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Keshab Das

Referees

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Editorial

The opening article of this issue carries the Presidential Address (by Jagannath Lenka) that was delivered at the 58th Annual Conference of the Odisha Economic Association. In a searching analysis of if the internationally-pursued export-led growth approach contributed to national economic growth, the author brings up mixed results and points to some fundamental initial conditions those might have critically and differently influenced both the processes and outcomes. Considering the Indian case, it was observed that even as in the short-run growth of exports and that of output do not quite co-move there could be a positive association between the two in the long run. Honing the policy, hence, would involve aspects beyond those of increasing the volume of exports as product diversification and moving up the value chain.

Taking a long time period of 1960-61 to 2024-25 on the β-convergence of income across the states the article (by Prabir De and Adrija Ganguly) shows divergence in income growth with symptoms of 'catching up' by poorer states. Sigma convergence scores also indicate rising inequality of income across the states. Of the major factors affecting conditional convergence/divergence subnational exports emerge as the most dominant. As exports are positively affected by the endowment of infrastructure, the authors make a case for improving both physical and soft infrastructure at the state level if reducing income inequalities and benefiting from exports are seen as important policy goals.

The next article (by RewanthRaichooti and Deba Prasad Rath) provides a comprehensive investigation of state-level trends in fiscal-monetary policy alignment and its impact on regional economic performance. Considering thirteen major Indian states, the study conceptualises an index-construction method to quantify policy alignment. Major findings of the analysis include the proposition that aligning policies better can raise economic growth by 0.7 to 0.8 percentage points and secure long term overall economic growth and stability. The authors suggest integrating subnational policy alignment as a permanent structural feature of the national macroeconomic framework.

By providing a comprehensive and critical overview on climate change and the consequent rise of waste, the following article (by Praveena Sanjay) alerts citizens of the ills of the prevalent highly energy-intensive linear growth

approach and argues for aiming to pursue a more sustainable and circular path. Expositing the world of circular economy growth model, the analysis draws upon relevant national and subnational (Odisha state) policies to suggest plausible future strategies for the state to benefit from the circularity goals of resource efficiency, resource sufficiency, and energy security.

The next article (by Shivam Agarwal and Rachna Mujoo) explores the nexus between carbon emissions, inflation, economic growth, and financial development in India, applying the Environmental Kuznets Curve framework.This study demonstrates that economic growth and foreign direct investment in India significantly increase carbon emissions. That suggests the incompatibility existing between financial expansion (including inflation) and sustainability.

Another article (by Purnendu Modak) explores the relationship between early marriage and total fertility rate, based on data from the National Family Health Survey 5. While this association is found prevailing, variations across states were found.Further, various demographic and socioeconomic factors—such as low household wealth, illiteracy, lack of contraceptive use, employment status, and caste—shape the total fertility rate among those who married young.

The article (by Motilal Mahamallik) analyses data across five rounds of the National Family Health Survey towards evaluating temporal trends, interstate disparities, and delivery-location trajectory categories—progressive, regressive, static, or indeterminate—among mothers with at least two children. The study underscores persistent vulnerabilities, revealing that a significant portion of mothers remain in the regressive or indeterminate categories regarding institutional delivery.

In an innovative and persuasive research note (by Nilakantha Rath) on teaching the rather dreary subject of price theory, a case has been made for the students to inculcate familiarity with arithmetic exercises to appreciate the theoretical foundations better. With concrete examples of price elasticity of demand, law of variable proportions and oligopolistic behaviour it is argued that engagement with pragmatic policy practices can sharpen students' mind in both theory and applications.

Focusing on the neglected aspects of valuing ecosystem services in agriculture, the research note (by Suvangi Rath) underscores the need to recognise supporting and cultural services. Moving beyond the usual provisional or output services, as say, in case of paddy cultivation in Odisha or India, ecosystem benefits of enhancing land productivity and crop variety are mostlyignored. Bringing in regional specificities in analysis and accounting promises to be both relevant and rewarding.

This issue carries two book reviews. The first review (by Manikantha Nataraj) discusses the fascinating and evolving subject of 'degrowth' including its interesting antecedents including what may be termed Gandhian economics. The second review (by Keshab Das) explores various challenges and possibilities of entrepreneurship in the domain of informality.

Keshab Das
Editor-in-Chief
Odisha Economic Journal

Reinvestigating the Export-Led Growth Hypothesis with Evidence from India

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Jagannath Lenka

Introduction

The Export-Led Growth Hypothesis (ELGH) postulates that a sustained increase in exports leads to lasting economic growth of a country. The justification lies in the belief that export expansion warrants more production of goods and services and therefore makes full use of resources, creates more employment, and magnifies income through the foreign trade multiplier. Moreover, it exploits economies of scale and increases the productivity of capital and labour by allocating resources more efficiently. The foreign exchange earnings through exports facilitate the import of capital goods and new technology. Consequently, it enhances the overall economic development and the well-being of the country. The hypothesis is also important in providing a theoretical argument in favour of outward-oriented development strategies in which export growth facilitates structural transformation by connecting micro-level efficiency improvements with macro-level growth outcomes and finally offers a framework for evaluating trade liberalisation and competitiveness policies.

The early wave of theories with respect to international trade and the benefits thereof were developed and popularised mainly by the classical school of economists, particularly by Adam Smith (1776), David Ricardo (1817), and John Stuart Mill (1848). They laid the foundation stone of trade theory on the basis of specialisation, efficiency and mutual benefits from international trade. Subsequently, these theories were refined, and enriched by the works of neo-

Jagannath Lenka, President, Odisha Economic Association (OEA), 2025-26.

This article is the Presidential Address delivered at the 58th Annual Conference of the OEA, held at the KIIT Deemed to be University, Bhubaneswar, February 7-8, 2026.

Acknowledgements: I express my heartfelt gratitude to Professor R. N. Patra and Professor Keshab Das, former Presidents of the OEA, for their invaluable guidance, encouragement, and insightful suggestions in preparing my Presidential Address. Their wisdom and unwavering support have greatly enriched this work. I also place on record my sincere thanks to Professor Jajati Parida and Dr. Kirtti Ranjan Paltasingh for their excellent technical support and timely assistance, which contributed significantly to the successful preparation of this address.

classical economists like Eli Heckscher (1919) and Bertil Ohlin (1933) and Gottfried Haberler (1936) emphasizing factor endowments and opportunity costs, respectively. Since then, arguments in favour of free trade and several incontrovertible benefits associated with it have been widely debated, discussed and documented in the economic literature (see, e.g., Bhagwati, 1978; Krueger, 1978). However, the Prebisch-Singer Hypothesis challenged the view that free trade benefits all trading partners equally. They argue that developing countries (DCs), in fact, tend to lose from free trade in the long run.

There was a systematic evolvement of ideas in the economic growth literature with the emergence of the endogenous growth theory in the mid-1980s and early 1990s. The works of Lucas (1988) on human capital and Romer (1990) on technological change led to the development of innumerable economic and econometric models. These models are used by economists to verify the ELGH and found that open economies grow faster compared to those that are closed (Edwards, 1998). The success stories of South-East Asian countries like Hong Kong (China), Taiwan, Singapore and the Republic of Korea, the so-called Four Asian Tigers, confirmed that trade is, in fact, the main engine of growth and motivated other DCs to switch from protectionism to liberalism. International financial institutions like the IMF and the World Bank encouraged DCs to implement structural adjustment programmes emphasising opening up to trade and foreign investment. Since then, the ELGH gained wide currency among academics (Feder, 1982; Krueger, 1990) and evolved into a "New conventional wisdom" (Tyler, 1981; Balassa, 1985) that shaped the development strategy and policies of a number of countries.

In addition to this, many DCs, including India, were forced to open up their economies because most of them experienced the balance of payments crisis, high fiscal deficits, and unsustainable debt burdens and had no options left rather than depend on multilateral organizations to implement adjustment and stabilization programmes. In order to correct imbalances in their basic macroeconomic indicators, these countries relied heavily on the export promotion approach as one of the most suitable and trustworthy mechanisms. As part of an outward strategy, a new set of policies rapidly became a key component for policymakers in DCs involved in adjustment and stabilization programmes. Therefore, many governments have tried to stimulate exports using diverse mechanisms and instruments like subsidies and tax exemptions.

Consequently, the economic literature concerning development economics, economic growth, adjustment and stabilization programmes had quickly rejected the inward-oriented approach and was suddenly placing great emphasis on export-led strategies. Most of the macroeconomic theorists and policymakers in DCs rapidly embraced the new wisdom, in the belief that by following this scheme their countries would achieve or regain the high rates of growth of the past.

A good number of research studies on ELGH have been carried out during the past 35 years. In fact, a new series of empirical studies has been conducted on a number of divergent lines of research, methodologies, and time periods across different countries. However, the evidence available in support of ELGH is far from conclusive, and this situation explains to some extent why this debate still exists in the economic literature. The purpose of this study is to reinvestigate and test the ELGH, using data from India.

The present exercise is organized as follows. Section 2 presents the review of literature. Data and methodology are discussed in Section 3. In Section 4, the results are analyzed and discussed. Finally, a summary of the findings and policy implications is presented in the concluding section.

2. Literature Review

Some of the earlier empirical studies made during the1960s and the 1970s, that need mention include the works of Emery (1967, 1968), Syron & Walsh (1968), Serven (1968), Kravis (1970), Michaely (1977), Heller & Porter (1978), Bhagwati (1978), and Krueger (1978). These studies collectively argue that rapid export expansion is positively associated with overall economic growth.

In the next two decades, the empirical work on ELGH strengthened and refined the earlier findings by employing improved econometric tools like causality tests, cointegration, and cross-country panel analysis. The works of Kavoussi (1984), Balassa (1985), Moschos (1989), Dollar (1992), Edwards (1992), Sachs & Warner (1995), Edwards (1998) and Giles & Williams (2000) confirmed that exports are a significant driver of long-run economic growth.

Literature on ELGH in the last twenty-five years reveals that advanced econometric techniques such as panel cointegration, dynamic panel GMM, ARDL bounds testing, and country specific causality analysis are in use to assess the nexus between export and growth. Studies such as Giles & Williams (2000) and Bahmani-Oskooee & Economidou (2009) reveal that export and economic

growth are cointegrated in the long-run though the direction of causality varies across countries. Awokuse (2003, 2007) finds that there is bidirectional causality between exports and economic growth rather than a strict ELGH. Harrison (1996) and Dollar & Kraay (2004), using large panel datasets, emphasize that export promotion contributes to growth mainly through productivity gains associated with openness, technology diffusion, and institutional quality. Sector-specific and disaggregated export studies by Herzer, Nowak-Lehman & Siliverstovs (2006) and Saeed & Hussain (2015) reveal that manufactured and high-technology exports have a stronger growth impact than primary exports. In the meantime, Chang, Kaltani & Loayza (2009) and Rodriguez & Rodrik (2001) noted with a caution that growth effects of exports are conditional on contemporary policies, human capital accumulation, financial development, and macroeconomic stability.

The studies on industrialized nations have analysed the cases of Canada, France, Germany, the United Kingdom, the United States, and Switzerland, among others. In only a few cases have the empirical results confirmed that export expansion was a key element in the economic success of those countries (Kugler, 1991; Afxentiou & Serletis,1992; Henriques & Sadorsky, 1996). Even more astonishing, it has been observed that internal forces were the 'handmaidens' of the great Japanese economic success in the twentieth century, not trade, as many have claimed (Boltho,1996).

In the Indian context, Bhat (1995), using the cointegration technique, found supportive evidence for ELGH while Chandra (2003) found a positive relationship between exports and economic growth. Jim & Chandra (2004) observed a bi-directional causality between export and economic growth. Padhan (2004) and Ray (2011), using co-integration and the error correction model, gave support to the ELGH. Dhawan & Biswal (1999) found short-run causality from export to gross domestic product (GDP), while Kuar & Sindhu (2012), using the multivariate framework, concluded in favour of export-led growth.

The studies that did not confirm the ELGH include the works of Jung and Marshal (1985), Sengupta & Espana (1994) and Sachs & Warner (1995). They found that ELGH is not supported in DCs due to their dependence on primary exports. Panas & Vamvoukas (2002) did not observe evidence in support of export-led growth. Reppas & Christopoulos (2005) invalidated the ELGH on the basis of their study on the nexus between export and economic growth for twenty-two African countries.

Ghatak & Price (1997); Asafu-Adjaye & Chakraborty (1999); Nataraj, Sahoo & Kamaiah (2001); Anwer & Sampath (2001); Sharma & Panagiotidis (2005); and Nain & Wasim (2010) in their studies on nexus between export and growth, refuted the ELGH in India.

From a review of the empirical literature on exports and growth since the late 1960s, it is evident that exports alone do not necessarily cause growth. The results reported are clearly sensitive to the variables employed, the theoretical framework assumed, and the econometric methodology employed. Since cross-section studies can obscure particularities of DCs, especially those that are low-income countries, the correct strategy to follow from an empirical point of view is to address the issue in a country-specific framework, using as much as possible the recent developments in time-series analysis.

3. Data and Methodology

The present study makes use of the data extracted from the *Handbook of Statistics on the Indian Economy* published by the Reserve Bank of India and Population Census of India for the years 2001 and 2011 relating to the variables presented in Table 1. The time period ranges from 2000-01 to 2024-25.

Table 1: Variables and Sources

Variable	Symbol	Source
Gross Domestic Product	GDP	All the variables' data are taken from RBI data base (except Population data, taken from Census)
Gross Capital Formation	GCF	
Population	POPN	
Exports	EXP	
Imports	IMP	

GDP at 2011-12 prices from 2000-01 to 2024-25 is used to measure the growth of the Indian economy and is the dependent variable. The independent variables include, Gross Capital Formation (GCF), Exports, Imports and population for the same period. While the GCF is expressed in 2011-12 prices, Export and Import figures are inflation adjusted. The population figures are the trend values assuming the same growth rate between 2001 and 2011.

GCF has a significant and positive impact on GDP as it enhances the productive capacity of an economy. Moreover, sustained growth in GCF signals investor confidence and supports structural transformation by enabling shifts from low-productivity to high-productivity sectors.

Exports play an important role in influencing GDP by acting as a key driver of aggregate demand and long-run economic growth. An increase in exports directly raises GDP through the foreign-trade multiplier, generating higher output, income, and employment. It also enhances supply side performance by promoting economies of scale, improving resource allocation, and fostering productivity gains through technological spillovers and increased competitive efficiency. Moreover, export earnings relax foreign exchange constraints, enabling greater imports of capital goods and essential inputs for domestic production. However, the impact of export on GDP is conditional on factors such as domestic linkages, value addition diversification, and the overall macroeconomic and institutional environment.

Imports generally reduce GDP because imported goods and services represent expenditure that leaks out of the domestic production system. However, imports can enhance productive capacity by providing intermediate inputs, capital goods, advanced technology. And cheaper consumption goods that improve efficiency, lower production costs and raise total factor productivity in the long run. Therefore, the impact of imports on GDP depends on the composition of imports, the structure of the economy and also the degree to which imports complement domestic production.

Population acts both as a growth driver and as a constraint, depending on its size, structure, and quality. Population impacts GDP through the supply and demand side channels. On the supply side, population growth expands the labour force, potentially increasing productive capacity and output provided it is supplemented by adequate capital formation, technological progress and human capital development. On the demand side, a larger population enlarges the domestic market by raising aggregate consumption and investment demand, which can stimulate output through the multiplier effect. However, excessive growth of the population may lead to capital dilution, lower labour productivity, and structural unemployment, thereby constraining GDP growth. Moreover, low per-capita income may retard savings and investment and weaken economic growth.

This paper makes a modest attempt to analyse the potential effect of exports on economic growth in India. In order to know that the variables are stationary, a unit root test is conducted by applying the Augmented Dickey Fuller (ADF) test. Furthermore, the optimal lag length for the model is determined using the VAR lag length criterion, provided by EViews, where different criteria are used to select the optimum lag length. Having selected the optimal lag length, an Autoregressive Distributed Lag (ARDL) model is run for analysing both short-run and long-run relationships between the independent and dependent variables.

4. Results and Discussion

4.1 *Augmented Dickey Fuller Test*

An ADF test is performed to account for the problem of non-stationary variables. This test is based on the null hypothesis of an existing unit-root. Rejecting this null hypothesis means that there is no unit root problem and the variable is stationary and accepting the null hypothesis means that there is a unit root problem and the variable is non-stationary. Table 2 shows the ADF test results, where the lag length was automatically selected by the LR, FPR, AIC, SC, and HQ Criteria (Table 3). First, the ADF test is run on level data to show the variables' non-stationarity. The results of the ADF test show that the variables such as GDP, GCF, EXP, and IMP, in their level form, have been non-stationary while POPN, is stationary. But it is found that the non-stationary variables are first-difference stationary (Table 2)

Table 2: Unit Root Test Results

Augmented Dickey–Fuller			
	Level	Ist difference	Conclusion
LnGDP	1.645	-4.083	I(1)
LNGCF	0.073	-4.150	I(1)
LNExport	0.665	-4.296	I(1)
LnImport	2.075	-4.899	I(1)
Population	-4.018		I(0)

4.2 *Selection of Optimum Lag*

Since there are different integration orders, some stationary I(0) and some non-stationary I(1), the ARDL model is adopted for analysing time series data to

capture both short-run and long-run relationships between variables. The Likelihood Ratio (LR) test, Final Error Prediction (FEP) test, Akaike Information Criteria (AIC) test, Schwarz Information Criteria (SIC) test and Hannan Quinn (HQ) test confirm that the optimum lag length is one (Table-3).

Table 3: VAR Lag Selection Criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-723.154	NA	2.17E+21	63.317	63.564	63.379
1	-622.07	149.428*	3.09e+18*	56.701*	58.182*	57.074*

4.3 *Results of ARDL Model*

The following equation is estimated to find both the short-run and long-run relationships between GDP (dependent variable) and GCF, EXP, IMP, and POPN (independent variables). â$_0$ represents the constant term, âs stands for regression coefficients. *$_t$ represents the error term.

$$LNGDP_t = \beta_{0+} \beta_1 LNGDP_t + \beta_2 LNGCF_t + \beta_3 LNGCF_{t-1} + \beta_4 LNEXP_t + \beta_5 LNEXP_{t-1} + \beta_6 LNIMP_t + \beta_7 LNIMP_{t-1} + \beta_8 POPN_t + \beta_9 POPN_{t-1} +_{*\S t}$$

The results for the short-run estimation (Table 4) reveal that there is no relationship between exports and the GDP. But there is a long-run relationship (Table 5) between exports and GDP. The estimated long-run coefficient represents the equilibrium impact of exports on the GDP. A statistically significant positive coefficient indicates that a sustained increase in exports may lead to a permanent increase in the GDP. The Error Correction term captures the speed of adjustment towards long-run equilibrium following a short-run shock. A negative and statistically significant Error Correction term confirms cointegration and indicates how quickly deviations from equilibrium are corrected. The diagnostic test results (Table 6) are robust enough to establish that there is a long-run positive relationship between exports and the GDP. The CUSUM (Figures 1 & 2) graphs confirm that a gradual drift creates a clear upward trend of GDP

Table 4: Short-run Elasticities of ARDL Model (Dependent Variable LNGDP)

Variable	Coeff	Std.error	Prob.
LnGDP	0.583**	0.175	0.004
LNGCF	0.306**	0.137	0.040
LNExport	0.080	0.207	0.704
LnImport	-0.008	0.192	0.967
Population	-0.968	1.330	0.477
ECM(-1)	-0.417**	0.175	0.030

Table 5: Long-run Elasticities of ARDL Model (Dependent Variable LNGDP)

Variable	Coef.	Std.error	Prob.
LNGCF	0.734	0.454	0.126
LNExport	1.633**	0.659	0.025
LnImport	-1.163**	0.494	0.032
Population	-2.319	3.976	0.568
Contant	1.593	4.127	0.705
F-stat	3.572		
Level of significance	Lower bound	Upper bound	
10%	2.45	3.52	
5%	2.86	4.01	
1%	3.74	5.06	

Table 6: Diagnostic Tests

Diagnostic test	F-stat	P value
Normality (J-B) test	15.550	0.000
Serial correlation	0.165	0.850
Breusch-Pagan-Godfrey test	1.327	0.300
ARCH test	0.110	0.743
Ramsey Rest	1.173	0.259

Stability Tests

Figure 1: CUSUM

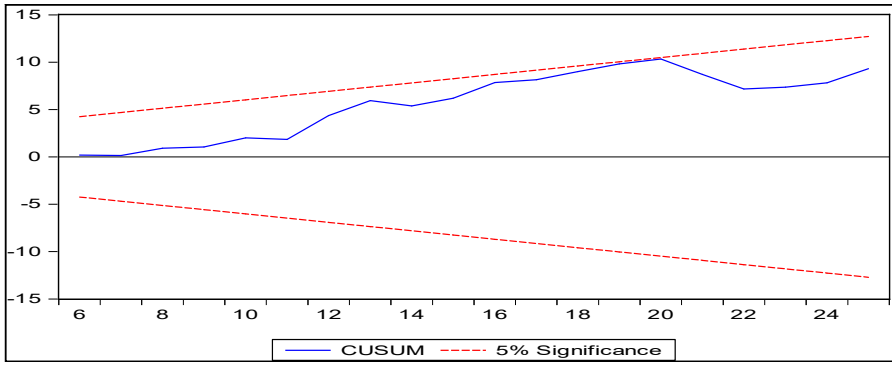


Figure 2: CUSUM of Square

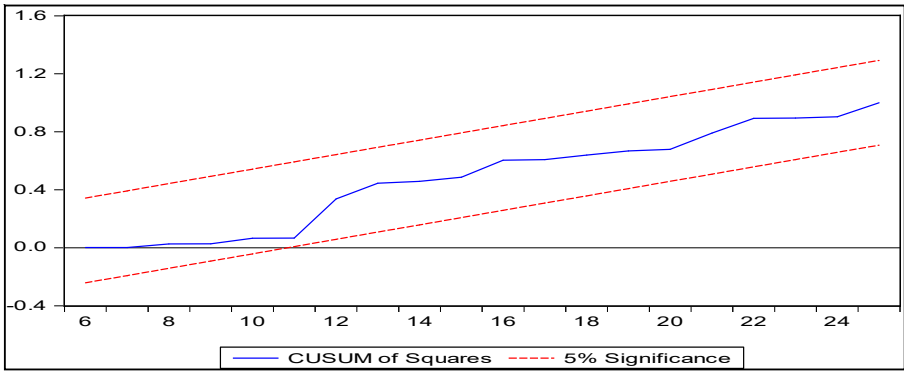


Table 5: Long-run Elasticities of ARDL Model (Dependent Variable LNGDP)

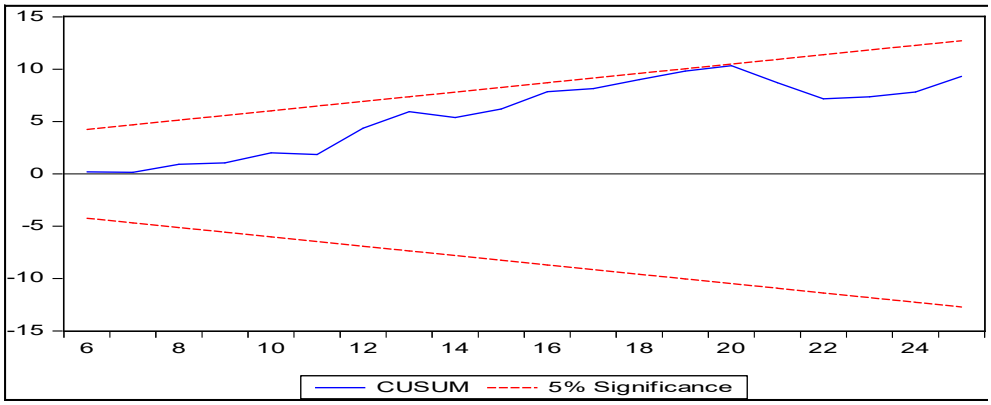
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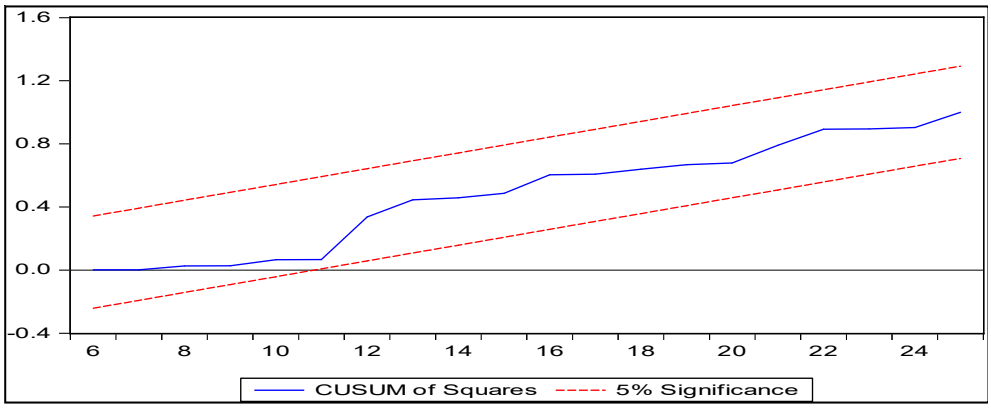
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Serial correlation	0.165	0.850
Breusch-Pagan-Godfrey test	1.327	0.300
ARCH test	0.110	0.743
Ramsey Rest	1.173	0.259

Stability Tests

Figure 1: CUSUM





5. Findings and Policy Implications

This section concludes the study by synthesizing the major empirical findingsand discussing their policy implications. The analysis was undertaken to reinvestigate the ELGH that is to find the relationship between exports and GDP in the context of the Indian economy using ARDL model. The findings derived from the econometric results are summarised and interpreted in light of the existing theoretical and empirical literature.

It was found that export growth and output growth do not share any significant co-movement in the short-run. However, in the long-run, there is a positive association between exports and GDP in India,and this association was found to be growing stronger over time. This implies that export expansion is a sustained driver of economic growth rather than a short-run stimulus.

The findings suggest the adoption of an export-led growth strategy, where trade openness and export promotion are considered the centrestage of long-run development policy. The governmentof India needs to prioritise exports as a structural engine of growth rather than depending solely on domestic demand. Policies are to be framed not only on increasing the volume of exports but also on diversifying export baskets and moving up the value chain.

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Regional Income and Exports in India: A State-level Analysis

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Abstract

The states play a vital role in achieving the goal of Atmanirbhar Bharat. A strong and resilient India requires states to converge in terms of income per capita. Very few studies have been found that have extensively examined income convergence/divergence over a long period of time, directly contributing to state-level exports. This empirical study analyses not only the regional income disparity but alsothe determinants of state-level exports. The study has been carried out for a period of 65 years, starting from 1960-61 till 2024-25, across 29 Indian states. The paper shows the divergent pattern of states due to larger state-level infrastructure and policy differences. While analyzing the determinants of state-level exports, the econometric model shows that per capita income, along with gross fixed capital,has a significant positive impact on state-level exports.However, the caveats are that gross value added is found to have a negative impact on state-level exports, whereas road density, being an important transport infrastructure, remains statistically insignificant. Therefore, the study highlights the rising income disparity across Indian states, thus affecting the inclusive development of the country and posing a serious challenge to unity in diversity.

Keywords: India, Odisha, Convergence, Divergence, Export, Growth

1. Introduction

States are the foundation of the Indian Union. With India's ascent as a leading global power, it has been heavily debated whether India's rise is accompanied by a convergence of Indian states in terms of income per capita. Indian states,

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29 in number today, have been facing the challenges of 'catching up' by the poorer ones. The diversity of India is, therefore, an ideal case to test convergence (or divergence) hypotheses with the help of neoclassical growth models since the diversity is reflected not only in terms of geographical space, population, and resource endowment but also visible in the income and growth rates.

As states have been experiencing a rise in income over the years, not only at the national level but also at the regional level, further integration of trade and investment between states and countries can be expected to enhance India's resilient journey towards Viksit Bharat 2047. While trade liberalisation coupled with an increase in trade openness among the developing countries has paid in narrowing down the development gap, its impacts on the income gap are rather mixed. On one hand, trade liberalisation improves wage inequality, whereas income inequality, on the other, can undermine the growth process, cause social conflict, and negate the benefits of economic integration (Wan*et al.*,2006; Urata, 2017). Indian states with higher access to global markets have grown much faster than those lacks in it. For example, states like Tamil Nadu, Karnataka, and Gujarat maintain high growth rates (often exceeding 10-11 per cent), backed by strong industrial output, technology services, and high foreign direct investment, whereas states such as Bihar, Jharkhand, Himachal Pradesh, and Madhya Pradesh fall much behind the front-runners in terms of the same indicators. Regional disparity is, therefore, more prominent across Indian states.

Commensurate with these growth experiences, some relatively poor state economies have excelled in their performance by joining the middle-income group, while there are others who linger in the relatively low economies but have experienced rapid growth. Such diversity in the growth patterns automatically leads to the question of convergence (or divergence), i.e., whether relatively poor state economies are 'catching up' with the relatively richer ones over time. Therefore, a study on the regional economic scenario of Indian states has its own merit. This paper exclusively investigates the per capita income gap for the Indian states by using the β-convergence andσ-convergence estimation method. Besides, as an extension of the hypothesis, this paper tries to find out the determinants of state-level exports.

Income convergence or divergence has also been observed across the world and between regions or within countries. For example, although the EU is one of the foremost regions to achieve income convergence over time, disparities persist between Western and Eastern European nations, as well as within

individual countries, driven by factors like housing, wages, and tax policies.[1] A similar trend is also observed in the case of Asia and Asian subregions. The income gap among Asian economies has declined over time, and there is a possibility of having unconditional convergence in the long run.[2]

In view of the above, this paper analyses the current situation of regional disparity in India. The rest of the paper is organised as follows. Section 2 introduces the background and briefly discusses the literature. Section 3 presents the methodology and data, whereas Section 4 discusses the analysis in three sub-sections to present the results of unconditional convergence, the factors causing conditional convergence, and analysis on sigma convergence, respectively. Conclusions are drawn in Section 5.

2. State-Level Disparity and the Stylized Facts

Regional disparity has been more prominent across Indian states in terms of per capita income.[3] Disparity across states exists in other parameters as well, like education level, literacy, infrastructure, capital formation, population, and regional infrastructure. Disparity in terms of standard of living across Indian states has significant implications for the running of national economies. Regional disparity has deeper implications in terms of capital and labor migration across prosperous regions, with a changing trade-off between inflation and unemployment. Disparities across regions give rise to political resentment in less prosperous regions, along with dissatisfaction with the political process, causing social unrest. Economic, social, and political grounds make regional policies necessary to be implemented to address the problem of regional imbalances to achieve a greater degree of economic unity across the regions.

The empirical literature on regional convergence in the Indian context has produced mixed evidence. Cashin and Sahay (1996) examined convergence/ divergence for 20 Indian states during the period 1961-1991 and found evidence of absolute convergence. They showed that poorer states initially grew faster than richer states. However, the dispersion of state-level real per capita income increased over time. Conversely, Ghosh *et al.* (1998) substantiated regional divergence

[1] Refer, for example, European Commission (2026).

[2] Refer, for example, Ghatak and De (2021).

[3]There are several studies which have dealt with the regional disparity in India, and some of the notable ones are Marjit and Mitra (1996), Ghosh et al. (1998), Aiyar (2001), Rangarajan et al. (2015), Saha and Iqubal (2014), Mahapatra and Sahu (2025), Ghosh and Kaustubh (2025), to mention a few.

across Indian states during the period 1960-1995 and highlighted the persisting inter-state disparities. Over the last few years, there has been rising inequality among Indian states in terms of per capita income. Ghosh *et al*. (1998) found that Indian states have been diverging over the period of the last 35 years starting in 1960. Moreover, this result did not nullify the role of planning through disbursement of development funds across the states. Questioning the conventional convergence interpretation, Rao *et al.* (1999) provided evidence of a consistent pattern of divergence across Indian states. On the other hand, Rangarajan *et al*. (2015) found the symptoms of "catching up" and greater convergence among Indian states during the period 2004-05 and 2012-13. By examining convergence or divergence among 20 major Indian states from 2000 to 2019, Ghosh and Kaustubh (2025) found that differences in productivity growth rates and steady states drive rising per capita income inequality across states. The population growth rate, the bank credit to GSDP ratio, and the shares of agriculture and industry in GSDP contribute to the differences in steady states across states.

According to Aiyar (2001), there is a meaningful difference between conditional and absolute convergence among Indian states. His paper shows that the neoclassical model predicts conditional convergence and that convergence among Indian states is proceeding apace. There is scope for policy to improve the growth rate of per capita income. He has identified two factors that seem to be extremely important in determining a region's steady state level of income: literacy and per capita private investment. In particular, even modest improvements in literacy and private investment appear to have a substantial positive effect on growth. Furthermore, the results suggest that both literacy and private investment can be influenced by policy, and hence individual state governments can play an important role in enhancing their own growth prospects.

In the post-reform period, several studies have witnessed substantial differences in the economic performance of Indian states, thus underscoring the importance of state-level policies, infrastructure, and investment conditions. Another study has shown substantial regional disparities, including differences in productivity performance and convergence across states of India (Kumar and Managi, 2012). An alternate database shows divergence among Indian states. Based on night-time light data, Saha and Iqubal (2024) conclude that Indian states have not shown a convergence pattern recently, and regional disparity remains a significant issue in the Indian economy. Their finding supports the existing literature in the Indian context, where regional convergence is absent among Indian states.

