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Department of Economics
Lady Shri Ram College for Women

E C C O L L O Q U I A L



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EDITOR'S NOTE

Following months of consistent effort, the Editorial Board is immensely proud to release the 22nd edition of Ecolloquial, the flagship, student-edited, annual economics journal of Lady Shri Ram College for Women. Ecolloquial was instituted in 2004 with the aim of nurturing intellectual curiosity among undergraduate economics students and contributing to contemporary discussions in economic thought by publishing high-quality, original student research. We have worked tirelessly to uphold these foundational goals.

To this end, we have introduced some changes this year; we are transitioning to a peer-reviewed model and aligning our practices with UGC guidelines. This advances our objective of maintaining the highest standards of academic and publication ethics.

For this year's edition, we have featured work on the following themes:

1. AI, Automation and the Future of Work
2. Trade Amidst Global Fragmentation
3. Understanding How Governance Shapes Economic Outcomes
4. Gender, Labour and the Care Economy
5. Rethinking Taxation and Welfare Policies
6. The Intersection of Climate, Sustainability and Economics
7. Behavioural Economics in Policymaking
8. Financial Innovation via Digital Technologies and Currencies
9. Financial Economics, Development Economics, the Economics of Health and Education
10. Microeconomics and Macroeconomics

To all the young researchers who have submitted their work, we hope this process has sparked inquiry and sown the seeds for your future research. To our readers, we hope this edition offers meaningful insights that you engage with further.

We are thrilled to share Ecolloquial 2026 with you!

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Sincere thanks to Dr. Kakali Barua, our faculty advisor from the Department of Economics

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RESEARCH PAPERS

Reframing Debt: The Productivity Dynamics of Public Borrowing in India

Khushi Garg

ABSTRACT

India's public debt is one of critical importance, and its impact on economic growth is contingent upon productive and non-productive expenditure. This research paper evaluates India's debt policy and demonstrates its sustained bias in favour of revenues, which employ borrowed resources for consumption rather than capital formation. It is significant in limiting the productivity-enhancing aspects of borrowing and cultivating economic growth. Addressing low productivity requires a paradigm shift in favour of sustained capital formation and rigorous control over revenues.

Keywords: Public Borrowing, Capital Expenditure, Revenue Expenditure, Capital Formation, Consumption Spending.

JEL Classification Codes: H63, H54, E62

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INTRODUCTION

Public debt is a vital fiscal instrument for financing expenditure beyond the existing revenues in developing countries like India. As defined by the Comptroller and Auditor General, it comprises the total liabilities of the public sector, raised at sustainable costs and risks to achieve development objectives. Exorbitant deficits have increased the public debt of India, which includes both internal and external liabilities against the consolidated fund and public account.

Though debt amounts capture people's interest, economic performance relies more on expenditure structure, where revenue expenditures finance recurring expenses such as salaries and subsidies, whereas capital expenditures develop assets, which contribute to economic development and debt servicing. Since the financial year 2000–01, India's government debt has generally remained in the range of 75–80% of GDP, largely reflecting the fiscal consolidation framework under the Fiscal Responsibility and Budget Management (FRBM) Act, 2003. Nevertheless, major macroeconomic disturbances, including the Global Financial Crisis (2008) and the coronavirus outbreak, caused the country's debt ratio to reach an all

time high of 87.67%. Post-pandemic recovery witnessed a slow correction of the country's debt ratio, which is around 81% of its GDP for 2023-24.

This study examines whether Indian government borrowing stimulates investment or promotes consumption, analysing General Government Debt, Capital and Revenue Expenditures, and Interest payments from 2000-01 to 2024-25. By emphasizing expenditure patterns over the volume of debt, it fills a lacuna in the existing literature and offers a paradigm shift in the form of capital-centric borrowing to ensure inclusive growth.

LITERATURE REVIEW

Public debt discussions have shifted from classical theory to empirical analyses emphasising qualitative utilization of borrowed funds over quantitative considerations.

The crowding-out theory postulated by classical theorists suggests that government debt leads to an increase in interest rates, hence displacing private investment (Zharku, 2018). However, the Keynesian approach emphasizes the stimulation of aggregate demand and growth due to public debt, which was confirmed through studies conducted on India in the period 1998-2012 (Bal, 2014). Further, the Domar sustainability condition suggests that the debt to GDP ratio reaches equilibrium where the rate of income growth exceeds the interest rate on borrowings.

Increasingly, modern research emphasizes the importance of debt composition rather than debt levels. In the same context, Hakhu (2015) and Das (2016) show that the effect of unproductive expenditures is harmful to real

GDP per capita in the long term, and capital expenditures are cointegrated with debt sustainability paths in India. The important point here is that Goyal (2018) finds that the fiscal multiplier associated with CAPEX is greater than 2.0, whereas the multiplier for REVEX is less than 1.0 in India, providing solid evidence for investment-based borrowing.

Besides, Aschauer (1989) proves that productive government expenditure could "crowd-in" private investments by mitigating infrastructure constraints and lowering production costs. Finally, Mohanty & Panda (2019) find via structural vector autoregression that expansions of public debt have had contractionary impacts on private investments in India in the past.

Intergenerational equity emerges as another key consideration. Fiscal deficits incurred through borrowing create future tax obligations without increasing productive capacity, thereby creating potential fiscal crises (Cecchetti et al., 2010). On the other hand, investments in productive resources are self-sustainable, funded by growth-related incomes (Eichengreen et al., 2023). In India, REVEX displays high persistence, whereas CAPEX operates as the residual that is adjusted during periods of consolidation (Goyal, 2015). The FRBM Act (2003, revised in 2018) incorporated the debt-GDP ratio into the fiscal rule framework; nevertheless, obtaining consistent off-budget data is an enduring challenge when trying to assess the real percentage of REVEX (Centre for Social and Economic Progress, 2024).

India's debt burden has seen much discussion, but its capital-revenue borrowing structure from 2000-2025 needs to be more thoroughly analysed. There were several structural events that took place during this period, such as the introduction of the FRBM Act in 2003, GST in 2017, and the economic shock of COVID-19. Most literature tends to explore the growth and sustainability of debt, neglecting the possible insights of the fiscal statistics on the allocation of resources. This study seeks to address this gap by developing a revenue–capital expenditure gap indicator, offering a clearer perspective on how public borrowing shapes spending priorities.

METHODOLOGY

Research Questions

The research questions for this paper shall be formulated as follows in an attempt to assess the productivity of Indian public debt:

1. To what extent has India's public borrowing been biased toward revenue expenditure relative to capital expenditure during the period 2000–2025?
2. How have structural shifts such as the FRBM Act (2003) and COVID-19 affected the productivity of India's public debt?
3. Is there a statistically significant relationship between changes in public debt and the revenue–capital expenditure gap in India?

Variables and Data Sources

This study uses annual secondary data for the period 2000–01 to 2024–25 to examine the composition and productivity of India's public borrowing. Fiscal and macroeconomic variables are compiled from the RBI's Database on Indian Economy (DBIE), Public Debt Management reports of the Department of Economic Affairs,

Union Budget documents, and official RBI publications. All variables are expressed in nominal terms to remain consistent with government fiscal reporting, and all data values are in rupees crores.

The variables under analysis are the five key variables: General Government Debt (GGD), Capital Expenditure (CAPEX), Revenue Expenditure (REVEX), Interest Payments, and Gross Domestic Product (GDP). The interest payments are analysed to assess the rigidity caused by debt, and GDP is the benchmark for the macroeconomic analysis of sustainability.

Analytical Framework

The empirical strategy combines descriptive ratio analysis with econometric estimation across five structural reference points: the pre-FRBM period, the post-FRBM period, the Global Financial Crisis, the GST implementation, and the COVID-19 shock and recovery. Four ratio indicators are constructed: the CAPEX-to-Debt ratio (productive investment share), the REVEX-to-Debt ratio (consumption spending share), the Interest Payments-to-Debt ratio (debt service pressure), and the Debt-to-GDP ratio (overall debt burden).

An econometric model in first differences examines short-run fiscal dynamics, avoiding spurious regressions from trending time series. The dependent variable is the Revenue–Capital Expenditure Gap, defined as the difference between the annual change in revenue expenditure and the annual change in capital expenditure. The baseline model relates this gap to changes in government debt and GDP and is estimated using Ordinary Least Squares, followed by diagnostic testing to ensure reliability.

TRENDS AND STRUCTURAL ANALYSIS

The Macro-Fiscal Landscape: Volume vs. Sustainability

The fiscal path followed by India from 2000-01 to 2024-25 has a structural dependence on borrowing to meet primary deficits. As shown in Figure 1 (next page), the General Government Debt (GGD) follows an upward nominal movement, rising above the ₹2,50,00,000 Crores level at the end of the period. However, sustainability is usually assessed through the Debt to GDP ratio, which displays a non-linear pattern controlled by specific “Structural Breaks.”

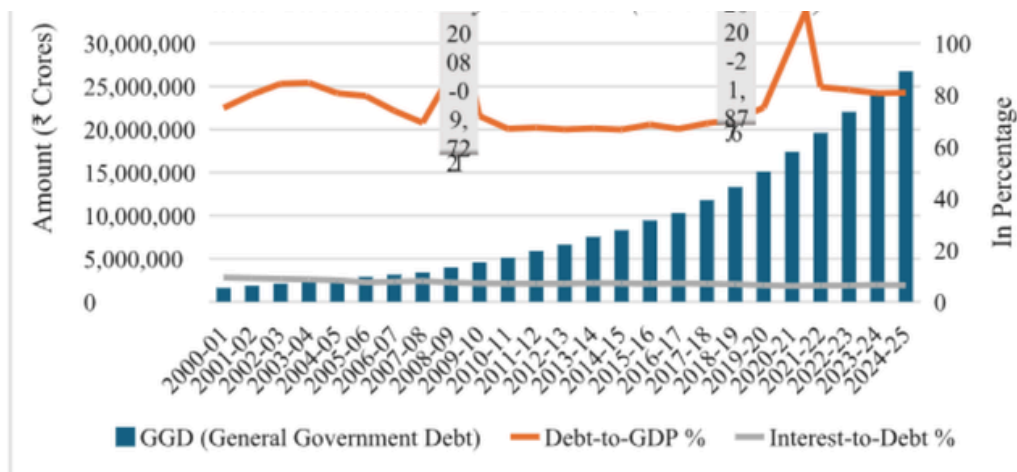
The first significant break occurred with the

FRBM Act of 2003. This legislative base constituted a fiscal consolidation period; the Debt to GDP ratio, having peaked in 2003-04 itself, commenced its gradual decline. The trend is interrupted by the Global Financial Crisis (2008-09), which constitutes the second structural break.

Figure 1 displays a “elbow” effect as the trend of consolidations flattened, with the government employing a counter-cyclical approach as the ratio shot to a notable 72.12% in 2008-09. Although the debt service ratio has been relatively flat in the mid-2010s, the impact of the pandemic in 2020-21 generated the largest structural break of the century, leading to a historic high in the ratio of 87.67%.

Figure 1

Evolution of General Government Debt and Sustainability Metrics (2000-2025)



Note: Sustainability ratios computed and graph constructed by the author using the following RBI datasets: Reserve Bank of India. (2025). Combined liabilities of the central and state governments. <https://rbidocs.rbi.org.in>, Reserve Bank of India. (2025). Database on Indian Economy (DBIE). <https://data.rbi.org.in>

In Figure 1, the Interest-to-Debt ratio serves as a vital indicator of fiscal pressure, representing the stubborn portion of the budget committed to servicing the existing debt stock. While the nominal volume of debt has surged, this ratio has remained an inherent, “Sticky” fiscal anchor that constrains future discretionary spending.

The Expenditure Bifurcation: Capital vs. Revenue

The core of the “debt productivity” debate lies in the allocation of borrowed funds between Capital Expenditure (CAPEX) and Revenue Expenditure (REVEX).

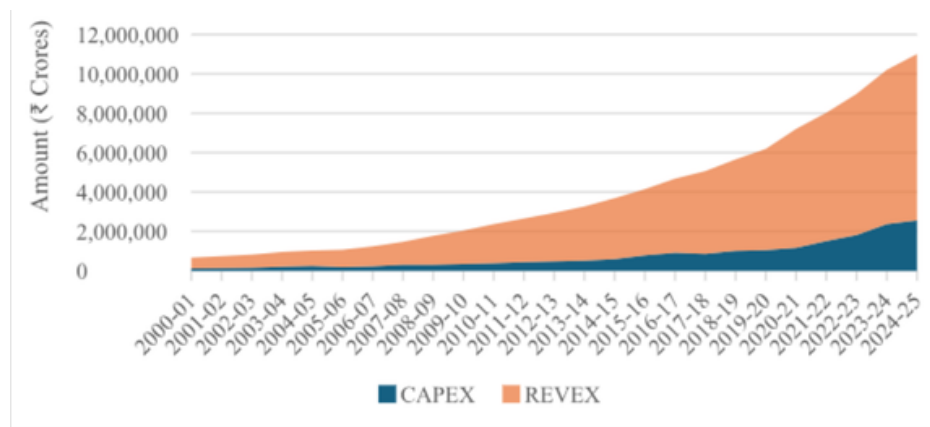
Figure 2 (next page) highlights a profound and persistent “REVEX-CAPEX Divide.” For nearly two decades, India’s fiscal system exhibited a bias toward consumption-led borrowing.

REVEX, comprising salaries, subsidies, and interest payments, shows an unbroken, aggressive upward slope, eventually exceeding ₹1,00,00,000 Crores. Its “sticky” nature is evident during the 2017 GST implementation; despite the structural shift in tax collection, REVEX outlays continued their ascent. Conversely, CAPEX (asset-creating investment) remained a fiscal residual for much of the study period. The widening gap in Figure 2 suggests that for much of 2000–2020, public borrowing was predominantly used to finance current consumption rather than future capacity.

Efficiency Ratios and the Productive Pivot

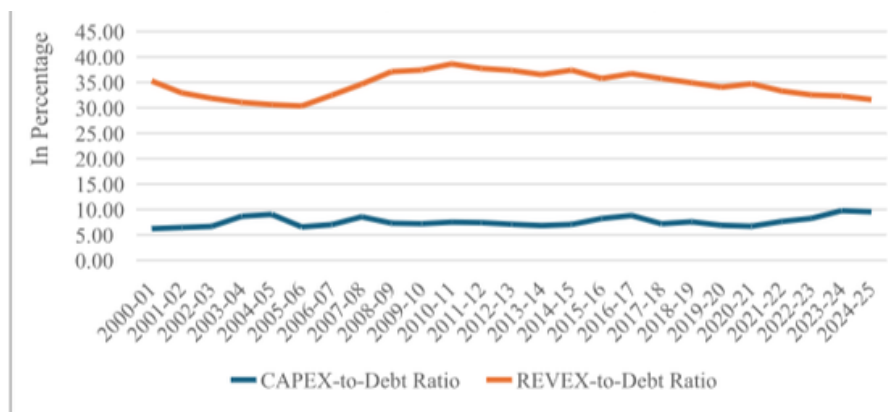
The efficiency of public debt is measured by the CAPEX-to-Debt and REVEX-to-Debt ratios as shown in Figure 3 (Next Page). A high REVEX-to-Debt ratio indicates that borrowing is being

Figure 2
Composition of Total Public Expenditure: The REVEX-CAPEX Divide



Note: Sustainability ratios computed and graph constructed by the author using the following RBI datasets: Reserve Bank of India. (2025). Database on Indian Economy (DBIE). <https://data.rbi.org.in/DBIE/#/dbie/home>

Figure 3
Comparative Debt-Utilization Ratios: Measuring Fiscal Productivity



Note: Ratios computed by the author using RBI DBIE data and DEA public debt statistics. Graph constructed by the author using the following sources: Reserve Bank of India. (2025). Database on Indian Economy (DBIE). <https://data.rbi.org.in>, Department of Economic Affairs, Government of India. (2025). Public debt management report. Ministry of Finance.

utilised for current consumption, which does not expand the economy's future repayment capacity. Throughout the 2010s, this ratio remained consistently high, reinforcing concerns about intergenerational equity.

