore, classifying states based on their distance from the national per capita income, (which exhibits higher GDP and per capita income), could provide valuable insights. By categorizing states/UT in this manner, the convergence hypothesis could be tested with additional explanatory variables to determine if the results hold true 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. This would enable a more comprehensive assessment of convergence patterns and enhance the generalizability of the findings.

By addressing these suggestions, future research can further enrich our understanding of economic growth and convergence dynamics, leading to more nuanced insights into the determinants and patterns of economic development.

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