Various orthodox economic theories have explained the phenomenon of regional inequality of income per capita; Solow (1956) predicted the convergence of per capita income to a common level given that taste and preferences, savings, investment, and technology remain the same across regions. The neoclassical theory depicts the catching-up effect of states as follows: due to the diminishing marginal returns to capital, the marginal product of capital is higher in poor regions compared to rich regions. Hence, the flow of capital to poor regions led to growth in the region more than in richer states with higher per capita capital. Hence, a similar amount of capital has a higher impact on poorer regions than rich regions; this led to the advent of "Unconditional beta (β) Convergence". The notion of unconditional convergence prevailed until the advent of "new growth theory" during the 1980s, pioneered by Romer (1986) and Lucas (1988). The assumption of diminishing marginal products of capital was questioned based on other economic forces in the system. Human capital formation, including research & development (R & D), prevents marginal products of capital from falling in the richer region. So, the convergence is based on different levels of education, R&D expenditure, and other factors identifying capital productivity. Hence, every state converges to its own level of steady state, which may persist or even widen, subject to widening of disparity of conditioning variables.

The other strand of orthodox equilibrium theory by Gunnar Myrdal (1975) in his book *Economic Theory and Undeveloped Region* propounds the idea of circular and cumulative causation, broadly meaning that economic success breeds economic success and failure breeds failure. It is not always the case of wage rate equalization when labor moves from a low-wage rate region to a high-wage rate region, as labor migration to other regions will lead to labor demand in that region. For the case of capital, a similar thing follows. Capital might not locate in a depressed region of human capital with lower future prospective yield of capital than a prosperous region. Trade also works in the same manner, to the advantage of more prosperous regions, with the existence of dynamic and static returns to scale. Kaldor (1970) incorporates regional growth in cumulative causation. This discusses the model of economic growth based on increasing returns; regional growth is a positive function of export growth, which happens to be a positive function of regional growth; also, export growth is a positive function of competitiveness and growth of income external to the region. Moreover, Verdon's law depicts that faster growth of output makes the region more competitive, which leads to faster export growth as they grow

faster. Hence, the neoclassical prediction of convergence has become the initial presumption, whereas divergence happened to non-orthodox prediction with yet to be answered.

In the recent context of the Indian economy, no studies have been found to measure the convergence or divergence across the regions for extended periods until recently. Also, we have tried to identify factors that can be conditional to beta (β) convergence. State exports are one of the important determinants that drive the per-capita income of the state; it may also lead to deviation of income from the initial level of income. State exports are also dependent on certain other factors as well, where per capita income remains important.

To examine regional disparities across states over time, it is necessary to empirically test the neoclassical growth theory. Income convergence refers to the narrowing of per capita income gaps among economies over time and requires poorer economies to grow faster than richer ones. The concept of conditional convergence is rooted in the Solow-Swan (1956) growth model, in which diminishing returns play a central role. Differences in capital endowments between richer and poorer states, combined with diminishing marginal returns to capital, imply that poorer states may grow faster and move toward a common steady state as capital flows from richer to poorer regions.

In view of the above, this paper aims to analyze whether the Indian states have witnessed income convergence (or divergence) over the period 1960-61 to 2024-25. The notion of convergence is measured with β-convergence and σ-convergence estimation methods to assess overall and individual variability. These two estimation methods are employed to study the presence of convergence (or divergence). Further assessment of state-level exports is tested with the help of a number of determining factors such as per capita income, infrastructure, human capital, etc. To do this analysis, we primarily use the regression-based approach developed by Barro and Sala-i-Martin (1992).

We investigate the β-convergence phenomenon. Then, in order to confirm the phenomenon of convergence, we also carry out the test for σ-convergence. Lastly, non-parametric estimation based on the approach of Quah (1993, 1997) has been employed to analyze the behavior, movement, or persistence of specific sub-groups within the distribution.

Although extant literature has examined the income convergence or divergence across Indian states, comparatively less attention has been given to examining

the evolution of convergence over a considerably long time period using current state-level data. In addition, the relationship between the performance of state-level exports and conditional convergence has remained less explored in comparison to the other way round.

3. Data and Methodology

In this study, we have mainly used data from the RBI Handbook of Indian States. The time period for income convergence/divergencehas been used from 1960-61 to 2024-25. For the second part of the study, to assess the factors affecting the state-level exports, we have used various indicators representing state-level per capita income, Gross Value Added (GVA), Gross fixed capital formation (GFC), national highways (NH), and per capita availability of electricity (PCAE). Since the state export data is available only from 2017, we have used the time period from 2017 to 2024. We have taken the natural log transformation for the variables to reduce their extent of variability. Log transformation also represents elasticity. We have converted state exports in Rs. by converting from US$ billion. The length of national highways has been converted into national highways per 100 sq. km of area.

The methodology followed here is two-fold: initially, we have progressed with unconditional convergence/divergence. For this to be measured, we plot the trend line and scatterplot of the growth rate of income per capita on the initial level of per capita income (measured in log value) to examine whether the states have grown together or diverged over time. This analysis also tells us how poorer and richer regions have grown without conditioning on other variables. Absolute β-convergence exists when poorer regions tend to grow faster than richer ones. β-convergence is measured by estimating a cross-sectional regression of the annual average growth rate of per capita income on the level of initial per capita income. The testing of absolute β-convergence has involved estimation of the regression based on Ghosh (2008).

$$G_{i,t,t-\tau} = \frac{[ln(Y_{i,t}) - \ln(Y_{i,t-\tau})]}{\tau} = \alpha + \beta \ln(Y_{i,t-\tau}) + \varepsilon_{i,t} \quad (1)$$

Here, $G_{i,t,t-\tau} = \frac{[ln(Y_{i,t}) - \ln(Y_{i,t-\tau})]}{\tau}$ is defined the annual average growth of per capita income of i^{th} region for the period t and t-τ, while $ln(Y_{i,t})$ and $\ln(Y_{i,t-\tau})$ are the terms denoting natural log of the i^{th} region's per capita income at time t and $t-\tau$. Here, is considered to be the length of the period. The sign and significance of the coefficient of per capita incomes how the phenomenon of convergence or divergence. When the coefficient of the initial level of per

capita income bears a statistically significant negative sign $\beta < 0$ it implies the absolute existence of β-convergence. The implication of a negative β coefficient on the initial level of per capita income signifies that regions having a lower initial level of per capita income grow rapidly compared to regions with a higher initial level of per capita income. This is also be noted that β-convergence happens to be a necessary condition for σ-convergence. At the initial level of income, poor states grow faster than richer ones, and the level of per capita income for both regions will tend to be equal over time. Hence, β-convergence will generate σ-convergence. Moreover, Sala-i-Martin (1996a, 1996b) shows that σ-convergence is related to thedispersion of the cross-sectional distribution of income decreasing over time, whereas β-convergence is concerned with the movement of different regions within the given income distribution.

Next, we have tested for sigma convergence, as unconditional beta convergence is necessary but not a sufficient condition for sigma convergence. Due to the steady-state level of per capita income, it seems that states have diverged over time due to widening of conditioning variables. We have considered 20 states based on the availability of export data. For analysis of the factors that may contribute to conditional convergence/ divergence, state exports stand out as an important one. Here, we have used a panel data model. The specification of the model is given in equations (2) and (3).

Model I: (2) $$\text{Ln}(EXP)_{it} = \beta_0 + \beta_1 \ln(PCNSDP)_{it} + \beta_2 \ln(GFCF)_{it} + \beta_3 GVA_{it} + \beta_4 LNH_{it} + \alpha_i + \gamma_t + \varepsilon_{it}$$

Model II: (3) $$\text{Ln}(EXP)_{it} = \beta_0 + \beta_1 \ln(PCNSDP)_{it} + \beta_2 \ln(GFCF)_{it} + \beta_3 GVA_{it} + \beta_4 LPCPA_{it} + \alpha_i + \gamma_t + \varepsilon_{it}$$

where, EXP_{it} denotes the state exports in Rs Lakhs; $PCNSDP_{it}$ denotes per capita net state domestic product; $(GFC)_{it}$ is the gross fixed capital formation for states, which is used as a proxy for state investment; GVA_{it} is the gross value added, which is the gross output of the states; $PCAE_{it}$is the per capita availability of electricity,which is an important component to drive state exports. NH_{it} is the length of national highway per 100 sq. km., which is another proxy forroad infrastructure. Here, $\alpha_1$are the state fixed effects, γ_t captures the year fixed effect, and ε_{it} is the random error term.

The fixed effect specification controls for unobserved heterogeneity across different cross-sectional units, time-invariant, influencing the dependent variable but not considered for modelling. Thus, the fixed effect (FE) model employed

to account for unobserved heterogeneity across states that remain constant over time includes geographical characteristics, historical infrastructure, institutional structure, and other structural factors (Woolridge, 2010; Baltagi, 2021). Here, the time period has not witnessed any major shocks except COVID-19. Therefore, we have ignored the year effect and focused on the state effect. Due to structural heterogeneous characteristics of the states, the fixed-effects model is preferred over the random-effects model provided by the Hausman test (Hausman, 1978).

4. Major Findings

The analysis for the study is carried out in threefold, and the major findings of the study are reported in the following sub-sections.

4.1 Unconditional Beta Convergence/Divergence

Table 1 lists 20 statesto illustrate the socio-economic profile of the states. We have considered two periods for the comparison of the basic indicators for the states.

Table 1: Socio-Economic Profile of the States

States	GSDP (2015-16) (Rs. million)	Share in total GSDP (%)	GSDP (2024-25) (Rs. million)	Share in total GSDP (%)	Total Population (Pop.) (million)	Share in Pop. (%)	Exports (2024-25) (Rs. billion)	Share in Exports (%)
Andhra Pradesh	604.20	4.43	1593.06	5.14	85	6.99	1979.49	5.33
Assam	228.00	1.67	643.67	2.08	31	2.58	52.48	0.14
Bihar	371.60	2.73	992.05	3.2	104	8.6	194.41	0.52
Delhi	550.80	4.04	1215.00	3.92	17	1.39	83.44	0.23
Goa	55.10	0.4	0.00		1	0.12	235.84	0.64
Gujarat	1029.00	7.55	0.00		60	4.99	11080.62	29.88
Haryana	495.50	3.64	1213.95	3.91	25	2.09	237.46	0.64
Himachal Pradesh	114.20	0.84	231.69	0.75	7	0.57	21.72	0.06
Jammu and Kashmir	117.20	0.86	516.256	1.66	13	1.04	6.67	0.02
Karnataka	1045.20	7.67	2883.90	9.3	61	5.05	2903.32	7.83
Kerala	562.00	4.12	1248.53	4.03	33	2.76	454.53	1.23
Madhya Pradesh	541.10	3.97	1503.40	4.85	73	6	745.33	2.01
Maharashtra	1966.20	14.43	4531.52	14.61	112	9.28	6272.69	16.92
Manipur	19.50	0.14	0.00		3	0.24	0.10	0.00
Punjab	390.10	2.86	838.64	2.7	28	2.29	175.45	0.47
Rajasthan	681.50	5.00	1704.34	5.5	69	5.66	682.47	1.84
Tamil Nadu	1176.50	8.63	3118.59	10.06	72	5.96	4960.05	13.38
Tripura	35.90	0.26	89.68	0.29	4	0.3	1.14	0.00
Uttar Pradesh	1172.20	8.6	2978.22	9.6	200	16.5	2093.60	5.65
West Bengal	797.30	5.85	1815.01	5.85	91	7.54	1206.63	3.25

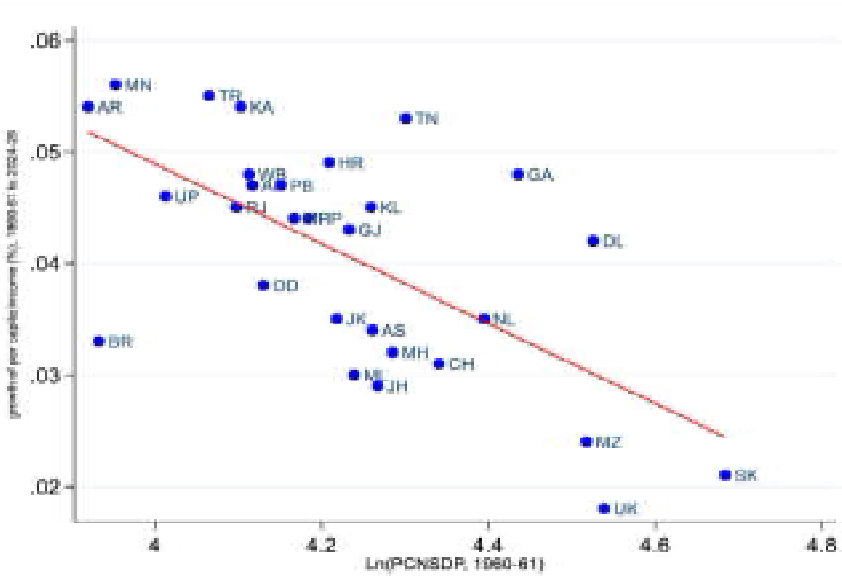
Source: Authors' calculation based on several secondary sources

Some of the states have shown a remarkable rise in GSDP as their shares in India's total state of West Bengal remains stagnant and Kerala and Delhi show a decline in it. Due to progress and development of certain infrastructure, including SEZs, the information technology and services sector, Tamil Nadu has witnessed the fastest economic growth and development of industries, infrastructure and sustainable development.[1] Some states still witness a low rise in per capita income, such as Tripura and Rajasthan. In the case of the state exports profile, the major leading states are Gujarat, Maharashtra, Tamil Nadu, and Karnataka having a major share in exports.

We have divided the analysis into two periods: (i) 1960-61 to 2024-25, and (ii) 1991-92 to 2024-25. While the first scenario will tell us the direction of convergence/divergence for the entire period, the purpose of the second scenario is to assess the same for the period of liberalization. The β-convergence scatter shows the inverse relationship between initial per capita income and the growth rate of subsequent periods. States with lower initial levels of per capita income tend to have higher growth rates, whereas states with already higher levels of per capita income tend to have lower growth rates. States like Madhya Pradesh, Tripura, and Karnataka have shown a remarkable rise in per capita income due to the initial lower level of income, thereby indicating the "catching up" effect of the states. Bihar shows a lower initial level of per capita income but a higher growth rate in later years. On the other hand, Delhi shows a relatively higher initial level of per capita income but has a relatively lower growth rate. Some of the states' incomes have grown at a similar pace, such as West Bengal, Punjab, Kerala, and Rajasthan. The overall negative slope of the fits entails the divergence of income among the states for both periods (Figures 1(a) and 1(b)).

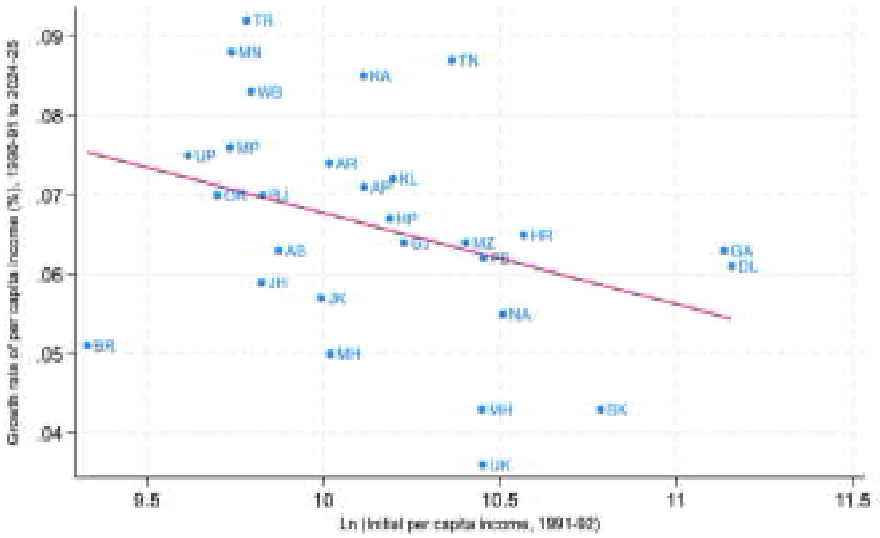
[1]Refer, https://www.thehindu.com/news/national/tamil-nadu/tamil-nadu-does-it-again-with-double-digit-economic-growth/article70913645.ece

Figure 1(a): Growth of Per Capita Income from 1960-61 to 2024-25 against Initial Level of Per Capita Income of 1960-61



Source: Authors' calculation

Figure 1(b): Growth of Per Capita Income from 1991-92 to 2024-25 against Initial Level of Per Capita Income of 1991-92



Source: Authors' calculation

Overall, both the period exhibits the same pattern of income divergence across the 29 states, with a negatively fitted slope indicating the tendency of poorer states to grow faster than initially rich states. This persisted for both the long run as well as the post-liberalization period, which is from 1990-91 to 2024-25. The distribution of states around the fit has changed noticeably; in Figure 1(a), for the long-run trend, the states remained clustered around similar growth rates, indicating that the states grew at similar rates. But in the post-liberalization period, the dispersion across the states increased, and states spread widely due to shifts in the initial income distribution, though substantial differences in growth performance existed. Considerable dispersion around the fitted line shows the heterogeneity in the convergence process across states. Both time period analysis shows the divergence of income across the countries, with considerable deviations from the common convergence path. This indicates that the initial level of income does not fully explain the differences in growth performance at the state level. Many factors, including human capital, infrastructure growth, industrial development, investment, institutional quality, and state exports, may contribute to the observed variation in growth rates. Hence understating the determinants of other factors, especially state exports, influencing the income heterogeneity across states remains pivotal.

4.2 Factors Causing Conditional Convergence/Divergence

The fixed-effectpanel data modelhas been used to estimate factors causing state-level exports, which can also be attributed to conditional convergence of income. The correlation among the variables along with the level of significance is given in Table 2. The diagnostic test results are briefed in Table 3. The estimated results corrected for standard errors are reported in Table 4. The following observations are worth noting.

The per capita income has a positive and significant association with state-level exports. A rise in per capita income of the states positively affects state exports due to the rise in higher productivity of states. Richer states have better infrastructure and logistics, a greater industrial base and diversification, along with better access to technology. Rich states also have more firms meeting international standards, fostering state exports. Gross fixed capital formation also has a positive association with state exports, indicating that state investment plays a crucial role in fostering exports by providing soft as well as physical infrastructure. But state gross output hasa negative but statistically significant relationship with state exports, thus implying that rising state output negatively

impacts state exports. However, this is not the case; due to beta-divergence across the states, state output shows a negative impact. Roads and highways are important for transporting the exportable goods from core to hub for export. The caveat is that the states' length of highways shows a positive impact on state export but remainsstatistically insignificant.

Table 2: Correlation Matrix

Variables	LSE	LPCPA	LGFC	LGVA	LPCNSDP	LNH
LSE	1					
LPCPA	0.5224 (0.000)***	1				
LGFC	0.9317 (0.000)***	0.4459 (0.000)***	1			
LGVA	(-0.1236) (0.140)	(-0.115) (0.17)	(-0.1091) (0.0227) **	1		
LPCNSDP	(-0.1194) (0.1338)	(-0.0464) (0.559)	(-0.1586) (0.0622)	0.7385 (0.000) ***	1	
LNH	0.4131*** (0.000)	(-0.1198) (0.5184)	0.6092 (0.000) ***	(-0.1842) ** (0.0389)	(-0.3094) *** (0.002)	1

Source: Authors' calculation
Notes: *** (p<0.01), ** (p<0.05), * (p<0.10)

Table 3: DiagnosticTest Results

	Diagnostic test	Statistic	p-value	Conclusion
Model I	Modified Wald test for groupwise heteroskedasticity	chi. sq. (7) – 2.87	0.8964	No heteroskedasticity
	Wooldridge test for first-order autocorrelation	F (1,6) = 1.419	0.2786	No autocorrelation
	Diagnostic test	Statistic	p-value	Conclusion
Model II	Modified Wald test for groupwise heteroskedasticity	chi. sq. (7) = 6159.73	0.000	heteroskedasticity
	Wooldridge test for first-order autocorrelation	F (1,17) – 80.787	0.4879	No autocorrelation

Source: Authors' calculation
Notes: *** (p<0.01), ** (p<0.05), * (p<0.10)

Table 4: Regression Results

	Model I		Model II	
Variables	Coefficient	t-statistic	Coefficient	t-statistic
Ln (PCNSDP)	(0.0667) **	2.00	(0.0554) *	1.68
Ln (GFCF)	0.3312***	4.09	(0.1899) **	(-2.16)
Ln (GVA)	(-0.090307) ***	-2.84	(-0.0690) **	2.24

Ln (NH)	0.0815449	0.37		
Ln (PCPE)			0.322	0.97
Constant	11.10917***	8.05	10.61074***	5.65
State fixed effects	Yes		Yes	
Observations (N)	107		125	
Number of states	18		18	
Within (R-sq)	0.2603		0.1507	
Between (R-sq)	0.767		0.801	
Overall (R-sq)	0.7402		0.762	
F-statistic	7.48		4.57	
Prob > F	0.000		0.00	

Source: Authors' calculation

Notes: *** (p<0.01), ** (p<0.05), * (p<0.10) The models consider robust standard errors.

Model II has been estimated to check for the robustness of the results. In Model II, per capita availability of electricity has been considered to see whether the obtained results remain unchanged or not. Overall, the results obtained from Model I also hold for this model expect PCPE. Like the length of roads and highways, it is positive but remains insignificant. Although availability of power remains crucial for the promotion of manufacturing exports. The model has suffered from a heteroskedasticity issue, as shown in Table 3. The diagnostic test results show that Model II has suffered from the problem of heteroskedasticity, whereas the problem of serial autocorrelation is absent in both models (Table 3).

4.3 Sigma Convergence/Divergence

β-convergence is not asufficient condition for the standard deviation (SD) or coefficient of variation (CV) of the regional per capita convergence of income due to random shocks. Hence, it is also not a sufficient condition for σ-convergence due to differences in per capita income that may diverge over time. To estimate the σ-convergence, we need to compute the evolution of SD and CV of gross state domestic product per capita across the whole sample of countries for the entire period (1960-61 to 2024-25). Here, we have computed it for the whole period and for all the countries considered in the study. Here, we have also computed the sigma convergence for the whole sample itself.

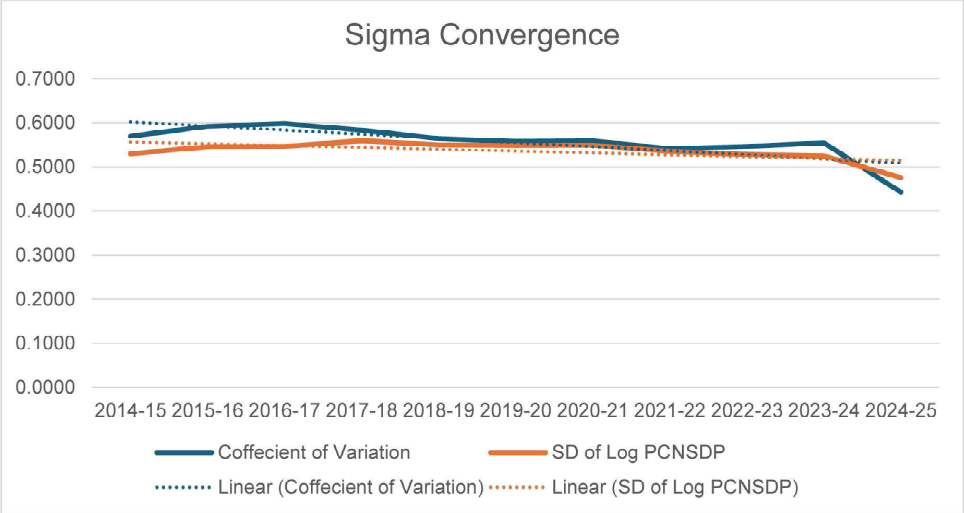
SD= 0.325900552+0.0040t R-sq.=0.8820

(0.000)

CV= 0.381956226 + 0.0038t R-sq.=0.72629

(0.000)

Figure 2:SD and CV of PCNSDP



Source: Authors' calculation

Both the CV and SD for all the regions for the whole period show rising trends, and the fits show apositive relation over the years. The rise in σ inequality is due to the rise in inequality across the income of the regions. The differences across the regions have increased over time, where rising inequality is leading to a rise in σ divergence due to the positive and significant coefficient of time *t*. The structural differences across states have caused such differences in income inequality.

5. Conclusion

The study has been conducted for the extended time period of 1960-61 to 2024-25 on the β-convergence of income across the states to map the current scenario of growth of income across the states. The β-convergence results have shown the differences in growth of income across the states. The results show the case of divergence in income growth across the states, with symptoms of 'catching up' for poorer states. Richer states have grown less, relatively lower than poorer states, due to underutilized capacity. Sigma convergence scores also show rising inequality of income across the states. The rising divergence among the states is plausibly due to growing differences in state infrastructure and state policies for providing opportunities to the state population. Given the condition of convergence/divergence across the states, the notion of conditional convergence is supported by the factors that lead to

conditional convergence/divergence across the states. Conditional convergence is dependent on factors like exports, human capital, literacy, and others; therefore, it remains important to understand the determinants causing factors impacting conditional convergence. State-level exports remain one of the most important factors causing conditional convergence/divergence across the states. Some of the factors positively affecting state exports are state infrastructure and per capita income, while the gross value added has a negative impact on state exports.

The results obtained in this study underscore the importance of state government policies to be more focused on improving physical as well as soft infrastructure to reduce income inequality across the states as well as improving factors like state exports on achieving conditional convergence.

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Article

Fiscal-Monetary Policy Alignment and State Economic Performance in India

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Abstract

Fiscal and monetary policy coordination is imperative in ensuring optimal macroeconomic outcomes. While extensive literature on these policy interactions exists, there is a dearth of India-specific works, particularly at the state level. This is particularly important as the states carry more than half of the public expenditure burden in India. In this paper, we provide a comprehensive examination of trends in state-level fiscal-monetary policy alignment and its impact on output. To enable such an analysis, the study conceptualised an index-construction method to quantify policy alignment. 13 major Indian states are considered in the analysis based on data availability, size of GSDP and participation in the primary market. These states make up 70 per cent of national output. Applying Panel VAR and Panel Random Estimates frameworks, the study answers three key questions. One, what is the nature of policy alignment in India? Two, what are the drivers of such an alignment? Three, what is the impact of policy alignment on output? The study finds that improved policy alignment can augment economic growth by 0.7-0.8 percentage points. Furthermore, while narrowing fiscal space can render subnational fiscal stance more sensitive to monetary stance, macroeconomic stabilisation continues to be the primary driver of policy alignment. While policy coordination is currently episodic and reactive, it must evolve into an explicit policy objective to ensure sustained macroeconomic stability and economic growth.

Keywords: Fiscal Policy, Monetary Policy, IS-MP framework, Taylor's Rule, FRBM Act and Inflation Targeting Regime.

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1.Introduction

Fiscal policy is the government's policy on taxation and expenditure, whereas monetary policy refers to the central bank's stance on interest rates, liquidity conditions and money supply. Changing these policies affects capital accumulation and employment dynamics, working through changes in aggregate demand conditions and the cost of capital. Complementarity between these policies is the degree to which the fiscal and monetary authorities of a country are aligned. Hence, policy complementarity can be achieved by ensuring a greater coordination between the central bank's pursuit of price stability and the government's management of expenditure and taxation.

The fiscal and monetary policies are the two pillars of macroeconomic policymaking, both for accelerating growth and ensuring stability (Reddy, 2017). But different official bodies with distinctive objectives, constraints, resources and incentives design and implement these policies (Laurens & Piedra, 1998). Consequently, achieving greater policy complementarity requires these bodies to jointly determine their respective objectives.

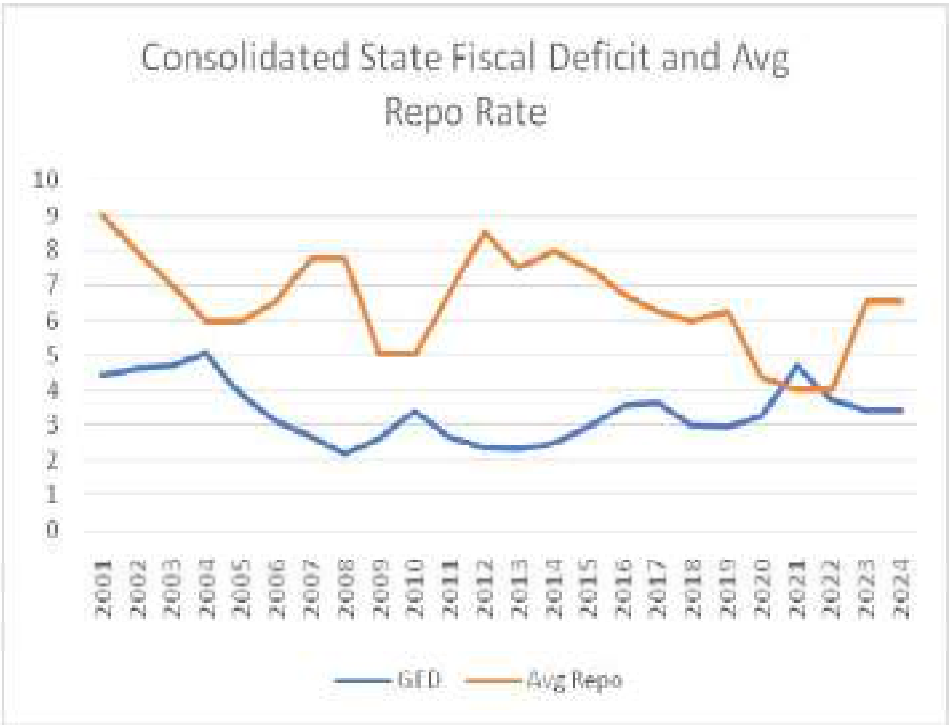
At a subnational level, policy coordination can also be conceptualised as policy alignment. This is due to the unidirectional causality between the monetary and fiscal policies. Since any one subnational government cannot influence the monetary policy while the monetary stance affects the subnational fiscal stance, we term subnational coordination as alignment. In this paper, the terms alignment and coordination are used interchangeably.

In India, the existence of vertical imbalance is well-documented. Given that state governments incur nearly 60 per cent of total public expenditure, focusing solely on the central government leads to an insufficient understanding of fiscal-monetary dynamics and, more importantly, its impact on national output. Furthermore, the rapid development of the State Development Loan (SDL) bond market has increased state dependence on market borrowing amidst narrowing fiscal space, making state finances highly sensitive to monetary policy changes. Research indicates that larger, more active states tend to borrow at lower yields, which further increases the sensitivity of subnational borrowing to prevailing interest rates (Padhi, 2020). In a bank-dominated financial system like India, the limited depth of long-term bond markets often results in a more pronounced crowding-out effect as well (Subbarao, 2026).

To analyse these subnational dynamics, this study applies a monetary union framework. Under this framework, the fiscal deficit and the Repo Rate are

utilised as the primary proxies for fiscal and monetary stances, respectively. In an aligned state, these variables share an inverse relationship: tightening monetary conditions are met with fiscal consolidation to ensure solvency and limit debt-servicing costs, while looser monetary conditions are complemented by expansionary fiscal policy to augment growth and reduce interest expenses. Since policy causality runs from monetary to fiscal policy, the fiscal policy of a single state cannot determine national monetary policy. Preliminary analysis reveals a correlation statistic of -0.22, suggesting that fiscal and monetary stances in India are coordinated, sharing an inverse relationship consistent with simultaneous expansion and contraction (Figure 1).

Figure 1: Fiscal and Monetary Stance



Based on these dynamics, this paper seeks to address the following research questions: First, what is the extent and nature of alignment between the fiscal stance of state governments and the monetary policy stance of the Central Bank? Second, how does a change in policy alignment influence the economic output of the states? Third, what are the primary drivers of policy alignment at the subnational level?

2. Review of Literature

The theoretical foundations of policy coordination were laid by Sergent and Wallace (1981). They show that when fiscal authorities dominate deficit financing decisions, the monetary authorities work in a passive role, monetising the deficits when financing via bond issuances becomes unsustainable. This phenomenon is termed Unpleasant Monetary Arithmetic (UMA). On the contrary, Unpleasant Fiscal Arithmetic (UFA) is a scenario where monetary authorities set the monetary policy without the fiscal role or consideration of the budgetary requirements of the fiscal policy. Optimal macroeconomic outcomes cannot be achieved in either case, emphasising the importance of policy coordination. Augmenting our understanding of policy coordination dynamics, Leeper (1991) demonstrates that determinate equilibria can only be achieved when one authority adopts a passive stance when the other is active. Conversely, a lack of policy coordination leads to indeterminacy and macroeconomic instability. Building on this larger framework, Gnocchi (2013) demonstrates through game theory that asymmetric commitment capabilities between the fiscal and monetary authorities create foundational coordination challenges, leading to suboptimal macroeconomic outcomes.