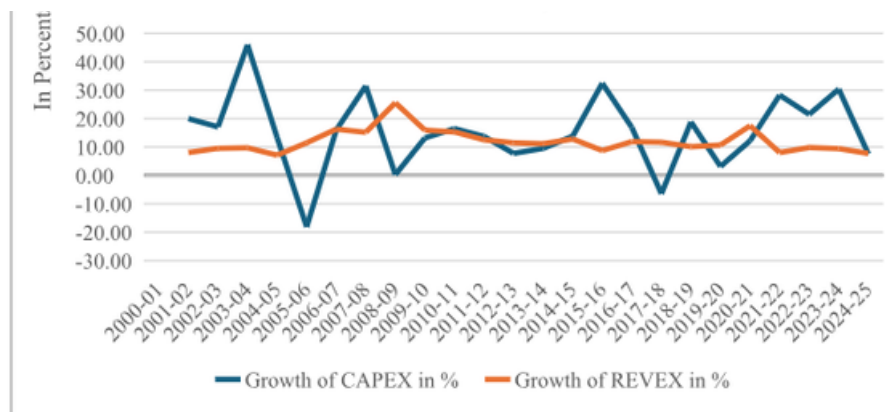
The structural break became apparent after COVID-2021-2025. Policy shifted toward infrastructure-led growth to escape the consumption trap. This "Corrective Trend" is visible in Figure 3 as the CAPEX-to-Debt ratio begins a steady climb, reaching its highest level in the 25-year series by 2024-25 (approaching the 10% mark). This transition marks a departure toward "investment-oriented" borrowing, aimed at improving long-term productive capacity.

Growth Dynamics: Volatility vs. Consistency

The growth patterns in Figure 4 (Next Page) reveal the government's operational priorities during structural breaks.

The Growth Rate of REVEX (orange line) is predictable, typically staying within a stable band. However, the Growth Rate of CAPEX (blue line) exhibits extreme volatility. The significant structural change observed in 2005-06 reveals a sudden contraction in CAPEX growth, declining to as low as -18%, whereas 2003-04 indicates an enormous surge of over 45%. As indicated in the graph, it is observed that following the 2020 COVID-19 event, there is a strategic and aggressive increase in capital outlays to boost and jumpstart the economy, with a notable increase of as high as 30% in 2023-24. The declining difference between REVEX and CAPEX growth rates after 2022 reveals economic sustainability.

Figure 4
Annual Growth Dynamics of Capital and Revenue Outlays



Note: Growth rates computed by the author using RBI DBIE data and DEA public debt statistics. Graph constructed by the author using the following sources: Reserve Bank of India. (2025). Database on Indian Economy (DBIE). <https://data.rbi.org.in>, Department of Economic Affairs, Government of India. (2025). Public debt management report. Ministry of Finance.

Critical Reflections on India’s Fiscal Trajectory

India’s debt journey from 2000 to 2025 demonstrates that while the quantity of debt is driven by global shocks, the quality of debt is driven by domestic policy choices. The analysis confirms a historic reliance on borrowing for “unproductive” revenue purposes. However, the aggressive CAPEX pivot in the final five years of the study offers a blueprint for fiscal sustainability. India must continue to prioritize debt-financed asset creation over debt-financed consumption.

EMPIRICAL ANALYSIS

Model Specification and Variable Construction

The empirical framework captures short-run fiscal dynamics using a first-difference specification to avoid spurious regression from trending time series. This focuses on

year-to-year changes, improving stationarity and isolating fiscal behaviour over the business cycle. The first differences of the variables were constructed as follows:

- Change in Gross Domestic Product
- Change in Capital Expenditure
- Change in Revenue Expenditure
- Change in General Government Debt

To directly test the investment versus hypothesis, a new fiscal indicator was constructed: the Revenue–Capital Expenditure Gap. This variable is defined as the difference between the change in revenue expenditure and the change in capital expenditure. This transformation provides a direct measure of the fiscal allocation bias. A higher value of the gap indicates that increases in expenditure are skewed toward revenue spending rather than investment spending.

The baseline econometric model to be estimated is:

This specification allows the study to examine whether changes in borrowing widen the revenue–capital gap and whether economic growth moderates or amplifies this relationship.

Estimation Technique

The model was run using Ordinary Least Squares (OLS) estimation in RStudio. OLS is appropriate given the linear specification and the objective of estimating the marginal effect of borrowing and growth on fiscal allocation. Diagnostic tests were conducted to verify that the classical regression assumptions are not violated.

Regression Results

From the regression results provided in Table 1 (Next Page), statistical significance and considerable explanatory variance are obtained; the model provides a measure for R² of 0.682 with an adjusted measure of 0.652, which translates into 65-68% for the variance explained for the gap in revenue and capital expenditures attributable to differences in change for government debt levels and GDP measures. The model can be deemed statistically significant based on the F-statistic (p < 0.001).

The coefficient on the change in government debt (Δ GGD) is positive (0.268) and highly significant at the 1% level. This result is central to the study’s research question.

Table 1
OLS Regression Results: Revenue-Capital Expenditure Gap Model

Variable	Coefficient	Std. Error	t-value	p-value
Intercept	110,271.028	37,019.70	2.979	0.007 **
	0.268	0.04	6.653	<0.001 ***
	-0.128	0.03	-4.227	<0.001 ***
Statistic		Value		
		0.682		
Adjusted R ²		0.652		
F-statistic		22.540		
Number of observations		24.000		

*(Signif. codes: *** p < .001, ** p < .01, * p < .05, . p < .1)*

The intercept term is positive and statistically significant. This implies that even in the absence of changes in debt or GDP, there exists an inherent upward bias toward revenue expenditure in fiscal dynamics.

It indicates that increases in public borrowing are associated with a widening revenue–capital expenditure gap. In practical terms, a one-unit increase in debt growth is associated with a 0.268 unit increase in the gap. This positive coefficient in Table 1 suggests that for every additional rupee borrowed, nearly 27% contributes to widening the gap in favour of consumption, corroborating the revenue bias discussed in Section 4.2. This suggests that borrowing is disproportionately directed toward revenue expenditure rather than capital formation.

In contrast, the coefficient on economic growth (Δ GDP) is negative (-0.128) and statistically significant. This indicates that stronger economic growth reduces the revenue–capital gap. During periods of higher growth, fiscal policy appears to be more oriented towards investment, suggesting that supportive economic conditions promote investment expenditure.

The results of all these tests point to an important fiscal asymmetry. Borrowing finances normal consumption, and growth stimulates investment.

Diagnostic Tests

To ensure the reliability of the estimates, several diagnostic tests were performed, the results of which are presented in Table 2.

First, the existence of multicollinearity in the independent variables was checked with the help of the Variance Inflation Factor (VIF) test. It is found in the given problem that the VIF values for the two independent variables are around 2.13, well below the stipulated maximum of 10.

Second, the application of the Durbin-Watson test has checked for serial correlation between residual values. The results give a value of 1.56, a corresponding p-value of 0.087, and indicate that there is a mild level of positive serial correlation, but it is not significant at 5%. As a result, the null hypothesis could not be rejected

Table 2
Diagnostic Tests

<i>Test</i>	<i>Statistic</i>	<i>P value</i>
<i>VIF – ΔGGD</i>	<i>2.129</i>	
<i>VIF – ΔGDP</i>	<i>2.129</i>	
<i>Durbin–Watson</i>	<i>1.560</i>	<i>0.087</i>
<i>Breusch–Pagan</i>	<i>0.530</i>	<i>0.767</i>

Another heteroskedasticity test was performed by the Breusch-Pagan test. The p-value of 0.767 shows that the null hypothesis of homoskedasticity could not be rejected. This confirmed that the variance of residuals was stable and the OLS estimates remained efficient. Overall, the results from the diagnostic tests affirm that the model meets all the assumptions that are made in classical linear regression and that the results for the coefficients of the model are reliable.

Econometric Synthesis and Discussion

The empirical results lend a strong supporting base to the consumption bias hypothesis of public borrowing in India. The positive and statistically significant correlation between debt growth and the revenue-capital expenditure gap points to a stronger link between public borrowing and the funding of revenue expenditures. Nevertheless, the negative correlation between GDP growth and the expenditure gap adds a further dimension to the observed correlation. In periods of rising GDP, fiscal policy tends to favour capital formation, suggesting the borrowing bias is partly cyclical.

Policy-wise, these findings stress the need to improve current fiscal and borrowing arrangements to ensure a proper link between debt build-up and productive investment in the public sector. Without this improvement, increasing public debt might not contribute to positive growth effects in the long run.

In brief, the results from the empirical analysis suggest that, while public borrowing has this potential impact, its effectiveness has actually been channelled towards revenue expenditure rather than investment over the sample period.

SYNTHESIS OF TRENDS AND ECONOMETRIC EVIDENCE

The combined evidence from the trend analysis and econometric estimation provides a coherent assessment of the evolving nature of India's public borrowing. While the descriptive analysis captures long-run structural patterns, the regression results offer statistical evidence on how borrowing is allocated across expenditure categories in the short run. Together, they shift the focus from the quantity of debt to its composition and productivity.

The trend analysis reveals that for most of the study period, India's fiscal system was characterized by consumption-oriented borrowing. Revenue expenditure grew steadily and persistently, while capital expenditure remained comparatively volatile and secondary. The widening gap between Revenue and Capital Spending, as revealed by Figure 2, and the sustainment of debt servicing, imply that over time, debt-sourced resources may have primarily been employed for servicing rather than creating capacity. However, post-COVID, it is clear that there is a marked break from the past. The increase in the CAPEX-to-Debt ratio and faster growth in Capital Expenditure point to a shift in policy focus.

The econometric results support the above description. The positive and statistically significant relationship between changes in government debt and the revenue-capital expenditure gap indicates that, in general, there has been a positive relationship between more borrowed funds and more spending on revenues compared to capital. However, at the same time, the negative relationship between GDP growth and the revenue-capital expenditure gap

indicates that in good economic times, there is more investment-oriented spending; hence, borrowed funds are more investment-focused during growth periods.

Collectively, the findings reveal a clear fiscal transition: India's debt profile shows a legacy of consumption-oriented debt flows being displaced by more recent investment-oriented utilisation. This combination of findings reinforces the main arguments presented in the paper: indeed, the sustainability and expansionary effects of fiscal debt depend on the utilisation of borrowed resources.

POLICY RECOMMENDATIONS

Indian fiscal experience points to an obvious structural bias: funds borrowed have been predominantly used to fund consumption instead of investments. The following policy suggestions seek to redress this issue and establish borrowing within an outcome-oriented paradigm.

First, a stronger commitment is needed for capital expenditures as the means for utilising funds borrowed. It is now necessary to formalise this effort into multilateral expenditure plans, which allocate money for infrastructure, logistics, and energy sectors – those that generate a proven high fiscal multiplier effect (Goyal, 2018).

Second, efficiency in the use of revenue expenditures is vital. Although social spending cannot be compromised for the sake of effectiveness, smarter subsidising practices and a rational approach to expenditures tied to salaries will allow for a decrease in crowding-out effects.

Third, it is important to tie borrowing practices to economic benefits. Coordination between the Ministry of Finance and public investment management organisations can help evaluate the economic prospects and ability to service debts of each project.

Fourth, maintaining the economy's growth is one of the ways of managing debt. From the empirical results, it is evident that growth in the GDP reduces the revenue-expenditure ratio, such that measures taken to increase growth also increase the quality of borrowing. Economic reforms that enhance the capacity of production are thus consistent with fiscal policy consolidation.

Lastly, there is a need for increased transparency on how debt finances government expenditure. Debt from off-budget financing and debt borrowing trends in the states are hard to monitor (CSEP, 2024). Increased public disclosure of debt could improve fiscal responsibility.

CONCLUSION

The purpose of this research was to investigate the extent to which the borrowing of India has been made mainly for capital formation and not consumption expenditure between the years 2000-01 to 2024-25. The results have clearly established a revenue orientation in the borrowing policy of India through an analysis of trends and through the use of econometric estimation. The trend results show that there is persistent growth in revenue expenditure compared to capital expenditure throughout the period under consideration. In addition, the econometric regression shows that growth in borrowing has been associated with an increase in the difference between revenue and capital

expenditures. The results of debt sustainability analysis showed sensitivity to shocks in the economy, particularly the global financial crisis and the pandemic. This implies that the efficiency of public borrowing depends on how it is used, and not just on the size of the borrowing.

Nevertheless, the paper makes another important observation. There has been a significant shift in the post-pandemic era towards increased CAPEX investments, higher CAPEX/Debt ratios, and a decrease in the growth differential between revenues and capital expenditures. The empirical findings support this idea as well. An increase in GDP growth rates results in a decrease in the difference between revenues and capital, thereby indicating an improvement in the quality of borrowing in response to economic trends. Some limitations can be noted regarding the scope of this paper as it uses aggregate secondary data and examines short-term dynamics, while other questions require further research at the state level in terms of long-term dynamics and causality between debt structure and GDP growth. Nonetheless, the principal conclusion remains valid – sustained and intensified CAPEX investment orientation beyond 2021 is critical for transforming India's public debt into a driver of sustainable economic development.

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Expansion of Solar Energy and Its Economic Effects in India

Harsh Saini

ABSTRACT

India has witnessed major changes occurring in the energy sector within the past decade. Solar energy has emerged as an important area of renewable and new energy. The growing demand for energy, fossil fuel consumption, and environmental concerns have also driven the growth of solar energy due to its availability, declining prices, and favourable policies. The present research aims to discuss the growth trend of solar energy and its association with Indian economic growth from 2010 to 2025. Descriptive and trend analysis have been done to show solar energy capacity, solar power generation, and GDP growth. The research findings show rapid growth trends of solar energy, particularly since 2016, along with the growth rate of electricity and a positive association between solar growth and Indian economic growth.

Keywords: Solar Energy, Renewable Energy, Economic Growth, Solar Capacity Expansion, Solar Power Generation, Clean Energy Transition, India Energy Sector.

JEL Classification Codes: Q42, Q43, O13

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INTRODUCTION

The increasing concern and problem about climate change, environmental pollution and depletion of fossil fuels shifted the focus of all the nations worldwide to the development of renewable energy sources. In which solar energy has been identified as one of the most important sources and plays a crucial role because of its abundance, renewability and pollution-free nature. India has great potential for solar energy as its environmental advantage of sunny days for most of the days in a year and helps to fulfil its growing demands for energy. In addition to this, the rapidly growing economy and industrialisation of the country have been the major contributing factors to the rising demand for electricity. This demand has been fulfilled by the production of electricity from coal, leading to environmental pollution and energy security concerns, thereby changing the focus towards the need for a cleaner and more sustainable source of energy. This has resulted in negative impacts, including increases in carbon emissions, environmental degradation, import dependence, and energy security concerns. To overcome these problems, the Indian Government started a movement towards the utilisation of clean energy, and the launch of the National Solar Mission in 2010 was a turning point in this

regard. Since then, because of the help of supportive policies, the reduction in technology costs, and competitive bidding, the solar energy sector has emerged as one of the fastest-growing segments of the Indian power sector.

Notwithstanding this rapid growth, there is a lack of empirical studies that have attempted to analyse the economic importance of solar energy in India. This current study aims to analyse the growth and economic importance of solar energy in India from 2010 to 2025, including the initial growth stage after the National Solar Mission and the subsequent accelerated growth stage. The study aims to analyse the trends of installed solar capacity and solar power generation and their relationship with the major economic indicators of GDP growth and employment generation. While using descriptive and trend analysis, the research aims to acknowledge the alignment of solar energy growth with the economic development of India. The study is important as it carries a point of view of solar energy specific economic development, which leads to the importance of solar energy as a major driver of sustainable economic development in India.

There is limited evidence on empirical studies that are specific to solar energy and its growth in India. Secondly, the generation of employment opportunities in the solar energy sector over a long period of time has not been adequately researched, with most research being conducted on short-term employment generation. Thirdly, there is a lack of analysis that compares the slow growth phase and the expansion phase of the solar energy sector.

Solar PV Potential in India (Ground Mounted)

The solar photovoltaic potential of India for ground-mounted stations is depicted in Figure 1 (Next Page) , which has been estimated by the National Institute of Solar Energy (NISE) under the Ministry of New and Renewable Energy (MNRE).

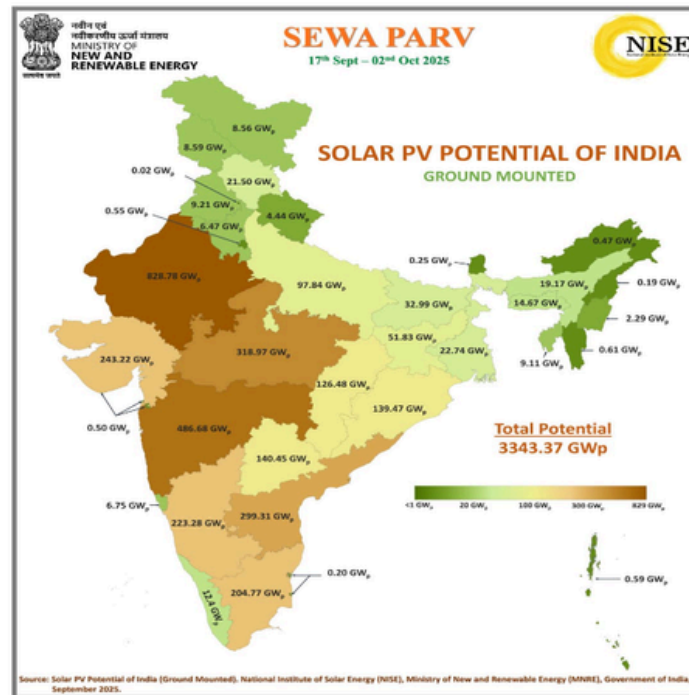
The map reveals a large and high concentration of solar potential in the western and central regions of the country in states such as Gujarat, Rajasthan, Madhya Pradesh, Maharashtra, and Karnataka. These states have high solar intensity and potential, large land availability and suitable climate conditions. On the other hand some of the northeastern and hill states have relatively lower ground-mounted potential.

India has one of the biggest solar power resources in the world, with an estimated ground-mounted solar PV potential of around 3343 GWp, as identified by NISE. But despite the huge potential available, only a small fraction of it has been tapped so far. As of 2025, India has an installed solar power capacity of around 135 GW approx., which is less than 3% of the estimated technical potential. This huge difference between the potential and the actual use of solar power clearly indicates that there is a huge potential available for the growth of the solar power sector, which will be a great contributor to the economic development of the country in the coming years.

LITERATURE REVIEW

The extant literature on the solar power industry in India is indicative of the evolution of this form of renewable energy from a secondary source of power to an essential part of economic and

Figure 1
Solar PV Potential of India



Source: Ministry of New Renewable Energy (MNRE), Government of India (2025)

sustainable development. The early literature centred on the potential, feasibility, and limitations of the use of renewable energy sources. According to Painuly (2001), while India had substantial amounts of solar energy, there was little adoption of solar energy owing to its prohibitive cost and lack of institutional and financing support. Bhattacharyya (2010) also reported that before 2010, renewable energy strategies and policies in India were piecemeal and unclear, leading to poor adoption rates.

One significant change in the literature is observed after 2010, following the implementation of structural policies and national missions for solar energy. According to Santosh Kumar (2024), this period proved vital in fostering investors' confidence and speeding up the development of solar power generation. The institutional processes of competitive bidding and reverse auctions lowered solar costs

and increased efficiency (Dr Subhash, 2025). These trends align with previous empirical studies conducted by Apergis and Payne (2010), who found that there exists a direct link between energy consumption from renewable sources and economic development, albeit not in the Indian context.

Policy backing and institutional support have remained important considerations in all studies. According to Majid (2020), policy stability and regulations were critical for maintaining investments in renewable energy sources. In a similar vein, Sreenivasulu (2022), as well as Santosh Kumar (2024), noted that good coordination between the federal and state governments was a critical determinant of the rate of adoption of solar energy. The post-2016 literature review also shows that policy goals have expanded from merely increasing capacity to other areas like value chain building, energy security, and job creation.

Technological improvements and cost savings are recognised as vital factors in solar power development. Advances in photovoltaic technology, economies of scale, and experience curves have resulted in a considerable reduction in the cost of solar generation (Dr Subhash, 2025; Babu, 2022). In addition, competition among firms has played a role in further reducing the costs and boosting efficiency (Majid, 2020). Nevertheless, while there is a reduction in the cost of generation, problems related to integrating, transmitting, and storing solar power persist (Bhattacharyya, 2010). Amer Bakir (2020) also stressed the need for developing local industries for the sustainable production of solar power.

Economic considerations relating to solar power generation constitute yet another topic of discussion in the relevant literature. A few studies have brought out the significance of renewable energy for economic growth by way of investments and capital accumulation along with industry growth (Apergis & Payne, 2010; Bhattacharyya, 2010; Amer Bakir, 2020). In the Indian case, huge solar energy projects have resulted in increased private investments as well as growth of other sectors, like manufacturing and construction (Amer Bakir, 2020). One more area of interest, according to the literature, is employment creation, especially concerning installation, maintenance, and operations (Santosh Kumar, 2024; Weischer, 2014). It is also seen that a lot of these jobs are of a temporary nature and project-specific, making them unsustainable in the long run (Santosh Kumar, 2024).

Environment and sustainability issues have been well discussed in the literature. The benefits of

solar energy, in terms of reducing carbon emissions and contributing to the fight against climate change, have been well documented (Upendra Kumar, 2025). Research has also pointed out its positive impact on sustainable development by producing clean energy and decreasing reliance on fossil fuels (Apergis & Payne, 2010; Chauhan, 2019). At the same time, new problems associated with land use issues, environmental degradation, and regional disparities have been noted, especially in relation to solar projects on a large scale (Chauhan, 2019). The management and recycling of solar panels pose another challenge that requires consideration from a sustainability perspective (Rajesh Kumar, 2020).

There are still several gaps that exist in the literature despite its broadness. An important drawback is that most existing studies evaluate renewable energy in general and ignore the unique contributions of solar energy to the economy and employment (Amer Bakir, 2020). Additionally, there are no sufficient studies about the rapid growth phase in India, especially after 2020 (Dr Subhash, 2025).

METHODOLOGY

Research Questions

1. What are the trends in the overall solar sector in India for the last decade?
2. How is the Indian Economy affected by the growth in solar energy?
3. What is the effect of the increasing application of solar energy on employment generation in India?
4. In what ways are policies and incentives driving the rapid development of the solar industry and the major challenges it faces in the Indian context?

Variables

The variables employed in this analysis are:

A) **Installed Solar Energy Capacity (in GW):** The installed solar energy capacity data are obtained and collected from the Ministry of New and Renewable Energy (MNRE) and the Central Electricity Authority (CEA). This variable represents the actual progress of solar development in India.

B) **Solar Power Generation (in MU):** The annual solar electricity generation data are obtained and collected from the Central Electricity Authority (CEA) and NITI Aayog. This variable represents the actual use of installed capacity and indicates the performance of the solar sector.

C) **Gross Domestic Product (GDP):** The GDP at constant prices is obtained from the National Statistical Office (NSO) and the World Bank database. GDP is employed as an indicator of economic performance.

D) **Employment in the Solar Sector:** The employment-related information is compiled from reports of MNRE and the International Renewable Energy Agency (IRENA). In cases where annual employment data are not available, employment trends are analysed through sectoral estimates and growth trends.

RESULTS

Trends in Installed Solar Energy Capacity

Figure 2 (Next Page) indicates a dramatic rise in the installed capacity of solar energy in India during the period of analysis. From a position of almost zero installed base in 2010, the progress

has been quite swift, particularly in the second half of the 2010s. This has further accelerated since 2016 and then again since 2020, thus establishing a paradigm shift in the energy sector of India.

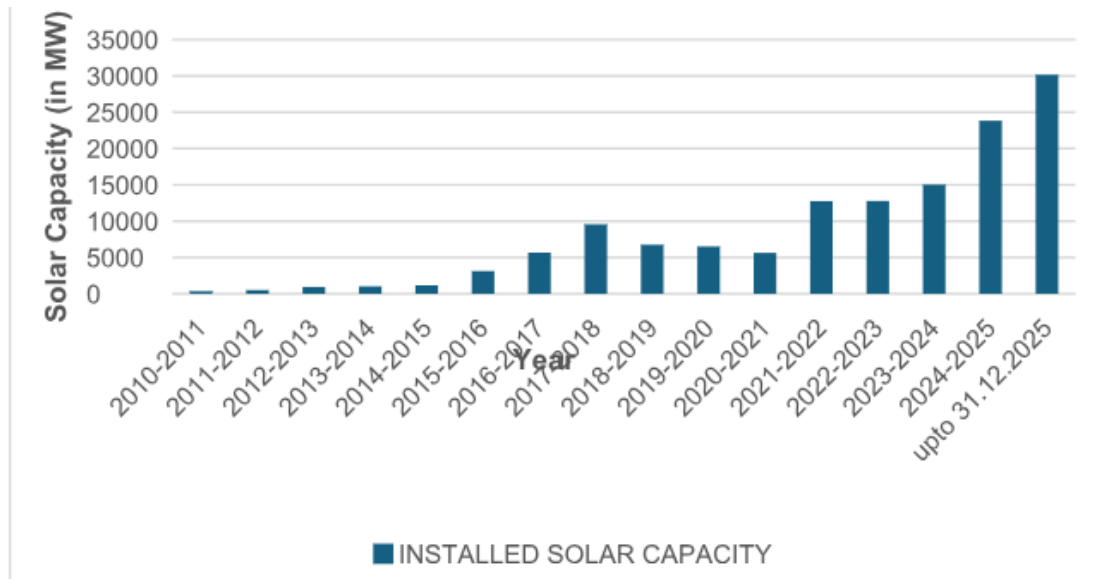
The trend analysis clearly indicates that there are three distinct phases in the overall period of analysis. The first phase, from 2010 to 2014, indicates a gradual increase in capacity, which is natural in the initial stages of adoption, with high technology costs and low market maturity. The second phase, ranging from 2015 to 2019, shows a sharp rise in capacity, which is in accordance with the scaling up of the National Solar Mission, the introduction of competitive bidding, and the involvement of the private sector. The third phase, ranging from 2020 to 2025, depicts an exponential rise in capacity, despite the initial hiccups due to the COVID-19 pandemic.

The fact that there has been a steady increase in the installed capacity is an indication of the strong policy support and confidence of the investors. It is also a result of reduced capital costs, improved project execution skills, and better integration capabilities. These findings are a testament to the fact that solar energy has moved from being a niche renewable energy source to being a mainstream energy source.

Solar Power Generation and Capacity Utilisation

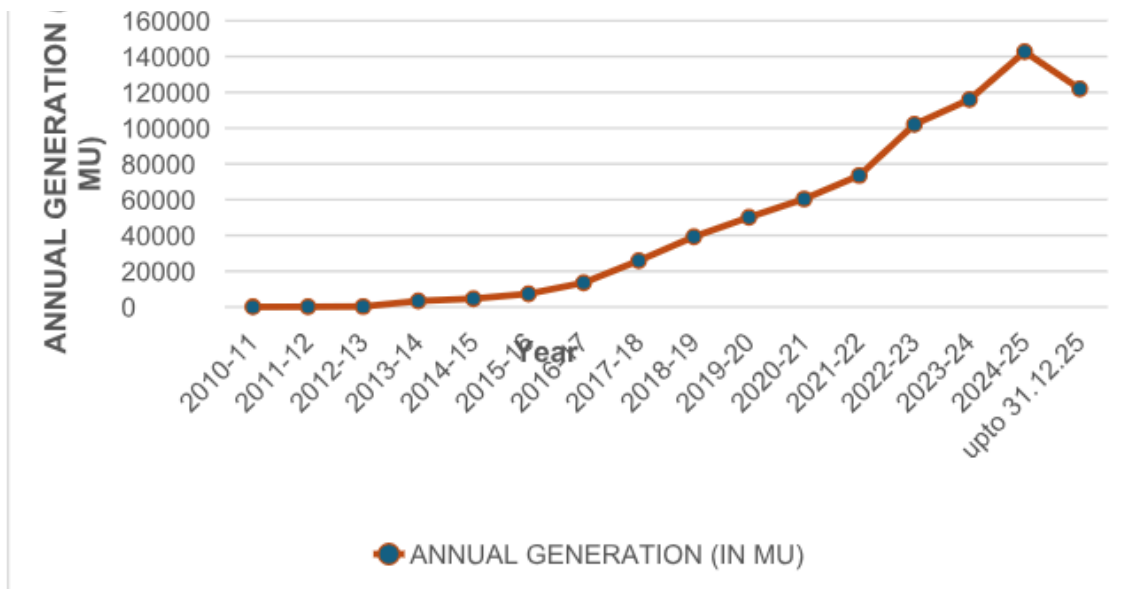
Figure 3 (Next Page) shows the analysis of solar power generation and clearly shows a trend that is very closely linked to the growth in installed capacity. Solar power generation has been steadily increasing over the years, with very sharp increases after 2016. The parallel trend

Figure 2
Installed Solar Capacity



Source: Author's Compilation based on MNRE (2025)

Figure 3
Solar Electricity Generation



Source: Author's Compilation based on CEA and NITI Aayog

between capacity addition and electricity generation indicates efficient use of capacity and improvements in efficiency.

Descriptive statistics reveal that the rate of growth of solar power generation has, in some years, outpaced the rate of growth of installed capacity. This is an indication of improved capacity factors due to advances in technology, superior site selection, and improved maintenance practices. The rising share of solar power in total electricity generation indicates its growing significance in the fulfilment of India's energy requirements.

Further, the trend analysis reveals that the variability in generation is quite constrained, which is an indication of enhanced management of the grid and the ability to predict generation. Although solar generation is quite variable, the steadiness in the growth of generation is an indication of learning and proper integration of solar generation with the overall electricity system.

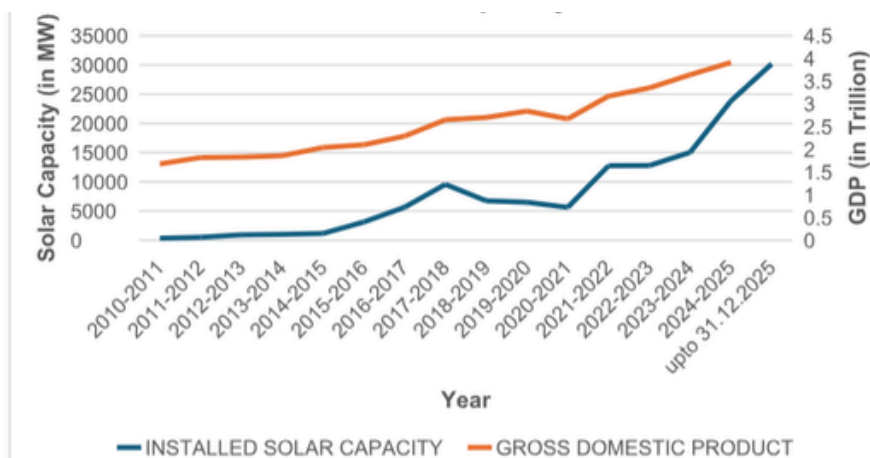
The findings emphasise that the development of solar power in India is not only capacity-driven but also performance-driven. The ability to convert capacity into a stable electricity output further strengthens the economic importance of solar power development and its role in energy security.

Relationship between Solar Energy Growth and GDP Trends

Figure 4 shows the analysis of GDP trends and solar energy indicators, which indicates a positive relationship between the growth of the solar energy sector and GDP. During the period of analysis, the GDP of India has been growing steadily, despite occasional setbacks in the global economy.

The trends of solar capacity and solar generation can be compared to the trends of GDP growth. A parallel trend is observed in the solar energy sector and GDP growth, especially during periods of rapid expansion in the solar energy sector. Years of rapid expansion in the solar

Figure 4
Installed Solar Capacity & GDP



Source: Author's Compilation based on World Bank and MNRE

energy sector and GDP growth, especially during periods of rapid expansion in the solar energy sector. Years of rapid expansion in the solar energy sector are often years of stable or improving GDP performance.

The results indicate that solar energy has a positive influence on economic development in a number of ways. The development of solar energy positively influences the economy by creating demand in the construction, manufacturing, logistics, and financial industries.

However, the findings also suggest that the growth of GDP is affected by a variety of macroeconomic variables. The macroeconomic variables affect the growth of GDP in a significant manner. Therefore, the findings of this study should not be interpreted as a causal relationship but as a correlation. The findings of this study are consistent with the argument that the growth of solar energy complements economic development and is consistent with the overall growth pattern of India, thereby establishing its importance as a strategic sector in the economy.