Arora's (2018) SVAR (sign-restricted VAR) research, which demonstrates an example of selective fiscal dominance, provides empirical validation for these theoretical ideas. In contrast to expenditure shocks, tax rebate shocks are accommodated by monetary policy through interest rate reductions. Additionally, the analysis shows that interest rate reductions are more successful than fiscal tools at boosting output. These results should be viewed in the context of observations made by Kamila et al. (2023), who discovered that since the FRBM Act was put into effect, India's fiscal policy has primarily been pro-cyclical, with only four instances of counter-cyclicality since 2004–05, which explains why interest rates are more effective at stimulating output.

However, India's structural features, especially the flat Phillips Curve noted by Dasgupta and Chowdhury (2023), may limit the efficacy of policy cooperation. According to their analysis, cost-push variables predominate in the dynamics of inflation, while the output gap and inflation have a statistically negligible link. This structural constraint makes the application of the Taylor rule ineffective since policy rates rise even when inflation is insensitive to shifts in the output gap. This suggests that the basic mechanism by which price

expectations impact economic activity and, consequently, monetary policy is compromised, limiting the efficiency of policy coordination.

The COVID-19 pandemic revealed the consequences of these limitations. When comparing actual policy coordination dynamics to the theoretically ideal combinations, Arora et al. (2022) found notable shortcomings. They discovered that when the ideal position was neutral, fiscal policy was expansionary. Similarly, when contractionary and expansionary policies were theoretically optimum, the monetary policy assumed an accommodative or neutral stance, respectively. Furthermore, research by Chakraborty and Harikrishnan (2022) shows that deficit financing did not result from fiscal deficits above 9 per cent of GDP during the COVID-19 period, as the government focused on liquidity infusion rather than financial transfers as a policy solution during the COVID-19 outbreak. This observation is also consistent with ingrained fiscal restraint brought about by the FRBM Act.

Sachdeva and Ahmed (2024) argue that alternative coordinating structures are better suited in India. Using the VAR modelling framework, they discovered that a shock to public spending has a favourable effect on private investment and Ricardian consumption. Additionally, they discovered that a monetary accommodation for such a stimulus can boost economic activity without leading to major spikes in public debt and inflation. These results contradict those of Arora (2018), who showed that interest rates are more effective in stimulating output without causing spikes in debt than government spending. But it is crucial to recognise that each policy's efficacy depends on the other. To ensure optimum macroeconomic results, it is therefore essential to comprehend and measure policy coordination.

The rapid theoretical advancements are leveraged by recent empirical works that explored policy coordination at the subnational level. For this purpose, a monetary union framework is applied, which allows us to model the policy interactions between states akin to the nations of a monetary union arrangement. Zia & Zhang (2025) empirically estimated subnational coordination dynamics employing a DSGE and an SVAR framework. Among many, their principal findings include: One, the existence of coordination between the provincial government's fiscal and the central bank's monetary policy. Two, such coordination would lead to the accumulation of provincial sovereign debt, compromising long-term debt sustainability goals. Three, when greater competition between the provincial governments is introduced, the

policies become uncoordinated. Lastly, when greater cooperation between the provinces is seen, the coordination is seen to improve along with debt sustainability. Similarly, Bi & Traum (2023) applied the monetary union framework, studying the American economy and its state fiscal policies during the COVID period. Their study shows that under unconventional monetary policies, central bank actions lead to a sizable increase in private investment while being muted in their impact on local and state fiscal expenditure.

The study aims to contribute to our understanding by adopting the index construction method to quantify coordination and conducting the analysis at a subnational level, providing insights into how states align their fiscal policy with the central bank's monetary policy and its impact on output.

3. Theoretical Framework

Under an inflation targeting regime, the IS-MP framework offers a strong analytical lens to examine the interactions between monetary and fiscal policy. The adoption of this methodology is appropriate given that India adopted a flexible inflation targeting regime (FIT) in 2016, since it enables us to examine the evolving dynamics in policy interactions.

Although this framework is most appropriate for examining policy changes following the implementation of FIT, the basic policy interactions are similar to how the IS-LM model operated, making it a suitable option for examining policy coordination during the whole research period. Within the IS-MP model, policy coordination can be defined as the complementary pursuit of monetary and fiscal policies. The interactions can be modelled in this framework, as follows: the output increases, but the interest rate stays unchanged when both authorities take an expansionary attitude (Figure 2). Similarly, output decreases while the interest rate stays unchanged during a coordinated contractionary policy stance (Figure 3).

Figure 2: Expansionary Policies

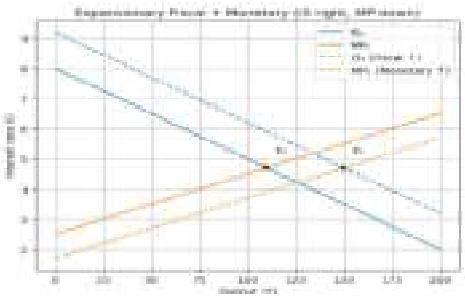
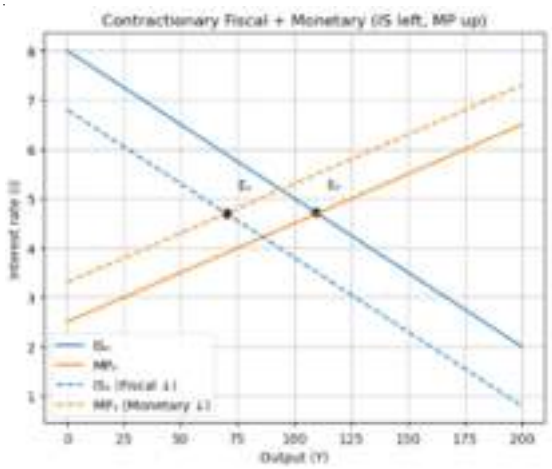


Figure 3: Contractionary Policies

The monetary and fiscal interventions in the outlined framework are carried out in a way that keeps the interest rate unchanged. Such an excessive input of liquidity into the banking system and eventually the actual economy would be inflationary and may even be detrimental if monetary accommodation surpasses fiscal expansion. In a similar vein, the economy will move toward a higher interest rate equilibrium if the monetary authorities fail to support a fiscal expansion by adding more liquidity to the system.



A coordinated contractionary stance exhibits the same phenomena. The equilibrium interest rate would be lowered if a contractionary fiscal stance were not accompanied by a contractionary monetary stance. This would be detrimental since it would negate the contractionary fiscal stance's primary goal. For this analysis, we therefore assume a stable interest rate in the short term.

To ensure a stable and determinate equilibrium, one of the policy arms must be passive if the other is active, according to Lepper's (1991) active-passive policy configuration. As a result, the monetary position must be passive in response to fiscal shocks if the fiscal policy is active. In a similar vein, if monetary policy is active, the fiscal position should be passive and adapt to the shifting monetary policy. In India, fiscal supremacy predominated in the years preceding the FRBM Act's implementation. Price stability became a

primary macroeconomic goal only after the transition to a market-based economy and the monetary and fiscal reforms.

Since 2016, the Flexible Inflation Targeting Regime (FIT) has been further adopted, introducing a Taylor-type rule to monetary policy in which the monetary stance responds to shifts in output gaps and inflation. On the other hand, the causal relationship extends from monetary to fiscal policy at the subnational level. This is due to the fact that the monetary authority would not alter its monetary position in response to the budgetary policies of any one state. As a result, we can model the best short-run policy interactions with the aid of an Active-Passive framework and the constant interest rate assumption.

Consequently, the equilibrium policy coordination function is derived as follows:

IS Curve (Linearised and open to fiscal stance) (1)

Where y = output gap, i = nominal policy rate, and f = fiscal stance. b > 0 and c > 0 MP Curve (Taylor's rule open to monetary stance)

(2) $$i = \varphi + \theta_y y + \theta_\pi(\pi - \pi^*) - \lambda m$$

Monetary policy responds to output and inflation gap; monetary stance m enters as an easing variable that lowers i.

Here, the coefficient of output gap (θy) and the coefficient of inflation gap (θÀ) stand for interest rate elasticity to output and inflation gaps, respectively.

Philips-style inflation relation (simple reduced form; target À* is constant):

(3) $$\pi - \pi^* = \kappa y + \varepsilon$$

Where k > 0 links output to inflation, and e is the noise shock. (So, Δ(À - À*) = κΔy + Δε)

$$y = a - bi + cf$$

Now, we will replace the inflation gap in Taylor's rule using the Phillips curve (Substituting 3 in 2):

(4) $$i = \varphi + (\theta_y + \theta_\pi \kappa) y - \lambda m$$

We now substitute the monetary policy rule into the IS function since the IS-MP equilibrium is determined by their joint interaction (Substitutingin 1):

(5) $$y = a - b\left[\varphi + (\theta_y + \theta_\pi \kappa)y - \lambda m\right] + cf$$

Upon further simplification and solving for the y term, we

(6) $$y = \frac{a - b\varphi}{1 + b(\theta_y + \theta_\pi \kappa)} + \frac{b\lambda}{1 + b(\theta_y + \theta_\pi \kappa)} m + \frac{c}{1 + b(\theta_y + \theta_\pi \kappa)} f$$

Since policy coordination is a coordinated shift in the monetary and fiscal stance, we derive the equilibrium condition between the changes in policy stances. As discussed above, a constant interest rate is assumed, and hence, a change in interest rate is

(7) $$\Delta y = \frac{b\lambda}{1 + b(\theta_y + \theta_\pi \kappa)} \Delta m + \frac{c}{1 + b(\theta_y + \theta_\pi \kappa)} \Delta f$$

Since we are estimating the equilibrium between changing policy stances, the derived Taylor's rule in equation 4 can be rewritten as:

$$\Delta i = (\theta_y + \theta_\pi \kappa)\, \Delta y - \lambda\, \Delta m$$

To estimate the equilibrium, we substitute 6 in 7, and we get:

$$\Delta i = (\theta_y + \theta_\pi \kappa)\left[\frac{b\lambda}{1 + b(\theta_y + \theta_\pi \kappa)} \Delta m + \frac{c}{1 + b(\theta_y + \theta_\pi \kappa)} \Delta f\right] - \lambda\, \Delta m$$

By simplification, we obtain:

(8) $$-\lambda\, \Delta m + (\theta_y + \theta_\pi \kappa)\, c\, \Delta f = 0$$

Hence, the equilibrium policy coordination condition can be written as:
When fiscal policy is active and monetary policy is passive

$$\Delta m = K\, \Delta f \qquad \text{where } K = \frac{(\theta_y + \theta_\pi \kappa)c}{\lambda}. \qquad (9)$$

When Monetary policy is active and fiscal policy is passive

(10) $$\Delta f = \frac{1}{K} \Delta m \qquad \text{where } K = \frac{(\theta_y + \theta_\pi \kappa)c}{\lambda}.$$

This equilibrium condition can also be written as:

$$\Delta m - K\Delta f = 0 \qquad (11)$$

Hence, the gap between the fiscal and monetary stance can be seen as the 'alignment/coordination gap.' Therefore, the lesser the gap between the respective policy stances, the greater the policy coordination and *vice versa.*

Implications for Policy Coordination

From this analysis, two cases emerge: Fiscal Activism and Monetary Activism.

Fiscal Activism:

When fiscal policy is active, it acts exogenously, shifting the responsibility to balance the interest rate to the monetary authorities. Let's assume that policy adjustments raised K (the interaction coefficient in Eq 9) to levels greater than 1, to illustrate both scenarios. Theoretically, to maintain a constant interest rate, a higher interest rate sensitivity (K) requires a more than proportionate infusion of liquidity (Eq 9). As a result, fiscal activism raises the need for liquidity, which makes coordination intrinsically challenging and only viable in times of crisis where inflation worries are subdued.

Monetary Activism:

When monetary policy is active, it exogenously sets the interest rate with an objective of ensuring price stability. Given the assumption that K is high, its reciprocal 1/K suggests that even a substantial shift in monetary policy only necessitates a small fiscal adjustment to restore equilibrium (Eq 10). This implies that policy coordination is simpler in an "Active Monetary and Passive Fiscal" paradigm. Since policy alignment at the subnational level functions under monetary activism, the fiscal reaction function can be modelled as seen in equation 10.

Active Shock	Macro Stabilising Response	Cost Minimisation Response
Monetary Expansion	Fiscal Expansion	Fiscal Expansion
Monetary Contraction	Fiscal Contraction	Fiscal Contraction

When looking at policy alignment at the subnational level, it is important to identify the drivers of such alignment. While the impact of a particular policy stance on output can be modelled within the IS-MP framework, understanding

the drivers of a particular stance is beyond its scope. For a monetary stance, the fiscal reaction function is based on the inflation rate and output elasticity to inflation (equation 10). However, amidst the narrowing fiscal space of the subnational governments and rapid growth of the State Development Loan (SDL) market, minimising the debt servicing cost is increasingly taking precedence. It is seen that larger and more active states in the SDL market tend to borrow at lower yields, making borrowing sensitive to the interest rates (Padhi, 2020).

Interestingly, it can be seen that irrespective of whether a subnational government aims to stabilise the macroeconomy or reduce their debt servicing cost, its fiscal stance would remain the same (Table 1). If monetary policy is expansionary, to ensure macroeconomic stability and satisfy the constant interest rate assumption, the fiscal stance will also turn expansionary. If it aims to minimise the cost of raising debt, then too the fiscal deficit expands. Similarly, if monetary policy is contractionary, the fiscal stance will turn tighter irrespective of cost minimisation or macro stabilisation objective. We will discuss more about it in the upcoming sections.

4. Data and Methods

The study employs GLS Panel Random Estimates and Panel VAR (Vector Autoregression) methodologies to assess the impact of policy coordination on output. A total of 13 Indian states are selected for our analysis for the time period FY2000-01 and 2023-24. To ensure the robustness of the findings and to uncover layered causal relationships, we first estimate the econometric specification using a GLS random estimates approach for static inference and then shift to a panel VAR framework for more dynamic insights. This approach provides robust inference into policy coordination and output while capturing the multidimensional nature of policy coordination. This section is organised into three subsections: (3.1) Construction of Coordination Indices, (3.2) Model Specification, and (3.3) Data.

4.1 Construction of Coordination Indices

To quantify the Alignment between the fiscal and monetary policy stance, we construct the Alignment Index labelled C1 (Table 2). The Index measure the degree to which fiscal and monetary authorities act in tandem. This can be either contractionary, where low fiscal deficits are sustained by high repo rates,

or expansionary, where an increase in fiscal deficit is accompanied by a lower repo rate known as "monetary accommodation." Nominal variables, such as the nominal repo rate and the fiscal deficit at current prices, have been used to create the coordination index. This method was selected to bring the analysis into line with the realities of policymaking. This method is especially useful for examining the dynamics of policy coordination, which is a short-run phenomenon.

The existence of "nominal rigidities" in the economy, such as sticky wages and prices, is discussed by conventional macroeconomic theory. This suggests that in the short term, real economic activity may be directly and significantly impacted by changes in nominal policy tools. As a result, this indicator offers a more precise assessment of the policy stance and its possible impact on output.

Table 2: Proxy Combinations for Fiscal and Monetary Policy Stance

Coordination Index	Fiscal Policy Stance (FPS)	Monetary Policy Stance (MPS)
C1	Gross Fiscal Deficit (% of GDP)	Average Repo Rate

Policy complementarity can be quantified as the gap between the monetary and fiscal positions using the equilibrium policy coordination function that was determined in Section 3. By calculating the absolute difference between the normalised monetary and fiscal positions, we operationalise this relationship. The level values of the normalised

$$Z(x_t) = \frac{x_t - \mu_x}{\sigma_x}$$

policy stance are taken into consideration empirically since these indices already include the cumulative policy position, even though the theoretical derivation is given in terms of changes (Δf, Δm). This enables us to monitor the evolution of the alignment dynamics over the sample period. We use the z-score normalisation technique to standardise the FPS and MPS variables so that the fiscal and monetary proxies may be compared. The z-score is calculated as follows for each time period t:

Where, σx is the sample standard deviation, and ux is the sample mean. By expressing each policy variable as a standard deviation from its corresponding

mean, this transformation eliminates scale and unit discrepancies from the data, enabling cross-temporal comparability. Next, we will calculate the difference between the MPS and FPS variables to assess policy coordination. Less complementarity will be shown by a larger difference between the two variables, and vice versa.

To guarantee that such a gap accurately represents the difference in policy attitude, both indices must undergo yet another crucial change. A greater budget deficit and a lower repo rate are associated with an expansionary policy stance during a coordinated policy deployment; the opposite is true under a coordinated contractionary stance. Therefore, coordinating and non-coordinating policies do not correspond to an unadjusted fall and rise in the difference between the

$$FPS_t^{adj} = -z(FPS_t)$$

two proxies. In order to fix this, we multiply the FPS variable's standardised values by -1, which inverts the variable and causes both policy stances to progress in the same direction.

The coordination score, which measures the degree of alignment, is then calculated as the absolute sum of the standardised fiscal and monetary positions. Since the goal of this study is to measure policy coordination, we are more concerned with the degree than the direction of policy position alignment. In order to accurately represent the level of policy alignment, we take the modulus of the "final coordination gap." The final coordination index is now calculated as follows:

$$\text{Substituting } FPS_t^* = -z(FPS_t):$$

$$CoordScore_t = \left| z(MPS_t) - (-z(FPS_t)) \right|$$

$$CoordScore_t = \left| z(MPS_t) + z(FPS_t) \right|$$

Finally, we invert the coordination score by multiplying it by -1. This transformation is introduced to simplify the interpretation of regression estimates. Now, a higher coordination score reflects greater alignment between fiscal and monetary stances. The inversion ensures that higher coordination corresponds to lower values (a lower gap in negative values), allowing the regression coefficient to be directly interpreted as follows: a one-unit increase

in coordination leads to an x-unit change in the dependent variable (output). This adjustment makes the empirical interpretation both intuitive and consistent.

Therefore, for modelling purposes, the coordination index is formulated as follows:

$$CoordIndex_t = -\left| z(MPS_t) + z(FPS_t) \right|.$$

4.2 Model Specification

Baseline Specification:

$$GSDP_GROWTH_{it} = \beta_0 + \beta_1 ALIGNMENT_INDEX_{it} + \beta_2 IND_SH_{it} + \beta_3 DEBT_{it} + \beta_4 CRUDE_t + \beta_5 CREDIT_{it} + \beta_6 CAP_OUT_{it} + \gamma_1 D_{COVID,t} + \gamma_2 D_{CRISIS08,t} + \mu_{it}$$

To empirically examine the impact of policy alignment on output, the study specifies a panel regression model with GSDP (Gross State Domestic Product) Growth as the dependent variable with alignment index and relevant macroeconomic controls as the independent variables. The primary variable of interest is the alignment index capturing the degree of alignment between the state fiscal and the central bank monetary policy. A lower value reflects stronger complementarity, hypothesised to have a positive impact on output. To control for structural heterogeneity, the model includes Industry Share (% of GSDP), which accounts for differences in sectoral composition. Variations in industrial structure can significantly influence growth trajectories, particularly in economies undergoing structural transformation.

Furthermore, the Debt-to-GSDP ratio is incorporated to control for the fiscal burden and sustainability concerns at the state level. Higher debt levels can limit the fiscal space and dampen growth through increased interest obligations and reduced developmental expenditure. Also, an increasing debt-to-GSDP ratio will limit the fiscal ability to align itself with the monetary stance, as its fiscal space would be constrained. Given India's increasing global economic integration, crude Price Growth is included as an exogenous control. Fluctuations in global oil prices affect inflation, production costs, and fiscal balances, thereby influencing state-level economic outcomes.

The model also accounts for financial sector dynamics through Credit Growth, which proxies liquidity conditions and the effectiveness of monetary transmission at the subnational level. Higher credit growth is expected to stimulate investment and consumption, thereby supporting growth. The growth in capital outlay is also included to measure the productivity of public expenditure. As opposed to revenue expenditure, capital outlay stimulates long-run growth through asset creation and infrastructure development. Additionally, to control for specific macroeconomic disruptions, two dummy variables are introduced for the COVID pandemic and the 2008-09 Global Financial Crisis (GFC).

4.3 Data

All variables in the model are sourced from authoritative sources, including the RBI and MoSPI. An exhaustive list of variables, including data source and transformations performed, is provided in Table 3.

This methodological framework is distinguished by its multi-dimensional and mathematically rigorous measurement of coordination. By combining robust index construction, theoretically grounded model specification, and comprehensive estimation and diagnostic procedures, the study provides a credible empirical assessment of the fiscal-monetary policy coordination and its macroeconomic implications.

The states were selected based on a two-pillar criterion. One, its active participation in the SDL bond market and two, the size of its GSDP. Moreover, the availability of consistent data was another crucial factor. The states that are more active in bond markets tend to be more sensitive to interest rate changes (Padhi, 2020). Similarly, the states with larger economies have greater space for developmental expenditure and hence a higher expenditure multiplier and its impact on output. The policy dynamics of the states that satisfy this criterion are best suited to be modelled within the IS-MP framework. Consequently, the selected states are: Delhi, West Bengal, Gujarat, Maharashtra, Karnataka, Kerala, Tamil Nadu, Haryana, Punjab, Rajasthan, Odisha, Madhya Pradesh, and Goa.

Table 3: Variable List and Transformations

Variable	Nominal/ Real	Transformations	Source
GSDP growth	Nominal	-	EPW-RF
Gross Fiscal Deficit	Nominal	-	EPW-RF
Repo Rate	Nominal	An annual average is computed	RBI Handbook of Statistics
Credit Deployment Growth	Nominal		EPW-RF
Oil Prices Change (Indian Basket in $)	Nominal	-	Petroleum Planning and Analysis Cell (PPAC)
Capital Outlay Growth	Nominal	-	EPW-RF
Debt-to-GSDP	Nominal	The data on debt levels is procured by EPW-RF. The ratio is manually calculated.	EPW-RF
Industry Share	Nominal	The data on Industrial Output is procured by EPW-RF. The ratio is manually calculated.	EPW-RF

5. Results

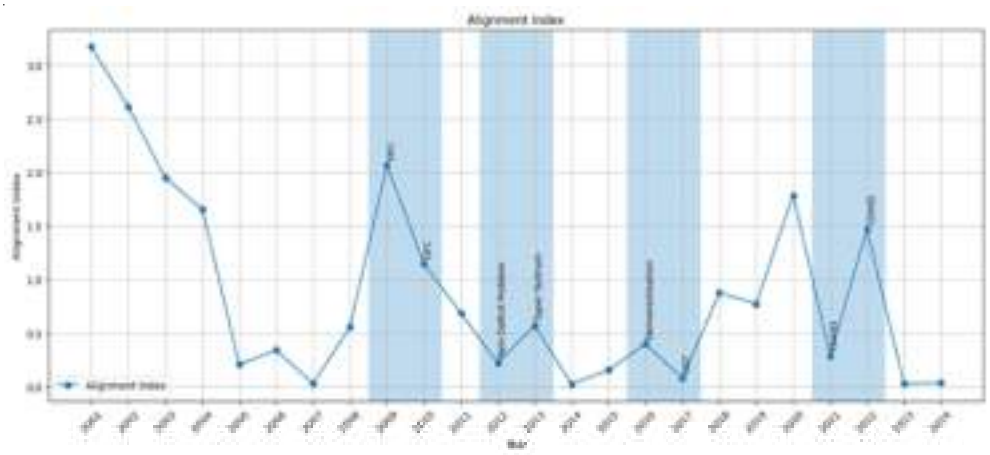
The Coordination Index developed in this study is constructed such that a lower score corresponds to a smaller gap between the chosen fiscal and monetary proxies. This design reflects the degree of alignment between the two arms of macroeconomic policy. When fiscal and monetary authorities act in sync, pursuing expansionary stances during downturns and contractionary measures during demand-driven booms, the coordination score decreases. In this sense, a lower score can be interpreted as a stronger and more deliberate role played by the state in stabilising the business cycle.

By evaluating the magnitude and evolution of fiscal-monetary coordination across different phases of the Indian economy, we can augment our understanding of the dynamics and effectiveness of policy coordination in India. In this endeavour, we need to answer two important questions: one, is coordination more active during crises, during economic peaks, or both? And, two, does the observed coordination appear to be proactive or largely reactionary?

Answering the first question, alignment seems to be more pronounced during the crisis period (Figure 4). Except for the Global Financial Crisis (GFC), the alignment index stayed close to 0.5 units for most of the time. The index value is the absolute difference between the standardised fiscal and monetary stances. This difference reached close to 2 units on the upper side and experienced the lows of about 0.02 units. As can be seen in Table 4, the alignment index improved to less than 0.5 units during major crisis periods.

This reveals a fundamentally reactive nature of policy alignment. At the same time, it is also the easiest period for the states to align with the monetary stance. This is due to higher political and economic incentives for both the fiscal and monetary authorities to adopt a contractionary policy stance. As demonstrated within the IS-MP framework (See Section 3), during an aggregate demand shortfall, an expansionary monetary and fiscal stance will simultaneously shift the output while keeping the interest rates constant. Therefore, due to this stabilising shock of policy alignment, it is found to be more pronounced during a shock to the aggregate demand.

Figure 4: Consolidated Subnational State Alignment Index



Answering the second question, policy alignment is more reactive because it intensifies during crisis periods. While the average index value stands at 0.88 units, the same value drops to less than 0.5 levels during crisis periods (Table 4). However, a notable exception to this reactionary policy alignment is the GFC crisis of 2008-09. While all the other major events with shock to aggregate demand saw the index contracting to 0.5 levels, the index stayed very high at 1.06 units during the financial crisis. This relative misalignment is due to the differing fiscal reactions at national and subnational levels.

Table 4: Alignment Index During Major Events

Major Event / Crisis	Alignment Index
Average Gap	0.880
Global Financial Crisis	1.608
Twin Deficit Crisis	0.223
Taper Tantrum Crisis	0.569
Demonetisation	0.082
GST Implementation	0.875
COVID-19 Pandemic	0.290

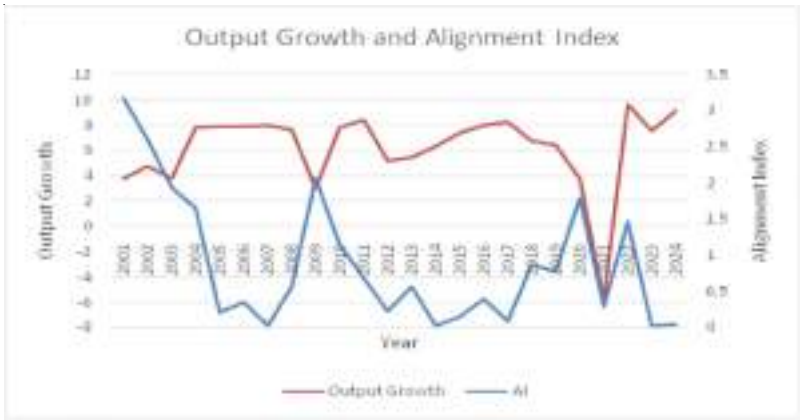
During the GFC, despite being relatively less exposed to global headwinds, the Indian government announced three fiscal stimulus packages. To enable these fiscal injections, the monetary policy stayed accommodative for a sustained period of time. As a result, while the monetary stance remained accommodative, the fiscal stance continued to be expansionary, allowing for a greater coordination at the national level. However, during this period, the Nominal GDP continued to grow at above 10per cent levels. Therefore, since the crisis did not impose a nominal growth penalty on the output, the states did not shift their fiscal gears to be more expansionary, while the monetary stance turned more accommodative. Hence, policy alignment at subnational levels did not improve during the GFC crisis.

These differing reactions between the fiscal authorities at the national and subnational levels also point to another critical policy challenge: impaired policy transmission. That is, if the monetary policy remained expansionary and the subnational fiscal authorities turn contractionary or neutral, the monetary policy transmission will not be optimal. Within the language of the IS-MP framework, the MP curve shifts rightward while the IS curve remains static. This meant that the output is not expanding to levels that it would have if the fiscal policy also turned expansionary, and that points to an inefficient policy intervention. Furthermore, such a policy interaction will also lower the interest rate, and since the nominal growth rate was still at healthy levels, such a monetary easing when the economy is still close to full employment levels would mean inflationary pressure. This potentially provides an alternative explanation for the high levels of inflation post-GFC crisis.

This period assumes further importance when viewed through the theoretical framework. There, we have demonstrated that the fiscal stance remains the same regardless of whether the government has a macro-stabilising motive or a cost-minimising motive. Accordingly, the state government'sfiscal stance should have turned more expansionary following this logic as the monetary stance turned accommodative. However, this anomaly during the GFC also points to the limitation of that assumption. In parallel, it strengthens the macro-stabilising hypothesis. The very fact that even during an accommodative monetary stance, the alignment did not improve, as there was no output shock,strengthens this hypothesis. At the same time, it is worth noting that the policy alignment did follow this framework for most of the period between 2001 and 2024.

While these findings provide valuable insights into the nature and causes of policy alignment, another significant question concerns the impact of such alignment on output. When both policies align, they simultaneously shift the IS and MP curves, pushing the economy to a higher output equilibrium while keeping the interest rate constant. Operationalising this relationship with the empirics of the study, the alignment index should share an inverse relationship with output growth. Such a relationship would confirm policy alignment, as improved alignment or a lower index value would signal a positive GSDP growth (Figure 5). The correlation coefficient between the alignment index and real GDP growth stands at -0.24, confirming the inverse relation and showing that coordinated policies accompany high growth rates.

Figure 5: Policy Alignment and Output Growth



To better understand the impact of policy alignment on output and the magnitude of it, we estimate the econometric specification outlined in Section 4.We estimated this specification in two primary frameworks: Panel GLS random estimates and Panel VAR models. The pre-estimation tests, including the test for cointegration and stationarity, are conducted. The variables in absolute values,including GSDP, are considered as growth rates to align with the short-run nature of the analysis. Consequently, the Pedroni cointegration test could not reject the null hypothesis of no cointegration at 10 per cent significance. Furthermore, the Levin, Lin and Chu stationarity tests were conducted, and the results are given in Table 5.

Table 5: Stationarity Test

S. No	Variable	Order of Integration
1	GSDP Growth	I(0)
2	Alignment Index	I(0)
3	Industry Share	I(1)
4	Debt-to-GSDP Ratio	I(1)
5	Credit Growth	I(1)
6	Capital Outlay Growth	I(0)
7	Crude Price Growth	I(0)

Furthermore, the Hausman Test was conducted, and the Random Effect GLS modelwas found to be an efficient alternative. Consequently, the model is estimated with I(1) variables incorporated after first differencing to avoid spuriousness in the results. Also, the variables, Industrial Share, Debt-to-GSDP, Credit Deployment Growth and Capital Outlay Growth are considered at a lag of one period to control for endogenity at contemporaneous levels. After estimating the model, the residuals were not robust to diagnostic tests, including heteroskedasticity and cross-sectional dependence, rendering the standard errors unreliable. To ensure the robustness of standard errors, white robust standard errors are generated. Similarly, for the VAR model, the White robust errors are used. The Cholesky ordering for dynamic estimates are as follows: Crude Price Growth, Alignment Index, Capital Outlay Growth, Debt-to-GSDP, Credit Growth, Industry Share, GSDP Growth. Given the unreliability of the asymptotic standard errors, which were found to suffer from non-normal error

term disturbances and heteroskedasticity,the Impulse Response Functions (IRFs) and Variance Decomposition are generated based on the Monte Carlo Bootstrapping method to generate confidence intervals at 1000 replications. On the reduced form estimation, the Akaike Information Criteria (AIC) was used for lag selection. Consequently, the model is estimated with three lag terms. Given the unreliable standard errors, the reduced form equation for GSDP growth is re-estimated using EGLS (Estimated GLS)with cross-section SUR weights to ensure that the parameters are efficient while yielding robust standard errors. Furthermore, table 6 provides the descriptive statistics for the variables in the model.