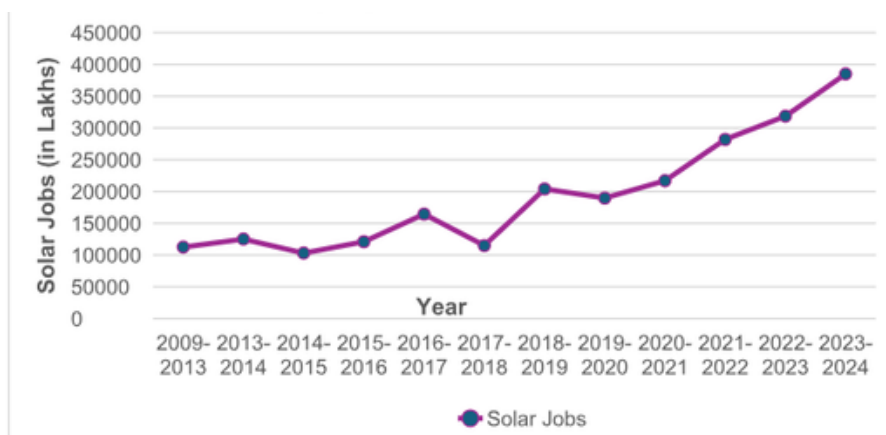
Employment Generation in the Solar Energy Sector

Figure 5 (Next Page) shows employment trends in the solar energy industry and an overall positive trend over the period of study, with significant fluctuations during different phases. Analysis shows that employment creation was significantly high during the phases of fast-paced capacity addition, especially during large-scale project implementation phases.

The findings indicate that employment creation in the solar industry is primarily driven by installation and construction activities, which are highly labour-intensive. Manufacturing, operation, and maintenance activities also contribute to employment creation, but to a relatively lesser extent. This accounts for the fluctuations in employment levels, as employment creation peaks during the peak installation phase and then remains stable.

Trend analysis emphasises that although solar energy provides substantial employment opportunities, these are largely of a project-

Figure 5
Employment Generation



Source: Author's Compilation based on IRENA

specific and temporary nature. Employment opportunities over the long term seem to be more closely tied to domestic manufacturing capabilities and the development of the power grid.

Despite the limitations of the data, the trend is that solar energy has become an important source of green employment in India. The development of the solar sector has provided employment opportunities at various levels, including semi-skilled and unskilled workers, thereby ensuring inclusive growth.

The results are consistent with the existing literature that views renewable energy as a more labour-intensive process than traditional power production, especially during the installation phase. However, the results also suggest the need for policies that can improve the quality of employment in the solar sector.

Phase-wise Comparison: Pre- and Post-Acceleration Period

Phase-wise analysis of the development of solar energy during the period of study shows that there has been a definite structural change in the Indian solar energy industry. Even though the study period is mainly focused on 2010-2025, there have been noticeable differences between the expansion phase (2010-2015) and the rapid expansion phase (2016-2025). This analysis will assist in comprehending the transition of solar energy from being a policy-driven pilot sector to becoming an integral part of the Indian economy.

The expansion phase (2010-2015) saw a small-scale development of solar capacity and solar

power production. This phase was characterised by experimentation, a lack of confidence among the private sector, and high production costs. Even though the National Solar Mission was initiated in 2010, which formed the institutional framework, the development of solar capacity was slow and incremental. The economic spillovers during this phase were minimal, and solar energy's contribution to GDP and employment was insignificant.

From an economic point of view, the rapid growth phase reflects a greater synchronisation between the growth of solar energy and overall macroeconomic variables. Mega solar power projects, private and foreign investments, and the development of related infrastructure have helped to create capital. Job creation has also increased during this phase, especially in the installation work, which indicates the labour-intensive nature of solar energy.

Therefore, the comparison of these phases reveals that the economic importance of solar energy in India has grown rapidly over the years. Although the initial phase was marked by the readiness of policies and feasibility studies, the latter phase indicates maturity, economies of scale, and better integration of the sector with the economy of the country. This is a clear indication that policy consistency, learning, and technological advancements are critical in allowing renewable energy to contribute to economic development.

DISCUSSION OF KEY FINDINGS

The results of this study are significant in understanding the pattern of growth and economic significance of solar energy in India.

Based on the descriptive and trend analysis, it has been revealed that solar energy has evolved from a complementary source of renewable energy to a critical sector in the energy and economic systems of India.

One of the most significant observations of this study is the steady and fast growth in the installation capacity and generation of solar energy in India, especially since the mid-2010s. This is an indication of the cumulative impact of favourable government policies, the reduction in the cost of technology, and the development of market structures. The parallel growth in capacity and electricity generation indicates that the development of solar energy in India has been quantitative and performance-oriented.

Another significant observation is the positive correlation between the growth of solar energy and GDP. Although the study does not establish causality, the concurrent trend of solar indicators and GDP growth indicates that the development of solar energy has occurred concurrently with the growth of the economy. The solar energy industry makes a contribution to economic activity through investment, infrastructure development, and backwards and forward linkages with other related industries like manufacturing, construction, and finance.

Job creation is identified as a complex but important impact of solar energy growth. The results show that solar energy generates a large number of job opportunities, especially in the construction and installation phases. However, the dominance of short-term and project-specific employment opportunities indicates a structural

constraint. Employment growth in the long term seems to depend on the development of the value chain, including manufacturing, operation and maintenance services.

It also emphasises the importance of policy intervention in influencing these outcomes. The transition from subsidy-based support to market-based support through competitive bidding has led to better cost efficiencies and scalability. However, the challenges of grid connectivity, land availability, and the financial viability of distribution companies continue to impact the quality of solar sector development.

The discussion above indicates that solar energy has emerged as a significant economic force not only as a clean energy option but also as a source of investment, employment, and energy security. The findings of the study support the fact that the development of renewable energy can meet environmental goals and economic growth objectives when policies and capacities are in place. However, the findings also emphasise the need for specific policy interventions to improve the quality of employment, infrastructure, and sustainability of the solar sector.

Policy Implications

The results of the study point to a number of policy implications that are very important for ensuring the sustainability and long-term economic impact of solar energy in India.

First, there is an immediate need to improve the country's grid infrastructure and energy storage systems. With the growing solar energy capacity in the country, the issue of integrating solar

energy into the country's grid infrastructure is likely to become more pronounced in the future. There is a need to make efforts to improve the country's transmission infrastructure, energy storage systems, and smart grid systems to ensure that the growing capacity of solar energy can be properly integrated into the energy mix. Otherwise, the economic benefits of the expansion of solar energy may be threatened.

Secondly, the financial viability of the distribution companies (DISCOMs) is a major challenge for the development of the renewable energy industry. The financial losses, delays in payments, and uncertainties in contracts are major concerns for the industry. There is a need to improve the financial viability of the DISCOMs through measures such as tariff reform, improvement in efficiency, and a change in organisational structure to ensure the long-term viability of solar energy procurement.

Third, the report highlights the need for domestic manufacturing and skill development. Although India has achieved considerable success in the installation of solar power capacity, the country's reliance on imported solar products hinders domestic value addition and job creation. Initiatives for the development of local manufacturing of solar modules, components, and technologies can prove to be helpful in improving the development of industries and reducing reliance on other nations. At the same time, skill development programs should be initiated to develop a skilled workforce that can help in the manufacturing, installation, and maintenance processes.

Scope for Future Research

The limitations of the current study form the basis for several research avenues that can be

explored in the future. Firstly, future studies can use econometric analysis to explore the causal relationship between the development of solar energy and economic growth, employment, and investment. Time series or panel data models can be used to explore the nature of these causal relationships in greater detail.

Secondly, there is considerable scope for sub-national studies. Given the fact that the distribution of solar potential and capacity is not even across states, sub-national studies can help explore the drivers, constraints, and effectiveness of policies at the regional level.

Third, future studies can concentrate on solar manufacturing, supply chain, and export potential, particularly in the context of India's manufacturing and trade policies. The role of solar manufacturing in employment, exports, and technology development would add valuable insights to the literature on renewable energy and economic development.

In conclusion, although the above study provides a descriptive account of the development of solar energy and its economic implications in India, future studies can benefit from this study to develop more empirical insights.

CONCLUSION

This research adds value to the available literature because it provides insights into India's energy transition and economic development. This work differentiates from previous studies in the literature by focusing not only on environmental aspects but also on renewable energy as an integral part of economic growth. In addition, contrary to previous work that viewed renewable energy as a general concept, this

research analyses solar energy independently and examines its dynamics as well as economic significance over time. These results are consistent with post-2010 research indicating a crucial role played by policies in the adoption of renewable energy, especially the National Solar Mission. Nevertheless, contrary to policy explanation, this work finds that solar energy growth in India is strongly linked to investment, infrastructure, and macroeconomic performance. The coexistence of growing solar energy, electricity production, and economic growth points to the complementary effect of solar energy on economic growth. Still, the research sheds light on another aspect that requires attention, which is labour market dynamics.

The increase in usage of solar energy in India is economically and developmentally relevant in numerous ways. First, it ensures energy security for the nation, due to reduced dependence on foreign fuel sources and susceptibility to market pricing. Moreover, the growth of the industry has led to capital formation and investment opportunities, as well as infrastructure development, which has led to multiplier effects within other sectors such as manufacturing and construction. At the same time, the sector has been receiving investment from domestic and international sources, which has helped consolidate India's status as a promising venue for renewable energy projects. Additionally, solar energy can play a part in the development of a balanced economy by encouraging the launch of projects in remote and underdeveloped regions. Such activities contribute to job creation, infrastructure building, and access to energy in poorly served regions. Even with geographical differences between regions of India, the ongoing growth of the solar sector promises much in terms of the economic development of the country.

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The Invisible Subsidy: Caste as a Structural Extraction Mechanism and the Political Economy of Manufactured Merit in India

Arunya Sakthi

ABSTRACT

Standard labour economics treats caste inequality in India as a problem of discrimination and a deviation from an otherwise neutral market. This paper argues that framing is wrong in a fundamental way. Drawing on Dr. Ambedkar's primary texts, principally *The Untouchables* (1948), *Who Were the Shudras?* (1946), *States and Minorities* (1947), and *The Buddha and His Dhamma* (1957), alongside the Buddhist economic principle of *Sammā Ājīva* (Right Livelihood), the paper proposes the Extraction-Conversion Cycle (ECC) as an original analytical framework. The ECC shows that the caste system does not merely penalise Dalit-Bahujan workers within a market; it constitutes the market's structure by channelling Dalit-Bahujan women and men into stigmatised, low-wage, and unpaid labour that generates the conditions (specifically, released time) for forward-caste capital formation. Crucially, the analysis distinguishes Savarna women, who occupy a structurally different position as beneficiaries of this arrangement, from Dalit-

Bahujan women, who bear its primary burden. *Annihilation of Caste* (1936) is engaged separately for what it was written to do: to argue to Savarna readers that their own system is economically irrational, and therefore appears in the normative section of this paper where that rhetorical alignment holds. Using triangulated data from the Time Use Survey (TUS 2024), the National Family Health Survey (NFHS-5, 2019–21), the Periodic Labour Force Survey (PLFS 2021–22), and the India Human Development Survey (IHDS 2011–12), the paper quantifies this time-transfer and its educational consequences. It concludes that the “meritocracy” narrative used to justify the status quo is internally incoherent, and that caste annihilation is an economic prerequisite, not merely a moral demand.

Keywords: Extraction-Conversion Cycle, Ambedkar, *Sammā Ājīva*, Dalit-Bahujan, Time-Poverty, Caste Capital, Graded Inequality, Political Economy

JEL Classification Codes: B54, J15, J16, J71, P16, Z12, Z13

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INTRODUCTION: THE WRONG STARTING QUESTION

When economists study caste in India, they typically ask: how much do Dalit workers earn relative to forward-caste workers, controlling for education and experience? The answer: a significant unexplained gap, attributed to discrimination, is by now well-established. But asking this question means you have already accepted a prior assumption: that there exists a neutral market into which groups are inserted more or less fairly, and that the problem is one of unfair exclusion or penalty within that market.

Dr. Ambedkar's analysis begins somewhere else entirely. In *The Untouchables: Who Were They and Why They Became Untouchables?* (1948), he traces the specific historical process by which the groups now called Untouchable were constituted as a permanently degraded labour class, not through market failure but through deliberate religious and social engineering that attached ritual pollution to certain forms of work and then confined certain people to those forms of work by birth. The texts Dr. Ambedkar wrote from within the experience of Dalit-Bahujan oppression, *The Untouchables and Who Were the Shudras?* (1946) are the appropriate foundation for understanding what

the caste system does to marginalised communities. What they show is that the market as it operates in India is not neutral ground disrupted by discrimination. It is built out of the coerced labour of people assigned to its lowest positions before they were born.

This paper attempts to develop that insight into a formal and novel framework called the Extraction-Conversion Cycle (ECC). In simple terms, the ECC argues this: Dalit-Bahujan women and men are structurally confined to stigmatised, undervalued, and often unpaid labour, cleaning, cooking, agriculture, sanitation, domestic service. This confinement is not incidental. It produces a transfer of time and resources from Dalit-Bahujan households to Savarna households. Savarna households convert that transferred time into educational credentials, professional networks, and geographic mobility, what circulates in the economy as "merit". The exploitation is therefore not a side-effect of the Indian economy. It is the mechanism by which one group's mobility is produced.

One point needs to be stated clearly from the outset, because it is often missed: this paper distinguishes analytically between Savarna women and Dalit-Bahujan women. Savarna

¹Bahujan in this paper denotes the marginalised castes that constitute the major population of the country; it refers to present day Scheduled Castes (Dalits), Scheduled Tribes (Adivasis/indigenous) and marginalised Shudra castes: cutting across religion, ethnicities and geographies.

²Savarna literally means "with varna", referring to those within the four-fold varna hierarchy (Brahmin, Kshatriya, Vaishya, Shudra), and that the term is used in this paper to denote dominant-caste communities whose social position within the Hindu order has historically conferred access to land, education, and respectable livelihoods.

are not equivalent to Dalit-Bahujan women in their structural position. Both groups face gender-based oppression within their households. But Savarna women, particularly in urban settings, are also *beneficiaries* of the extraction mechanism, and they are the ones who outsource domestic labour to Dalit-Bahujan women at suppressed wages, thereby freeing themselves to enter the formal labour market. The burden of domestic labour is not transferred from Savarna women to Savarna men; it is displaced downward along the caste hierarchy onto Dalit-Bahujan women, who now carry both their own household's unpaid burden and someone else's paid-but-suppressed domestic work. To treat all women as equally burdened by domestic labour is to obscure this displacement and to let the caste dimension of the exploitation disappear.

The paper is structured as follows. Section 2 develops the ECC theoretically, grounded in Dr. Ambedkar and Buddhist economics. Section 3 describes the data and methodology. Section 4 provides the empirical triangulation across TUS 2024, PLFS 2021–22, NFHS-5, and IHDS 2011–12. Section 5 argues that the meritocracy claim is internally incoherent, while Section 6 deals with counterarguments and limitations. Section 7 concludes.

THEORETICAL FRAMEWORK: THE EXTRACTION-CONVERSION CYCLE

Dr. Ambedkar's Political Economy: What Was Done to the Dalit-Bahujan

Dr. Ambedkar's economic thought is not primarily a critique of capitalism in the abstract.

It is a historical and structural account of how a specific group of people was produced as an unfree labour class, and of what would be required to undo that production. The primary texts for this account are *Who Were the Shudras?* (1946) and *The Untouchables: Who Were They and Why They Became Untouchables?* (1948), written from within and about the experience of those at the bottom of the varna-jati order.

In *Who Were the Shudras?* Dr. Ambedkar traces the historical mechanism by which the Shudra varna was denied the right to education, property, and respectable livelihoods through Brahminic legal and religious codes. The Manusmriti provisions he analyses are not merely social arrangements, they are economic ones. The prohibition on Shudra property accumulation meant that even if a Shudra earned wages, they could not convert earnings into assets that would give them economic independence. The Shudra was to remain dependent, by design: “The Shudra was not to be allowed to accumulate property. If he did accumulate property, the king had the right to take it away from him” (*Who Were the Shudras?* Ch. IX). The contemporary echo of this is directly visible in NFHS-5 data: 68 percent of women in India own no land. Among Dalit-Bahujan women specifically, the rate of assetlessness is higher still, and without land, there is no outside option, no capacity to refuse exploitative employment, and no intergenerational wealth to transmit.

In *The Untouchables* (1948), Dr. Ambedkar went further. He showed that the category of “Untouchable” was not a natural social division but a constructed one, a group deliberately assigned to the most stigmatised forms of labour

(handling human waste, dead animals, leather, cremation) through a religious code that then made their stigma heritable. The pollution designation is economically functional in a precise way: it ensures that no person from a higher jati will compete for these occupations, because doing so would mean accepting social degradation. This removes all competitive pressure on wages in these occupational categories. The Dalit sanitation worker, the Bahujan domestic worker, these are not people who ended up in low-wage jobs by bad luck. They are people *produced* as a low-wage class because the system required that class to exist and required it to be cheap.

In *States and Minorities* (1947), Dr. Ambedkar extended this analysis into an explicit economic programme. Writing as the chief architect of what a free India's constitution should guarantee, he argued that political democracy is a hollow promise when private employers can govern the lives of individuals through economic power alone: "If private employers are allowed to govern the life of the individual by virtue of their economic power, political democracy becomes a myth" (*States and Minorities*, §3). The dominant-caste household that employs a Dalit-Bahujan woman as a domestic worker at ₹333 per day, with no written contract, no social security, no right to refuse, and no asset base that would allow her to walk away, is exercising exactly the kind of economic governance Dr. Ambedkar identified as incompatible with democracy. It is not a free market transaction. It is a structurally coerced exchange backed by centuries of manufactured scarcity.

Buddhist Economics and Sammā Ājīva

In *The Buddha and His Dhamma* (1957), written

in the final months of his life after his conversion to Buddhism, Dr. Ambedkar found in the concept of Sammā Ājīva or Right Livelihood, the fifth element of the Noble Eightfold Path, an economic criterion that cuts to the heart of what the caste system destroys.

Right Livelihood, as Dr. Ambedkar read it, is not simply the injunction to avoid harmful work. It is a positive principle: a worker's vocation should be one in which they can put their "head, heart, and hand" into unity, one in which the work expresses who they are, develops their capacities, and sustains their dignity. Hereditary occupational assignment forecloses this unity completely. The Dalit sanitation worker cannot bring head, heart, and hand to work that was assigned to them before they were born, that carries social stigma, and from which exit is structurally barred. The caste system is therefore not merely economically inefficient, in the sense that talent is mis-allocated, it is ethically destructive, in the sense that it denies the conditions for a dignified human life to entire communities.

This Buddhist economic framework provides a positive standard against which the ECC can be evaluated. The question is not merely whether Dalit-Bahujan workers earn less. They clearly do. The question is whether the economic arrangement produces conditions in which everyone can pursue Right Livelihood. The answer, as the ECC demonstrates, is no, and the reason is structural, not accidental.

The Three Stages of the Extraction-Conversion Cycle

The ECC has three connected stages. Together, they describe how Dalit-Bahujan labour is the material foundation on which forward-caste

“merit” is built.

Stage 1: The Stigma-Labour Trap. The caste system attaches notions of ritual pollution to reproductive and manual labour: cleaning, cooking, caring for the sick and elderly, agricultural work, sanitation. This stigma does two things at once. It confines Dalit-Bahujan women and men to these occupations by social and reputational pressure, choosing other work risks social exclusion, violence, and the loss of whatever position one has. And it suppresses wages for these occupations, because the moral order, not competitive bidding, performs the allocation. No dominant-caste person will compete for these jobs, so the Dalit-Bahujan worker has no bargaining power. The result is what Sukhadeo Thorat, building on Dr. Ambedkar, calls the stigma-labour trap: religious and social sanctions keep wages for essential reproductive services artificially low, with the surplus flowing to dominant-caste households that purchase those services cheaply.

Stage 2: The Time-Transfer. When a Dalit-Bahujan woman performs domestic service for a Savarna household, she does not merely produce a cooking or cleaning service. She produces time for that household. The Savarna woman is released from reproductive labour; the Savarna man was never expected to perform it. This released time, the time-surplus, is the actual transfer. It is not denominated in rupees, which is why it does not appear in GDP or wage statistics. It is denominated in hours. Hours released from domestic labour can be spent on study, professional development, networking, and leisure. Hours trapped in domestic labour cannot. When a Savarna woman enters the formal labour market, she does not absorb her own domestic

burden, she externalises it to a Dalit-Bahujan domestic worker. The Dalit-Bahujan domestic worker now carries two burdens simultaneously: the unpaid domestic labour of her own home, and the paid-but-suppressed domestic labour of the Savarna home. Her time-poverty is the structural precondition for the Savarna woman's time-surplus.

Stage 3: The Conversion. The time-surplus generated in Savarna households is reinvested in what Satish Deshpande (2013) calls the conversion of ritual caste capital into modern human capital: elite private schooling, competitive coaching, professional networks, and the acquisition of credentials that circulate in the knowledge economy as “merit”. The conversion renders the extraction invisible, the forward-caste professional appears to have achieved their position through individual effort in a fair competition. The labour subsidy that made that competition structurally unequal has been laundered by the market mechanism and re-emerges as “ability”.

DATA AND METHODOLOGY

This paper uses four datasets, each providing evidence for a different stage of the ECC. The approach is relational: the datasets are read in conversation with the ECC framework rather than as independent snapshots of inequality.

Time Use Survey (TUS) 2024 (NSO, MoSPI): The second all-India time-use study, covering 139,487 households and 454,192 persons of age six and above. Activity classification follows CATUS 2016. This is the primary source for Stage 2, quantifying the domestic labour burden and time-poverty differential by gender.

National Family Health Survey (NFHS-5), 2019–21 (IIPS/MoHFW): A stratified two-stage national survey of 636,699 households, providing indicators on women’s employment, autonomy, asset ownership, and decision-making power. This is the primary source for Stage 1, documenting the structural constraints that constitute the stigma-labour trap at the household level.

Periodic Labour Force Survey (PLFS) 2021–22 (NSO): India’s primary employment and unemployment survey. Data analysed through Unconditional Quantile Regression and OB-RIF decomposition by Mishra and Trivedi (2024) across 34,035 urban workers. This is the primary source for the wage-suppression component of Stage 2.

India Human Development Survey (IHDS-II) 2011–12 (Desai, Vanneman, and NCAER): A nationally representative panel survey of 42,152 households across 1,503 villages and 971 urban neighbourhoods, with caste-disaggregated data on education expenditure, income, and social mobility. This is the primary source for Stage 3, documenting the differential educational investment that constitutes the Conversion.

One limitation requires honest acknowledgement: none of these datasets provides caste- disaggregated time-use data. The TUS 2024 presents time use by gender and sector but not by social group. This invisibility of Dalit-Bahujan women and men in official statistics is not neutral. It reproduces the analytical obscurity that the ECC is designed to challenge. The paper addresses this gap in two ways. First, it explicitly separates the Savarna women’s position from the Dalit-Bahujan women’s position in the analysis, using structural reasoning grounded in Dr. Ambedkar’s framework. Second, it uses the IHDS caste-disaggregated educational expenditure data to demonstrate at the Conversion Stage that the caste gap in capital formation is real, not merely theorised. The methodological call made here is that the NSO should include social group as a cross-tabulation variable in future TUS releases.

EMPIRICAL EVIDENCE

Stage 1: The Stigma-Labour Trap: Structural Constraints from NFHS-5

Before quantifying the time-transfer, it is worth

Table 1
The Extraction-Conversion Cycle: Structural Positions

Dimension	Dalit-Bahujan Household (Extraction)	Savarna Household (Accumulation)
Primary Resource	Time and Body (coerced into stigmatised labour)	Time-Surplus (purchased cheaply through ECC)
Women’s Labour	Double Burden: own household unpaid + Savarna household suppressed-wage work	Domestic burden externalised; formal labour market entry enabled
Economic Outcome	Time-Poverty; wage suppression	Professional credentials; capital formation
Market Identity	Hyper-visible caste stigma (occupational allocation by birth)	Performed “castelessness” (naturalised merit)
Educational Investment	Constrained by time-poverty, income poverty, and asset denial	Amplified by time-surplus → private schooling + coaching

establishing that the structural conditions which make the trap a trap, and not simply a labour market outcome that could be escaped through individual effort, are documented at scale.

NFHS-5 (2019–21) shows that only 32 percent of currently married women aged 15–49 are employed in any work beyond housework, compared to 98 percent of currently married men (NFHS-5, Vol. I, Ch. 14, §14.1). Among those who are employed, 15 percent receive no payment at all for their work. This is not a trivially small figure. It means that roughly one in six employed women is performing economic activity for which she receives nothing, labour that is invisible to wage data, GDP accounting, and standard discrimination studies alike.

The barriers that prevent exit from this trap are equally documented. Only 42 percent of women are allowed to go alone to the market, the health facility, and places outside their village or community, meaning 58 percent lack full freedom of movement (NFHS-5, Vol. I, §14.7). A worker who cannot move freely cannot comparison-shop for employers, cannot attend vocational training outside the village, and cannot use the informal networks through which better work is accessed. Freedom of movement is an economic variable, not just a social one.

Asset ownership compounds the trap. Only 32 percent of women own land alone or jointly, compared to 42 percent of men (NFHS-5, Vol. I, Ch. 14). Land is the primary route to agricultural credit, collateral for small enterprise, and crucially the economic security that would allow a worker to refuse exploitative employment. Without land, the worker has no outside option. Knowing this, the employer offering ₹333 per day for casual agricultural labour faces a worker with no credible threat to walk away.

Finally, 11 percent of currently married women participate in none of the three key household decisions, about their own health care, major household purchases, and visits to family (NFHS-5, Vol. I, §14.4). Even among employed women who earn cash, only 18 percent make decisions about their own earnings alone; 14 percent have their earnings controlled entirely by their husband (NFHS-5, Vol. I, §14.2). This matters for the wage suppression in Stage 2: a woman who cannot individually choose to quit, cannot move to find better work, owns no assets, and has no control over her earnings is structurally unable to negotiate for a higher wage. The stigma-labour trap is not sustained by stigma alone, it is sustained by the intersection of caste stigma with these material and mobility constraints.

Stage 2: The Time-Transfer: TUS 2024 and PLFS 2021–22

The Domestic Labour Differential (TUS 2024)

The TUS 2024 provides the clearest numerical picture of the domestic labour differential. Among those who participated in unpaid domestic services on the reference day, female participants spent an average of 289 minutes, just under five hours, compared to 88 minutes for male participants: a gap of 201 minutes, or more than three hours per day (TUS Fact Sheet, 2024, Table 4).

This is not merely a gender gap. It is a caste-structured displacement. When a Savarna woman joins the formal labour market, the domestic labour she leaves does not distribute equally across the household. It goes to a Dalit-Bahujan domestic worker, purchased at the suppressed wages described above. The TUS 2024 data on participation rates illustrates the scale:

81.5 percent of women participate in unpaid domestic services on any given day, against 27.1 percent of men (TUS Fact Sheet, 2024, Table 1). For care work, 34 percent of women participate against 17.9 percent of men.

Female participants in paid employment spend 341 minutes per day on employment activities, compared to 473 minutes for male participants, a gap of 132 minutes per working day (TUS Fact Sheet, 2024, Table 4). For Dalit-Bahujan employed women, this second shift includes both their own household's unpaid work and their paid domestic work in Savarna households, a compounded burden of uncompensated or under-compensated time. Expressed as a proportion of the day, women devote 19.7 percent of their 24 hours to unpaid domestic and care work combined, against 2.6 percent for men (TUS Fact Sheet, 2024). The comparison across TUS 2019 and TUS 2024 provides no comfort: female time per person in unpaid domestic service has barely shifted, from 243 to 236 minutes, over five years. The burden is reproducing itself, not diminishing.

Wage Suppression (PLFS 2021–22)

Using Unconditional Quantile Regression on PLFS 2021–22 data across 34,035 urban workers, Mishra and Trivedi (2024) find that the average daily wage for male urban workers was ₹843.12 against ₹722.82 for female urban workers, a mean gap of 14.3 percent. The OB-RIF decomposition reveals that the wage gap is largest at the bottom of the distribution, 0.65 log points at the 10th percentile, and shrinks towards the upper end. The unexplained component accounts for the overwhelming

majority of the gap: 0.50 log points at the 10th percentile, 0.32 at the 25th, 0.33 at the median (Mishra and Trivedi, 2024, Table 3). It is largest precisely at the bottom, where Dalit-Bahujan women, concentrated in elementary occupations, casual agriculture, and domestic service, are most represented. The Dissimilarity Index of 0.2234 indicates that 22.34 percent of female workers would need to change occupational categories to achieve wage parity with male workers (Mishra and Trivedi, 2024). Under the ECC, this is not a measure of preference; it is a measure of structural allocation, the caste-stigma trap channelling workers into specific niches regardless of individual capacity. Earlier data from PLFS 2021–22 highlights the casual labour end: regular urban female employees earned approximately ₹4,800 monthly against ₹6,300 for males - a 24 percent gap; urban casual female labourers earned ₹333 daily against ₹483 for males - a 31 percent gap. The domestic worker receiving ₹333 per day is, for that price, transferring the hours released from domestic labour into the Savarna household that employs her.

Stage 3: The Conversion: IHDS Data on Educational Investment by Caste

The Conversion Stage of the ECC asks: where does the time-surplus go? The answer, supported by IHDS data, is that it goes disproportionately into the children's education of forward-caste households, specifically, into private schooling and tutoring, which are the primary mechanisms through which caste capital is converted into modern human capital.

The India Human Development Survey (IHDS-II, 2011–12) documents stark caste disparities in

educational attainment. Forward-caste households, the IHDS “Others” category, comprising primarily Savarna groups, have a mean years of schooling of 13.9 years for the highest-educated adult in the household, compared to 6.2 years for Dalit-Adivasi (SC/ST) households (IHDS data, cited in Giri, 2014). In terms of household income, forward-caste households earn nearly 47 percent more than the national average annual household income, while Dalit households earn 21 percent less and Adivasi households 34 percent less (Oxfam India, 2022, citing Socio-Economic Caste Census 2011).

The consequences for access to private education are direct. Scheduled Tribe children have the lowest rates of participation in private schooling at 12.7 percent, followed by Scheduled Caste children. Sending one child to a private school at the secondary level would consume 27 percent of a Scheduled Tribe household’s total income and 23.3 percent of a Scheduled Caste household’s income, in comparison to far lower proportions for forward-caste households with incomes 47 percent above the national average (Oxfam India, 2022).

The private tutoring and coaching market makes this disparity even sharper, because it is the mechanism by which credential competition for elite institutions, IITs, IIMs, UPSC, is structured. ST and SC students are significantly less likely to take private tuition than those in more privileged castes, and expenditure on private tuition is considerably less in ST, SC and OBC households compared to more privileged caste groups (MHRD, 2016). NSS 80th Round data confirms the scale: urban households spend

roughly ₹13,600 per year per boy and ₹12,500 per girl on private tutoring alone, expenditure figures that are structurally inaccessible to roughly ₹13,600 per year per boy and ₹12,500 per girl on private tutoring alone, expenditure figures that are structurally inaccessible to SC/ST households whose highest-earning member brings in less than ₹5,000 per month in **83.55 percent** of cases (Socio-Economic Caste Census, 2011).

The ECC’s Conversion Stage is therefore empirically grounded. The time-surplus that Savarna households acquire by purchasing Dalit-Bahujan domestic labour at suppressed wages is reinvested into exactly this educational infrastructure. The Dalit-Bahujan domestic worker’s ₹333 per day, earned at wages held below competitive levels by the stigma-labour trap, enables the forward-caste household to spend ₹13,000 per year on coaching, which in turn enables that household’s children to compete for IIT or UPSC on credentials that are routinely called “meritocratic”. The labour subsidy is invisible because it has been laundered through the market and re-emerges as “ability”.

WHY THE MERITOCRACY ARGUMENT IS INTERNALLY INCOHERENT

The dominant defence of caste-hierarchical outcomes, including the opposition to reservation policies, rests on the claim that open competition rewards merit, and that forward-caste professionals have earned their positions through superior effort and ability. The ECC demonstrates that this claim is incoherent at three levels.

First, the competition is not open. Meritocracy requires that competitors start from positions that are not structurally rigged in advance. The ECC shows that the starting positions are constituted by extraction. The IIT aspirant from a forward-caste household competing with a coaching budget of ₹13,000 per year, a mother freed from domestic labour by a Dalit-Bahujan domestic worker earning ₹333 per day, and land assets providing economic security, this aspirant is not competing on individual merit. They are competing on the accumulated product of the ECC's three stages.

This is the precise point where *Annihilation of Caste* (1936) is correctly deployed, and it is worth being explicit about why. Dr. Ambedkar wrote that text not for Dalit-Bahujan communities but as a prepared address to the Jat-Pat-Todak Mandal, a reformist organisation of caste Hindus who had invited him to speak, which then cancelled the event when his argument proved too radical for them. The text's intended audience was Savarnas. Its argument was directed at them: your own system is irrational, your claims of superiority are unfounded, and you, not Dalits, are the ones who need to destroy caste. When Dr. Ambedkar wrote that the caste system is “not merely a division of labour” but “a division of labourers” (*Annihilation of Caste*, §4), a system where occupational positions are inherited before any individual has demonstrated ability, he was making that argument *to the group that benefits from it*. This is exactly the rhetorical situation this section occupies. To claim that those on the upper floors of the caste tower have “merited” their position is, as Dr. Ambedkar was telling Savarna Hindus directly, ideological mystification in service of privilege, not economic description.