Table 6: Descriptive Statistics

	GSDP Growth	Alignmc nt Index	Crcdit Growth	Capital Outlay Growth	Crude Pricc Growth	Dcbt to GSDP	Industry Share
Mean	12.27	-1.01	16.20	20.38	8.60	27.09	24.68
Standard Error	0.34	0.05	0.48	2.77	1.45	0.59	0.42
Median	12.67	-0.76	15.79	13.04	8.77	26.65	24.05
Mode	#N/A	-0.89	#N/A	-2.95	17.83	19.11	36.66
Standard Deviation	6.06	0.88	8.53	48.86	25.65	10.37	7.36
Sample Variance	36.73	0.77	72.75	2387.45	658.17	107.55	54.21
Kurtosis	1.49	0.80	0.55	83.04	0.50	-0.17	0.05
Skewness	-0.29	-1.12	0.39	6.96	0.35	0.06	0.24
Range	43.13	4.00	58.51	714.47	121.80	52.39	36.06
Minimum	-10.02	-4.01	-8.69	-75.42	-45.14	0.36	8.43
Maximum	33.11	-0.01	49.83	639.05	76.66	52.74	44.49

Table 7: Econometric Estimation Results

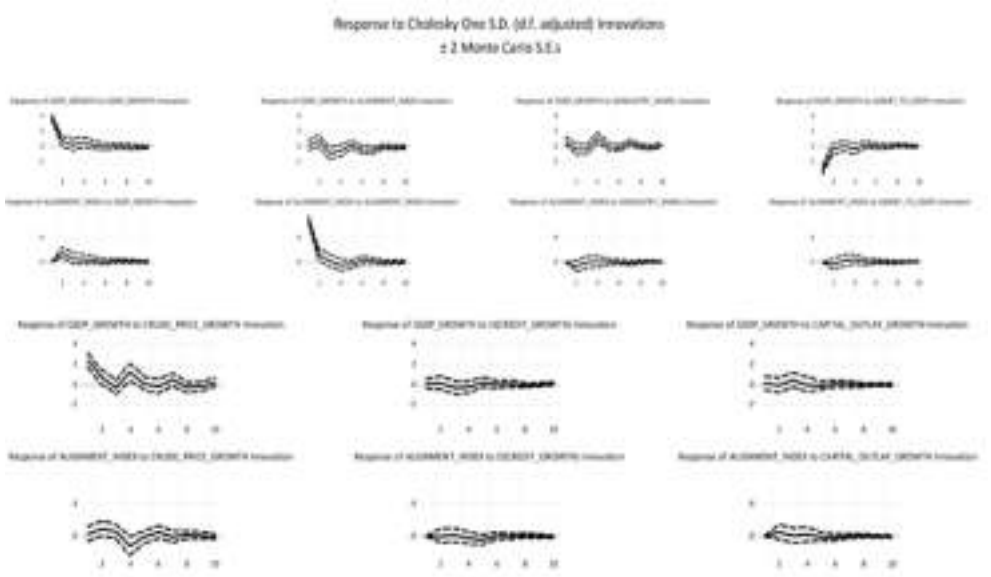
Variable	GLS Random Estimates	VAR Reduced Form	Note
Alignment Index	0.77**	0.83*** (lag)	At VAR lag 2: -1.2
Industry Share	-0.49 (lag)	-0.17 (lag)	At VAR lag 3: 0.36***
Debt to GSDP	0.107 (lag)	0.08 (lag)	
Crude Price Growth	0.06***	0.02 (lag)	At VAR lag 3: 0.06***
Credit Deployment Growth	-0.09 (lag)**	0.03 (lag)	At VAR lag 3: -0.04**
Capital Outlay Growth	0.005 (lag)	-0.001(lag)	-
COVID Dummy	-12.96***	-	-
GFC Dummy	4.52***	-	-
Adj R^2	0.34	0.25	-
Model Significance	Significant at 1%	Significant at 1%	

*** , **,* are significant at 1%, 5% and 10% levels, respectively.

Dependent variable: GSDP_GROWTH

Excluded	Chi-sq	df	Prob.
ALIGNMENT_INDEX	11.29479	3	0.0102
D(INDUSTRY_SHARE)	10.25832	3	0.0165
D(DEBT_TO_GSDP)	1.413162	3	0.7025
CRUDE_PRICE_GR...	8.159407	3	0.0428
D(CREDIT_GROWTH)	2.249823	3	0.5222
CAPITAL_OUTLAY_...	1.703117	3	0.6362
All	42.59587	18	0.0009

Figure 6: Impulse Response Functions



6. Discussion of the Results

The empirical findings offer novel insights into the fiscal-monetary alignment dynamics at the subnational level in India. Synthesising the findings from the constructed Alignment Index, panel random estimates, and dynamic Vector Autoregression (VAR) models, several critical themes emerge regarding the nature, causes, and impact of policy alignment within a federal structure modelled under a monetary union framework.

Policy Alignment at the subnational level in India is primarily a reactionary phenomenon. The temporal evolution of the Alignment Index reveals that policy alignment as measured by the coordination gap narrows during major crisis periods marked by aggregate demand shocks. For instance, during the COVID-19 pandemic, the index dropped to 0.29, which is significantly below the long-run average of 0.88 (Table 4). This suggests that during crises, the political and economic incentives increase for both the central bank and subnational fiscal authority to adopt an expansionary policy stance, leading to greater alignment.

However, the Global Financial Crisis (GFC**)** of 2008-09 stands as a notable anomaly where the alignment gap remained high at 1.608. While the central government and the RBI coordinated closely to provide stimulus, subnational entities did not shift their fiscal gears with equal intensity. This discrepancy is likely explained by the fact that the GFC did not impose a severe nominal growth penalty at the time, leaving states with less immediate pressure to adopt expansionary stances despite accommodative monetary conditions. This period reveals another critical policy implication of misalignment: impaired policy transmission. Looking through the IS-MP framework, when theMP shifts rightward while the subnational fiscal stance remains static, the resulting output expansion is sub-optimal. Moreover, the resultant fall in interest rate and easy money regime can result in inflationary pressures since the economy is still close to a full employment level. This phenomenon can provide an alternative explanation for a high inflation phase after the global financial crisis.

The econometric results provide robust evidence for the benefits of policy coordination on regional economic performance. Both the GLS Random Effects and VAR reduced-form models indicate that improved alignment (a reduction in the index gap) is associated with a statistically significant increase in GSDP growth. The analysis reveals that for every unit improvement in alignment index, an immediate 0.77 per cent increase in GSDP growth is seen, which rises to 0.83 with a one-year lag (Table 7). Furthermore, the Granger Causality test confirms that the Alignment Index is a leading indicator, temporally predicting GSDP growth at the 5 per cent significance level (Table 8). It can be inferred from the variance decomposition that apart from the alignment index, past GSDP performance, debt levels and crude prices significantly explain the variance in GSDP growth (Table 9).

Table 9: Variance Decomposition

Variance Decomposition of GSDP_GROWTH:

Period	S.E.	GSDP_G	ALIGNME	D(INDUS	D(DEBT_	CRUDE_	D(CREDI	CAPITAL
1	5.518313	47.30339	0.060091	1.686179	31.38332	19.22133	0.041300	0.084474
		(1.28397)	(0.03561)	(1.11508)	(1.28091)	(1.27126)	(0.31548)	(0.58571)
2	5.682653	45.86736	1.747587	2.257816	29.91000	19.85099	0.142228	0.105725
		(4.30689)	(1.82488)	(1.30796)	(4.27425)	(4.56588)	(0.67093)	(0.80297)
3	5.709485	44.28795	4.048859	2.530598	29.77044	19.33645	0.472685	0.644042
		(5.17180)	(2.34634)	(1.50804)	(4.12890)	(4.33391)	(0.87667)	(1.23070)
4	6.050029	40.95070	4.437611	5.000033	26.31479	21.49026	0.540401	0.583023
		(4.84329)	(2.38670)	(2.35177)	(3.90719)	(4.45616)	(0.91405)	(1.18956)
5	6.109382	40.82409	4.515177	5.631762	26.31050	21.40781	0.686870	0.623768
		(4.87979)	(2.41773)	(2.33782)	(3.87681)	(4.41899)	(1.07168)	(1.20990)
6	6.122361	40.51936	4.931749	5.753085	26.13187	21.34034	0.692007	0.635177
		(4.89664)	(2.50849)	(2.40756)	(3.86680)	(4.44317)	(1.07459)	(1.21746)
7	6.189782	39.78821	5.383519	6.314344	25.84932	21.55583	0.675704	0.633373
		(4.17200)	(2.56332)	(2.63734)	(3.84126)	(4.48296)	(1.04723)	(1.20041)
8	6.200213	39.65574	5.386580	6.293330	25.84664	21.69871	0.701252	0.635775
		(4.18511)	(2.56827)	(2.61983)	(3.83465)	(4.44589)	(1.03899)	(1.20137)
9	6.208048	39.58544	5.391156	6.329568	25.83713	21.77182	0.700832	0.634207
		(4.20894)	(2.57808)	(2.65031)	(3.84085)	(4.50389)	(1.03889)	(1.20124)
10	6.215782	39.49220	5.403041	6.356419	25.82727	21.80223	0.712781	0.634081
		(4.23951)	(2.57165)	(2.69422)	(3.84176)	(4.52515)	(1.03705)	(1.20072)

Furthermore, the Impulse Response Functions (IRFs) show that a one-standard-deviation shock to policy alignment triggers an immediate rise in economic growth that persists for approximately two quarters (Figure 6).These findings support the theoretical construct of the IS-MP framework. When fiscal and monetary authorities act in sync, they simultaneously shift the IS and MP curves, pushing the economy toward a higher output equilibrium while maintaining a stable interest rate environment.

Despite the clear short-term benefits, this study identifies a critical constraint. The negative coefficient for the second lag of the alignment index (-1.2 percent) suggests that the benefits of coordination are not infinite and may even reverse if accommodation is prolonged. While not statistically significant,viewed through the lens of the Fiscal Theory of the Price Level (FTPL), sustained monetary accommodation of state-level fiscal deficits can eventually trigger high price levels and financial instability. This instability necessitates a drastic tightening phase, leading to subsequent negative growth. Thus, while alignment is a highly effective tool for short-run stabilisation, it must be managed carefully to avoid long-term output penalties associated with debt servicing costs and inflationary volatility.

The discussion of results also accounts for the role of external shocks and structural composition in determining state output.The positive coefficient (0.06) for crude price growth initially appears counterintuitive for an oil-

importing nation. However, this likely reflects the correlation between crude prices and global demand cycles. This is where periods of rising oil prices often coincide with global and domestic economic expansions that drive Indian GSDP growth. Similarly, the negative sign on lagged credit growth reflects the cyclical nature of credit deployment, where rapid expansion often precedes a period of deleveraging or tightening. Furthermore, the debt-to-GSDP ratio remains a critical structural burden, influencing the "passive" role states must play to ensure budgetary solvency.

While greater coordination during crisis periods can be captured easily, interpreting the coordination gap during normal times requires an understanding of optimal policy coordination. Goyal (2018) argues that a strict Leeper (1991) style policy configuration cannot result in optimal outcomes in a supply-constrained economy like India. A sustained active monetary and passive fiscal stance can constrain growth below its potential, as the tighter monetary conditions may restrict growth, while a contractionary fiscal stance may not address supply deficiencies of an emerging economy. This is because, in an emerging market economy, output is understood to be largely demand-induced while inflation is driven by supply-side pressures. Consequently, optimal policy coordination would be: the fiscal authority focusing on easing supply-side constraints to shift the Aggregate Supply (AS) curve downwards, while the monetary authority ensures a conducive macroeconomic environment to result in demand-led growth. The positive output responses to alignment suggest that the active monetary mandate (focused on price stability) and the passive fiscal response (focused on solvency and stabilisation) are creating a more predictable and stable regional economic environment. Finally, it also signals signs of maturity in the Indian economy since growth under Leeper-style coordination with supply constraints can only be explained by rising productive capacities.

As evidenced by the IRFs, a one standard deviation shock to the GSDP growth results in a statistically significant increase in policy alignment (Figure 6). As discussed in the results section, the differing levels of fiscal activity during the GFC and other economic crises show that the crisis-driven macro-stabilisation objective dominates the cost minimisation objective. While the latter may assume increasing significance due to narrowing fiscal space for the fiscal authorities, the IRF validates the macro stabilising hypothesis as the principal driver of policy alignment. This finding further strengthens the application of post-Keynesian frameworks such as the IS-MP at subnational levels.

7. Conclusion

The findings of this study provide a comprehensive evaluation of the subnational fiscal-monetary policy nexus in India, highlighting its critical role in regional economic performance. An assessment of the alignment index across time reveals that coordination at the subnational level is primarily reactive, intensifying during major crisis periods. Such an episodic crisis-driven alignment is crucial in aiding fast economic recovery during a crisis, but its continued pursuit will allow for a stable macroeconomic trajectory. Therefore, the pursuit for policy alignment must evolve beyond crisis management to emerge as an explicit and objective policy target.

The econometric results show that better aligned policies can result in a significant growth premium. It is seen that a unit increase in the alignment index can contribute between 0.7 and 0.83per cent in GSDP growth across both contemporaneous and lagged effects. This shows that beyond crisis management, policy alignment can be an effective tool for economic expansion at the state level. While the growth benefits are clear, our results also identify threshold levels beyond which alignment can penalise economic expansion. Sustained accommodation by the monetary authorities can lead to unsustainable fiscal expansion that can increase the inflationary pressure and trigger a cyclical downturn that can impede economic activity, indicating that prolonged accommodation can become growth-penalising.

Modern macroeconomic frameworks, specifically the FRBM Act and the Flexible Inflation Targeting (FIT) regime, serve as essential guardrails. These institutional mechanisms prevent the risks of fiscal dominance and ensure that the pursuit of policy alignment does not compromise long-term price stability or debt sustainability. Furthermore, the analysis of the post-GFC period illustrates that a lack of alignment leads to inefficient policy transmission. When subnational fiscal stances diverge from national monetary objectives, the intended impact of monetary easing is blunted, leading to sub-optimal output equilibrium and distorted interest rate environments.

In summary, for India to achieve durable macroeconomic stability,including price stability andminimise output gaps, subnational policy alignment must be integrated as a permanent, structural feature of India's macroeconomic framework.

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Mainstreaming Circular Economy: Towards A New Sustainability Paradigm

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Abstract

The article provides a critical overview of the current planetary crisis caused by climate change and the proliferation of waste. It stresses the urgent need to move away from the current, highly energy-intensive, linear pathway of growth toward a more sustainable, circular one. Drawing on empirical evidence and a literature review, it provides a worldview of the circular economy growth model, focusing on policies and schemes of the Government of India and Odisha that serve as entry points for unlocking opportunities to mainstreamthe circular economy. The article provides plausible strategies and measures for Odisha to support the transition to a new sustainability paradigm and achieve the all-important circularity goals of resource efficiency, resource sufficiency, and energy security.

Keywords: Circular Economy, Climate Change, Waste crisis, Resource efficiency, Odisha

Introduction: The Climate Change and Waste Crisis

We, as a human civilisation, are at a crossroads today. We are facing not one but a triple planetary crisis: first, climate change; second, biodiversity loss; and third, pollution and waste (UNEPa, 2024). The science is loud and clear. Economic growth in its current form is unsustainable. The indiscriminate use of Earth's material resources for the production and consumption of goods, and the consequent rise in global greenhouse gas emissions, largely driven by a fossil-fuel economy, are the key drivers of the current unsustainable pattern of growth and the planetary crisis.

Total global material extraction has tripled over the last 50 years. It is expected to grow by a staggering 60% by 2050 (from 2020 levels), from100 billion tonnes

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today to 160 billion tonnes (UNEPa, 2024), if we continue on our current business-as-usual trajectory. Extraction and processing of material resources (which include fossil fuels, minerals, non-metallic minerals, and biomass) account for over 55% of greenhouse gas (GHG) emissions and 40% of particulate matter-related health impacts.

Official figures available from Indiastat that resource extraction in the country (as of 2019) is around 1580 tonnes/acre, which is considerably higher than the world average of 450 tonnes/acre, with a much lower recycling rate of 20-25% versus 70% in developed countries like Europe (NREP, 2019). The official report says that if we assume a GDP of 8% per annum until 2030 and thereafter 5%, the total material consumption in 2030 would be 14.2 BT (billion tonnes). This means a tripling of demand for primary materials compared to 2010, particularly for energy carriers, metals, and non-metallic minerals.

Owing to this unrestricted extraction and use of materials for economic growth along with the increase in use of fossil fuels (that is coal, oil and natural gas) for fuelling this growth, global greenhouse gases, which are the main drivers of climate change (especially carbon dioxide emissions), have increased exponentially, reaching a record 57.7 GtCO2e in 2024, a 2.3% increase from 2023 levels (Figure 1), with India ranking first in absolute increase in emissions (+165 Mt CO_{2e}[1]), as shown in Figure 2 (UNEPa, 2025). Record atmospheric CO_2 concentrations of 422.5 parts per million[2]were witnessed in 2024 around 3 ppm higher than 2023 and 50% higher than pre-industrial levels[3]. On 7 December, 2025, they stood at 427.48 ppm (EO, 2025). The Intergovernmental Panel on Climate Change (IPCC) projects that if emissions and temperatures continue to increase exponentially,the world could see temperatures as high as 3.6°C by the end of the century, which is a dangerous scenario (IPCC, 2021).

[1] CO_{2e} is a metric used to standardize the measurement of emissions of different GHGs with CO_2.

[2] Parts per million is the measurement of how much of a given greenhouse gas, like carbon dioxide, is in the air. So, if carbon dioxide is at 422.5 parts per million, that means in one million molecules of air, 420 are carbon dioxide. This may seem like a small number, but greenhouse gases are potent heat absorbers. Even small increases accelerate the impacts of climate change.

[3] Pre-industrial levels are taken as the benchmark or baseline for maintaining healthy levels of carbon dioxide in the atmosphere. It refers to the 1850 –1900 period, an example of climate before large-scale fossil fuel use, when CO_2 was ~ 280 ppm.

Figure 1: Total Net Anthropogenic GHG Emissions, 1990–2024

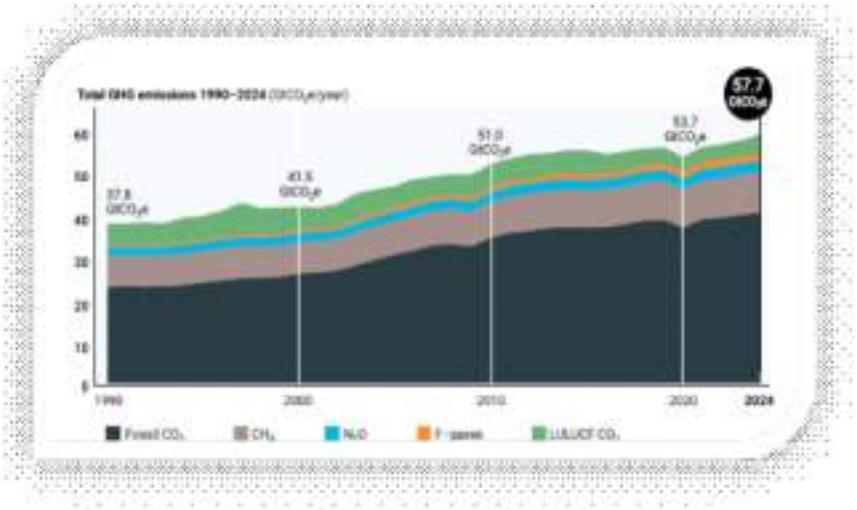
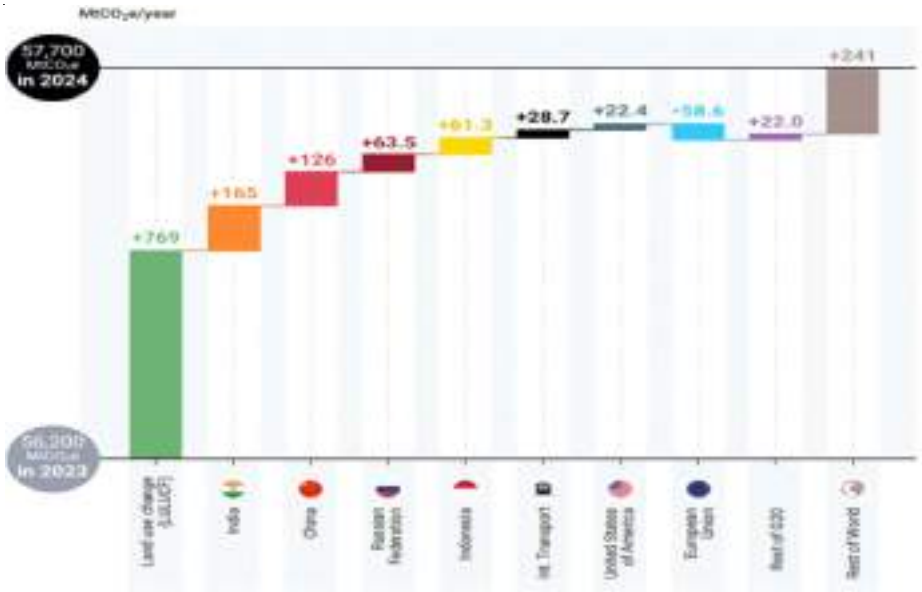


Figure 2: Contributions to the Increase in GHG Emissions in 2024 from 2023 levels of the Six Largest Emitters, the Rest of the G20 Members, the Rest of the World, International Transport and LULUCF



Source: Emissions Gap Report, 2025, United Nations Environment Programme.

To prevent emissions from increasing further, global leaders launched the Paris Agreement, a legally binding international treaty on climate change, adopted by 195 Parties at the UN Climate Change Conference (COP21) in Parisin 2015. Currently, as of January 2026, there are 194 Parties to the Paris Agreement, including India, which is committed to reducing its emissions intensity (the volume of emissions per unit of GDP)by 45% by 2030, from 2005 levels, and achieve cumulative electric power installed capacity of 50% from non-fossil sources by 2030 through its nationally determined contributions (GOI, 2022).

The overarching goal of the Paris agreement is to hold "the increase in the global average temperature to 1.5°C, or well below 2^0C, above pre-industrial levels, by the end of the century." Limiting global warming to 1.5°C will significantly reduce the risks, adverse impacts, and related losses and damages from climate change. Failing to do so will lead to increasingly frequent and dangerous extreme weather events, including heatwaves, droughts, wildfires, and heavy precipitation and flooding (IPCC, 2021). Exceeding 1.5°C could also trigger multiple climate tipping points — such as the breakdown of major ocean circulation systems, the abrupt thawing of boreal permafrost, and the collapse of tropical coral reef systems — with abrupt, irreversible, and dangerous impacts for humanity (UNa, n.d.).

So are we on track to meet the Paris agreement? Unfortunately, no. The planet is already 1.4°C warmer compared to pre-industrial levels (EO, 2025). Moreover,we are still not even halfway towards the end of the century. In fact, predictions by the Copernicus Climate Change Service (an EU Program) show that, going by the current growth trend, we could reach the 1.5°C threshold by March 2029 (EO, 2025), just three years down the line.

Alongside the climate change crisis, the second planetary crisis we face is the waste crisis. This paper focuses on three critical waste sectors: municipal solid waste (MSW), e-waste, and plastic waste.

In 2020, global MSW generation was estimated at 2.1 billion tonnes per year. Given the current rate of economic growth and rapid population rise, it is projected to increase by 56% to 3.8 billion tonnes by 2050 (UNEPb, 2024) if urgent action is not taken to curb its increase. The report states that in 2020, the total global societal cost due to MSW was US$361 billion.If not addressed, the total global costs could increase to US$640.3 billion by 2050.

Nevertheless,ifdealt with, it could help mitigate 15%–25% of global GHG emissions (UNEPb, 2024).

In 2021-22, India generated about 65 million tonnes of waste annually, of which over 62 million tonnes were MSW (organic waste and recyclables such as paper, plastic, wood, and glass). It was observed that only about 75-80% of municipal waste is collected; of this, only 22-28% is processed and treated. The remaining MSW is dumped into open landfills. By 2031, MSW generation in India is projected to increase to 165 million tonnes, and by 2050, up to 436 million tonnes (Agnihotri, 2022).

As of 2025, 130 million tonnes of plastic pollute the environment each year. Plastic pollution is expected to more than double over the next 15 years, from the current 130 million tonnes to 280 million tonnes. The grim news is that health impacts from plastic pollution, which include heart disease, asthma and cancer, areexpected to increase by 75% by 2040 (PEW, 2025). If the global plastic system were a country, it would be the third-largest GHG emitter by 2040, with emissions set to increase by 58%to 4.2 gigatonnes of CO2e in a business-as-usual scenario. This is equivalent to the emissions from one billion gasoline-powered cars, mainly due to production activities (PEW, 2025). A 2024 study published in the journal *Neture* states that India is the world's largest contributor of plastic pollution, accounting for 9.3 Mt year 1, equivalent to nearly one-fifth of global plastic emissions (Cottom et al., 2024).

In terms of e-waste, a record 62 billion kg was generated globally in 2022 (equivalent to an average of 7.8 kg per capita, per year); only about 22.3% of this e-waste was formally collected and recycled in an environmentally sound manner (ITU and UNITAR, 2024).To emphasise the magnitude of the global e-waste problem, consider that the 62 billion kg of e-waste generated could fill 1.55 million 40-tonne trucks, forming a bumper-to-bumper line encircling the equator. That is the magnitude of the waste generated.

Need for a Circular Economy

Given this overwhelming evidence of GHG emissions and waste generation, it is clear that countries across the globe can no longer afford to tread the 'business-as-usual' pathway of 'unrestricted' economic development. There is an urgent need to shift from this traditional growth paradigm of depleting natural resources and proliferating waste to a new sustainability paradigm, in which

economic growth embraces resource longevity and efficiency through the circular economy.

Our current production and consumption patterns follow the linear model of growth, or the 'cradle to grave' approach: from the extraction of raw materials to processing, manufacturing, distribution, use, and finally disposal (Figure 3). It does not consider the need for environmental regeneration or the sustainable use of our natural resources. We therefore need to rethink and adopt a new development paradigm. A paradigm which replaces the 'cradle-to-grave' approach with a 'cradle-to-cradle' or 'circular' approach (Figure 4). A concept developed in the 1990s by Prof. Dr Michael Braungart, William McDonough and EPEA Hamburg, it means a system in which materials never become waste, and we restore nature by keeping products and materials in circulation through processes such as maintenance, reuse, refurbishment, remanufacturing, recycling, and composting (EMF, 2024; Fiksel et al., 2021; Sanjay, 2018). By doing so, the circular economy helps in the fight against climate change, waste, and biodiversity loss, the key challenges of the triple planetary crisis facing humankind today.

Figure 3: Cradle-to-Grave Approach: Linear Model of Growth

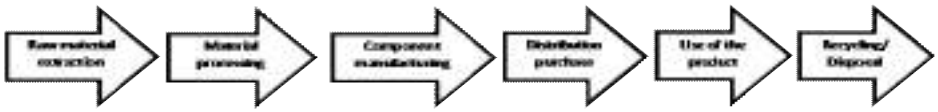


Figure 4: Cradle-to-Cradle Approach: Circular Model of Growth



Source: White et. El., *Okala: Learning Ecological Design*, Phoenix; *Module on Resource Efficiency*, DMU, Leicester, UK.

According to the Ellen MacArthur Foundation (EMF, 2024), the circular economy is based on three principles, driven by design:

- Elimination of waste and pollution
- Circulation of products and materials (at their highest value)
- Regeneration of nature

Most of us know the 3Rs of a circular economy: reduce, reuse, and recycle. While this is the basic foundation of the circular economy, the literature points to many more Rs. There is the 5R approach, which adds 2 Rs, resulting in 'reduce, reuse, refurbish (upcycle), repair and recycle'. Then the 8Rs which starts with refuse, followed by rethink, reduce, reuse, repair, recyle, rot, and recover; then the 9Rs of redesign, reduce, reuse, repair, renew, recover, reject, remanufacture and recycle; and the 12Rs of reuse, repair, refurbish, renew, rescue, return, recover, recycle, review, redesign, reduce and reject.

To put it in a nutshell, the salient features of a circular economy (CGR, 2025; EMF, 2024; Sanjay, 2018) are listed in the following.

1. Products are so designed that they are easily recycled, reused, disassembled and remanufactured.
2. There is a circular flow of technical and biological materials within and beyond the product's value chain and even after its useful life.
3. It emphasises continuous innovation to extract maximum value from all resources being used, and ideally, nothing is called waste.
4. Products, services and every instance of material usage are designed to remain in the value chain for the longest period possible.
5. Ideally, the total energy requirement in a circular economy is met from renewable sources such as wind and solar.
6. There is (net) job creation as repair, maintenance and refurbishment require more workforce compared to new resource extraction.

The economic and social advantages of a circular economy are manifold.

- The World Economic Forum (WEP, 2019) says that a circular economy can increase global GDP by 7% by 2030, creating a 4.5 trillion USD global economy.

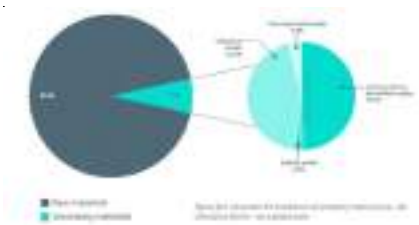
- According to the European Commission (EC, 2020), applying circular economy principles across the EU economy has the potential to increase EU GDP by an additional 0.5% by 2030, creating around 700,000 new jobs in key sectors.
- According to the Government of India (PIB, 2025), a circular economy could lead to a USD 2 trillion+ market, creating around 10 million jobs by 2050.

Regarding financing for the circular economy, UNEP has stated that an estimated USD 350 billion has been allocated to it since 2019. The total value of public equity funds grew from USD 0.3 billion to USD 6.6 billion between 2019 and 2023. The number of sovereign bonds also grew more than 13-fold, with a cumulative issuance of USD 93 billion (UNEPb, 2025). In India, circularity in the key sectors of steel, solar, construction and demolition waste, batteries, agricultural waste, wastewater, and organic waste is expected to result in INR 11.5 lakh crore ($132.2 billion) annual market by 2047, creating 8.4 million full-time equivalent (FTE) jobs and building INR 10.8 lakh crore ($124.8 billion) in investments (RMI, CEEW, 2024).

Gaps and Challenges in the Circular Economy

Despite the various advantages a circular economy offers, critical gaps and challenges hinder its mainstream adoption. According to the Circularity Gap Report (CGR, 2025), which reviews the current state of the circular economy worldwide, circularity fell from 7.2% in 2018 to 6.9% in 2021. This means that only 6.9% of the materials entering the global economy are secondary, with construction and demolition waste accounting for the largest share at 49.6%, industrial waste at 44%, and MSW at only 3.8% (Figure 5). The remaining 93.1%is raw material, viz.,new materials excavated from the earth.

Figure 5: Global Secondary Material Consumption



Source: Circularity Gap Report, 2025, Circle Economy

The move towards a circular economy is fraught with some key challenges. Based on the voices of stakeholders from the waste sector, these include a lack of rules and regulations for segregation of waste at source as per different categories (MSW, e-waste, plastic) at the local (municipal) level, weak or no appropriate infrastructure facilities for storing and recycling of waste, and a lack of awareness and capacity building. Over and above, a major challenge is the lack of sustainable consumerism or environmentally sustainable behaviour among common citizens, which hinders the move towards more green products and the recycling of waste (Fiksel et al., 2021; WISE, 2020).

Circular Economy in India: Policy and Regulation

In 2006, the Government of India enacted the National Environment Policy to safeguard the environment.While the policy was not focused on the circular economy, it was the first to address key aspects of circular economy, such as resource efficiency, waste minimisation, and recycling (CII, 2025). Later in 2000, the Government of India introduced the Municipal Solid Waste (Management and Handling) Rules, which wererevised in 2016 and renamed Solid Waste Management Rules. In addition to this, key regulations for waste include:

- E-Waste Management Rules, 2011,Amendment (2022)
- Hazardous and Other Wastes (Management and Transboundary Movement) Rules, 2016, Amendment (2024)
- Battery Waste Management Rules, 2022
- Plastic Waste Management Rules, 2016, Amendment (2024)
- Environment (Construction and Demolition) Waste Management Rules, 2025
- Environment Protection (End-of-Life Vehicles) Rules, 2025

The Government of India has initiated several policies and schemes that can act as key entry points in charting the way forward towards a circular economy in India. Some of these are highlighted below.

- Union Budget of India, 2026

  √ Recognising the need for sustainability and long-term supply security, the Government of India has approved a 1,500-crore incentive scheme to promote recycling of critical minerals, including rare earths. The

scheme will run from 2026 to 2031 and focus on recovering minerals from e-waste, end-of-life electronics, and industrial scrap.

√ The Government of India will also support mineral-rich states like Odisha, Kerala, Andhra Pradesh and Tamil Nadu to establish dedicated rare earth corridors to reduce import dependence and boost domestic manufacturing, besides incentivising permanent magnet production and recycling of critical minerals. This initiative aligns with the National Critical Mineral Mission established last year (with an outlay of about INR 16,300 crore), which aims to strengthen domestic capabilities across the value chain, especially in the recycling of critical minerals such as rare earth elements.

√ The Union Budget also mentions proposals to streamline GST on recycled materials, aimed at eliminating long-standing tax disadvantages in the sector, making recycling commercially viable and encouraging industries to reduce waste and improve material efficiency.

- The Draft National Resource Efficiency Policy, 2019, was prepared with the objective of promoting sustainable production and consumption patterns, enhancing resource efficiency, and reducing the environmental impact of economic activities.
- One of the most important regulations is the Extended Producer Responsibility, where producers are made responsible for end-of-life product management – from collection and recycling to environmentally safe disposal.India formally adopted EPR in 2011 under the E-Waste (Management & Handling) Rules. It has now widened its scope to include plastics, batteries, hazardous and construction and demolition waste and end-of-life vehicle scrap (IB, 2025; EY, 2025).
- The Ministry of Road Transport and Highways, Government of India, launched the Voluntary Vehicle Modernization Programme or Vehicle Scrapping Policy in 2024, aimed at phasing out unfit polluting vehicles through a network of Registered Vehicle Scrapping Facilities (RVSFs) and Automated Testing Stations (ATSs). It is stated that there are 60+ RVSFs across 17 States/UTs and 75+ ATSs across 12 States/UTs operational in the country (PIB, 2024).

Mainstreaming the Circular Economy: Way Forward

Odisha has put in place some relevant policies that focus on key aspects of circular economy, such as the Vehicle Scrappage Policy of Odisha 2022, Odisha Export Policy 2022, Odisha Food Processing Policy 2022, Industrial Policy Resolution 2022, and Odisha MSME Development Policy, 2022, etc. In addition, the Government of Odisha has recently come out with the 'Framework for Circular Economy Vision 2036' (SPCB and FECC, 2025).