Ajantha Subramanian's *The Caste of Merit* (2019) demonstrates how this mystification works institutionally. Her study of IIT admissions and alumni culture shows how forward-caste families have converted accumulated social and economic capital, precisely the kind produced by the ECC's Conversion Stage, into the language of “merit” and “ability”, and then use that language to resist affirmative action as a distortion of a supposedly neutral meritocracy. The process Dr. Ambedkar named in 1936 is the process Subramanian documents in 2019 at India's most prestigious engineering institutions.

Second, the prices are not competitive. Standard market efficiency arguments hold that voluntary exchange at market-clearing prices produces welfare-maximising outcomes. The ECC demonstrates that the price of domestic and reproductive labour is not a competitive equilibrium price. It is a stigma-suppressed price, held below its competitive level by occupational confinement through the stigma-labour trap, the denial of mobility documented in NFHS-5 (58 percent of women cannot go to all three reference places alone), the denial of assets (68 percent of women own no land), and the denial of decision-making autonomy over their own earnings. A Pareto efficiency argument built on stigma-suppressed prices is not a welfare argument. It is an argument for the perpetuation of extraction dressed in the language of efficiency. When talent is allocated by birth rather than capacity, the economy also loses the output those workers would have produced in better-matched roles, Dr. Ambedkar's point in *The Buddha and His Dhamma* about the “high level of ineptitude in resource allocation” produced by hereditary occupation.

Third, the arrangement fails the criterion of *Sammā Ājīva*. The Buddhist economic framework holds that an economic arrangement is just only when it enables each worker to bring head, heart, and hand into unity in their work. The Dalit-Bahujan domestic worker who spends more than five hours per day in domestic service across two households, who cannot move freely, owns no land, has no decision-making autonomy over her earnings, and earns ₹333 per day, cannot be said to be practising Right Livelihood. She is practising coerced livelihood: work assigned by birth, not chosen by capacity; sustained by stigma, not negotiated freely; remunerated at a stigma-suppressed rate, not a competitive one. The *dukkha* or the suffering, this arrangement produces is not a byproduct of economic development. It is the mechanism by which the extraction functions and reproduces itself.

On all three grounds, the conclusion that Dr. Ambedkar addressed directly to Savarna Hindus in 1936 is also the conclusion the ECC's political economy reaches from within the data: caste annihilation is not a welfare concession external to rational economic policy. It is the prerequisite to studying economics and policy in India.

COUNTERARGUMENTS AND LIMITATIONS

The Mobility Objection: Does Upward Movement Disprove the Cycle?

The most common objection to a structural account like the ECC is that it cannot account for Dalit-Bahujan upward mobility, the fact that some individuals from marginalised communities do escape low-wage labour, acquire education, and enter professional roles. If the were truly closed, this movement would be

impossible. IHDS panel data between 2005 and 2012 does show that some households escaped poverty across social groups, including among Dalits, and this is taken by some commentators as evidence that caste has become economically irrelevant.

The objection misreads what the ECC claims. The framework is a structural account of how the system reproduces itself, not a claim that individual exit is impossible. A structurally extractive system can absorb individual exceptions without changing its fundamental logic, indeed, the visibility of individual Dalit-Bahujan success is often precisely what makes the structural extraction less visible, because the exception is used to deny the rule. The IHDS panel data makes the systemic picture clear: while forward-caste households earned 47 percent above the national average in 2011–12, Dalit households earned 21 percent below it, and this gap had not narrowed meaningfully since the first IHDS round in 2005 (Desai et al., 2010; Oxfam India, 2022). Among those escaping poverty, the IHDS data shows the largest share is from forward castes (73 percent of the previously poor had become non-poor by 2012), followed by OBCs (70 percent), with Dalits at 63 percent and Adivasis at 48 percent (Desai and Dubey, 2017). The cycle reproduces differential rates of mobility by caste even as it allows some movement at the margins. Marginal elasticity within a structurally extractive system is not evidence against the structure; it is evidence of how sophisticated the structure is.

The Endogeneity Objection: Is Caste Just a Proxy for Poverty?

A technically stronger objection from quantitative economics is that the wage

suppression and time-poverty documented in this paper may not be caused by caste-specific mechanisms at all. Poverty itself, independently of caste, produces limited mobility, low bargaining power, asset-lessness, and restricted access to education. On this reading, the ECC's Stage 1 (the stigma-labour trap) is not caste doing something specific to labour markets; it is poverty doing what poverty always does, and caste is a correlated but not causal variable.

This objection has a direct empirical answer. The unexplained component of the wage gap in Mishra and Trivedi's (2024) OB-RIF decomposition, 0.50 log points at the 10th percentile, is unexplained precisely *after* controlling for observable human capital characteristics including education, experience, sector, and enterprise type. If poverty alone were driving the gap through its effects on education and skill acquisition, controlling for those variables should eliminate the gap. It does not.

Standard wage gap models only look at the 'average' worker. But the Extraction-Conversion Cycle operates most aggressively at the bottom of the economic ladder. The OB-RIF decomposition allows us to zoom in specifically on the 10th percentile, the poorest workers. What it proves is twofold: First, the wage gap is massive at the bottom. Second, it proves the endogeneity objection wrong. That means even if you give a Dalit-Bahujan domestic worker the exact same education and experience as a dominant-caste worker, the gap remains. The maths proves that poverty isn't causing the wage gap; the structural stigma of caste is.

Moreover, the IHDS data shows that at similar income

levels, Dalit-Adivasi households have a mean highest educational attainment of 6.2 years against 13.9 years for forward-caste households, a gap that is not simply explained by income differentials, because it persists within income quintiles (Giri, 2014). Thorat and Newman's (2010) audit studies in Indian labour markets further demonstrate that identically qualified candidates with Dalit-identifiable names receive significantly fewer interview callbacks than candidates with upper-caste names, holding all observable characteristics constant. Caste is not merely a proxy for poverty. It is an independent mechanism of exclusion that operates on top of poverty and would continue to operate even if poverty were eliminated.

The Intersectionality Objection: Are Savarna Women Really Beneficiaries?

A third objection comes from feminist theory: characterising Savarna women as "beneficiaries" of the extraction mechanism is too blunt an instrument, because Savarna women also face serious patriarchal subordination within their own households, limited inheritance rights, pressure around marriage, violence, and constrained decision-making. To label them as beneficiaries risks erasing this oppression and producing a false solidarity between Savarna men and Savarna women that does not exist in practice.

This objection identifies a genuine theoretical complexity but does not undermine the ECC's analytical move. The ECC is a structural analysis of positional relationships, not a claim about subjective experience or the absence of oppression within any given group. A Savarna woman can simultaneously face patriarchal oppression within her household and occupy the

structural position of a buyer of Dalit-Bahujan domestic labour at suppressed wages, these operate at different scales and through different mechanisms. What the ECC insists on is that the first fact does not cancel the second. The Savarna woman's patriarchal subordination is real; it is also true that her domestic burden is being borne by a Dalit-Bahujan worker who earns ₹333 per day and has even less decision-making autonomy, even less mobility, and even fewer assets. Both oppressions coexist but are not comparable due to the sheer scale in the latter's position and experience. The analytical error the ECC corrects is treating gender as a uniform axis that positions all women identically relative to all men, an error that makes the caste-structured displacement of domestic labour invisible.

Limitations

Three data limitations deserve explicit acknowledgement. First, and most significantly, the absence of caste-disaggregated time-use data in official Indian statistics means that the inter-caste time-transfer at the core of the ECC is inferred from structural reasoning rather than directly measured. The TUS 2024 Fact Sheet presents data by gender and sector but not by social group. This is the paper's primary empirical constraint, and addressing it requires a methodological change in NSO's TUS design, specifically, the inclusion of social group as a cross-tabulation variable in future releases.

Second, the IHDS educational expenditure data used to demonstrate the Conversion Stage is from 2011–12. While the structural caste gap in educational investment has not narrowed, the income gap between forward-caste and Dalit-Bahujan households documented in the

Socio- Economic Caste Census 2011 and Oxfam India's 2022 analysis remains severe, the absolute coaching expenditure figures from the NSS 80th Round (2025) are more current and were used where possible. Researchers with access to the forthcoming IHDS Wave 3 (2022–24) data will be better positioned to update the Conversion Stage analysis.

Third, the PLFS wage analysis cited here is drawn from Mishra and Trivedi's (2024) urban sample. The ECC's mechanisms are not limited to urban areas, the stigma-labour trap operates with equal force in rural agricultural labour markets, but the wage data cited does not fully represent the rural dimension. Caste-disaggregated rural wage analysis at the same level of methodological sophistication as the Mishra-Trivedi urban study remains a gap in the secondary literature.

CONCLUSION

This paper has proposed the Extraction-Conversion Cycle as a framework for understanding how caste hierarchy and capital accumulation are connected in India, not through discrimination within a neutral market, but through the structural constitution of the market itself by Dalit-Bahujan labour.

The three stages were empirically grounded across four datasets. NFHS-5 established the structural constraints of the stigma-labour trap: denied mobility, denied assets, and denied decision-making autonomy that prevent Dalit-Bahujan women from resisting the terms of their exploitation. TUS 2024 documented the 201-minute daily domestic labour differential and showed that this burden is displaced, not shared, across caste lines, falling on Dalit-Bahujan women rather than being redistributed within

Savarna households. PLFS 2021–22 showed wage suppression concentrated at the bottom of the distribution where Dalit-Bahujan women are most represented, a 0.65 log-point gap at the 10th percentile, predominantly unexplained by observable characteristics. IHDS 2011–12 demonstrated the Conversion: forward-caste households with incomes 47 percent above the national average invest heavily in private coaching from which SC/ST households, where the highest earner brings in under ₹5,000 per month in 83.55 percent of cases, are structurally excluded.

The normative argument follows directly. A competition constituted by one group's structural exploitation of another cannot produce meritocratic outcomes. Prices suppressed by stigma cannot produce efficient allocations. An economy that forecloses Right Livelihood for Dalit-Bahujan workers fails the Buddhist economic criterion of non-harm. On all three counts, the conclusion holds: the emancipation of Dalit-Bahujan women and men is not a welfare concession external to economic rationality.

A final methodological point stands as a policy recommendation: the NSO should cross-tabulate time-use data by social group in future TUS releases. The current absence of caste from TUS disaggregation makes it structurally impossible to directly measure the inter-caste time-transfer the ECC theorises. Closing that gap would allow future researchers to move from structural inference to direct quantification.

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From Payments to Investing: Digital Infrastructure and Household Financial Behaviour in India

Divya Garg

ABSTRACT

Over time, the increasing popularity of digital payment systems has changed the way Indian households participate in formal financial systems. This study extends earlier research on the rise of Unified Payment Interfaces (UPIs) by incorporating them with Systematic Investment Plans (SIPs). Earlier literature has targeted these two concepts independently. This research identifies the link between digital payment systems and systematic investment plans using time series analysis from 2010–2025 and regression evidence showing a strongly significant correlation.

Keywords: Digital Payments; Unified Payments Interface; Systematic Investment Plans; Household Finance; Financial Infrastructure; India

JEL Justification Codes: G11, G23, C22

INTRODUCTION

The Indian financial system has witnessed significant change during the past decade, influenced by the speed at which the digital environment has developed and the manner in which financial behaviour has altered. The traditional environment where financial transactions occurred in cash and actual bank counters has gradually given way to a system in which financial transactions, savings, and investments increasingly take place in virtual environments. Digital technology reduces transaction costs and allows more segments of society to be brought into the mainstream financial system (Demirgüç-Kunt et al., 2022). As the interface with financial services progresses from being episodic to being routine in nature, individuals tend to adopt more systemic structures of saving and investment like SIPs (Systematic Investment Plans), which require rules to be set in place rather than rational decision-making engines.

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India's payment system has moved progressively to advanced stages of technological advancement from initial stages involving electronic transfer and card-based systems to the use of mobile and internet instruments. The significant structural shift in the system came with the introduction of the Unified Payment Interface (UPI) in 2016 by the NPCI. (Cornelli et al., 2024). The introduction of the UPI led to a substantial reduction in the overall friction associated with conducting financial transactions. The widespread adoption of the system has led to a phenomenal shift in the manner of retail transactions. In addition, investment systems, which were increasingly integrating into the financial system, were accessible via the same mechanical interfaces that financial transactions use. SIPs, which are a preferred means of encouraging disciplined savings through systematic investment plans in the system, are particularly suitable in the system since they convert intent into hard-and-fast commitment.

While growth has been recorded in both areas, the usual approach is to look at every area in isolation from the other. While studies conducted so far on digital payments focus on issues of efficiency and finance (Narayan & Ghosh, 2024; Modwel & Trivedi, 2023), studies done on SIPs concentrate on behavioural issues (Sharma et al., 2023; Dabral et al., 2023). However, this ignores the chances that the growth recorded in digital payments could have some impact on systematic investment behaviour.

Research Questions

This research seeks to answer the following questions:

1. Does the development of digital payment methods in India have an impact on the systematic investment behaviour of households?
2. Are there any statistical correlations between the developments in digital payment mechanisms and Systematic Investment Plans (SIP)?
3. Are digital payment methods considered behavioural architecture?

Drawing from trends in the pre- as well as post-UPI era from 2010-2025, as well as from a dual framework of structural and statistical evaluation, it analyses whether technological transformation in payments is accompanied by continuous evolution in systemic investing.

LITERATURE REVIEW

A research literature has started to grow on the payment system reforms in emerging economies, and the Indian UPI system has often been mentioned as a paradigm case for such reforms. Scholars such as Cornelli et al. (2024) and Demirgüç-Kunt et al. (2022) illustrate the impact of digital payment systems on lowering transaction costs, enhancing financial inclusion, and increasing formal financial system participation. While the literature on the Indian system has extensively discussed the institutional aspect of UPI and its adoption paths (Mangal, 2025; Narayan & Ghosh, 2024), this line of literature primarily looks at the dimensions of 'efficiency,' 'inclusiveness,' and macroeconomic consequences of digitization.

Another stream of parallel research on “Systematic Investment Plans” includes topics such as investor behaviour, risk discipline, and expanding mutual fund participation. For example, in research by Sharma et al. (2023), Dabral et al. (2023), and Fernando & Aathilakshmi (2025), researchers examined SIP adoption using behavioural and portfolio considerations. Parallel research on digitization in mutual fund services, as seen in works by authors such as Metre & Parashar (2019) and Ramya et al. (2025), recognizes the role of technology in breaking entry barriers to investment, though studying investment behaviour in isolation from payment systems (Metre & Parashar, 2019; Ramya et al., 2025).

Though simultaneous growth in digital payments and SIP has been witnessed, literature has seen very few attempts at integrating these together from a single perspective. Some try to analyse the elements of payments in isolation from SIPs, while others attempt to examine SIP in isolation from the technological environment facilitating routine financial engagement.

In that context, this paper contributes to the literature by attempting to analyse digital payments and SIP as two sides of the same coin in terms of household financial transformation. In essence, the paper uses structural analysis coupled with statistical scrutiny in the pre- and post-UPI environment to establish the phenomenon promoted in the paper.

DATA AND METHODOLOGY

To address the research questions outlined above, the study employs a time-series analytical framework from institutional sources on the evolving digital and investment environments in

India. The sources of the data used for this analysis are the Reserve Bank of India (RBI), the National Payments Corporation of India (NPCI), and the Association of Mutual Funds in India (AMFI). The time period chosen is 2010-2025, enabling us to compare before and after UPI, as well as the COVID-19 pandemic disruption and subsequent consolidation. The domain of financial activity being studied here is at the macro rather than at the micro-level. The variables of interest are SIP contribution indicators, digital transaction amounts with specific reference to UPI, and macro-level variables like Gross Domestic Product (GDP). The year 2016 has been chosen as a structural turning point corresponding to the emergence of UPI, while the year 2020 has been chosen as a global shock period.

The study has employed a structural descriptive framework combined with statistical evaluations. Trend analysis with indexed values is performed to find alignment trends between digital payments and systematic investing over time. Phase-wise analysis can be done with identified points corresponding to technology and economic events. To statistically evaluate the correlation between digital payment growth and systematic investing plan growth, a regression framework is employed using the rates of growth.

Heteroskedasticity and autocorrelation consistent standard errors are employed with a limited data sample due to its time-series nature. The statistical layer evaluates the descriptive findings quantitatively, showing the extent of correlation between observed trends.

FINDINGS

Structural Expansion of SIP Investments

Systematic Investment Plans exhibit signs of a shift in investment from discretionary investment to rule-based household financial behaviour. To begin with, early years show low and volatile growth in SIPs, reflecting that systemic investment had yet to reach normal behaviour. The rate of growth was restricted by procedural difficulties and information constraints. However, later on, after the mid-2010s, it was observed that while growth earlier increased erratically, it was followed by a period of sustained acceleration. Growth becomes compounding rather than event-driven, indicating institutional stabilization of investment habits.

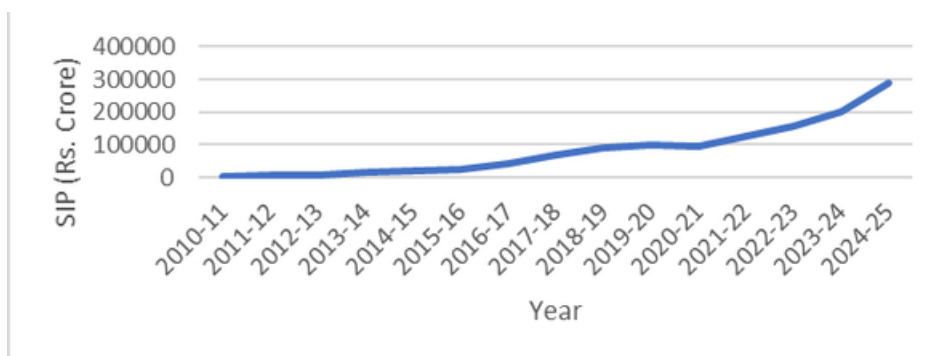
Figure 4.1 outlines the aggregate trend in SIP investment in India. A structural break has been achieved in the post-2016 period, with a sharp rise in the slope of growth. The consistency of upward trends further supports that SIP investing has moved beyond a supplementary form with embedded technology support.

Expansion of Digital Payment Infrastructure

The evolution of SIP investing is part of the overall evolution of digital payments. Digital payment systems start as optional financial mechanisms and gradually develop into mainstays of the financial system, which are able to facilitate repetitive low-value transactions. This is a prerequisite for minimizing friction in operations and for automated financial commitment, which is a prerequisite for sustained SIP investing.

Figure 4.2 (Next Page) shows that the UPI transactions scale exponentially after the introduction of the system in 2016. The sharp and non-linear pattern of the transaction growth shows that it is not a temporary concept; rather, it has reached the maturity stage or the infrastructure stage, which can be referred to as habituation. UPI evolves quickly into a mature system that can accommodate the ‘backbone’ of financial mechanisms.

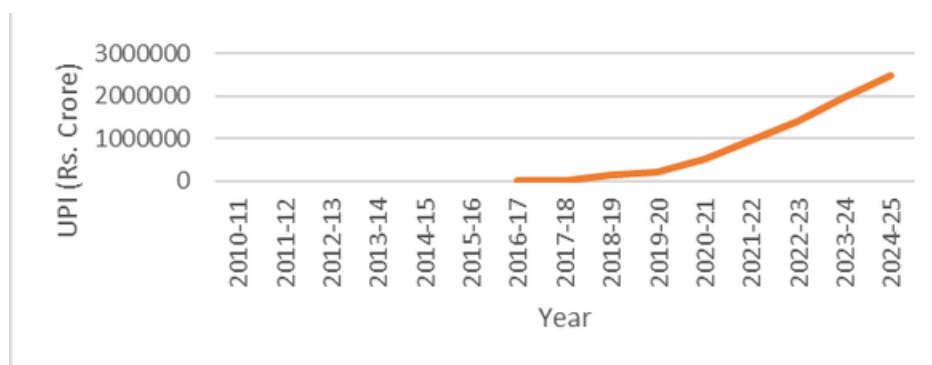
Figure 1
Trend in SIP Investments in India (2010-11 to 2024-25)



Source: Compiled and calculated by the author from AMFI data.

Figure 2

Growth of UPI Transaction Value in India (2016-17 to 2024-25)



Source: Compiled and calculated by the author from NPCI data

Figure 4.3 (Next Page) Total digital payments stayed on their secular upward trajectory despite temporary shocks. The post-shock recovery is strong, suggesting resilience and normalization. The fact that the system can expand even during stress conditions further reinforces this interpretation that digital payments represent self-sustaining behavioural infrastructure rather than episodic usage channels.

Alignment of SIP Investments with Digital Payments (UPI)

When consolidated with data on digital payments, a corresponding structural pattern in SIP investment emerges. Sustained increase in systematic investments occurs during times of rapid digital expansion: Infrastructure scaling seems to reduce both operational and psychological barriers to disciplined financial participation.

It can also be clearly seen from Figure 4.4 (Next Page) that considerable co-movement prevails after 2016. The co-movement is persistent but not transitory; thus, structural alignment seems to prevail instead of cyclical coincidence. The

normalization of digital payments seems to follow the normalization of systemic investing because of their long-term commitment.

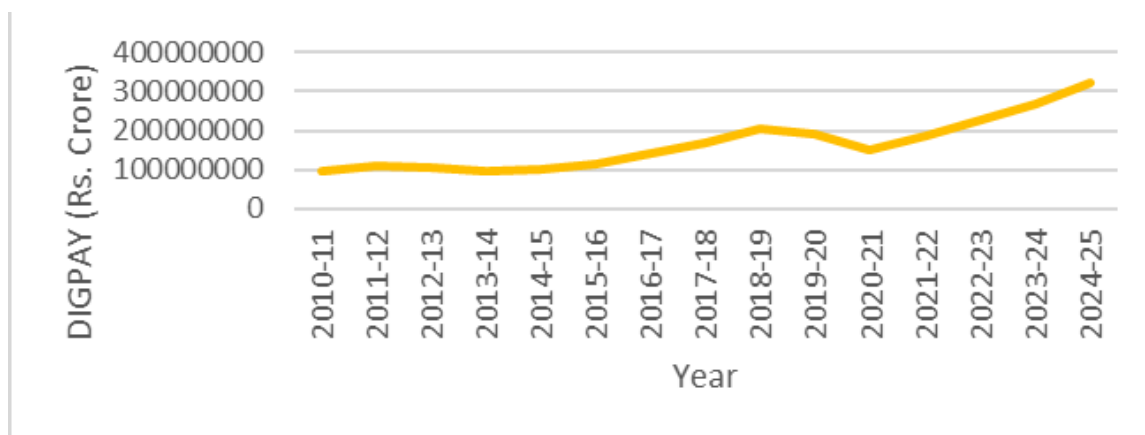
SIP Deepening Relative to GDP

Macro-economic comparison also enables the differentiation of cyclical growth from structural changes. Had SIP growth simply kept pace with income growth, its ratio with respect to GDP would be constant instead of increasing. However, the ratio does increase over time, which may be interpreted as the strengthening of the institutional hold of systematic saving through investment in the national saving system itself.

Figure 4.5 (Next to Next Page) traces a gradual and consistent rise in SIP investments relative to GDP. It indicates that the increasing ratio of SIP investments to GDP reflects a progression of systematic investing from a small financial niche to a broad base of savings vehicles. The pattern provides further support that digital infrastructure causes structural integration of investment behaviour and counters financial enthusiasm.

Figure 3

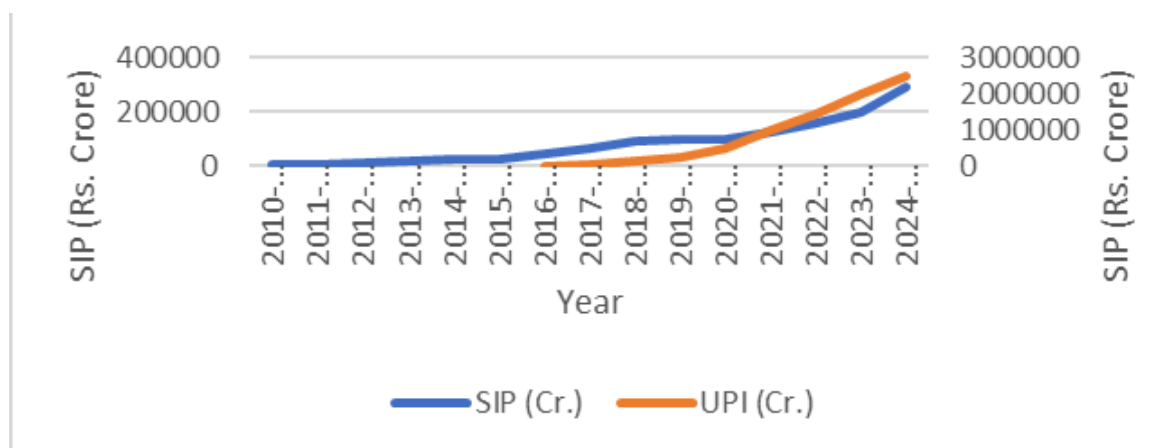
Trend in Total Digital Payment Transactions in India (2010-11 to 2024-25)



Source: Compiled and calculated by the author using RBI data.

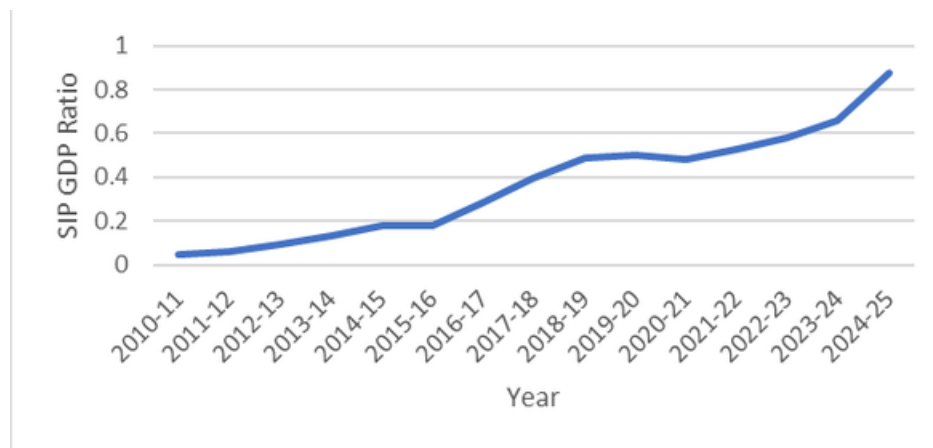
Figure 4

Comparative Trend of SIP Investments and UPI Transactions



Source: Compiled and calculated by the author from AMFI and NPCI data.

Figure 5
SIP as a Percentage of GDP



Source: Compiled and calculated by the author using SIP and GDP data.

From these trends, it is evident that the rise of digital payments and the normalization of systematic investments are not two independent variables. The shift from variable SIP participation growth to consistent acceleration occurs at precisely the time when digital payment systems become normalized as an integral part of financial behaviour. Consistent with this observation is the persistence of SIP growth relative to GDP and its synchronicity with digital payments scaling. It is also evident that financial investments, normalized as an integral part of financial behaviour, exhibit scale and growth rate consistency with digital payments. While descriptive evidence of trends is subjective and does not establish cause and effect, it remains a sufficient rationale for performing statistical analysis and comparison. Empirical analysis of the trends is attempted in the following sections.

EMPIRICAL ANALYSIS

This section performs a check on whether the increase in digital payments is statistically related to investment growth. The goal here is to quantify how well this descriptive analysis fits. The regression framework here is used to check for structural association and not to claim causal identification.

Model Specification

To avoid spurious correlation arising from trending levels, the model is specified in annual growth rates:

$$GrSIP_t = \alpha + \beta \cdot GrDIGPAY_t + u_t$$

where:

- $GrSIP_t$ = annual SIP growth rate
- $GrDIGPAY_t$ = annual digital payment growth rate
- u_t = disturbance term

The value of β indicates how elastic investment growth is responding to the increase in digital payments.

Regression results

Table 1

OLS Regression Results: SIP Growth Model

<i>Variable</i>	<i>Estimate</i>	<i>Std. Error</i>	<i>t value</i>	<i>p</i>	
Constant	15.093	3.907	3.863	0.012	*
Digital Payment Growth	0.841	0.197	4.269	0.008	**

<i>Statistic</i>	<i>Value</i>
R-squared	0.785
Adjusted R-squared	0.742
F-statistic	18.23
Observations	7

Note: OLS coefficients reported. Significance codes: *** $p < .001$, ** $p < .01$, * $p < .05$, . $p < .10$.

Table 2

Newey–West (HAC) Robust Inference

<i>Variable</i>	<i>Estimate</i>	<i>Robust Std. Error</i>	<i>t value</i>	<i>p</i>	
Constant	15.093	1.869	8.074	0	***
Digital Payment Growth	0.841	0.143	5.894	0.002	**

Note: Newey-West heteroscedasticity and autocorrelation consistent standard errors: Coefficients are the same as with OLS; inference comes from the robust standard errors

The model's estimation is conducted with Ordinary Least Squares (OLS). Due to mild persistence typical in macro-financial series, standard errors use heteroskedasticity and autocorrelation consistent (also called Newey-West) standard errors. The model's coefficients are based on the estimation conducted with OLS, but statistical significance results from robust standard errors. While the estimation's coefficients provide information about the coefficients' values, robust standard errors provide appropriate statistical inferences for those values.

The estimated coefficient on the growth in digital payments is positive and statistically significant at robust levels. An increase of one percentage point in the growth in digital payments is related to an increase of approximately 0.84 percentage points in the growth in SIPs, with the effect being large compared to the fluctuations in investment size every year. This suggests that the expansion in digital infrastructure corresponds considerably to systematic investment behaviour.

Diagnostic Tests

Diagnostic testing indicates no major econometric violations.

First of all, the high explanatory power of this model shows that the shift in digital payment activities explains a significant part of the change in SIPs, even with a small yearly sample size. This again supports the idea of payment system modernization and systematic investment as part of one single process rather than two separate processes.

Mild serial correlation is certainly economically plausible, given that financial behavior changes gradually and financially related dynamics often display persistence. Habit formation and infrastructure scaling underlie, respectively, SIP participation and digital technology adoption, not annual-specific shocks.

To control for valid inference with such a level of persistence, Newey-West HAC standard errors are employed. The main coefficient remains highly significant after robust correction, thus implying that the finding is not driven by any form of residual dependence.

Table 3
Diagnostic Tests

<i>Test</i>	<i>Statistic</i>	<i>df</i>	<i>p.value</i>
Durbin–Watson (Autocorrelation)	1.138		0.097
Breusch–Pagan (Heteroskedasticity)	1.529	1	0.216

Note: Alternative hypothesis for the Durbin-Watson test: autocorrelation exists, and it is positive.

Interpretation

The empirical evidence confirms the structural argument presented through the trend analysis. There is a close relationship between the expansion of digital payment instruments and the growth in systematic investments, which is an indication of a strong relationship through co-movement. The findings are in line with a behavioural-institutional mechanism through which digital infrastructure reduces repeated transactional friction, embeds automation, and converts discretionary financial decisions into rule-based commitments.

In this context, digital payments are treated as infrastructure rather than distinct tools for executing transactions. They help to lower costs, raise reliability in executing transactions, and regularize habitual financial engagement. In this perspective, participation in SIP forms an integral part of regularized transactions and behaviour, permitting households to conjoin investment with everyday financial behaviour. The regression measures the structural relationship between infrastructure scaling and normalization of investments discovered through the descriptive analysis.

DISCUSSION

The emergence of digital payments in India is therefore more than a modernization of technology in transaction management; it embodies a paradigm shift in the manner in which individuals interact with the formal financial sector. Traditionally, individuals interact with formal channels of saving and investing in a manner that is episodic in nature, with high decision-making frequency. The

emergence of digital technology is characterized by a behaviour in which transactions, in general, become a continuous process, as opposed to intermittent. Financial behaviours are not only influenced by income levels or literacy but also by the “architecture” through which financial transactions take place. (Modwel & Trivedi, 2023; Vadera & Khobar, 2024). When transactions become almost instantaneous in nature, the “cognitive cost of repeated decisions” reduces. In other words, systems such as digital payments function more like a “behavioural infrastructure” that modifies the environment in which behavioural decisions take place (Reddy Srinivas et al., 2024; Yenni et al., 2024). Regular experience with digital transaction execution helps to reduce the “psychological distance” among consumption, saving, and investment activities. SIPs perfectly match this environment since they change the investment process into a “rule” rather than a “decision process” (Yenni et al., 2024; Gour, 2020).