Building on India's and Odisha's policy and regulatory framework, somestrategies and measures that Odisha could explore or adopt, are presented below, that could aid in mainstreaming the circular economy into the state's developmental agenda, providing an integrated approach to tackling the waste and climate crisis.

- Integrate circular economy efforts with decarbonization measures, especially in the energy and manufacturing sectors, given that coal is the mainstay of power generation in the state with an installed capacity of 77.5% (in 2021-22), and only 5% of installed capacity is from renewable energy (Srivastava et al, 2025). With the launch of Odisha's Renewable Energy Policy in 2022, which envisages the achievement of (minimum) 43% renewable energy by 2030, the state has been provided with a dedicated pathway to increase its total share of RE in Odisha's energy mix. This would complement Odisha's circular economy vision 2036.
- Odisha's industrial and domestic sectors together account for over 70% of Odisha's total power consumption (Srivastava et al, 2025). An effective way to reduce energy consumption in the industrial sector and recover energy wasted in industrial processes is recycling it through combined heat and power (CHP) projects that convert waste energy into electricity and thermal energy. Energy recycling through CHP can be implemented in areas with high energy consumption, such as industrial and manufacturing facilities and public institutions, including hospitals and universities (PE, n.d.).
- The European Union (ECa n.d.) has brought out key directives for facilitating a circular economy which could act as examples for Odisha. These include:

√ The 'Directive Empowering Consumers for the Green Transition', providing them/ with information on the durability and reparability of goods and the consumer's legal guarantee rights, directly at the point of sale. Consumers play a vital role in paving the pathway towards more efficient and sustainable resource use. Raising consumer awareness is essential for a resource-efficient future.

√ The 'Directive on Repair of Goods', which establishes the 'right to repair'.

- With the design stage of a product accounting for more than 80% of the lifecycle's environmental impacts, it is imperative to focus on design for sustainability or 'Resource Efficient Design', as it creates more sustainable products, processes, services, and systems that aim to increase product longevity by using resources more efficiently (Sanjay, 2018). The European Union's 'Eco-design for Sustainable Products Regulation', which ensures more environmentally sustainable and circular products, could be taken as an example in buildingongoingcircularity efforts.
- Conducting a baseline carbon emissions inventory to assess and evaluate the total emissions generated in energy-intensive sectors such as steel, iron, aluminium, textiles, petrochemicals and food, etc, could provide valuable benchmarks for reducing waste and emissions in these critical sectors, complementing Odisha's circular economy vision.
- Development of amarket instrument such as green public procurement or GPP -The European Commission defines GPP as a process where "public entities seek to procure items with reduced environmental footprints compared to conventional alternatives." (ECb, n.d.).Public spending accounts for approximately 15% of global greenhouse gas emissions and almost 30% of India's GDP, suggesting that sustainable procurement practices, especially in government bodies and public enterprises, can significantly impact climate mitigation efforts (IISD, 2024). Green Public Procurement focuses onreducing environmental impacts throughout the lifecycle of goods and services, thereby achieving the circular economy as the outcome.
- Today, 55% of the world's population lives in urban areas, and this figure is expected to increase to 68% by 2050 (UNb, n.d.). As cities are highly energy-intensive and key drivers of global emissions, there is an urgent need for more concerted climate action by local

governments to move towards sustainability and circularity. Introducing quantifiable targets and benchmarks that are SMART, i.e., specific, measurable, achievable, relevant and time-bound, along with appropriate government mechanisms is key (WISE, 2022). For example, setting a target to recycle 'x%' of municipal waste and 'y%' of packaging waste by a certain timeline (say 2030), or drafting a regulation to prohibit the dumping of waste in landfills by a certain timeline, etc.

- Establishment of a circular economy cell, as has been carried out at the national level, could be considered within the urban local bodies, i.e., municipal corporations,who could act as nodal authorities for regulation, implementation and monitoring efforts (WISE, 2022) for circularity, thus facilitating and strengthening bottom-up, local governance and more empowered and circular cities in the state.

Role of the Academia and Research Institutions

What can academic and research institutions do to help the transition to a circular economy?

- Develop a new curriculum for the circular economy and provide suitable accreditation to enable future economists, engineers, lawyers, and other key professionals to be able to prepare for and find solutions to the growing climate and waste crisis.
- Educational institutes can introduce cross-learning and create internship opportunities with NGOs, private firms, government, etc., that would aid knowledge sharing and enable students to gain hands-on experience in work happening in the circularity sphere.
- Organisation of capacity building training programs and faculty development programs should also be strengthened for generating awareness and also initiating discussion and dialogue that could enable policy and regulation to be scaled up.
- The academia should build collaboration and partnerships with NGOs, private players and sister educational and research organisations to brainstorm and undertake research and critical studiesfor adopting the 'cradle-to-cradle' approach, thus spurring policy and aiding the transition from a resource-intensive economy to a resource-efficient and sustainable economy.

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Analysing Macroeconomic Trade-offs between Economic Growth, Financial Development and Sustainability in India

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Abstract

This study employsthe Environmental Kuznets Curve (EKC) framework to explore the nexus between carbon emissions, inflation, economic growth, and financial development in India, offering insights for policy and research. While the literature has extensively analysed the growth-environment nexus, limited attention has been paid to the roles of inflation and financial development in shaping environmental outcomes. By incorporating inflation and FDI into the EKC framework, this study seeks to address this gap and provide a broader macroeconomic perspective on environmental sustainability.Using annual data from 1971 to 2021,the study examines the nexus among key variables, including GDP growth, CPI inflation, CO2 emissions growth, and FDI growth. The findings suggest that economic growth significantly increases carbon emissions, implying that India remains in the early stage of the EKC. FDI growth also contributes to higher emissions, indicating a trade-off between financial expansion and environmental sustainability. Additionally, inflation is found to have a positive impact on CO2 emissions, suggesting that rising price pressures may indirectly encourage environmentally unsustainable production practices.

Keywords: Inflation, Environmental Sustainability, Foreign Direct Investment, Trade-offs, Economic Growth.

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1. Introduction

The pursuit of sustainable development (SD) has become increasingly prominent in contemporary economic discourse. Economies are increasingly focused on conserving resources for future generations while simultaneously protecting the environment as they pursue economic advancement. Developing nations like India are making notable effortsto achieve the SD objectives. In this context,India aims to achieve net-zero carbon emissions (CEs) by 2070.As part of this commitment, the government of India launched the LiFE (Lifestyle for Environment) mission globally on October 20, 2022. Earlier, the Prime Minister of India had described it during the COP26 at Glasgow in 2021 as "LiFE envisages bringing everyone together to adopt an environmentally conscious lifestyle for 'mindful and deliberate utilisation, instead of mindless and destructive consumption'. Evidence suggests that behavioural interventions and changes in consumption and lifestyle patterns can contribute to reductions in household energy use and carbon emissions (Khanna et al., 2021; Vita et al., 2019).

This initiative is vital for combating environmental degradation (Envir. Degr.) caused by rising greenhouse gas (GHG) concentrations.According to the NITI Aayog Report, "India is already in the midst of a transition toward a low-carbon economy. The share of coal in the energy mix of India is likely to decline to 40% by 2040 from 46% currently." (Saraswat & Bansal, 2021). India is making deliberate efforts to reduce its carbon footprint to zero.

As the world's 4th largest economy and one of the fastest-growing, India faces the complex challenge of reconciling rapid economic growth (E.Gr.) with environmental sustainability (Envir. Sust.). The relationship between E. Gr. and Envir. Degr. has been widely analysed through the Environmental Kuznets Curve (EKC) hypothesis, which suggests that Envir. Degr. initially increases during the early stages of economic development before eventually declining as income levels rise and cleaner technologies are adopted. The EKC framework highlights the policy dilemma between economic development and environmental protection. However, while many studies have examined the trade-off between economic growth and carbon emissions in India, relatively little attention has been paid to the role of other macroeconomic factors, such as financial development (Fin. Dev.) and inflation, in shaping environmental outcomes.

From a theoretical standpoint, CEs are intrinsically tied to economic output. Similarly, inflation is connected to economic output through various mechanisms.

1. Through the Phillips Curve, which connects inflation and unemployment, and Okun's Law, which links unemployment to output growth.

2. Through the New Keynesian Phillips Curve (NKPC), which connects inflation directly to output.

Through these channels, inflation can indirectly influence CEs by raising the cost of eco-friendly products, thereby decreasing demand and increasing reliance on cheaper, more polluting alternatives.Therefore, understanding the relationship between factors such as Fin. Dev., inflation, and CEs aresignificant as India pursues growth and sustainability. The country aims to achieve a 5-trillion-US-dollar economy by 2028, while also focusing on self-sufficiency and Envir. Sust.India aims to increase renewable energy use and achieve zero CEs by 2070, with a 30% reduction by 2030.Given these competing objectives, it becomes important to examine how macroeconomic factors influence environmental outcomes and whether E. Gr. can be reconciled with sustainability goals.

Understanding the interaction between macroeconomic variables and environmental sustainability is particularly important for emerging economies such as India, where rapid E. Gr. is accompanied by increasing environmental pressures. As India continues to expand its industrial base, attract foreign investment, and pursue ambitious development targets, the environmental consequences of macroeconomic activities have become a critical policy concern. Examining the roles of Fin. Dev. and inflation alongside economic growth provide a broader macroeconomic perspective on Envir. Degr. Such an approach allows policymakers to better understand whether economic expansion and financial deepening contribute to environmental stress or support sustainable development. Moreover, given India's commitment to achieving net-zero CEs by 2070 and expanding renewable energy adoption, empirical evidence on the macroeconomic drivers of CEs becomes essential for designing effective environmental and economic policies. Therefore, analysing the joint relationship between E. Gr., Fin. Dev., inflation, and CEs not only contributes to the academic literature but also provides important insights for policymakers seeking to balance economic development with environmental sustainability.

The remainder of this paper is structured as follows. Section 2 presents the theoretical background and literature review. Section 3 describes the study objectives, data, and methodology. Section 4 discusses the empirical results and findings. Finally, Section 5 concludes the study with policy implications and limitations.

2. Theoretical Background

The EKC hypothesis proposes an inverted U-shaped relationship between economic development and Envir. Degr. The hypothesis suggests that environmental degradation initially increases with economic growth as economies undergo industrialisation and experience rising energy consumption. Beyond a certain level of economic development, however, environmental degradation may decline as economies adopt cleaner technologies, strengthen environmental regulations, and develop greater environmental awareness (Grossman & Krueger, 1995).

During the 1990s, economists mostly discussed the idea of "too poor to be green" (Becherman, 1992). Beckerman argued that although E. Gr. initially causes Envir. Degr., the best way to achieve environmental improvement is through higher income and technological advancement.The *World Development Report* (1992) suggested that although E. Gr. may worsen some environmental problems in the short run, sustained economic development can generate the financial and technological resources necessary to address environmental challenges.

The inverted U-shaped curve typically represents three phases of economic development (Panayotou, 1993; Kaika & Zervas, 2013; Sarkodie &Strezov, 2019): (i) the Pre-Industrial Economy (P-IE), characterised by the primary sector and low-income levels; (ii) the Industrial Economy (IE), primarily identified by the secondary sector and associated with middle-income levels; and (iii) the Post-Industrial Economy (Pt-IE), characterised by the development of the tertiary sector and service-oriented activities and associated with higher income levels. During the P-IE phase, limited economic activity resulted in abundant natural resources and less waste generation (Kaika & Zervas, 2013; Stern, 2004). However, the use of polluting technologies, limited environmental awareness, and the prioritisation of economic growth contributed to increasing environmental degradation (Yandle et al., 2002). During the IE phase, industrialisation leads to the depletion of natural resources and accumulation

of waste, while economic growth is positively associated with environmental degradation before the turning point. In contrast, the Pt-IE phase is characterised by a shift towards information-intensive industries and a service-oriented economy, accompanied by stricter environmental regulations and the adoption of cleaner technologies, thereby reducing environmental degradation (Kaika & Zervas, 2013; Stern, 2004). Thus, after the turning point, economic growth becomes negatively associated with environmental degradation.

However, empirical evidence on the EKC hypothesis remains mixed. Several studies have found support for the inverted U-shaped relationship between economic growth and environmental degradation, including studies focusing on the Indian economy (Managi & Jena, 2007; Rasool et al., 2020). At the same time, other studies argue that the EKC relationship may vary depending on model specification and the inclusion of additional variables such as energy consumption, industrial structure, or financial development (Villanthenkodath et al., 2021).

Therefore, while the EKC framework provides an important theoretical basis for analysing the relationship between economic growth and environmental degradation, it may not fully explain environmental outcomes without considering additional macroeconomic factors.

2.1. Financial Development and CO_2 Emission

The relationship between financial development and CO_2 emissions remains theoretically and empirically ambiguous. On the one hand, financial development can facilitate access to finance, mobilise resources, and support technological advancement and environmental investments, thereby potentially reducing environmental degradation (Tamazian& Rao, 2010; Shahbaz et al., 2013). On the other hand, improved access to financial resources can stimulate investment, industrial production, energy consumption, and economic expansion, which may increase CO_2 emissions, particularly when investment is concentrated in energy-intensive sectors (Baloch et al., 2019; Gök, 2020).

Empirical evidence further suggests that the environmental effect of financial development may vary across countries, regions, and levels of financial-sector maturity. Charfeddine and Kahia (2019) found a limited impact of financial development on environmental quality in the MENA region, while Zhao and Yang (2020) reported that improvements in financial development could reduce CO_2 emissions at the Chinese provincial level. In contrast, Dar and Asif (2017)

found that financial development and energy consumption contributed significantly to environmental degradation in India. Rajpurohit and Sharma (2020) further indicated that although moderate levels of financial development may increase carbon emissions, greater financial-sector maturity can eventually facilitate the adoption of environmentally efficient technologies.

Overall, the existing evidence does not establish a uniform relationship between financial development and environmental outcomes. Instead, the direction and magnitude of the relationship appear to depend on the structure of investment, energy use, technological development, and the level of financial-sector maturity. This mixed evidence provides a rationale for examining the role of financial development alongside other macroeconomic factors when analysing CO_2 emissions.

2.2. Inflation and CO_2 Emission

Compared with the extensive literature on economic growth and environmental degradation, relatively limited attention has been devoted to the relationship between inflation and CO_2 emissions. The existing evidence is mixed, with studies reporting negative, positive, and statistically insignificant relationships. Jamel and Maktouf (2017) examined the relationship among inflation, economic growth, and environmental pollution and found that inflation negatively affected economic development, while the direct relationship between inflation and CO_2 emissions was not statistically significant. Similarly, Koçak et al. (2019) reported a negative relationship between inflation and CO_2 emissions in highly polluted countries, although the relationship was not statistically significant across other countries. Baloch et al. (2020) also found an insignificant relationship between inflation and CO_2 emissions in their analysis of Sub-Saharan African countries.

In contrast, evidence from more recent studies points towards a positive association between inflation and environmental degradation. Rahman et al. (2022) found that inflation positively affected CO_2 emissions in Pakistan when incorporated into an agricultural model. Zheng et al. (2024) further showed that inflation and industrial expansion can increase carbon emissions through higher production activity and energy consumption, while Hondroyiannis et al. (2025) identified a significant positive association between inflation and carbon emissions in high-income countries. These contrasting findings indicate that the environmental consequences of inflation may depend on the underlying

economic structure, production activity, energy use, and country-specific conditions.

Therefore, although the inflation-CO_2 emissions nexus remains relatively under explored, the emerging literature suggests that inflation may constitute an important macroeconomic factor influencing environmental outcomes. This provides a basis for incorporating inflation into the EKC framework alongside economic growth and financial development, particularly in the context of a developing economy such as India.

Despite the extensive literature examining the relationship between economic growth and environmental degradation within the EKC framework, limited empirical attention has been paid to the role of macroeconomic factors, such as inflation and financial development, in shaping environmental outcomes. Consequently, the interplay among economic growth, financial development, inflation, and carbon emissions remains under explored, particularly in developing economies such as India.

3. Objective and Methodology

In India, it was found that the relationship of output growth and CEs was done extensively but none of the work included the impact of inflation and Fin. Dev. in the pre-described relationship.The paper included data from the period 1971 to 2021 (annual data). The data was extracted from WDI – World Bank and Our World in Data. The variables included in the analysis are listed in Table 1 along with their descriptions.

Table 1: Variable Names and Descriptions

Variables	Description (According to WDI)	Unit of account	Source
CO2 emissions Growth Rate	"Carbon dioxide emissions are those stemming from the burning of fossil fuels and the manufacture of cement. They include carbon dioxide produced during consumption of solid, liquid, and gas fuels and gas flaring."Data were converted to growth rates to express as %age.	Metric Tons. Converted into growth rate (in %).	Our World in Data
GDP – Growth Rate	"GDP at purchaser's prices is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products. It is calculated without making deductions for depreciation of fabricated assets or for depletion and degradation of natural resources. Data are in current U.S. dollars. Dollar figures for GDP are converted from domestic currencies using single year official exchange rates. For a few countries where the official exchange rate does not reflect the rate effectively applied to actual foreign exchange transactions, an alternative conversion factor is used." Data were converted to growth rates to express as %age.	Current US$. Converted into growth rate (in %).	World Development Indicators

Consumer Price Index – Inflation Rate	"Consumer price index reflects changes in the cost to the average consumer of acquiring a basket of goods and services that may be fixed or changed at specified intervals, such as yearly. The Laspeyres formula is generally used. Data are period averages." The index was converted into an inflation rate.	Index based on 2010. Converted into inflation rate (in %)	World Development Indicators
Foreign Direct Investment Growth Rate	"Foreign direct investment are the net inflows of investment to acquire a lasting management interest (10 percent or more of voting stock) in an enterprise operating in an economy other than that of the investor. It is the sum of equity capital, reinvestment of earnings, other long-term capital, and short-term capital as shown in the balance of payments. This series shows total net FDI. In BPM6, financial account balances are calculated as the change in assets minus the change in liabilities. Net FDI outflows are assets, and net FDI inflows are liabilities."Data were converted to growth rates to express as %age.	Current US$. Converted into growth rate (in %).	World Development Indicators

Source: *World Development Indicators*

After collecting the required dataset needed for the analysis, the model will be formulated. The model, to be formulated using the mentioned tools, is derived from the Original EKC model, asshown in equation (1). The model formed for this paper is as follows:

$$CO2g_t = \alpha_0 + \beta_1 GDPg_t + \kappa_1 GDPg_t^2 + \gamma_1 CPIi_t + \delta_1 FDIg_t + \mu_t \quad (1)$$

Where:

$CO2g_t$ denotes CEs (taken as a proxy for Envir. Sust.) at time t.

$GDPg_t$ denotes GDP – Growth Rate (taken as a proxy for Output Growth) at time t.

$GDPg_t^2$ is the square of .

denotes Consumer Price Index – Inflation Rate at time t.

denotes FDI– Growth Rate at time t.

GDP growth was integrated into the model, as in Rahman et al. (2022), who examined sectoral growth in key industries in Pakistan. However, for India, a sectoral growth analysis is less applicable due to the country's post-reform diversification across various sectors. FDI is identified as a strong indicator of Fin. Dev. because it has a direct impact on E. Gr. and inflation and can

effectively function as a treatment variable. To ensure robustness and accuracy in the model, only specific variables were selected for consideration.

After the model formulation, the study incorporates certain econometric tools, such as unit root tests, autoregressive techniques, and the like. These tools help analyse the nexus between these variables.

4. Results and Discussion

Table 2 provides summary statistics for the variables included in the model.

Table 2: Descriptive Statistics

Variables	$CO2_t$	$GDPg_t$	$GDPg_t^2$	$CPIi_t$	BM_t
N. Obs.	31	31	31	31	31
Min.	64.75	-15.85	0.06	3.33	42.18
Max.	179.56	29.40	864.60	13.87	87.78
Range	114.81	45.25	864.54	10.54	45.60
Mean	113.35	7.72	138.25	7.27	63.76
Median	98.43	8.42	77.42	6.62	65.55
Sum	3513.84	239.27	4,285.84	225.32	1,976.55
SE Mean	6.83	1.62	34.59	0.57	2.60
Variance	1446.31	81.30	37,085.05	10.04	209.31
St. Dev.	38.03	9.02	192.57	3.17	14.47
Skewness	0.42	0.01	2.41	0.49	-0.24
Kurtosis	-1.38	1.08	6.67	-0.96	-1.51

Source: Author's Calculation

Since the study incorporates a theoretical model in Section 3, it is necessary to assess the stationarity of all variables included in the model. This paper has applied three unit-root tests. The tests used are the most preferred and widely used methods for time-seriesanalysis.

To examine the stationarity properties of the variables, three unit-root tests were employed: the Augmented Dickey-Fuller (ADF) test (Dickey & Fuller, 1979, 1981), the Phillips-Perron (PP) test (Phillips & Perron, 1988), and the Zivot-Andrews (ZA) test (Zivot & Andrews, 1992). While the ADF and PP tests assess stationarity without explicitly accounting for structural breaks, the ZA test allows for an endogenous structural break in the series (Zivot & Andrews, 1992; Margarido, 2001). The inclusion of the ZA test is particularly relevant because structural changes may affect the results of conventional unit-root tests. The results of the unit-root tests are presented in Table 3.

Table 3: Unit Root Tests

Tests/ Variables		Unit Root Tests		
		ADF Test	PP Test	ZA Test
At Level				
$CO2_t$		-4.226***	-6.976***	-7.933***
$GDPg_t$		-4.332***	-6.578***	-7.952***
$GDPg_t^2$		-5.137***	-6.621***	-8.087***
$CPIi_t$		-5.955***	-5.204***	-7.329***
$FDIg_t$		-6.156***	-8.009***	-8.631***
Null Hypothesis:		Unit root		
Critical Values:	***1%	-4.04	-4.15	-5.57
	**5%	-3.45	-3.50	-5.08
	*10%	-3.15	-3.18	-4.82

Source: Authors' Calculation

As is known, the ZA unit root test is a test which also provides a structural break in the variables, so we have presented the breakpoints of the I(0) data in the Appendix. The unit root test results show that all variables are integrated of order 0 (I (0), which means that OLS estimation may be sufficient to provide insight into this nexus.

Table 4: Ordinary Least Squares Result

Variables	Coefficient
Intercept	4.653 (0.909) ***
$GDPg_t$	0.104 (0.086)
$GDPg_t^2$	-0.003 (0.004)
$CPIi_t$	0.026 (0.092)
$FDIg_t$	0.002 (0.004)
Signification codes: '***' 0.01 '**' 0.05 '*' 0.1	
Multiple R^2	0.048
Adjusted R^2	-0.034
F Statistics (P – Value)	0.585 (0.675)

Source: Author's Calculation
Notes: The parentheses value in the coefficient column shows the standard error.

The estimated value from OLS is not significant. This means the OLS result for model (2) is meaningless. So, the model may require estimation using autoregressive techniques that incorporate the effects of lag values.Therefore, this study uses the Autoregressive Distributed Lag (ARDL) Modelling technique.The ARDL model has notable advantages, particularly in its ability to be applied to models where variables are integrated at different levels or at the same levels, including those that are stationary at level (I(0)) or first differenced (I(1)), without requiring pretesting for unit roots. This flexibility allows for robust estimation in the presence of mixed orders of integration among variables or when all variables are stationary at the same levels.

Table 5 presents the result of the Bound Co-integration test. The result of the cointegration test indicates whether the model has a long-run equilibrium. This means it indicates whether the model exists in the long run.

Table 5: Bound Co-integration Result

Bound Test	Test Statistics		
F	60.143		
Critical Value I (0)	10%	5%	1%
	2.614	3.136	4.306
Critical Value I (1)	10%	5%	1%
	3.746	4.416	5.874
Null Hypothesis:	No Co-integration		

Source: Author's calculation

The results of the Bound test indicate that the model is cointegrated in the long run, confirming the existence of a long-run equilibrium relationship between the variables. In this section, the findings from the long-run model are presented, while the short-run estimates have been moved to the Appendix. This decision was made to highlight the significance of the long-run analysis and to minimise distraction from the short-run results. Table 6 presents the results of the long-run cointegration model.

Table 6: Long-Run Co-integration Result

Variables	Coefficient
Intercept	-0.751 [0.396] *
$GDPg_t$	0.555 [0.221] ***
$GDPg_t^2$	-0.011 [0.009]
$CPIi_t$	0.620 [0.229] ***
$FDIg_t$	0.022 [0.013] *
Signification codes: '***' 0.01 '**' 0.05 '*' 0.1	

Source: Author's calculation
Notes: The parentheses value in the coefficient column shows the standard error.

Both GDP growth and FDI growth are positively related to CEs. Theoretically, GDP growth presents an inherent dilemma for CEs, suggesting that economic development is often accompanied by an increase in CEs, particularly in the early stages of development. This is because, during the initial phase, economies tend to focus on infrastructure expansion and industrialisation, which leads to environmental degradation. Based on this theoretical framework, the long-run model also suggests that India is in the first phase of development, where an increase in E. Gr. significantly reduces the Envir. Sust. This finding is consistent with several studies on developing economies that support the early-stage EKC hypothesis. Furthermore, the insignificance of the squared term in E. Gr. indicates that the second phase of development, in which environmental quality improves, has not yet been observed in India.

Similarly, FDI growth also suggests that with every FDI investment, CEs will increase in India. This may be because a large portion of FDI is directed toward infrastructure and industrial sectors, which are generally energy-intensive and environmentally damaging. This result is in line with studies such as Baloch et al. (2019) and Gök (2020), which find that financial development can increase environmental degradation. However, it differs from studies like Shahbaz et al. (2013), which highlight the potential of financial development to improve environmental quality through technological advancement. From a policy perspective, this implies that the environmental impact of FDI depends on its sectoral allocation and regulatory framework.

The long-run model also shows that the inflation rate is positively related to the CEs, indicating that higher inflation leads to higher CEs. The estimated result suggests that a 1% increase in inflation leads to a 0.62% increase in CEs. This result can be explained by the fact that rising prices may encourage firms to reduce costs associated with environmentally friendly practices and technologies, thereby increasing reliance on more polluting alternatives. This finding is supported by recent studies, including Zheng et al. (2024) and Hondroyiannis et al. (2025), although some studies report mixed or insignificant relationships. From a policy perspective, this suggests that maintaining macroeconomic stability is important not only for economic performance but also for environmental sustainability.

Table 7 presents the diagnostic tests and shows that the model is robust, as there is insufficient evidence to reject the null hypotheses for all tests.

Table 7: Diagnostic Test Result

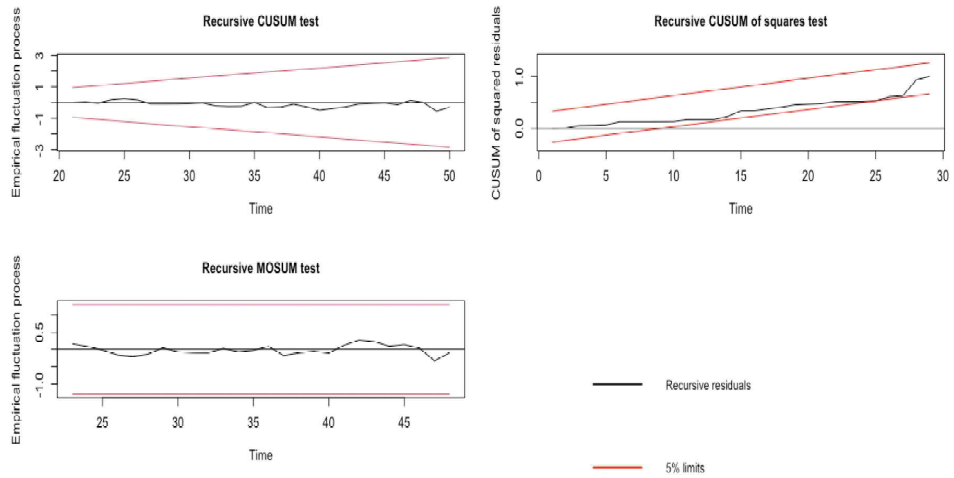
Diagnostic Test	Test Statistics	Diagnostic Test	Test Statistics
Breusch (1978) and Godfrey (1978)	0.128 [0.724]	Breusch and Pagan (1979)	27.27 [0.162]
Shapiro and Wilk (1965)	0.958[0.086]	Ramsey's (1974) RESET	1.138 [0.335]
Null Hypothesis	Model is Robust		

Source: Author's calculation.

Notes: The parentheses value shows the p-value of the tests.

Figure 1 shows the stability graph for the ARDL-estimated model, which indicates that the model is fully stable.

Figure 1: Stability Graph of ARDL Estimation



Source: Authors' compilation

5. Concluding Observations

The findings of this study suggest an ethical dilemma in India, indicating that E. Gr. comes at the expense of Envir. Degr. This dilemma has sparked a longstanding debate over whether the country should prioritise economic development or environmental preservation. The study also identifies a trade-off between Fin. Dev. and Envir. Sust., reinforcing the argument that macroeconomic expansion, if not properly regulated, can intensify environmental pressures. In addition, the study contributes to the literature by

establishing a link between inflation and CEs, an area that has received relatively limited empirical attention.

Unlike most existing studies that primarily focus on the growth-environment nexus within the EKC framework, this study extends the analysis by incorporating inflation and financial development into a unified empirical framework. By doing so, it provides a broader macroeconomic perspective on environmental degradation in the context of a developing economy like India.

From a policy perspective, the findings highlight the need for a more balanced development strategy. In particular, the transition to affordable, accessible renewable energy sources is essential to reducing carbon emissions without compromising economic growth. Strengthening environmental regulations for foreign investment and promoting green financial practices can help mitigate the adverse environmental effects of financial development. Furthermore, maintaining macroeconomic stability, especially controlling inflation, is important as rising inflation may indirectly encourage environmentally unsustainable production practices.

However, the study is subject to certain limitations. First, the analysis is based on aggregate macroeconomic variables, which may not fully capture sector-specific environmental impacts. Second, the use of FDI as a proxy for financial development may not reflect the complete dynamics of the financial system. Third, the study focuses only on India, which may limit the generalisability of the findings to other economies.

Future research can extend this study by incorporating additional variables such as renewable energy consumption, technological innovation, and institutional quality to provide a more comprehensive understanding of environmental sustainability. Moreover, sectoral-level analysis and cross-country comparisons can offer deeper insights into the relationship between macroeconomic factors and environmental outcomes.

Overall, the study suggests that achieving sustainability in India requires a strategic shift toward cleaner energy sources and environmentally responsible economic policies. Such a transition can help India move toward the second phase of development, as suggested by the EKC framework, where economic growth and environmental sustainability can be achieved simultaneously.

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Appendix

Appendix Table 1: Zivot and Andrews Structural Breaks

Variables	Intercept	Trend	Both
$CO2g_t$	2008	2019	2019
$GDPg_t$	2011	2007	2002
$GDPg_t^2$	2002	2007	2002
$CPIi_t$	2007	2000	2007
$FDIg_t$	2011	2007	2005

Source: Author's calculation

Appendix Table 2: Error-Correction ARDL Model Result

Variables	Coefficient
$Ect(CO2g_t)(-1)$	-0.751*** [0.141]
$d(GDPg_t)$	0.209*** [0.072]
$d(GDPg_t)(-1)$	-0.402*** [0.117]
$d(GDPg_t)(-2)$	-0.236*** [0.089]
$d(GDPg_t^2)$	0.002 [0.003]
$d(GDPg_t^2)(-1)$	0.017*** [0.005]
$d(GDPg_t^2)(-2)$	0.014*** [0.004]
$d(CPIi_t)$	0.149 [0.099]
$d(CPIi_t)(-1)$	-0.404*** [0.109]
$d(CPIi_t)(-2)$	-0.158 [0.102]
$d(FDIg_t)$	0.002 [0.004]
$d(FDIg_t)(-1)$	-0.015*** [0.005]
$d(FDIg_t)(-2)$	-0.007* [0.004]
$d(FDIg_t)(-3)$	-0.009*** [0.003]
$d(CO2g_t)(-1)$	-0.469*** [0.152]
$d(CO2g_t)(-2)$	-0.447** [0.187]
$d(CO2g_t)(-3)$	-0.203 [0.175]
Intercept	-4.830*** [0.973]
Signification codes: '***' 0.01 '**' 0.05 '*' 0.1	
Multiple R^2	0.794
Adjusted R^2	0.674

Source: Author's calculation.
Notes: The parentheses value in the coefficient column show the standard error.

Article

Impact of Early Marriage on Total Fertility Rate in India

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Abstract

This study examines the influence of early marriage on total fertility rate (TFR) using data from the National Family Health Survey 5 (NFHS-5) to investigate the association between TFR and early marriage among married women in India. More than 60,000 ever-married women aged 15 to 30 were employed in the study. The findings show that women in early marriage have a higher prevalence of TFR compared to women in adult marriage across all states in India. In some age cohorts, women who were married young have greater age-specific fertility rates (ASFR) than women who were married as adults. The mean age at childbearing is lower for those who marry early and demographic characteristics such as poor household wealth, illiteracy, no contraceptive use, working status, and caste influence TFR among women married at an early age. The analysis using multiple linear regression models demonstrates a positive association between early marriage and TFR in India after controlling for socio-economic variables. Additionally, the regional analysis shows variations across states such as Bihar, West Bengal, and Telangana concerning the association between early marriage and TFR.

Keywords: Early marriage**,** Total Fertility Rate, Probit model, NFHS-5.

Introduction

India is the world's most populous country and is experiencing significant social, economic, and demographic changes (IMF, 2023; Lee & Mason, 2010). Although the country has made remarkable progress in education, healthcare, women's empowerment, and economic development, early marriage among women remains an important challenge (Vijaya & Balu, 2023). Early marriage affects not only the lives of women and children but also influences fertility

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levels, population growth, maternal and child health, and overall socio-economic development (Singh et al., 2021; IIPS and ICF, 2017). According to the National Family Health Survey (NFHS-5, 2019–21), about 23.3 per cent of women aged 20–24 years were married before the legal age of 18. At the same time, India's TFR has declined to 2.0 children per woman, which is below the replacement level of 2.1. However, considerable differences exist across states. States such as Bihar, Jharkhand, Rajasthan, Uttar Pradesh, Madhya Pradesh, and West Bengal continue to report relatively high levels of early marriage and fertility. These regional differences suggest that early marriage may still play an important role in shaping fertility behaviour in India (UNICEF, 2023; Singh et al., 2021). Previous studies have consistently shown that women who marry at younger ages are more likely to begin childbearing earlier and have more children during their reproductive years (Rajaretnam, 2016; Yang & Gu, 1991; Raj et al., 2010). Early marriage often limits educational attainment, employment opportunities, decision-making power, and access to reproductive healthcare. As a result, women who marry early are more likely to experience higher fertility, poor maternal health outcomes, and economic disadvantages (Lee & Mason, 2010; Vijaya & Balu, 2023). Recent research also indicates that delayed marriage contributes to lower fertility rates, improved family well-being, and greater opportunities for women's social and economic participation.

Recognising these challenges, the Government of India has introduced several policies and programmes to reduce early marriage and improve the status of women. The Prohibition of Child Marriage Act (PCMA), 2006, legally prohibits marriage below the age of 18 years for girls and 21 years for boys (Chakravarty, 2021; Modak, 2019). National initiatives such as Beti Bachao Beti Padhao (BBBP), the National Health Mission (NHM), Rashtriya Kishor Swasthya Karyakram (RKSK), Poshan Abhiyaan, and various scholarship schemes for girls aim to increase school participation, improve adolescent health, delay marriage, and promote gender equality (Chakravarty, 2021; Yoosefi et al., 2023; Götmark & Andersson, 2020). In recent years, policy discussions have also focused on raising the legal age of marriage for women to further improve educational attainment, reproductive health, and women's empowerment (Wells et al., 2022; Parsons et al., 2015; Onagoruwa & Wodon, 2017; Kumar & Kumar, 2021). Recent evidence suggests that marriages below the age of 15 have declined substantially in India. However, marriage among girls aged 15–17 years continues to occur in many parts of the country (Modak, 2019). Therefore, many contemporary studies use the term "early marriage" rather than "child

marriage" when examining marriages that occur before the legal age but mainly within the 15–17 age group (Onagoruwa & Wodon, 2017). Following this approach, the present study uses the term early marriage to analyse its relationship with fertility outcomes among women in India. Despite the growing literature on marriage and fertility, an important research gap remains. Most previous studies have focused either on the prevalence of child marriage or on fertility trends separately. Limited research has examined the specific impact of early marriage on TFR in contemporary India using recent nationally representative data. Furthermore, few studies have compared fertility differences between women who married early and those who married as adults while considering demographic and socio-economic factors and regional variations across states.

This study seeks to fill this gap by examining the relationship between early marriage and fertility among ever-married women aged 15–30 years in India using NFHS data. It also explores how demographic characteristics and state-level differences influence this relationship. The study is highly relevant from a policy perspective because reducing early marriage can contribute to lower fertility, improved maternal and child health, higher educational attainment, greater gender equality, and sustainable economic development. The findings may help policymakers strengthen existing programmes and design more effective, evidence-based interventions to delay marriage, improve reproductive health, and support India's long-term demographic and development goals.

Objectives

This study follows some objectives:

1. To examine the relationship between marital status (early marriage and adult marriage), demographic characteristics, and TFR among married women aged 15–30 years in India.
2. To investigate whether regional variations influence the relationship between marital status and TFR by comparing selected states in India.
3. To provide policy recommendations for reducing high fertility associated with early marriage and improving the reproductive health and socio-economic status of women in India.

Data

The National Family Health Survey (NFHS), a nationally representative survey that provides vital insights into a range of TFR-related topics in India, was

carried out by the Ministry of Health and Family Welfare in partnership with the International Institute for Population Sciences (IIPS) for this analysis. The data used are from the fifth round of the NFHS survey conducted in 2019-2021. The dataset utilised in this analysis includes information on 63,851 ever-married women aged 15-30 years in India. This paper selects the 15-30 age group because women's fertility rate declines after age 30. A thorough analysis of TFR between women who married young and those who married later in life is made possible by this cross-sectional dataset, which uses NFHS-5 individual recoded data. The purpose of this research is to provide insights into how early marriage affects TFR in India.

Methodology

A) Multivariate Analyses of Fertility: To estimate the impact of early marriage on TFR in India. This paper uses a multiple linear regression model. The dependent variable (M) represents TFR. In the first model, the Ordinary Least Squares (OLS) method has been applied to a regression analysis to examine the impact of early marriage on LFP in India. The first model can be written as

$$M_{i1}=\theta_0+\theta_{1i1}X_{1i1}+\epsilon_1 \ldots\ldots(1)$$

In this model, Mi1 represents the i-th individual, and the subscript 1 denotes the total fertility rate. It is an outcome variable. Moreover, θ_0 is the intercept term, and θ_1 is the coefficientof the explanatory variable, respectively. Here, the regressor variable, say, early marriage, which is constructed as a binary variable, i.e.,married before 18 years (X_1) and married after 18 years, is the reference category. Here, ε1 is the error term.

In the second model, some demographic variables are added to the first model, which is a controlled variable. Below represents the equation:

$$M_{i1}=\theta_0+\theta_{1i1}X_{1i1}+\theta_{2i1}X_{2i1}+\theta_{3i1}X_{3i1}+\theta_{4i1}X_{4i1}+\theta_{5i1}X_{5i1}+\theta_{6i1}X_{6i1}+\theta_{7i1}$$
$$X_{7i1}+\theta_{8i1}X_{8i1}+\theta_{9i1}X_{9i1}+\theta_{10i1}X_{10i1}+\theta_{11i1}X_{11i1}+\theta_{12i1}X_{12i1}+\epsilon_2 \ldots\ldots(2)$$

In this model, θ_0 is the intercept term and θ_1, θ_2, ... $\theta_{12}$are the coefficients of explanatory variables, respectively. Here, control variables are women year of schooling (θX_2), experience physical violence (θX_3), antenatal care (θX_4), currently working (θX_5), Under weight (θX_6), modern contraceptive uses (θX_7), belong to nuclear family (θX_8), spousal age gap (θX_9), marriage duration (θX_{10}), household wealth (θX_{11}) and family planning on TV (θX_{12}). Here, θ_2 is the error term (see Appendix A**).**

The study uses data from NFHS-4 (2015-16) and NFHS-5 (2019–21). The NFHS provides comprehensive information on fertility, marriage, family planning, maternal and child health, nutrition, and socio-economic conditions. For this study, only ever-married women aged 15–30 years were selected from the women's dataset. Variables related to fertility, age at marriage, education, household characteristics, contraceptive use, and health indicators were extracted and re-coded to align with the study's objectives. Missing observations and inconsistent responses were excluded from the final analysis to improve data quality. The NFHS is one of the most reliable demographic and health surveys in India. It follows internationally accepted survey procedures and uses a large sample size covering all states and union territories. Data collection is carried out through standardised questionnaires, trained field investigators, and rigorous quality-control measures. Therefore, NFHS data are widely used by researchers, policymakers, and international organisations for demographic and public health research. Despite its strengths, the NFHS data have some limitations. First, the survey is cross-sectional; therefore, it identifies associations rather than direct causal relationships.

Second, information such as age at marriage, age at first birth, and fertility history is based on respondents' self-reports and may be affected by recall bias. Third, some important cultural and social factors influencing fertility, such as family pressure, gender norms, and personal attitudes toward childbearing, are not fully captured in the survey. Finally, because the analysis focuses only on women aged 15–30 years, the findings may not represent fertility behaviour among older women.

Outcome Variable: According to Dharmalingam et al. (2014), the TFR is a crucial metric for assessing population growth in India. If a woman reaches her childbearing age of 15 to 30 years, her TFR is the average number of children she would have over her reproductive life (Cheng et al., 2022; Ghaem et al., 2019; ESCAP, 2000; Nargund, 2009). Only the 15–30 age range is covered in this investigation. TFR is computed by summing all age-specific fertility rates (ASFRs), dividing by 1,000, and then multiplying the result by 5, which is the breadth of the age-group gap (Raftery & Ševèíková, 2023; ESCAP, 2000). More precisely, TFR = (Sum of ASFR x 5) / 1,000.

Regressor Variables: The age at marriage of women does not give us enough information to compute our conclusions, the age at cohabitation[1] variable was used in this study as a proxy for women's age at marriage (IIPS & ICF, 2017;

Crawford et al., 2011; Perelli-Harris et al., 2019; Guzzo, 2019; Favara et al., 2016). The regressor variable is women in early marriage, a binary variable (i.e., married before 18 years and married after 18 years), with married after 18 years as the reference category.

Control Variables: This paper uses control variables to capture the effect of early marriage on TFR in India. Here, control variables can be classified into three categories: individual, partner, and household-specific variables. The individual-specific variables include women's level of education, physical violence, antenatal care, modern contraceptive usage, employment, and family planning heard on TV. The partner-specific variable includes the spousal age gap. The household-specific variables include nuclear-family status and household wealth. This paper provides some literature support for mentioning control variables in our analysis. Here, women with more years of schooling are negatively associated with the number of living children due to the higher occupational aspirations of married women (Jungho, 2016; Chen, 2022). In addition, women's health is considered to be the main determinant of fertility choices. Being underweight is negatively associated with the fertility choices of married women (Sharma et al., 2015; Samad et al., 2022). Moreover, women's working conditions play a vital role in determining the fertility choices of married women. Women with a higher working status are less likely to prefer fertility choices (Upadhyay et al., 2014; Samad et al., 2022). In addition, women with antenatal care (Samad et al., 2022), who use modern contraceptive methods (Dadi et al., 2020; Dommaraju, 2010), and hear family planning onTV or radio (Debayan et al., 2022; Pandey & Singh, 2018) have been negatively associated with the TFR of married women (Lasong et al., 2020; Westoff et al., 2011). Moreover, household characteristics, such as household structure and wealth, are considered the main determinants of the TFR among married women. Women from joint families and those with low household wealth are positively associated with the TFR of married women (Upadhyay et al., 2014). Finally, a higher spousal age gap indicates lower status for married women in the household, which is positively associated with the number of living children of married women (David et al., 2021).

Results

The purpose of the study is to analyse the demographic and socioeconomic characteristics of Indian women, with particular emphasis on variations in TFR

[1]Age at cohabitation is determined by the age when women began living with their spouse.

between those who married young and those who married later in life. Household wealth level, caste, religion, and location of living are important factors taken into account. The descriptive statistics demonstrates variations in TFR among these two groups of women. By exploring these socio-economic and demographic factors, the study seeks to understand their influence on the TFR of early-married women in India compared with that of adult-married women. This section will provide a comprehensive analysis of how these variables affect TFR within each group, shedding light on key nuances that may contribute to differing fertility patterns among women in different marital circumstances in the Indian context.

Table 1: Prevalence of TFR across Indian States

State	TFR	TFR for Adult marriage	TFR for early marriage	Women between the ages of 15 and 30 who were married before turning 18 years (%)
A & N Islands -	0.54	0.4	2.29	10.79
Andhra Pradesh	1.01	0.89	2.36	25.38
Assam	0.98	0.69	1.88	24.66
Bihar	**1.69**	**1.24**	**2.78**	**31.94**
Goa	0.37	0.26	2.51	5.07
Gujarat	0.9	0.66	2.26	18.27
Himachal Pradesh	0.7	0.6	2.55	7.09
Jammu & Kashmir	0.29	0.24	2.29	5.96
Karnataka	0.94	0.75	2.07	17.65
Kerala	0.68	0.64	1.83	4.91
Lakshadweep	0.27	0.26	0.71	1.44
Maharashtra	0.97	0.71	2.25	19.02
Meghalaya	0.97	0.67	2.72	11.55
Manipur	0.74	0.5	2.2	10.61
Mizoram	0.56	0.44	2.29	8.02
Nagaland	0.51	0.39	2.81	9.25
Sikkim	0.33	0.23	1.5	8.67
Telangana	**1.2**	**0.92**	**2.44**	**21.87**
Tripura	1.1	0.82	1.68	27.06
West Bengal	**1.21**	**0.76**	**1.81**	**32.61**
Uttar Pradesh	0.93	0.75	2.46	11.64
Uttarakhand	0.77	0.67	2.24	8.49
Odisha	0.89	0.7	1.94	15.16

Rajasthan	1.01	0.81	2.19	19.71
Delhi	0.59	0.45	2.2	7.8
Tamil Nadu	0.85	0.7	2.22	11.15
Puduchcrry	0.49	0.38	2.56	9.05
Punjab	0.62	0.51	2.1	5.64
Haryana	0.93	0.79	2.37	12.4
Arunachal Pradesh	0.7	0.51	1.91	19.89
Chhattisgarh	0.83	0.7	2.43	12.07
Chandigarh	0.5	0.36	2.76	7.33
Jharkhand	1.07	0.96	2.45	22.71
Madhya Pradesh	1.11	0.88	2.43	20
All India Average	0.79	0.61	2.21	16.36

Source: Calculated by the author using NFHS-5 data. All are in point value

Table 1 indicates that the TFR is highest in Bihar (1.69 points), followed by West Bengal (1.21 points) and Telangana (1.20 points). It suggests that across all states in India, women in early marriage have a higher prevalence of TFR compared to women in adult marriage. It provides important insights into fertility patterns and demographic trends across states.

Table 2: Age-Specific Fertility Rates and Total Fertility Rate of Ever-married Women Aged 15–30, Who Were Married at an Early Age as Compared to Adults in India

Age-specific fertility rate	Total	Adult marriage	Early marriage
15-19	0.058	0.015	0.234
20-24	0.164	0.153	0.189
25-29	0.108	0.131	0.067
Total Fertility Rate	1.943	1.911	2.588
Number of women's	337924	236462	101462

Source: Calculated by the author using NFHS-5 data. All are in point value.

Table 2 presents the ASFR and TFR of ever-married women aged 15–30 who were married at an earlier age than adults in Indi

a. In addition,early marriage has been associated with higher ASFR in the 15–19 age group (0.234 vs 0.015 points) and the 20–24 age group (0.189 vs 0.153 points) than adult marriage. This implies that in these particular age groups, early marriage is linked to increased fertility rates. The results offer important

insights into India's demographic dynamics by illuminating the potential effects of early marriage on fertility trends across age groups.

Table 3: Relationship between Mean Age at Childbearing(MAC) and Ever Married Women Aged 15-30, Who Were Married at an Early Age as Compared to Adults in India

	NFHS-4		NFHS-5	
	Adult marriage	Early marriage	Adult marriage	Early marriage
Mean age at childbearing	20.35	18.62	22.01	19.68
Number of cases (women)	205772	40560	87832	17993

Source: Calculated by the author using NFHS- 4 & 5 data. All are in point values.

Table 3 represents the relationship between the mean age at childbearing.[1] (MAC) Moreover, ever-married women aged 15–30 who were married at an earlier age than adults in India. The findings reveal that women who married as adults have a higher mean age at childbearing than those who married early (20.35 years vs 18.62 years in NFHS-4 and 22.01 years vs 19.68 years in NFHS-5) in India. Notably, the mean age at childbearing increased from NFHS-4 to NFHS-5 for both categories of women, indicating an improvement in the age at marriage in India. These insights provide valuable information about trends in early marriage and their potential impact on fertility rates and maternal health.

Table 4: Prevalence of Total Fertility Rates of Ever-married Women Aged 15–30, Who Were Married at an Early Age Compared to Adults by Demographic Characteristics in India

Demographic characteristics	Adult marriage	Early marriage
Women education		
illiterate	1.50	2.64
Primary	1.33	2.33
Secondary	1.01	2.16
Higher	0.36	1.89
Wealth Quintile		
Poor	0.97	2.21
Middle	0.87	2.19
Richer	0.70	2.16
Contraceptive Use		
No method	0.87	3.15
Traditional Method	2.12	2.63

[2.]Mean age at childbirth (MAC) is calculated by dividing the total age-specific fertility rates by the weighted midpoint of each age group (Powers and Xie,2000).

Modern Method	2.08	2.49
Employment		
Working	0.62	1.85
Not working	0.89	2.26
Residence		
Urban	0.57	2.18
Rural	0.94	2.27
Religion		
Hindu	0.80	2.24
Muslim & others	0.88	2.27
Caste		
Schedule caste	0.84	2.28
Schedule tribe	0.83	2.23
Other backward classes	0.86	2.37
Others	0.64	2.12

Source: Calculated by the author using NFHS-5 data. All are in point value.

Table 4 presents TFRs for ever-married women aged 15–30 who married early and those who married as adults, across various demographic characteristics in India. The study acknowledges that demographic characteristics are influential variables in determining TFR in India. The findings reveal that across all demographic characteristics examined, the TFR of women in early marriage exceeds that of women in adult marriage. Among poor households, the TFR for early-married women is notably higher than that for adult-married women (2.21 vs 0.97). Illiterate women who married early also exhibit a higher prevalence of TFR compared to their counterparts who married as adults (2.64 points vs 1.50 points). Moreover, early-married women show a greater prevalence of TFR when they do not use contraceptives compared to adult-married women (3.15 points vs 0.87 points). In addition, early-married working women have a higher TFR prevalence than those who marry as adults (1.85 points vs 0.62 points). Scheduled Tribe category members also show a similar pattern, with a greater prevalence among early-married individuals than among those marrying as adults (2.23 points vs 0.83 points). Consequently, it can be inferred that across various demographic characteristics in India's context, women who marry at an early age have a higher total fertility rate than their counterparts who marry at an adult age. This analysis provides valuable insights into the socio-economic and demographic influences on fertility outcomes across different marital circumstances among Indian women aged 15-30 years.

Table 5: Association Between Women in Early Marriage and Total Fertility Rate in India

Dependent variables:	1st Model		2nd Model	
Total Fertility Rate	Coef.	SE	Coef.	SE
Early marriage	0.260***	0.005	0.140***	0.022
Year of schooling			0.018***	0.003
Experience physical violence			0.083***	0.02
Women's antenatal care			-0.084***	0.019
Currently working			0.175***	0.028
Underweight			.128***	0.02
Modern contraceptive use			0.015	0.022
Nuclear family			0.056**	0.02
Spousal age gap			0.043	0.031
Marriage duration			0.025	0.022
Household wealth			-0.131***	0.009
Heard family planning on TV			0.133***	0.021
_Cons	20.025***	0.002	13.157***	0.069
Observation	241,178		16,235	

Source: Calculated by the author using NFHS-5.

Notes: *, **, *** refer to 10%, 5%, and 1% levels of significance, respectively, for regression control for women's year of schooling, experience physical violence, women's antenatal care, currently working, women underweight, using modern contraceptives, belongs to nuclear family, spousal age gap, marriage duration, household wealth and heard family planning on TV. All are in point value.

Table 5 illustrates the relationship between early marriage among women and India's TFR using multiple linear regression models. This study utilises married women aged 15 to 30. In the first model, women in early marriage show a 0.260-point increase in TFR in India. As a result, early marriage is positively associated with TFR in India. In the second model, women's socio-economic variables are added alongside early marriage to show its impact on TFR in India. After controlling for socio-economic variables, it has been observed that women who marry early show a 0.140-point increase in TFR. This result shows a positive relationship between early marriage among women and the TFR in India, after controlling for women's demographic characteristics. More specifically, our results suggest that women who are early married would increase the probability of a total fertility rate by 14 per cent in India. Here, the estimated coefficient is statistically significant at the 1 per cent level. In this model, there

is no multicollinearity. To analyse the possible effect of women in early marriage on TFR, after controlling for demographic variables, this paper accepts the null hypothesis, that is, the above-mentioned hypothesis is valid, and rejects the alternative hypothesis. One of the reasons, in our patriarchal society, is that large numbers of families want more children and sons' preferences (Nasrullah et al., 2013; Kumar & Rohtak, 2018; ICRW, 2006; Le & Nguyen, 2022). The groom's family pressures young brides to prove their fertility as early as possible after marriage (Nayan, 2015; Dixit et al., 2021; UNICEF, 2018). Moreover, young brides are often faced with sexual harassment. They are forced to have multiple children at very short birth intervals (Wodon et al., 2017; Parsons et al., 2015; Abera et al., 2020). Therefore, this analysis suggests that women entering early marriage have increased India's TFR.

Table 6: Association Between Women in Early Marriage and Total Fertility Rate among Three Indian States

Dependent variable: Total Fertility Rate	Bihar		West Bengal		Telangana	
		Robust		Robust		Robust
	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.
Early marriage	0.059	0.005	0.023*	0.019	0.016	0.015
Year of schooling	-0.293***	0.017	-0.024**	0.02	-0.001*	0.002
Physical violence	-0.295	0.208	-0.005	0.002	0.011	0.01
Women's antenatal care	0.546***	0.02	-0.008*	0.011	-0.014*	0.002
Currently working	0.152**	0.067	0.005***	0.002	0.026	0.011
Underweight	0.098**	0.032	-0.003	0.009	-0.005*	0.002
Modern contraceptive use	-0.192*	0.097	-0.003	0.002	0.006	0.012
Nuclear family	-0.208***	0.026	0.002	0.002	-0.003	0.002
Spousal age gap	-0.008	0.023	-0.001	0.002	0.001**	0.002
Marriage duration	0.313***	0.065	0.004***	0.003	0.001	0.003
Household wealth	-0.007	0.026	-0.005**	0.002	-0.003*	0.003
Heard family planning TV	0.048**	0.017	0.001	0.001	0.002	0.001
_Cons	-0.048**	0.026	0.012**	0.002	0.013*	0.002
Observation	3,609		1,902		2,475	

Source and Notes: Same as in Table 5.

Table 6 highlights the association between early marriage and TFR among three states in India: Bihar, WB and Telangana. Three states are chosen based on regression results in the previous table, which show that early marriage among women is positively associated with TFR in India. This finding seeks to determine whether it is applicable. This paper chooses three states: Bihar, WB,

and Telangana. In Bihar, a high percentage of early marriage and high rates of TFR are found, but in West Bengal, a higher percentage of early marriage and a lower rate of TFR are found. Now, for Telangana, find a lower early marriage rate and a higher TFR. For those reasons, this paper chooses three states. The analysis indicates a positive association between early marriage and TFR in West Bengal. This means that in West Bengal, high levels of early marriage are associated with higher total fertility rates. One of thereasons is that women who were married at an early age have higher chances than those married at an adult age to report early fertility due to a lack of use of modern contraceptive methods. They have less incentive to use modern contraceptive methods, especially in rural areas, which is directly related to TFR (Raj et al., 2009; Fan & Koski, 2022). On the other hand, for states like Bihar and Telangana, no association was found between early marriage and TFR. This suggests that high TFR in these states may be influenced by other significant factors unrelated to early marriage. Further research or analysis may be necessary to identify these additional influential factors contributing to high TFR in Bihar and Telangana.

Discussion

The present study examines the relationship between early marriage and TFR among ever-married women aged 15–30 years in India. The findings show that women who marry before the age of 18 years have higher fertility levels than women who marry as adults. This pattern is found across different states, age groups, and socio-economic backgrounds, indicating that age at marriage is an important factor affecting fertility behaviour. The study reveals that Bihar has the highest TFR among early-married women, followed by West Bengal and Telangana. Women who marry early generally start childbearing at a younger age and remain in the reproductive period for a longer time. Therefore, they are more likely to have more children than women who marry later. The ASFR analysis also shows that fertility is highest among women aged 15–19 and 20–24 who married early, highlighting the strong link between early marriage and early childbearing. The findings further show that women who marry as adults have a higher MAC than women who marry early. The increase in MAC from NFHS-4 to NFHS-5 suggests that Indian women are gradually delaying marriage and motherhood. This change may be due to improved educational opportunities, increased women's participation in the workforce, urbanisation, and greater awareness of reproductive health. The socio-economic analysis

indicates that fertility is particularly high among poor, illiterate, and socially disadvantaged women who marry early. Women who do not use contraceptives also show higher fertility levels. These findings suggest that education, economic status, and access to family planning services play an important role in reducing fertility. The results should be viewed in the context of recent fertility trends in India. According to NFHS-5, India's TFR has declined to around 2.0 children per woman, which is below the replacement level of 2.1. This decline reflects improvements in female education, contraceptive use, healthcare services, and delayed marriage. However, regional differences still exist, with states such as Bihar continuing to report relatively high fertility levels. Recent government initiatives such as the National Health Mission, Rashtriya Kishor Swasthya Karyakram (RKSK), Beti Bachao Beti Padhao, and programmes promoting girls' education and family planning aim to reduce child marriage and improve reproductive health. These policies can help lower fertility rates by encouraging girls to remain in school and delay marriage. The findings are also relevant to current demographic debates in India. While population growth was once the main concern, discussions now focus more on women's empowerment, reproductive rights, gender equality, and population ageing. The study supports the view that fertility decline can be achieved through education, healthcare, and social development rather than through strict population-control measures. Overall, the study suggests that early marriage remains an important factor contributing to higher fertility in India. Delaying marriage, improving girls' education, expanding family planning services, and strengthening women's empowerment programmes can help reduce fertility levels and improve the health and well-being of women and children across the country.

Conclusion

This study examined the relationship between early marriage and TFR among ever-married women aged 15–30 years in India, using data from NFHS-4 and NFHS-5. The findings show that women who marry before the age of 18 generally have higher fertility levels than women who marry at adult ages. Early-married women tend to begin childbearing earlier, have higher ASFR, and experience a lower mean age at childbearing. As a result, they remain exposed to childbearing for a longer period and are more likely to have more children. The study also found important regional differences. A significant positive relationship between early marriage and TFR was observed in West Bengal. In contrast, no significant association was found in Bihar and Telangana

after controlling for demographic and socio-economic factors. This suggests that fertility behaviour is influenced not only by age at marriage but also by education, household wealth, contraceptive use, access to healthcare, and social and cultural factors. Therefore, policies aimed at reducing fertility should consider state-specific conditions and needs. The findings highlight the importance of education, family planning, and women's empowerment in reducing fertility levels. Women with better education and greater access to reproductive health services are more likely to delay marriage and childbirth, resulting in lower fertility. The results are particularly important in the context of recent demographic changes in India. Although India's TFR has declined to around replacement level according to NFHS-5, early marriage remains a challenge in several regions and continues to contribute to higher fertility among young women. The study supports current government efforts such as Beti Bachao Beti Padhao, the National Health Mission, RKSK, and the Prohibition of Child Marriage Act, 2006. Strengthening the implementation of these programmes, improving girls' education, expanding family planning services, and increasing awareness about the harmful effects of child marriage can help further reduce fertility and improve maternal and child health. Overall, the study concludes that reducing early marriage is important for achieving sustainable population growth, promoting gender equality, and improving the social and economic well-being of women in India. Future research should focus on state-specific factors affecting fertility to develop more effective, evidence-based policies.

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Article

Institutional Delivery in India: Has the Mindset Changed?

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Abstract

Union and state governments in India have implemented numerous programs to promote safe- institutional deliveries through cash incentives, offering transport facility, and provide insurance coverage. Using data from the last five rounds of the National Family Health Survey (NFHS), this paper examines temporal trends and state-level disparities in institutional delivery rates. Additionally, it categorizes mothers, with at least two children, into progressive, regressive, static, or indeterminate based on their place of delivery. Findings reveal that mothers are still found to be indetermined and regressive in their choice of institutions. In other words, given all facilities, mothers are often transitioning from well-equipped medical facilities to less adequate birthing environments.

Keywords: Institutional Delivery, 'Maternal Mortality$_2$ new borne health

Introduction

Maternal mortality and newborn health have been challenging to mitigate around the globe. Maternal and new-born mortalitiesare perceived as manifestations of a weak service delivery system and a lack of awareness among the women. Worldwide, moves have been initiated to bring improvements in institutional delivery to ensure low maternal and new-born mortality rates. Realizing the concern at hand, reduction of maternal (Goal- 4) and child mortality (Goal-5) were put in place in the *Millenium Development Goals*[1] to address this issue in priority. Established empirical evidence suggests a negative relationship between 'institutional delivery' and 'maternal mortality & new-born complications' (Joe and *et al*, 2018). It is also well accepted that

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[1]The issue and possible solutions were well recognized at international academic and civil society forums and placed in the SDG target i.e. "By 2030, reduce the global maternal mortality ratio (MMR) to less than 70 per 100 000 live births and the neo-natal deaths to 12 per 1000 live births" (3.1).

improvement in maternal & new-born mortality is possible through ensuring higher proportion of 'institutional delivery'.

Despite understanding and effort, improvements have not been realized in both maternal and new-born mortalities around the Globe [1].India recorded 24,700 number of maternal deaths in 2023, translating to a Maternal Mortality Ratio (MMR) of 116 per one lakh life births[2]. A majority of preventable maternal deaths (about 94%) occur in resource-constrained institutions in Low- & Middle-Income Countries (LMICs) (Saha et al, 2021). Elsewhere, it is also mentioned that improving facility-based delivery has been recommended as the most cost-effective way to reduce maternal and child mortality. Both Union and State Governments in India have been working in the direction of ensuring improved and free medical facilities for 'safe delivery care' though a wide chain of existing government medical institutions, along with partial financial support to make use of the existing facilities of local private medical institutions. With this background, using the NFHS unit level data, this paper will examine the (i) progress registered in institutional delivery in last three decades, (ii) shift in preferences of eligible mothers from public to private medical institutions for a safe delivery, and (iii) patterns of use of medical institutions for delivery by mothers during their last few deliveries.

Methods and Data Sources

This paper uses secondary data from last five rounds of NFHS conducted in more or less every five years with the last rounds released in 2019-21[3]. The NFHS is a nationally representative cross-sectional survey and designed to produce estimates at the national and state levels in India. It mainly collects information relating to demographic, health & nutrition issues. The data is owned by the Ministry of Health and Family Welfare (MoHFW), collected with the expert guidance of the International Institute of Population Sciences (IIPS), Mumbai. The NFHS Survey follows stratified two-stage sampling design

[1]Around 260,000 women's deaths reported throughout the globe during and following pregnancy and childbirth in 2023 (Maternal mortality).

[2] The world saw a total of 2.4 lakh maternal deaths in 2023, which equates to a Global Maternal Mortality Ratio of 190.5 maternal deaths per one lakh live births.

[3]It may be noted that the National Family Health Survey–6 (2023–24) has been released recently. However, access to the unit-level records is expected to take a few more days.

in rural areas and three stage sample design in urban areas. The NFHS-5 (2019-21) survey selected 664972 households (interviewed 636699) and 747176 eligible women (interviewed 724,115) aged 15-49 years with response rate of 98 per cent and 97 per cent respectively. In addition to the NFHS-5 (2019-21) data, NFHS-4 (2015-16)[1], NFHS-3 (2005-06), NFHS-2 (1998-99) and NFHS-1 (1992-93) were also considered to estimate the number of institutional and non-institutional deliveries during the period of each respective study. The analysis is based on sample women who delivered more than one baby in last five years.

Using NFHS 1-5, estimation is being carried out on the number of institutional and non-institutional deliveries across states by sector. The sample considers all live births in the five years before the survey. This estimation is being carried out using unit level records from the KR file of last five rounds of NFHSs.

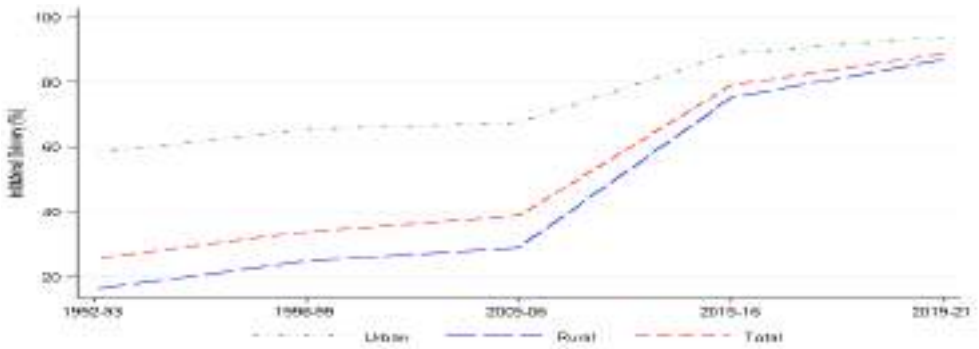
Section I

Trend of Institutional Delivery in India

Institutional deliveriesare defined as total live births in any institution in five years preceding the survey. Institutional delivery increased from 26% in NFHS-1 (1992-93) to 89% during NFHS-5 (2019-21). Even though the percentage of institutional deliveries in urban areasis higher than that in rural areas, over time the gap between rural and urban areashas reduced. The rate of growth of institutional delivery between NFHS-3 (2005-06) to NFHS-4 (2015-16) is steeper than both beforeand after the period. Janani Suraksha Yojana (JSY) introduced under the umbrella of National Rural Health Mission (NRHM), is a centrally sponsored conditional cash transfer scheme designed to address institutional delivery. The implementation of JSY acted as a major catalyst for escalating the demand for institutional delivery services across India, laying the groundwork for the massive surge in institutional births recorded in subsequent surveys like NFHS-4 (2015-16).

[1] A total of 601,509 households and 699,686 women were interviewed in the NFHS-4, with response rates 98 per cent and 97 per cent, respectively.

Figure 1: Percentage of Institutional Delivery by Place of Residence 1992-93 to 2019-21



Source: Author's estimation based on NFHS-1-5.

Indian Government Schemes and Policies for Promoting Institutional Delivery

Both union and state governments have initiated various programs /schemes at different points of time to address the issue of maternal mortality ratio and infant child deaths through ensuring institutional delivery. The government's initiatives to "encourage women to give birth in medical institutions rather than at home" began to intensify in the early 2000s, particularly in developing countries like India. The percentage of non-institutional delivery has registered a decline from 74.41% in 1992-93 NFHS-1 () to 11.41% in 2019-21 (NFHS-5). In other words, the percentage of institutional delivery increases from 25.59% in 1992-93 (NFHS-1) to 88.59% in 2019-21 (NFHS-5). Institutional delivery registered a growth of 9.12% per annum in last 27 years. A distinct change observed after 2005-06 NFHS-3, the percentage of institutional delivery took a hike. Since 1998-99, percentage of institutional delivery in urban area remains higher than that of the Rural area. However, the rate of change of percentage of institutional delivery in rural areas after NFHS-3 (2005-06) is much higher than that of the rate of change in urban areas.

Efforts have been made by both union and state governments in India to reduce 'maternal and new-borne mortality' and improve 'maternal and neonatal health' through policies, programs and schemes. Private medical institutions have been coming forward along with the public medical institutions, to ensure all deliveries

under a skill personal. Institutional delivery in India has increased irrespective of region, location, economic ladder, social group and religion.

India has made considerable progress in institutional deliveries,reaching 88.6% by 2019-2021. MMR has declined from 130 (100,000 live births) in 2014-16 to 97 in 2018-20 (SRS 2022). India has incentivized institutional delivery through introducing schemes and programs. Even though India's institutional delivery rate is higher than some of the developing countries, wide variations observed across states. However, the variations in institutional delivery across states and over NFHS rounds is noticeable. It can be observed from Tables 1 & 2, that variation in percentage of institutional delivery across state and over NFHS rounds is very clear in both rural and urban area of India. Over the years, not only has the variation across states declined, but also the rate of growth of institutional delivery (in percentage) is higher in rural areas than that of the urban areas. As a result of this, percentages of institutional delivery in rural and urban areas during NFHS-5 (2019-21) are closer to each other. A closer look at the trend in percentage changes in institutional delivery indicates that the changes became sharper between NFHS-3 (2005-06) and NFHS-4 (2015-16). This is the period where both union and state governments initiated a number of schemes and programs to boost institutional deliveries.

A paired 't' test was conducted to examine whether there is a significant difference in institutional delivery observed between rural and urban area over different NFHS rounds. Institutional deliveries in urban areas were substantially ahead of rural areas, with mean differences ranging from 25 to 35 percentage points. The t tests confirm these gaps are highly significant ($p < 0.001$), underscoring a pronounced disparity in access to institutional deliveries during the early rounds.

Institutional deliveries in rural areas show remarkable progress, narrowing the gap to under 10 percentage points. While the paired t tests still indicate statistical significance (owing to the sample size), the practical difference is much smaller, suggesting that rural populations have nearly caught up with their urban counterparts.

Table 1: Percentage of Institutional Delivery (Rural)

Sl. No.	States & UTs	1992-93	1998-99	2005-06	2015-16	2019-21
1	Jammu & Kashmir	17.67	28.67	44.36	81.94	90.58
2	Himachal Pradesh	12.61	25.36	39.76	75.23	87.55
3	Punjab	21.38	31.92	47.60	91.50	95.53
4	Uttar Pradesh	6.56	11.34	16.09	66.70	82.79
5	Haryana	11.03	14.93	26.71	80.32	94.42
6	Delhi	27.11	34.50	47.00	85.42	90.40
7	Rajasthan	7.18	14.84	20.84	82.29	94.24
8	Bihar	7.66	12.32	15.30	61.70	74.67
9	West Bengal	21.45	31.44	32.20	71.92	91.56
10	Odisha	9.72	19.04	31.30	84.50	91.30
11	Madhya Pradesh	7.51	12.14	14.41	73.66	87.76
12	Gujarat	23.75	33.08	39.24	85.22	92.16
13	Maharastra	25.43	34.48	48.92	86.72	93.12
14	Andhra Pradesh	20.70	40.16	55.88	88.67	96.00
15	Karnataka	25.76	38.56	54.77	93.33	96.15
16	Kerala	86.01	92.36	98.98	99.85	99.78
17	Tamil Nadu	49.08	72.43	83.95	98.68	99.43
18	North Eastern States	9.71	17.31	20.90	64.42	78.69
19	UTs	85.53	90.75	91.84	95.11	98.87

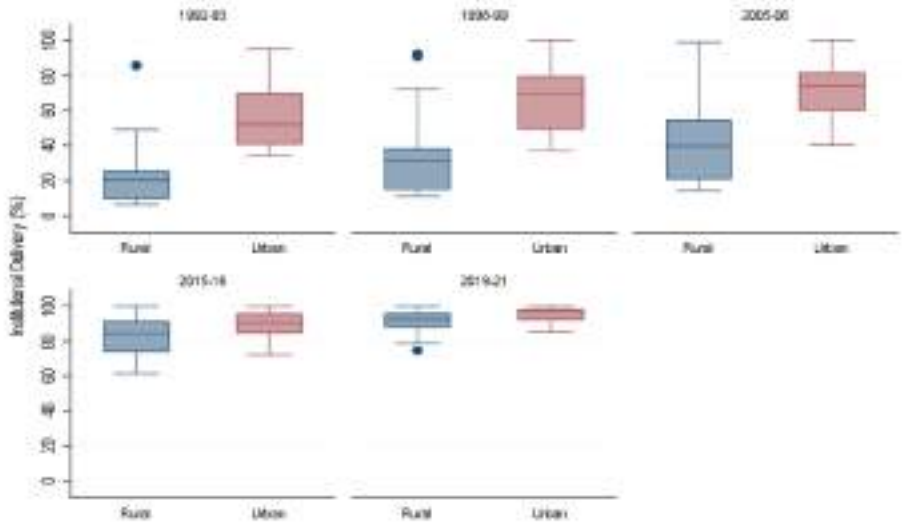
Source: Same as in Figure 1.

Table 2: Percentage of Institutional Delivery (Urban)

Sl. No.	States & UTs	1992-93	1998-99	2005-06	2015-16	2019-21
1	Jammu & Kashmir	46.65	74.64	74.01	97.29	98.57
2	Himachal Pradesh	57.92	72.06	75.89	90.56	93.09
3	Punjab	35.86	56.03	57.93	88.97	92.04
4	Uttar Pradesh	34.58	37.24	40.21	72.20	85.70
5	Haryana	36.92	47.12	64.02	80.57	96.10
6	Delhi	46.01	62.68	60.10	84.37	91.81
7	Rajasthan	34.78	47.65	63.71	90.25	97.51
8	Bihar	41.64	40.71	47.02	76.55	85.20
9	West Bengal	65.81	79.73	79.66	83.60	92.26
10	Odisha	40.59	55.14	63.07	89.74	97.47
11	Madhya Pradesh	49.98	49.19	56.70	91.40	95.12
12	Gujarat	62.17	69.21	75.70	93.35	97.79
13	Maharastra	73.67	80.86	83.32	94.80	96.72
14	Andhra Pradesh	70.18	78.59	81.51	96.46	98.18
15	Karnataka	67.12	78.83	81.81	95.07	98.34
16	Kerala	95.18	100.00	100.00	99.81	99.73
17	Tamil Nadu	89.97	92.49	92.39	99.16	99.79
18	North Eastern States	52.20	62.13	62.21	88.95	91.53
19	UTs	88.85	91.76	92.57	95.77	98.40

Source: Same as in Figure 1.

Figure 2: Percentage of Institutional Delivery by Sectors over NFHS Rounds



Source: Same as in Figure 1.

The results demonstrate a steady decline in the rural–urban disparity from NFHS-1 (1992-93) through NFHS-5 (2019-21). This convergence reflects improvements in healthcare access and utilization in rural areas, reducing the historical divide between rural and urban institutional delivery rates.

The paired 't' tests confirm that although rural areas lagged significantly behind urban areas in the early NFHS rounds, the gap has progressively diminished. By NFHS-5 (2019-21), rural and urban institutional delivery rates are much closer, signaling a successful narrowing of inequities in maternal healthcare access.

Numerous schemes and programs were implemented both by the union and the state governments to bring improvements in the state of new-born, and maternal health condition. These schemes and programs may be categorized into four broad heads, (i) offering cash incentive for institutional deliveries, (ii) offering necessary transport and residential facilities for a safe delivery[1], (iii) bearing all expenses relating to caesarean-section delivery, and (iv) insurance coverages for delivery/ post-delivery complicacy all to encourage institutional delivery. Inferences can be drawn by observing the time of

implementation and nature of schemes /programs by union and state governments to bring improvements in institutional deliveries, the schemes have an impact on institutional delivery in India. A dramatic shift is observed in the place of delivery figure in India with a sharp increase in the proportion of institutional delivery after 2005-06. In other words, the institutional delivery variable became sensitive enough to respond well to schemes/programs implemented since 2005-06.

As discussed earlier, programs and schemes implemented by both union as well as state governments to address maternal and child mortality may be broadly categories into (i) Transport & Residential Facility, (ii) Conditional Cash Incentive, and (iii) Insurance & Medicare coverages, (iv) Free delivery services and Quality improvement. In the year 2023-24, the number of beneficiaries under *Janani Suraksha Yojana* (JSY)[1] reported by State/ UTs were Rs.102.55 lakhs with an expenditure of Rs.1814.86 crores (Annual Report, 2024-25, MoHFW, p.54). Cash incentives are provided to eligible mothers through (i) *Janani Suraksha Yojana*[2], (ii) *Pradhan Mantri Matru Vandana Yojana*, (iii) *Janani Shishu Surakha Karyakram and* a few state-initiated schemes/programs. Accredited Social Health Activists (ASHAs) receive a package for facilitating these deliveries, typically Rs. 600 in rural areas and Rs.400 in urban areas, which covers both antenatal care and the delivery itself.

Delivery in Public and Private Medical Institutions

Interestingly, rural deliveriesin public health institutions is always higher. In other words, a significant number of mothers in India delivered their babies in public health institutions during last five rounds of NFHS.The rural-urban gap in accessing the type of institutions has widened over the last period, implying movement of mothers towards private medical institutions inboth rural and

[1]Birth Waiting Homes (BWHs) were established in remote and tribal areas to promote institutional delivery and improve access to healthcare facilities.

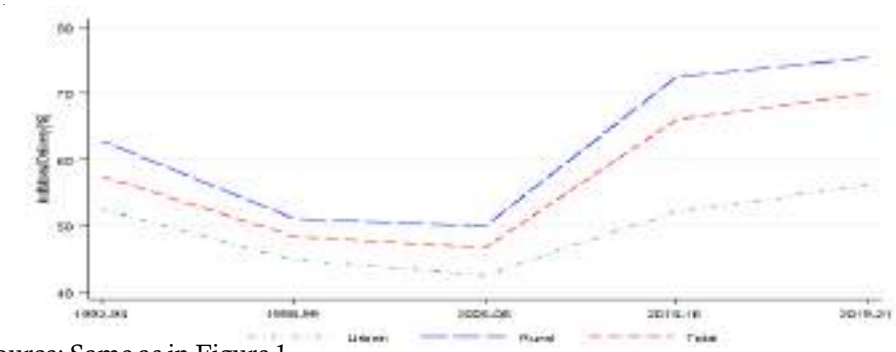
[2]Janani Suraksha Yojana (JSY) is a safe motherhood intervention under NHM introduced in 2005 by the Government of India. It is being implemented with the objective of reducing maternal and neonatal mortality by promoting institutional delivery among pregnant women. It is a centrally sponsored scheme, which provides cash assistance with delivery and post-delivery care.

urban areas. However, the rate of shift towards private medical institutions by rural mothers is more than that of urban mothers.This may be due to the higher base in urban areas.

Delivery by mothers from rural areas in public health institutions has consistently been higher compared to urban areas. Across the last five rounds of the NFHS, a significant proportion of mothers in India delivered their babies in public health facilities. Interestingly, the rural–urban gap has widened over time, reflecting a growing shift of mothers toward private medical institutions. The pace of this shift has been greater among mother residing in urban areas than their rural counterparts.

During 1992–93 (NFHS-1), about 57.39% of mothers delivered in public medical institutions. This figure rose to 69.89% in 2019-21 (NFHS-5). The trend was not linear: the share declined up to 2005–06 (NFHS-3), then increased to 66.0% in 2015-16 (NFHS-4) , and further to 69.89% in 2019-21 (NFHS-5). Over successive NFHS rounds, the gap between rural and urban areas in public-institutional deliveries has widened, with urban mothers increasingly opting for private medical institutions for child birth.

Figure 3: Delivery in Public Institutions by Place of Residence 1992-93-2019-21



Source: Same as in Figure 1.

State level variations in both rural and urban areas are quite visible in Table 3 & Table 4, mothers' delivery in public medical institutions in last five years preceding the survey.

[3]JSY is a 100% centrally sponsored scheme with provision for cash assistance at delivery and in the post delivery period. The aim of this scheme is to reduce maternal and neonatal mortalities by promoting institutional deliveries. This scheme has been modified from earlier National Maternity Benefit Scheme (NMBS) and, is now being run as a part of NRHM.

Sl. No.	States & UTs	1992-93	1998-99	2005-06	2015-16	2019-21
1	Jammu & Kashmir	86.1	83.52	84.80	94.01	95.75
2	Himachal Pradesh	90.6	81.11	85.76	81.03	83.06
3	Punjab	48.1	22.31	23.65	63.93	60.29
4	Uttar Pradesh	73.8	54.68	38.33	72.02	73.96
5	Haryana	60.1	23.85	37.36	68.68	64.68
6	Delhi	37.8	48.18	65.96	94.33	57.36
7	Rajasthan	84.6	75.96	69.62	79.05	83.43
8	Bihar	51.2	24.96	16.45	76.67	78.22
9	West Bengal	89.9	86.96	81.25	79.21	82.81
10	Odisha	90.0	88.49	85.27	91.45	87.62
11	Madhya Pradesh	84.0	68.93	73.57	90.46	91.06
12	Gujarat	46.6	29.12	26.28	41.73	51.26
13	Maharastra	57.3	48.75	43.68	58.66	63.91
14	Andhra Pradesh	50.5	26.11	37.68	42.41	55.94
15	Karnataka	63.7	59.40	60.31	73.66	72.77
16	Kerala	43.9	38.22	36.07	40.90	37.77
17	Tamil Nadu	56.0	48.32	58.35	74.79	74.44
18	North Eastern States	84.6	76.00	69.65	86.75	90.18
19	UTs	54.6	48.53	54.44	79.65	76.80

Source: Same as in Figure 1.

Table 4: Percentage of Delivery in Public Institution (Urban)

Sl. No.	States & UTs	1992-93	1998-99	2005-06	2015-16	2019-21
1	Jammu & Kashmir	56.41	83.53	74.63	83.61	88.78
2	Himachal Pradesh	88.79	77.17	87.50	76.53	68.99
3	Punjab	21.95	16.52	24.33	46.45	51.11
4	Uttar Pradesh	51.43	38.84	24.08	43.03	50.96
5	Haryana	49.25	29.69	40.83	57.47	50.59
6	Delhi	55.97	49.85	50.07	65.58	68.39
7	Rajasthan	78.75	71.39	57.28	63.78	72.29
8	Bihar	43.94	29.67	20.10	53.08	55.56
9	West Bengal	76.21	64.66	66.74	66.36	68.08
10	Odisha	77.68	74.58	66.55	74.57	72.65
11	Madhya Pradesh	69.43	61.83	60.54	69.18	72.25
12	Gujarat	39.42	20.43	26.56	30.18	37.41
13	Maharastra	48.69	44.65	39.11	48.97	52.55
14	Andhra Pradesh	33.75	23.67	36.81	31.06	43.39
15	Karnataka	52.12	48.98	46.27	52.62	56.90
16	Kerala	44.05	42.33	35.37	35.65	30.31
17	Tamil Nadu	50.27	47.98	50.88	59.14	58.11
18	North Eastern States	71.11	68.71	64.28	67.79	72.90
19	UTs	41.00	35.43	41.00	71.19	70.58

Source: Same as in Figure 1.

Section III

Using NFHS-5 (2019-21) data, this section discusses movements of place of delivery of mothers during different deliveries that occurred in the last five years preceding the survey. Only those mothers were taken into account for analysis who have delivered at least two children in the considered period.

Out of total 747176 eligible women, 177998 women delivered at least one child in the last five years period preceding the survey. In other words, 24.58% women out of all eligible women delivered at least one child in the last five years preceding the survey. For progressive and regressive analysis, movements of mothers during different deliveries (up to maximum of last six births are carried out using IR files. Around 51045 (28.68% of the mothers who delivered at least one baby in last five-year period) mothers have delivered at least two children in last five-year period. These mothers were taken as our sample size for this analysis.

Mothers were classified into four categories based on the sequence of places of delivery across their last six births: (i) progressive, (ii) indeterminate, (iii) regressive, and (iv) static. A mother is categorized as progressive if each successive birth occurred in a healthcare facility of a higher level than the one used for the previous birth. A mother was classified as indeterminate if deliveries took place at different types of healthcare facilities without following a consistent upward or downward pattern. The regressive category included mothers whose successive births occurred in healthcare facilities of a lower level than those used for previous births. Mothers were classified as static if all deliveries occurred at the same level of healthcare facility. In this case few mothers may deliver all of her children either at home, public health care facilities or private health care facilities.

It is presumed that every mother wishes to deliver their baby in proper health care institutions under safe hands. The increasing number of medical institutions in India and schemes by both union and state government to encourage mothers to rely on medical institutions increased the cases of 'institutional deliveries' in India. Further, with the increase in the economic status of households, level of literacy of women, accessibility to medical institutions, and schemes & programs to increase institutional delivery expedited the transition. Not only

has the rate of institutional delivery registeredprogress, but also the rate gap between rural urban reduced significantly in last five NFHS rounds.

Table 5: Transition of Mother Who Delivered More Than One Child in Last Five Years

Transition Type	Rural	Urban	Total
Progressive	783	4522	5305
Indeterminate	51	393	444
Regressive	768	4241	5009
Static	6832	32454	39286
Total	8434	41610	50044

Source: Author's estimation from NFHS-5.

Only 10.60% of mothers reported moved to a better place for next delivery. Almost similar proportion of mothers (10.01%) also reported to a worse place for their next delivery. Around 0.89% mothers reported different ladder of places for different delivery. However, the lion share (78.50%) mother reported no transition during different deliveries. Out of total mother reported delivered two or more children, 10.81% of them delivered all their children at home. With increasing literacy rate, communication, medical institutions and facilities, and schemes; delivering at home in 21st century invites a debate to identify the reasons. Most mothers reported no transition, are from rural areas (82.61%).

Conclusion

This study highlights that the percentage of institutional delivery has been increasing over time. However, variation across states is quite visible even across different NFHS rounds. When mothers from rural areas are still delivering babies in public health institutions, mothers from urban areas prefer to use private medical institutions over the years. Insurance and cash incentives encourage mothers to access private medical institutions. Even though socio economic indicators visualized positive changes among women, 10% women

delivering at home out of who reported no transition is a serious issue. In other words, they have been giving birth to their children at home, away from modern medical facilities. If left unaddressed, this challenge may shatter the aspirations of reducing maternal mortality and preventing newborn and child deaths.

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Appendix

Appendix Table A1: A List of Few Important Government Programs / Schemes to Improve Institutional Delivery

	Transport & Residential Facility	Conditional Cash Incentive/Financial Assistance	Insurance & Medicare	Free Delivery Services	Quality Improvement
Central Sponsored Schemes/ programs	Janani Shishu Suraksha Karyakram (JSSK), 2011	Janani Surakhya Yojana, 2005	Ayushman Bharat Pradhan Mantri Jan Arogya Yojana (AB PM-JAY), 2018	Janani Shishu Suraksha Karyakram (JSSK), 2011	LaQshya Programme, (2017)
	Maternity Waiting Homes (MWHs) under NRHM launched in 2005	Pradhan Mantri Matru Vandana Yojana (PMMVY), 2017	Employees' State Insurance Scheme,1952	Surakshit Matritva Aashwasan (SUMAN), 2019	Midwifery Initiative, 2018
	102/108 Ambulance Services (2014, 2005)	Pradhan Mantri Matru Vandana Yojana (PMMVY), 2017			
State supported Programs	Maa Gruha (Odisha), 2013		Bhamashah Swasthya Bima Yojana (BSBY), 2015, Rajasthan	Mukhya Mantri Nishulk Bal Sewa Yojana, 2011 Bihar	
	Sishu Abong Matru Mrityura Purna Nirakarana Abhijan has been implemented in the state of Odisha since 2015-16.	Dr. Muthulakshmi Reddy Maternity Benefit Scheme (MRMBS), Tamil Nadu		Chiranjeevi Yojana, Gujarat, 2005	
	Prashav Griha (Chhattisgarh)	Vijaya Raje Janani Kalyan Bima Yojna , 2006 (Madhya Pradesh)			
	Chirayu Scheme (Chhattisgarh)	Mukhyamantri Shramik Sewa Prasuti Sahayata Yojna, 2018, Madhya Pradesh			
	Janani Express Yojana, Madhya Pradesh	Mamoni Scheme ,2018 Assam			
	Prasav Hetu Parivahan & Upcha, 2005, Madhya Pradesh	Prasooti Araike,2013 Karnataka			
	Waiting Huts, 2018, West Bengal	KCR Kit Scheme, 2017, Telangana			

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	Maternity Waiting Homes, Uttarakhand	Janani Bal-Suraksha Yojana (JBSY), 2006 Bihar			
	Amma Odi / Amma Vodi Ambulance Transport, 2018, Telangana	Dr. Muthulakshmi Reddy Maternity Benefit Scheme, 2006 (revamped from a 1989 initiative)			
		Swasthya Sathi, West Bengal 2016			
		Ammavodi Scheme, 2019, Andhra Pradesh			

Sources : Government Websites.

Teaching Price Theory

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Teaching economic theory, specially, price theory, in our colleges is often a difficult task, resulting in well-meaning teachers thinking it is a thankless task. I suggest that students may, indeed should be, asked to do arithmetic exercises as an obligatory task in order that the relevance of these theoretical formulationsbecome clear to them, leading to their better performance in the examination and, what is more, in real life when policies involving these concepts are being discussed. Let me begin with consumer demand.

Demand by the consumers of any good or service depends on his income, his taste, and the prices of different goods and services he wishes to buy. In economic analysis we are interested in the behaviour of a group of people in society, not of individuals. But our formulations start with the individual. The group behaviour is the summation of the behaviour of the individuals constituting the group.

Let us start with the income of the individual or the individual household. Let us take the example ofan individual household with a monthly income of Rs.920, which are spent onfive commodities and services: a,b,c,d and e. Let us call our total money income as Y.

Y=QaxPa+QbxPb+QcxPc+QdxPd+QexPe

where Qa stands for quantity of commodity/service a, etc., and Pa stands for price of commodity/service a, etc.

In year 2024 let us assume that Qa was 20 units and the price of a per unit was Rs.5, Qb was 20 units and Pb was Rs.15, Qc was 30 and price per unit was Rs.12 and Qd was 16 units and price was Rs. 4 per unit and Qe was12 units and price per unit was Rs.8, with total expenditure being Rs. 920. This may be

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one household's monthly expenditure or the average expenditure of families of a class of people. Let us call this the base year.

If the real expenditure (or income, assuming all income is spent) of the household is to be kept unchanged at the base year level in the succeeding years, when the prices of the different commodities/services are changing, then we should collect the prices of the very commodities in the succeeding years. Let us assume that the average prices of these five commodities in the next year, 2025, are Pa=Rs.7, Pb=Rs.18, Pc=Rs. 10, Pd=Rs. 5 and Pe=Rs. 10. Then, to keep the real expenditure (or income) unchanged, meaning for the householdto be able to buy the same commodities/services as inthe base year, 2024, the household would need (Qa 20xPa Rs. 7 + Qb 20x Pb Rs.18 + Qc 30 x Pc Rs. 10 + Qd 16 x Pd Rs. 5 + Qe 12 x Pe Rs. 10 =) Rs.1,000. Therefore, to keep the household's real expenditure unchanged in year 2025, the household will need Rs.80 more per month. The Labour Bureau of the Government of India collects,in a particular year, from defined classes of the rural and urban sample households, every month the quantities of different commodities and services consumed and the pricesat which these were purchased. In the succeeding year the Labour Bureau collects, from shops from which such household purchase these, the prices of those very commodities. This helps the Bureau to calculate what iscalled the Consumer Price Index. In our example above, the year for which both prices and quantities are collected, the Bureau calls it the Base Year. 2024 is the base year for the Consumer Price Index (CPI). For the base year the CPI is stated as 100. Valuing the base year quantities with the next year's prices, the Bureau calculates the value of the total expenditure in that year that will keep the household's real expenditure unchanged. This is expressed as Rs.1000/Rs.920 = 108.6956, or rounded to 108.7. It shows that to keep the real expenditure unchanged; the household's total expenditure has to increase by 8.7 per cent.

This is how the dearness allowances, paid to the government employees, areestimated every year by the government. The idea is to keep the real income, represented by the real expenditure of the average household, unchanged. The government employee's salary in year 2025 will be increased by 8.7 per cent to compensate him for the change in prices.

The Labour Bureau is expected to conduct a fresh consumer expenditure survey every five years, to revise the base year's quantities. Because, commodities consumed by households change over time, their income in real terms also

change overtime, leading to their purchasing different quantities of commodities and services. Moreover, the real income, in economic terms is the money income that keeps the consumer on the same indifference curve as in the base year. By compensating with the dearness allowance, the consumer is on a slightly higher indifference curve. That is reason for revising the base year frequently. So, a five-yearly fresh enquiry is considered appropriate. How the older index (CPI) with an earlier base year is linked to the new index, I shall not get into here.

Now, I would suggest that once this has been explained to the students, a question may be asked for them to think and reply. It is like this: Till some years ago the Labour Bureau used to calculate a consumer price index for the plantation workers in India. To do this, it used to conduct a consumer expenditure surveyinabase year of a sample of plantation worker households. Now, there was a difference about the plantation workers. A government law required that all plantation workers should be provided living accommodation near the plantation *free* by the plantation company.So what the Labour Bureau did was: collect the quantities purchased and the prices paid by the sample households in the base year. Since housing was free, the Labour Bureau collected from the local market the comparable rent of the type of house the workers had, as a basis for the rent. In the next year the Bureau collected prices for all commodities that featured in the workers base year survey, but kept the estimated rental value of the free house unchanged. The base year estimated rent was roughly ten percent of the household's total expenditure. And, with this unchanging price of accommodation, the Bureau calculated the CPI every subsequent year. This CPI was used by the plantation companies to compensate the workers with dearness allowance on their wages. The students may be asked to say if the method followed by the Bureau was right or wrong and explain their answer. This will help them understand the CPI properly.

Price Elasticity of Demand

The demand for any particular commodity by a consumer depends upon its price, the prices of other goods consumed, substitutes or complements, and of-course on his income. Now if all commodity prices for a consumer and his money income are raised in the same proportion then it will result in no change in his demand forany commodity. This makes it clear that the demand by a consumer of any commodity depends not only on its price but also on the prices of other commodities and his income, So demand forany commodity

depends on its price in relation to the prices of the other commodities consumed and his income. So, when we try to understand the demand for a commodity by a consumer in relation to its price, we presume that the prices of other commodities and his money income remain unchanged. Now, prices are given to the consumer in the market. On the basis of these prices, his income and his taste, the consumer decides to purchase any commodity. If the price of a commodity changes, then the quantity demanded of that commodity will also change. The price is the independent variable; the quantity of the commodity demanded is the dependent variable.

Change in quantity/change in price shows the ratio of change in quantity because of a change in price. But the percentage change in quantity/percentage change in price is called a measure of the *price elasticity of demand.* Suppose we start from the position of a person's equilibrium position where he, with an income of 100 rupees, is buying 50 units of X at a price of Rs.1 a piece and 50 units of commodity Z at a price of Rs 1 per unit. Now, suppose the price of X declines to 60 paisa per unit. The person can buy 50 units of X for Rs.30, 50 units of Z for Rs. 50 and will be left with Rs 20. This is the extra income that the consumer is left with as a result of the change in price of X. With the same money income he can now buy more of X and Z. Talking about X, he may spend, let us assume, 40 per cent of this extra income on purchasing X. We call this the *marginal propensity to consume* X– Mx; it is 0.4. The extra quantity of X that will be demanded is: [Mx multiplied by the change in the price of X, that is, (-40paisa x 50 units of X), divided by Px, that is, the price of X]. This comes to [0.4(- 40 paisax50 units)/ 60 paisa] =13.3 units of X. This is called the *income effect* of a change in price of a commodity when the prices of other commodities and the money income are kept unchanged. Note that the extra (real) income following the change in price of X, Rs.20, is not the Income Effect. The income effect is the effect on the quantity demanded of X due to the change in (real) income following the change in price of a commodity. This, in the example, is 13.3 X. We can write this as:-Mx(-ch. in Px xQx)/Px.

We saw above the income effect of a change in the price of a commodity. But given the new income, there is going to be a substitution between X and Z due to the change in their relative price. This is best measured by the change in the new price line which would be tangent to the old indifference curve at a new point. There are two points to be note here. First, the best measure of real income with the change in price of X is the old indifference curve which

measures the consumer's satisfaction with changing relative prices. Following the lowering of the price of X, a new budget line with changed price of X and the old price of Z will be tangent to the old indifference curve at a lower point of the curve. This shows a change in the quantity of X now consumed following a lower price of X with real income constant. This change is measured by the slope of the changed budget line multiplied by the change in price of X. The slope is written by s_{zx}. This, multiplied by the change in price of X, is the change in the quantity demanded of X following the substitution in the demand for X as a result of the decline in the price of X. $s_{zx} \cdot \Delta P_x$

In the measure of the income effect above, there is a negative sign. The reason is the change price of X here is negative, the price has declined. But the increase in income is positive. So to express the income effect of the change as result of the decline in the price of X which is positive figure, it is necessary to express the entire with a negative sign, which will make the change in quantity demanded of X positive. In case of the substitution effect above, the multiplication of ($s_{zx} \cdot \Delta P_x$) by change in Px will leave only the change in the quantity of X which in this situation is positive. Therefore, the sum of the two effects – the substitution effect and the income effect – will be a greater change in Qx ΔQ_x Now we have $\ddot{A}Q" = s_{zx} \cdot \ddot{A}P" + M" \left(-\frac{Q_x \cdot \Delta P_x}{Px}\right)$

Price elasticity of demand for X is the percentage change in the quantity demanded of X divided by the percentage change in the price of X. Symbolically, it is $\frac{\Delta Q_x / Q_x}{\Delta P_x / P_x} = \frac{\Delta Q_x}{Q_x} \times \frac{P_x}{\Delta P_x} = ç"$). Therefore, to express our change in demand for X as elasticity, we may multiple both sides of the equation by $\frac{P_x}{\Delta P_x \cdot Q_x}$. The total equation will be

$$\ddot{A}Q" \left(\frac{P_x}{\Delta P_x \cdot Q_x}\right) = s_x \cdot \Delta P_x \left(\frac{P_x}{\Delta P_x \cdot Qx}\right) + M_x \cdot \left(-\frac{Qx \cdot \Delta P_x}{P_x}\right)\left(\frac{P_x}{\Delta Px \cdot Q_x}\right).$$

Simplifying the equation by cancelling common numerator and denominator we have = $- M"$. If after the change in the price of X, the real income is kept unchanged, then the elasticity of demand for X will be only the substitution part.

The income effect part of the above equation can also be stated in a different way. Let us assume that the total money income is stated as Y. Now, the average propensity to consume X is (Px x Qx)/Y, $\frac{Q_x \cdot P_x}{y} = a$". The income elasticity of demand for X will be percentage change in the expenditure on X divided by the percentage change in income of the demander, that is, $\frac{\Delta(Q_x \cdot Px)/Q_x \cdot P_x}{\Delta y / y} = \varepsilon_x$,$\therefore M_x = \varepsilon_x \,.\, a$"

Therefore, Mx can also be written as $\eta_{zx} = \eta^s_{zx} + a$" $.\varepsilon_z$, that is, income elasticity of demand for X multiplied by the average propensity to consume X If the expenditure on a commodity is a very small part of the total expenditure of the demander, then there will be very small difference between the its total price elasticity of demand for a commodity and only the substitution part of his demand. But if the expenditure on the commodity is a large part of the income then its total price elasticity of demand will be much larger than only the substitution part of it.

So far, we have discussed the demand for a normal good. There are commodities which a consumer may buy less when his income rises substantially. In economic analysis we call such commodities an *inferior good*. It is best to remember that a good is an inferior good to a consumer when, on his income becoming higher, he buys less of that good. There is no good which by itself is an inferior good. It is inferior to the consumer only at a certain stage of his income. If the price of such a commodity falls, then given his money income, his marginal propensity to consume the good will decline; he will demand less of the good. In such a case the income effect of demand, instead of being positive, will be negative and his total elasticity of demand will be smaller than the substitution part of his total price elasticity of demand.It is necessary to note that the price elasticity of demand for a commodity is always negative, except when the good is avery inferior good, whose income effect outweighs its substitution effect. I have so far discussed a fall in price of the good. A rise in the price with money income unchanged will have the opposite effect. Please work it out.

The price elasticity of demand is usually negative. If it is less than 1 in absolute terms, then it is said to be inelastic demand. If it is more than 1 in absolute terms, then it is called elastic demand. And, if the elasticity is 1 in absolute terms, then it is called unit elastic demand. Can you say what will happen to the total expenditure on the commodity following a change in its price, if its demand is inelastic/elastic/unit elastic?

We have so far discussed elasticity of demand for a commodity whose price changes. What about the demand for commodity other than the one whose price changes,in our example, commodity Z ? This is called the cross elasticity of demand (for Z when the price of X changes). Instead of going through the whole process again, I shall only state the final equation, leaving it to the student to work it out to arrive at the final equation. That is $\eta_{zx} = \eta^{s}_{zx} + a\text{“}\ .\varepsilon_{x}$

Similarly , work out the price elasticity of goods which are complements to one another.

It would be useful to ask the students to make calculations of elasticity from available survey date. The National Sample Survey Organisation has been conducting consumer expenditure surveys in rural and urban areas of every state of India for the last 70 years. They publish the data in tabular form for average individuals with different levels of total expenditure, in rural and urban areas. I would suggest that students see these reports and try and calculate income elasticities for individuals in different income categories in a particular year for both rural and urban areas of a state. Since these are discrete data for dfferent per capita expenditure levels, it would be useful for them to calculate Arc Elasticity, rather than point elasticity. In Arc elasticity we should take the denominator for percentage change not the Income of the base year but the sum total of the base year and the current year or the two consecutive levels of total expenditure as in the NSS reports. Calculating such elasticity will help the students not only understand the meaning of elasticity and its relevance but also the nature of our society. Prof. Milton Friedman had at one time stated that those commodities which have an income elasticity of 2.0 or more may be called luxuries. I would invite our students to do the arc elasticity calculation for different commodities and services of our rural and urban households to find out if there are any which qualify as luxuries in our society.

Applications of the Law of Variable Proportions

Normally while discussing the law of diminishing returns, we take the example of a fixed factor and study the impact of the application of a variable factor to it in the process of production. And, given the price of the variable factor, we find the equilibrium point where the value of the marginal product of the variable factor equals the price (or cost) of the variable factor unit. The student is familiar with this. But I want to draw his attention to the average and total product due to the fixed factor. In the law of variable proportion this refers to

the factor in shortest supply. In our text book example, the fixed factor land produces the highest return per acre of land. Take the case of a farmer who has, say, some 15 acres of cultivable land in a patch and he has only one well. The well water over the year can irrigate at most two acres of sugarcane; for, an acre of sugarcane requires 1800 acre-inches of irrigation water during the year. Assume that an acre of sugarcane produces 40 tons of cane in the year. Also, assume that the farmer can grow hybrid jowar on his fields which require 18 acre-inches of irrigation water in the season. Find out the yield of irrigated hybrid jowar per acre. And take the price of sugarcane as well as jowar that is declared as the MSP (minimum support price). Now decide what the farmer should grow with his well water, sugarcane or jowar, and why. I think he will grow jowar. But, you are required to give your reason indetail.

With this reasoning, go forward and decide what should be the use of flow irrigation water in any major flow irrigation area in our state. In the state irrigation water is the factor of production in agriculture in shortest supply. Not more than 40 percent of the total cultivated are of the state can be ever irrigated in the present manner, when sugarcane takes 80 percent of the total irrigation water in the year. Why do farmers grow what they grow under irrigation, and not what your exercise tells you they should grow? I am not giving data on per acre yield of irrigated jowar and the prices of jowar and sugarcane. Indeed, the student may like to get data on other irrigated seasonal crops from available sources and test their exercise with such data. This is important to see the relevance of such exercise for policy formulation in the state.

Oligopolistic Behaviour

When we study monopoly behavior in theory, we come to the conclusion that a monopolist exploits consumers since he prices his product such that the consumer pays a higher price than what he would be charged in a competitive market. When there are only a few producers in the market, we call this situation as oligopolistic. A bigger oligopoly firm tries to buy off or drive out the other producers in the market with its deep pocket. For example, one big mobile company in India offered to provide free mobile service to all its customers for free for six months from the date it stated operation. What would it mean for the other few firms in the field?

A new drug company produces a new drug for a disease. A big company purchases the drug paying it much higher price than it proposed to sell it for, and finally the big company does not keep the drug in the market.

Can the student list similar methods by which the big firm tries to drive the competing new smaller firms from the market. What is the approach to preventing this? Does it work? Why?

Students should be asked to list such propositions and discuss the methods of controlling such practices. Most capitalist countries have regulatory bodies established under law to control such activities by powerful oligopolies. The students may be asked to find out about such bodies in India and the United States of America. How successful have they been? The students should be asked to find out from available literature.

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Making the Invisible Visible: The Case for Valuing the Ecosystem Services of Indian Agriculture

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Abstract

Agriculture is unusual among economic activities in that it both supplies and depends upon ecosystem services, yet markets reward only its provisioning outputs, grain and straw, while the regulating, supporting, and cultural services it generates go uncounted and uncompensated. In this article we argue that valuing these hidden services is not an act of commodification but the precondition for managing agricultural natural capital deliberately rather than depleting it by default. Drawing on evidence from the Indian agricultural landscape and from paddy ecosystems in Odisha, this article shows that provisioning services dominate measured value while supporting and cultural services remain critically understudied; that land productivity and crop diversification raise agroecosystem service values whereas demographic pressure erodes them; and that irrigated paddy, though more productive, carries heavier ecosystem dis-services than rainfed systems. These findings make the case for region-specific valuation coefficients and for policy instruments, payments for ecosystem services, green credit, carbon markets, and subsidy repurposing, that can align farmer incentives with the long-term health of agroecosystems.

Keywords: Agriculture, Ecosystem Services, Markets, Natural Capital.

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The Double Life of Farmland

Agriculture occupies a peculiar double position in the natural world. It is, at once, one of the largest beneficiaries of ecosystem services and one of their largest consumers and degraders. The same farmland that depends on pollination, soil formation, nutrient cycling, and water regulation also reshapes those very processes through tillage, irrigation, and agrochemical use (Power, 2010; Swinton et al., 2007). In India, where agriculture anchors the food and livelihood security of a vast rural population, this dual dependence is not an abstraction. It is the quiet foundation on which the wider economy stands. Yet most of what agriculture gives back to society, and much of what it silently erodes, never appears on any ledger.

The concept of ecosystem services, the direct and indirect benefits that nature confers on human welfare, offers a way to make this hidden accounting visible (Costanza et al., 1997; MEA, 2005).

Since the foundational work of the late 1990s and the Millennium Ecosystem Assessment, the field has grown into a vast transdisciplinary enterprise (Costanza et al., 2017; Daily, 1997). But agriculture has remained an awkward fit within it. We readily price the grain and the straw, because they pass through markets; but rarely price the carbon held in the soil, the groundwater recharged beneath a flooded paddy, or the micronutrients mineralised by an earthworm.

The Issue: Missing Markets, and A Missing Number

The core problem is one of missing markets and market failure. Agricultural ecosystems generate a continuous stream of regulating, supporting, and cultural services that are real, valuable, and economically consequential, and almost entirely uncompensated (Garbach et al., 2014; Van der Ploeg et al., 2010). Because these services carry no price, they are systematically under-provided. A farmer who conserves soil biota or maintains on-farm diversity is rewarded for none of it; one who depletes them pays no penalty. The predictable outcome is the intensification spiral, in which the pursuit of higher marketed yield steadily erodes the non-marketed services on which long-term productivity itself depends.

This is not a merely theoretical concern. Despite being an agrarian economy, India has produced remarkably few valuation studies of agroecosystem services,

and most existing work concentrates on forests rather than farmland (Chopra et al., 2022; Manjula et al., 2019). The first dedicated quantification of agroecosystem services in the country appeared only in 2017 (Pathak et al., 2017). The studies that do exist are localised, methodologically uneven, and heavily weighted toward provisioning services that already possess a market value. Supporting and cultural services, precisely those most vulnerable to neglect, remain the least studied of all. The result is a policy vacuum: we cannot manage, reward, or protect what we have never troubled to count.

Why Value Nature at All?

A familiar objection holds that monetising nature is reductive, even ethically suspect. The objection has force, and the tension between the economic and the ethical view of nature is genuine (Spangenberg & Settele, 2010). But the alternative to valuation is not a purer appreciation of nature; it is the default valuation of zero that markets already assign. A service priced at nothing is a service invisible to every cost-benefit analysis, every subsidy decision, and every land-use plan. Valuation, properly understood, is not an attempt to reduce nature to money, but to give the unpriced a seat at the table where decisions are actually made (Dasgupta, 2021; Pascual et al., 2023). If biology tells us what natural systems do, economics helps design the institutions that reward their conservation.

What the Evidence Says

My study set out to fill part of this gap for India in general and Odisha in particular, across three connected questions: how much are India's agroecosystem services worth, and what drives that value; how has land-use change reshaped those values over time; and how do the services of irrigated and rainfed paddy compare. This was the rationale behind my doctoral thesis, "Economic Valuation of Agricultural Ecosystem Services in Odisha: A Comparative Analysis between Irrigated and Rainfed Paddy Agroecosystems," which was deliberately designed to move from the macro scale of a national meta-analysis down to the micro scale of field- and plot-level assessment.

The work was undertaken with three objectives. The first was to estimate the overall economic value of ecosystem services from the agricultural landscape in India. The second was to map and study the land use–land cover (LULC)

dynamics of ecosystem services in the rainfed and irrigated ecosystems of Odisha. The third was to assess and compare the economic value of irrigated and rainfed paddy ecosystem services in Odisha, on the basis of primary field data.

Each objective called for a distinct method. For the first, I conducted a systematic review and meta-analysis of secondary evidence for India, following the PRISMA framework, pooling 817 valuation estimates from the published literature and fitting a generalized linear mixed-effect model (in log–log form) to identify the drivers of ecosystem-service value. The empirical model took the form $\ln(y) = a + b_1 X_1 + \ldots + b_{12} X_{12} + u$, where the value of an agro-ecosystem service was explained by the type of service (provisioning, regulating, supporting, cultural), the valuation method used (direct market, revealed preference, stated preference, others), population density, land productivity, crop diversification, and journal type.

For the second objective, I drew on Landsat imagery processed in ArcGIS over the 2005–2020 period. Villages with the highest and lowest net sown area were selected through purposive sampling, and unsupervised classification was used to generate LULC maps for 2005, 2010, 2015 and 2020. Change was detected using the standard change-percentage formula (Sannigrahi et al., 2021), and ecosystem-service values were estimated using the coefficient and equivalent-factor method (Xie et al., 2008), with the equivalent factor defined as one-seventh of the gross income from crop provisioning, scaled by ecosystem-specific coefficients, and the change in value computed as $\Delta ESV = ESV_{2020} ESV_{2005}$.

For the third objective, I collected primary data in Odisha in 2023, comparing Bargarh (irrigated) and Khordha (rainfed), with two villages in each district. Two hundred soil samples (50 per village) were drawn through simple random sampling using a random number table, and eight ecosystem services and dis-services were valued in the field, food, the straw by-product, soil fertility, soil formation, carbon sequestration, micronutrient mineralisation, hydrological flow, and greenhouse-gas emissions as a dis-service, using a combination of direct and indirect market valuation, replacement cost, and benefit transfer.

The results bear out the value of this layered approach. At the national level, the meta-analysis of 817 estimates showed that provisioning services dominate

the measured economic value of Indian agroecosystems, even though regulating services have been the most frequently studied; agro-ecosystems remain the least-studied ecosystem type in India. The mixed model indicated that land productivity and crop diversification raise ecosystem-service values significantly ($p < 0.001$), while higher population density lowers them. Direct-market methods account for the bulk of the existing literature, with stated- and revealed-preference methods used less often, though the use of benefit transfer is rising. The analysis also exposed a methodological monoculture: most Indian studies lean on the benefit-transfer method, importing coefficients from elsewhere for want of local data (De Groot et al., 2012; Nelson & Kennedy, 2009).

The spatial analysis showed that ecosystem-service value rose over 2005–2020, with a total change of Rs. 55.5 lakh/ha/yr — Rs. 48.0 lakh in the irrigated ecosystem against Rs. 7.4 lakh in the rainfed one. Water regulation (Rs. 17.4 lakh) and waste treatment (Rs. 13.7 lakh) accounted for the largest share of this gain, together about 56 percent of it, reflecting improvements in irrigation and waste facilities, while food production and raw-material provision contributed the least. The underlying land-use dynamics were mixed rather than uniform: farm area fell by roughly 24 per cent in Bungapali but expanded in Madanpur and Baghamari. The exercise also surfaced a recurring weakness in this kind of work, namely the dependence on borrowed value coefficients (Kindu et al., 2016; Xie et al., 2008) that assume spatial homogeneity and routinely misstate local realities.

Finally, the field valuation in Odisha showed that irrigated paddy delivered a net ecosystem-service value of Rs. 3.43 lakh/ha/yr, about 45 per cent higher than the Rs. 2.36 lakh/ha/yr of rainfed paddy, although rainfed systems led in micronutrient mineralisation and soil formation. Irrigation, however, came with a higher climate cost: the greenhouse-gas dis-service was Rs. 11392/ha/yr in irrigated systems against Rs. 9039 in rainfed ones. In both systems, provisioning services (food and straw) dominated the total value, so that irrigation raised net ecosystem-service value while simultaneously deepening the associated climate dis-service. The headline figure conceals an important reversal. Rainfed paddy outperformed irrigated paddy in two crucial supporting services, soil formation and micronutrient mineralisation, reflecting healthier earthworm populations and lighter agrochemical loads. Meanwhile, the largest ecosystem dis-service, greenhouse-gas emission, was higher in irrigated systems owing to prolonged submergence (Kumar et al., 2016). Provisioning services accounted

for roughly half to two-thirds of total value, consistent with rice-valuation studies across South and East Asia (Nayak et al., 2019; Rasheed et al., 2021; Rath et al., 2023; Yu et al., 2011). In short, the system that looks most productive on a simple yield ledger also carries the heaviest hidden environmental cost, a trade-off that remains invisible without valuation.

From Numbers to Policy

Objective 1 — National valuation: The meta-analysis showed that regulating, supporting and cultural services carry real economic value yet stay invisible in markets, so policy must formally value them rather than treat them as worthless. Since diversification and land productivity raised ES value, promoting diversification becomes a direct lever, and credible national values now allow subsidies to be repurposed toward ES-building practices, underlining the need for India-specific coefficients in place of borrowed ones.

Objective 2 — LULC dynamics (2005–2020): The region-specific ES and dis-service estimates generated here form the building blocks for designing PES schemes. With water regulation and waste treatment driving 56% of the ESV gain, investment in irrigation and waste infrastructure clearly delivers an ecosystem dividend; but because gains were highly uneven across villages, land-use planning should be spatially targeted rather than uniform.

Objective 3 — Irrigated vs rainfed paddy: Field-level ES values give farmers a credible entry point into the Green Credit Programme and carbon markets. Irrigation raised net ES value by 45% but also the GHG dis-service, so its expansion must be paired with mitigation; rainfed systems, leading in soil formation and micronutrient services, deserve protection for those roles. As provisioning dominates value in both systems, green technologies can be layered in without threatening food security.

Taken together, these findings carry a clear message for policy. Quantifying agroecosystem services is not an academic indulgence; it is the precondition for a set of instruments that India is already beginning to build. Robust valuation makes it possible to design payments for ecosystem services that reward small and marginal farmers for conservation rather than penalising them for it, converting a positive externality into farm income. It supplies the evidence base for linking farmers to the country's Green Credit Programme and to

voluntary carbon markets, where soil carbon and avoided emissions can become tradable assets. And it gives government a rational footing for repurposing existing input subsidies toward practices that sustain, rather than deplete, natural capital (Foley et al., 2011; Tscharntke et al., 2012).

The paddy comparison sharpens the point. If irrigated systems generate more value but also more dis-services, the policy aim is not to choose between them but to close the gap, through alternate wetting and drying, direct-seeded rice, crop diversification, and a measured shift toward organic and integrated practices that preserve soil biota while protecting food security. None of these calibrations is possible without first knowing what each service is worth. Valuation, ultimately, is what allows ecosystem services to be folded into the Sustainable Development Goals and into mainstream agricultural planning, rather than treated as a green afterthought.

The Unfinished Agenda

Two cautions temper the optimism. First, every number here is conservative. Cultural services, the spiritual and traditional significance of rice in a state that greets its first harvest with the festival of Nuakhai, went unquantified for want of method and data, as did several dis-services beyond greenhouse gases. The true net value of these systems is almost certainly higher, and more complex, than any single figure can convey. Second, the field cannot keep importing its coefficients. The most urgent methodological need is the development of region- and ecosystem-specific valuation coefficients, so that Indian agroecosystems are measured on their own terms rather than through proxies drawn from distant landscapes (Maes et al., 2012; Scholte et al., 2015).

Conclusion

The benefits that agriculture draws from and returns to nature have always been present; what they have lacked is a number. Assigning that number is not about commodifying the countryside. It is about ending the fiction that these services are free, and therefore expendable. For an agrarian economy facing mounting demographic and climatic pressure, the case for valuing agroecosystem services is no longer academic. It is the difference between managing our natural capital deliberately and depleting it by default.

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Degrowth: Revitalizing Critical Development Studies, Julien-François Gerber Practical Action Publishing Ltd., Warwickshire, 2026.

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Can an economy deliberately shrink and call that progress? That is the question at the heart of Julien-François Gerber's *Degrowth*, a book that arrives with extraordinary ambition for a series aimed at students, teachers, and practitioners of development studies. It does not just explain a radical idea; it situates that idea inside critical development studies, putting it in conversation with dependency theory, post-developmental thought, and Marxian political economy. Put simply, degrowth argues that rich economies should deliberately produce and consume less, while poorer economies pursue selective, targeted growth aimed at converging living standards within ecological limits. It holds three concerns together: first, a finite planet cannot sustain infinite growth forever; second, rising GDP rarely makes people happier, healthier, or more connected; and third, growth is usually paid for by extraction and poverty. Gerber insists degrowth must be studied rigorously, argued for publicly, and organized and lived out all at once. That fusion of scholarship, politics, and activism gives the book its charge. Six propositions carry the argument, each anchored by a country case study and a thinker's brief profile, moving from how capitalism grows through its colonial history, its effect on poverty and human well-being, a concrete programme for change, a vision of a plural world beyond one-size-fits-all development, and finally the political strategy needed to get there.

The opening chapters lay the groundwork. The author's research approach sees the economy as relational, multi-layered, and substantive, meaning shaped

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by connections, hidden causes, and real human needs, not just numbers. It is already at work by Chapter 2, where capitalism's eight structural growth-pressures (competition, investor demands, unemployment, tax-dependent finance, debt, class struggle, ideology, and population) are read as the deeper forces beneath the surface data that mainstream economics usually stops at. The critique of the Kuznets curvemakes the point sharply: the curve claims inequality rises, then falls, as economies grow. He shows it fails not just on the evidence, but because its assumptions are unrealistic; treating the economy as isolated ignores who holds power and assumes well-being and ecology can simply be priced. Once these assumptions collapse, so does the curve's promise that growth eventually fixes its own damage. Drawing from political economist Eric Pineault, Chapter 2's adoption of accumulation as extraction-plus-externalisation provides one of the book's strongest theoretical foundations: private property is capitalisms reward, while pollution, dignity, and barren land are the unvalued remainder pushed onto "sinks".

Chapters 3 and 4 show how GDP became the economy's scoreboard, and how growth's success story left most people behind and the planet worse off. He critiques the World Bank's $1.90-a-day poverty line as baseless, arguing no single income number can capture poverty's real dimensions—health, dignity, and status—among others. He particularly emphasizes that rising GDP has drifted apart from well-being, even as it never drifted apart from ecological damage. Chapter 4 turns to alienation; the feeling of being disconnected from your own work, community, and self, which the growth economy produces almost by design. Gerber draws here on Karl Marx and on the psychologist Erich Fromm, who called this widespread emptiness the "pathology of normalcy"—a hollowness so common that it gets mistaken for simply being human, rather than recognized as a symptom of how we live. A section on Frantz Fanon extends this point: colonial rule damages the mind as much as the economy, and true liberation cannot simply mean catching up to a European model of progress.

Chapters 5 and 6 move from critique to a programme. He calls for planning the economy around well-being rather than market prices, and for turning privately owned resources into shared, community-managed ones. A telling hesitation appears when he turns to dependency theory, the idea that rich countries grew wealthy partly by keeping poorer countries poor. He uses Samir Amin's diagnosis to name the problem, but stops short of Amin's own political programme, which called for poorer countries to build strong, planned, state-

led industries of their own. In its place, he turns to anarchist and autonomist critiques of statism, citing James C. Scott on the state's homogenizing violence and Achille Mbembe on sovereign power over life and death, and proposes small, self-governing, federated communities as the alternative. This vision is captured in the idea of a "pluriverse"—a concept drawn from the Zapatistas and Arturo Escobar—where no single model of development is correct, only many valid ones existing side by side. It is a genuinely valuable idea, and it keeps the book from claiming one final answer. Further, The author is admirably aware of the risks and warns readers not to romanticize community or tradition as well.

The search for a Global South alternative to market and statist planning, and to Eurocentrism in general, leads The author to the Gandhian economist J.C. Kumarappa's idea of trusteeship, harmony, and moral economy, and to Bhutan's Gross National Happiness index. But this leaves a question unanswered: can moral appeals to living in harmony replace, or complement, a political need for redistribution of ownership and power? The tension resurfaces when Gerber approvingly cites both Fanon, who defended anti-colonial violence as sometimes necessary, and Kumarappa, whose entire outlook is built on non-violence. Put simply: degrowth borrows the Marxian diagnosis, but its institutional and political teeth go missing, substituted with a mix of post-development pluralism, anarchist federalism, and diverse approaches to community and local self-governance. The author further offers Cuba's Special Period as another example of degrowth in action. But it proves something different: Cuba's shrinking economy was forced by the Soviet collapse and the US embargo, not freely chosen. That is not the same as choosing to consume less; much like a Gen Z worker juggling three gigs to survive isnot making the same choice as someone deliberately moonlighting on a passion project.

After diagnosing capitalism's growth compulsion, tracing its colonial roots, exposing its human and ecological costs, and sketching a constructive programme for a post-growth world, Chapter 7 makes its final case: degrowth as a radical ideology, not one reform option among others. On strategy, he sensibly treats protest, prefiguration, and policy reform as three necessary tracks rather than rivals, borrowing Erik Olin Wright's typology to explain how each actually engages the system: protest is ruptural, confronting dominant structures head-on; policy reform is symbiotic, working through existing institutions to bend them from within; and prefiguration is interstitial, building the alternative

in the cracks and gaps the system doesnot fully control, rather than confronting it directly or waiting to seize power first. Prefiguration gets the most attention, illustrated through Rojava's experiment in democratic confederalism. It is genuinely inspiring, though its space to experiment came from an unusual state vacuum during the Syrian civil war—precisely the kind of crack in the system's control that interstitial strategy depends on, and a unique condition not easily expected to be repeated elsewhere.

To answer who should actually drive this change, The author applies Kalyan Sanyal's concept of the "need economy": small farmers, vendors, and self-employed workers who exist alongside, but never quite inside, the formal economy. He sees this group, not a shrinking industrial working class (the proletariat), as degrowth's real social base. Drawing from Sanyal, he describes the need economy as something threatened by capitalism, needing protection, not something capitalism equally depends on. Looking closer, many of these small-scale workers turn out to be informal labour tied to big firms through subcontracting and debt—technically self-employed, but just as dependent as any employee, minus the power to negotiate. Hence, this workforce is better organized as workers with real claims and rights, not as a group needing charity, which changes who degrowth should actually be looking to as its base.

Nonetheless, the author delivers an extraordinarily rich synthesis of political ecology, post-development, and heterodox economics. What makes *Degrowth* an invaluable book in critical development studies, in the end, is not that it has all the answers, but that it asks serious questions with real courage. He refuses the comfortable path of treating degrowth as a footnote to mainstream economics or a lifestyle choice for the privileged; he insists it belongs at the centre of how we think about development itself, and he backs that insistence with genuine scholarship, wide reading across traditions, and an honest engagement with voices from Africa, Latin America, and the Indian subcontinent that most development textbooks never bring into the same room. For students and early researchers, this book is an invitation to read economics as if power, ecology, and dignity actually mattered to it, and to see the Global South not as a place development happens to, but as a place already generating the ideas the world will need next. Few books manage to be this rigorous and this hopeful at the same time; *Degrowth* does, and that combination alone makes it inspirational to read

Entrepreneurship in India's Unorganized Sector: Challenges and Opportunities
Leo-Paul Dana and Naman Sharma (Eds.)
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Research on entrepreneurship has traversed a long distance since the days of Werner Sombart and Joseph Schumpeter who contributed substantively by positioning the entrepreneur as an innovator who disrupts market equilibria. Academic frameworks and methodological approaches in entrepreneurship research have shifted notably from basic economic models to nuanced, context-driven approaches. While till the 1980s entrepreneurship was largely focused on identifying and tracing aspects of psychological or behavioural traits in *individuals* who saw or were alert to business opportunities, the subsequent couple of decades witnessed enquiries into role of institutions and networking as elevating entrepreneurial pursuits. Post-millennium, research on entrepreneurship has pondered over the salience of sustainability in business, new disruptive technologies and deciding under extreme/unknown uncertainty (theory of effectuation) to be able to reach higher echelons of markets. However, there has also been a growing stream of entrepreneurial research that unravels challenges within the domains of informality, limited resource endowments, constrained or no state/society support as typically found in the Global South. The book under review is a welcome addition in this direction.

Wading through the maze of informality in the Indian context, the several chapters in this book locate challenges, opportunities and exceptional contexts within which microentrepreneurs have spun their stories of participating in the

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world of layered business. With a lucid and rather simplistic introduction, the editors generalise four 'stages' of the entrepreneurial journey, namely, initial stage, establishment phase, growth/expansion stage, and sustainability stage. The opening chapter is followed by three articles engaging with the fast-changing landscapes in terms of technology, demand and diverse policy options. The chapter by Lavisha, Mandeep and Ram underscores how inclusion drives entrepreneurial success, demonstrating that diverse teams foster superior decision-making, creativity, and market agility. Citing examples mainly from top Indian IT companies and a few dynamic subsectors as healthtech, agritech, fintech, and edutech as they performed in the post-reforms period, it emphasizes that diversity and inclusion serve as vital catalysts for broader economic growth by expanding access to capital, opening new markets, and accelerating innovation. However, the chapter is marred by verbosity and lacks analytical rigour and not backed by any concrete data.

The chapter by Jugal and Swati points to the commonplace proposition that the massive unorganised sector has emerged a hotbed of entrepreneurship especially as a form of self-employment for the youth. The chapter meanders around dated data and unconnected narratives. For instance, in conclusion, it observes that "People working as self-employed in the unorganised sector have their lives profoundly affected by the amount of institutional finance that is accessible to entrepreneurs. A whopping 84% of working-age women and 67% of working-age men in rural areas were engaged in some kind of agriculture, Central Statistical Organization, India (2006). There has been an increase in the male unemployment rate of 6.7% in urban areas and 8.1% in rural regions, from 5.6% to 9.0%, Central Statistical Organization, India (2007)" (p. 40). It is unclear as to what the authors wish to convey to the reader.

In keeping with the vibe and quality of introductory chapters, this one by Kumar states the obvious in a nonchalant and unclear manner as, for instance, "The chapter will prove conducive to the development of entrepreneurship in the unorganised sector and help in the creation of holistic benefits for all the stakeholders who are part of value chains operating in the unorganised sectors of the economy." This leads the reader nowhere (p. 45).

While these three 'general' chapters have little to contribute to knowledge or understanding about entrepreneurship in the unorganised sector in India, the

following two chapters deal with what these mention as 'policy and support framework'. The chapter by Arya and Dadwal touches upon basic details of several schemes (some of them not connected to the unorganised sector) and provides no coherent analysis that would be helpful. It is poorly organised and has some references to a few Asian countries without indicating the relevance in the Indian context. It is unclear what the authors drive at when they state that "This paper emphasises on the existence of a hidden entrepreneurial culture in the Indian informal economy and presents a developmental framework to support micro-enterprise owners. The hidden entrepreneurial culture for entrepreneurship in Indian unorganised sector considers the existence of entrepreneurial endeavours, attitudes, and behaviours in Indian societies that might not be readily obvious or well known. Due to societal or cultural reasons, entrepreneurship may not always be publicly embraced or supported." (p. 76). The following chapter in this section by Mahima, Veeralakshmi and Sharma again is marked by commonplace discussions and lacks analytical strength. Though it promises to be a primary survey-based study, very little space has been allotted to that and there are hardly any policy insights.

Four chapters have been presented under the theme 'Technological and Digital Integration'. Pursuing the Grounded Theory, that allows for an exploration of the complex relationships between various actors and factors, the qualitative information derived from the studyin Uttar Pradesh by Garima and Uma identifies key factors affecting digital integration of handicraft entrepreneurs. These include awareness, skills, access options, adaptability and consumer acceptance of digital technology and also social norms, and other external factors. However, the survey is based a thin sample of only twelve respondents spread across four categories; handicraft entrepreneurs are only three. The anecdotal information emaciates both analysis and conclusions. The next three chapters by Amita, Priyanka and Sandeep; Supriya and Rakshit; and Pramit are marked by verbosity and vacuousness. Several paragraphs and sections within these chapters are general statements, as one would find in the concerned official websites, and not necessarily addressing the concerns of entrepreneurship in the unorganised sector.

The following section includes four chapters around the theme 'Women's Empowerment and Role in Entrepreneurship'. The chapter by Satya and Yamini takes a journey through changing fortunes of rural women entrepreneurs as

their enterprises are supported through a collective effort by financial institution, state and non-government agency in Gujarat. Trough a fairly detailed analysis, it points to the favourable effects of targeted interventions including credit access,social security insurance, skill enhancement and market linkages leading to formalisation of enterprises and enhanced business for the artisans. The next chapter in this section raises interesting questions regarding the role of SHGs in promoting rural women entrepreneurship. Taking a case study in West Bengal, authors Saugat, Soma and Sitangshu attempt to capture the entrepreneurial skill gaps among the members of women-led SHGs. The chapter by Sharma, Ankita and Deepanshi drops deep in quality as it merely lists role of women entrepreneur in the unorganized sector (pp. 222-223) and touches upon a few broad subsectors like healthcare, artisanal activities, tourism, hospitality and so on. But in contrast to the casual descriptions, it claims that this "paper aims to identify the role, problem, and future opportunities for rural women entrepreneurs. This paper highlights their development, expectations, and struggles. This research will contribute to a deeper comprehension of unorganized business operations and assist policymakers in crafting appropriate legislation that will safeguard these enterprises' interests going forward". (p. 217). The fourth chapter in this section by Tanmoy and Saugata is another analytically and substantively frail article that hardly relates to the central theme of the volume. This chapter again confirms how casually an issue of import has been dealt with.

The last section on 'Sector-Specific Studies and Cases' includes two chapters. The one by Suresh, Arunachalam and Rashmi on agroforestry and rural entrepreneurship is sketchy and replete with bullet points and micro notes on a vast range of issues/activities/schemes that does not lead to any coherent discussion. The only useful part is brief narrations on a couple of cases even as these lack any empirical content and insights from the field. The last chapter by Kriti, Devbrath and Neha, drawing upon a field survey of handloom enterprises in rural Jharkhand though is somewhat relevant, includes some unrelated descriptions of the sector in India, Jharkhand and Bangladesh (as shown through Figures 4, 5 and 6) without contextualising the abrupt references to these.

Apart from sloppy writing marring the readability in most chapters, in a few abstracts, strangely, bibliographic references are made, often improperly at that.

This book has been edited with very little care and attention paid to the seriousness of the subject at hand. Generally speaking, it is an ensemble of emaciated and directionless articles.

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Before submitting the manuscript, authors are requested to read the aims and scope of the journal, instructions for submission and ethics in publishing. Papers not prepared accordingly may be turned down or would be asked to resubmit.

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Book

Levien, M. (2018). Dispossession without development: Land grabs in neoliberal India. New York: Oxford University Press.

Website

Rao, M. G. (2017).Central transfers to states in India: Rewarding performance while ensuring equity. Report prepared for the NITI Aayog. Retrieved from https://niti.gov.in/writereaddata/files/document_ publication/ Final%20Report_25Sept_2017.pdf(Date of last access Month Date Year)

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