This interpretation is supported by the regression results above. First, the strong and significant relationship between growth in digital payment and growth in SIP confirms the close relationship between scaling infrastructure and normalizing investment. The empirical evidence here confirms what the trends above suggest: the normalization of investment and the modernization of payment systems are part of the same structural change process in the economy.

This process is an additive one, which is path-dependent. Once SIPs become a regular habit, households develop the competency to make consistent financial commitments. Participation in SIPs survives through macroeconomic

disturbances, thereby suggesting that rule-based investing indeed exhibits a tendency of being habitual behaviour, as opposed to discretionary action. Digitalisation helps develop transactional competency into financial discipline over time via reduced transactional friction.

Interpretations such as these must be viewed in context with a particular study. The framework is concerned with identifying structural alignment, as opposed to corresponding causal relationships. The data is at an aggregate time-series level, which does not capture heterogeneity at the household, income group, or even regional levels. In addition, while digital finance ecosystems are constantly in flux, it is impossible to ascertain such behavioural trends in the long run.

Nevertheless, it is unlikely that this congruence between infrastructural expansions and investments normalizations is coincidental. Certainly, with the Indian example, there is evidence that digital public infrastructures can refashion the finances of households by embedding investment practices into daily life. Indeed, the research findings outline that payment systems can shape not just efficiencies but also financial behaviour

POLICY RECOMMENDATIONS

The results of this study have several far-reaching implications that go beyond efficient payment processes. As seen from the case of India's UPI payment system, the use of digital payment technology can also serve as a macro-financial tool which both increases capital mobilisation and ensures stability of retail participants and decreases sentiment-based

volatility. This means that the implementation of digital payment infrastructure must be viewed by policy-makers as not simply an element of fintech solutions but a key aspect of savings and investment systems.

The deployment of such a payment solution in underdeveloped parts of countries, and among poor people or first-time investors, could expand the pool of systematic investors.

However, infrastructure growth must go hand-in-hand with effective systems for protecting investors. Reducing the costs of entry via digital technology not only makes households vulnerable to behavioural problems like impulse investment, financial product mis-selling, and cyber threats but also makes them susceptible to unethical practices in the industry. The regulatory bodies like SEBI and RBI must take care of the fact that the easy access made possible through digital platforms must be complemented with mandatory disclosures, easier risk communication, and grievance handling systems that can be accessed even by low-literacy people. It is not only necessary to bring the household sector into the financial system but to keep them there too.

Financial literacy programs need to be developed in accordance with the process of digitalisation. Programs designed around conventional concepts like awareness about financial products were sufficient in an era where finance was not heavily digitised. The contemporary world requires moving to behavioural financial literacy, whereby households will learn about investment disciplines, the importance of compound interest, and the dangers of stopping SIPs when markets are in turmoil. The incorporation of such ideas in

school curricula and through digital onboarding processes, as well as AMFI's awareness programs, will lead to sustained financial literacy among consumers.

The final takeaway from the Indian model is the importance of its lessons for other emerging countries trying to promote household financial inclusion. In the case of countries that are building digital infrastructure, whether in the form of payments networks, digital identity systems, or open banking ecosystems, policymakers should not overlook the possible behavioural benefits associated with the system beyond its main transactional role. A coordinated policy that combines the improvement of payment systems with efforts to deepen capital markets could speed up the shift from a cash-based system and episodic engagement into a rule-based engagement. The Indian case shows that when digital systems are developed with inclusive design and behavioural architecture in mind, they can become an authentic institution for asset building.

CONCLUSION

In this paper, an attempt was made to determine whether the development of digital payments in India has impacted the normalisation of systematic household investments on a structural basis. Descriptive and regression evidence strongly indicate such a linkage. The shift towards consistent growth in SIP was made after the normalisation of digital payments in India, especially the rise in the popularity of Unified Payments Interface (UPI). An econometric study highlights a strong and statistically significant correlation between digital payments and SIPs.

The core contribution is the shift from viewing digital payments as transactional technology to behavioural infrastructure: As payments become instant, predictable, and routine, SIPs become an integral part of this structure, transforming discretionary investments into automatic commitments executed on the platform.

Apart from being empirical, the findings reveal a much deeper structural change – once the institutional approach to investment through rule-based involvement is in place, it continues through periods of macroeconomic disturbances, signalling the existence of institutional behaviour rather than mere enthusiasm for investing. The main limitation of the current research is that it is conducted within the context of an aggregate macro-level framework, which cannot account for individual, income, and regional heterogeneity and establishes association instead of causation. Further research conducted at the level of individual households, through longitudinal studies of SIPs, or across different countries, could shed light on whether the case of India is an institution-specific phenomenon or representative of a more general pattern in the developing world. Despite these limitations, the results indicate that digital public infrastructure can serve as an institutional mechanism to discipline investment behaviour.

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Understanding Persistent Participation in India's Futures Market Through the Lens of Behavioural Economics

Rudransh Shukla

ABSTRACT

This paper looks at how traders in Indian futures markets react after experiencing losses. It uses daily futures data from the National Stock Exchange of India to study major indices and stock futures at the contract level, carefully considering rollover effects. Trading volume and open interest capture changes in market participation, with open interest normalised for comparison across contracts with different liquidity levels. The analysis compares next-day participation after loss-making and gain-making days using year-by-year averages. The results indicate that losses usually do not cause a withdrawal from the market. Instead, open interest often stays stable or even increases after loss-making days, with participation levels similar to those seen after gains. This trend is particularly strong in stock futures, while responses in trading volume vary more. Overall, the findings suggest that short-term losses do not deter continued participation in futures markets and highlight the influence of behavioural factors on trading decisions in leveraged environments.

JEL Classification: G13, G14, G11

Keywords: Open Interest, Loss Aversion, Futures Market, Prospect Theory

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INTRODUCTION

Futures markets play a crucial role in the modern financial system. They allow participants to manage risk, speculate on price changes, and take on borrowed positions to boost their exposure to the price shifts of underlying assets. In India, the quick growth of the derivatives segment has attracted many individual traders to futures trading, especially in index and stock futures (Securities and Exchange Board of India, 2024). This expansion has improved market liquidity, but it has also raised worries about increasing participation despite significant losses.

Recent evidence shows that a large number of individual traders in the Indian futures and options market regularly incur losses. At the same time, participation in the derivatives segment has grown significantly over the last few years (FY2019-24) (Securities and Exchange Board of India, 2023; Securities and Exchange Board of India, 2024). This situation, where many traders face losses while trading activity continues to grow, poses an important question. If losses indicate poor performance, why don't traders respond to that feedback by reducing their trading or leaving the market?

Most existing research on futures markets has focused on the links between prices, trading volume, open interest (OI), and volatility. These studies have greatly contributed to our understanding of price discovery and information flow in the markets. However, there has been less focus on how traders react after experiencing losses, especially in the short term and at the market-wide level (Bessembinder & Seguin, 1993; Joshi, 2021). This gap is particularly important in futures markets, where leverage, daily mark-to-market settlement, and frequent price feedback can influence decision-making differently compared to cash markets.

This paper aims to fill this gap by examining how market participation changes after days of losses or gains in Indian futures markets. The study specifically asks: does a day of losses impact the next day's open interest differently than a day of gains for traders with long futures contracts? Participation is analyzed using open interest, which shows the level of outstanding exposure, while trading volume measures trading activity. By focusing on responses after losses and gains, the study aims to determine if negative outcomes lead to reduced participation or if traders keep exposing themselves to market risk.

The research uses daily futures data from the National Stock Exchange of India and analyzes it at the contract level for major stock and index futures. It examines futures contracts separately by expiry to avoid cross-contract contamination. The study refines the data to exclude days close to expiry or the first notice day, and it normalizes open interest measures for comparison across instruments with varying liquidity. Yearly aggregation is used to see if the observed participation patterns persist over the long term or are just due to isolated market events.

The results show that days of losses are often followed by steady or increased participation in futures markets. For both stock and index futures, changes in open interest tend to stay close to their average even after losses occur. Additionally, there is a significant chance of an increase in open interest after a loss-making day. Stock futures show particularly strong post-loss participation compared to index futures, while trading volume appears more variable and less consistent than changes in open interest.

These findings suggest that short-term losses do not discourage investors from participating in futures markets. Instead, traders often remain vulnerable to risk even in tough situations. The paper interprets these trends through insights from behavioral economics, highlighting the impact of overconfidence and loss aversion on trading behavior in leveraged environments (Kahneman & Tversky, 1979; Barber & Odean, 2000).

Research Questions

Building on these observations, this study is guided by the following research questions:

1. Does a day of losses in the Indian future's market lead to a statistically distinct changes in next day open interest compared to a day of gains?
2. Do the post-loss patterns differ between index futures and stock futures?
3. Does the persistent trading in the Indian future's market despite losses reflect the realities of behavioral economics predictions?

LITERATURE REVIEW

The rapid growth of India's equity derivatives market presents an interesting paradox. SEBI (2023, 2024) reports that 89% to 92.8% of individual futures and options traders suffered net losses from FY2019 to FY2024. Despite this, overall participation almost doubled during the same time, with 76.3% of loss-making traders returning to the market in later years. This ongoing participation, even after repeated losses, is the main puzzle that this study aims to explore.

Prospect theory provides the main framework for understanding this behavior. It suggests that individuals assess outcomes based on a reference point, giving more weight to losses than to equivalent gains (Kahneman & Tversky, 1979). The shape of the value function in the loss area indicates risk-seeking behavior rather than risk-averse behavior after losses. This means losses might oddly encourage continued market involvement instead of driving traders away. Lien (2001) elaborates on this in the context of futures. He shows, using a constant-absolute-risk-aversion approach, that loss aversion does not influence optimal hedge ratios in a fair market. However, it can either decrease or increase futures positions based on market conditions like backwardation or contango, depending on how intense the loss aversion is. This indicates that the effect of loss aversion on participation is unclear and needs to be tested empirically. Additionally, Chou et al. (2005) highlight that factors like margin requirements affect trader reactions to negative price changes. Higher risk aversion raises the margin needed to avoid reneging on contracts. This is particularly relevant for the mark-to-market settlement process on the NSE.

Research on trader behavior in futures markets shows that leaving the market due to losses is not the usual response. Wang (2003) analyzed fifteen US futures markets using Commitments of Traders data. He found that hedgers tend to engage in positive feedback trading by increasing their positions after price increases and keeping them even after price falls. Speculators often take the opposite approach. Broader studies on individual investors support this view. Barber and Odean (2000, 2001) found that retail investors trade excessively and continuously even when their performance is poor. They attribute this to overconfidence, where traders consistently overrate their private information and the effectiveness of their strategies.

This study uses the methodology of Bessembinder and Seguin (1993), who identified open interest as a suitable measure of market depth and ongoing participation, separate from the short-term activity seen in trading volume. Pardo and Lucia (2010) further this idea by showing that the ratio of daily changes in open interest to trading volume is the clearest measure of taking new positions. It effectively differentiates between days when new positions are created and those when existing ones are closed. In India, Pati and Rajib (2010) and Joshi (2021) found significant links between open interest, volume, and volatility in NSE futures markets. Meanwhile, Mougoué and Aggarwal (2011) demonstrated that open interest reflects a level of market commitment that volume alone cannot capture.

DATA AND METHODOLOGY

This study includes two types of data. The main dataset features daily futures data at the contract level, which was downloaded from the Historical Contract-wise Price Volume Data section on the National Stock Exchange of India's official website. This data is publicly available through NSE's derivatives historical data archive (NSE India, n.d.). For each futures contract, we collected the following variables: opening price, closing price, total open interest, and the number of contracts traded each day. The dataset spans three calendar years—2020, 2022, and 2024—covering 13 underlying instruments, which include major equity indices and individual stocks. This results in a total of 499 individual futures contracts. To reduce the impact of rollover-related issues, we excluded the first three and last three trading days of each contract from our analysis. This is because open interest and volume during those times are heavily affected by contract initiation, the first notice day, and expiry-driven position closures.

The secondary data source consists of aggregate information from two reports published by the Securities and Exchange Board of India. The first report is titled *Analysis of Profit and Loss of Individual Traders Dealing in Equity F&O Segment*, which covers FY2019–22 (SEBI, 2023). The second report covers FY2022–24 (SEBI, 2024). These reports provide overall statistics about the percentage of loss-making traders, average profit and loss figures, and participation rates over multiple years. This information helps to contextualize the contract-level findings of this study.

Methodology

The objective of this study is to examine changes in the futures market following realised trading losses, using open interest as a proxy for trader behaviour. The methodology adopts a contract-level, outcome-conditioned framework, focusing on next-day participation metrics following loss-making and gain-making days.

Contract-Level Segmentation

All futures contracts are analysed independently at the contract-expiry level. Let c denote a futures contract and t denote trading days within that contract. Each contract is treated as a distinct trading environment to prevent cross-contract contamination.

For each futures contract, the following data points are collected:

- **Date:** Trading date in DD-MM-YYYY format
- **Open Price:** Opening price for the trading day
- **Close Price:** Closing price for the trading day
- **Open Interest:** Total number of outstanding contracts that have not yet been settled or closed
- **Contract Expiry Date:** For contract identification and rollover management

Rollover and Boundary Adjustment

Futures contracts exhibit abnormal trading behaviour near initiation and expiration due to margin adjustments, contract switching, and settlement-related position closures. To mitigate these effects, observations are trimmed symmetrically from each contract:

$$T_c \in \{4, \dots, T_c - 3\}$$

That is, the first three and last three trading days of each contract are excluded.

Liquidity Conditioning

To restrict the analysis to meaningfully traded periods, a day t is considered only if the open interest of the preceding trading day satisfies:

$$OI_{c,t-1} \geq 2000$$

This ensures that measured changes in open interest reflect active participation decisions rather than mechanical noise associated with illiquid contracts.

Identification of Trading Outcomes

Daily trading outcomes are defined using intraday price movements:

$$\Delta P_{c,t} = Close_{c,t} - Open_{c,t}$$

A trading day is classified as loss-making if

$$\Delta P_{c,t} < 0 \text{ and gain-making if } \Delta P_{c,t} > 0$$

Open Interest Dynamics and Normalisation

Open interest represents the total number of outstanding futures contracts and reflects market participation rather than directional sentiment, as each contract consists of one long and one short position (Bessembinder and Seguin 1993; Mougoué and Aggarwal 2011).

Daily open interest change is defined as:

$$\Delta OI_{c,t} = OI_{c,t} - OI_{c,t-1}$$

To ensure comparability across contracts with heterogeneous liquidity, open interest changes are normalised using a rolling average (Pati and Rajib 2010; Joshi 2021):

$$\bar{OI}_{c,t}^{20} = \frac{1}{n_t} \sum_{k=0}^{n_t-1} OI_{c,t-k}, n_t \in [5,20]$$

The normalised open interest change is then given by:

$$NOI_{c,t} = \frac{\Delta OI_{c,t}}{\bar{OI}_{c,t}^{20}}$$

Observations that do not have a minimum of five past trading days are excluded from the analysis to avoid unstable normalisation.

Next-Day Behavioural Response Design

The study examines next-day participation responses conditional on prior trading day outcomes using:

- Average normalised open interest after loss-making and gain-making days
- Average percentile of change in open interest after loss-making and gain-making days
- Percentage of loss-making and gain-making days after which open interest increased or decreased

These variables are averaged across 499 contracts to identify overarching trends in market behaviour.

Analysis

The results in Table 1 show year-wise averages for major indices and stock futures, including average normalised open interest following losses, average percentile change in open interest after losses, the percentage of days in which open interest increased after losses, corresponding metrics after gain-making days, and volume-based measures.

The analysis is conducted separately for index futures and stock futures, and results are reported at the instrument-year level by aggregating observations across all contracts within each year.

Indices exhibit an average of 46.9 percent loss-making days and 53.06 percent gain-making days, while individual stocks exhibit approximately 52 percent loss-making days and 48 percent gain-making days, leading to an overall weighted average of 51.25 percent loss-making days and 48.74 percent gain-making days. At the year level, neither losses nor gains dominate the sample.

For index futures, the average normalised open interest change after a loss-making day is 0.26, compared to 0.35 after a gain-making day. The average percentile of normalised open interest change after loss-making days is 43.55, compared to 47.9 after gain-making days. Approximately 53.46 percent of loss-making days are followed by an increase in open interest, compared to 59.71 percent after gain-making days.

For stock futures, the average normalised open interest change after a loss-making day is 0.519, compared to 0.457 after a gain-making day. The average percentile after loss-making days is 51.3, compared to 50 after gain-making days. Approximately 59.3 percent of loss-making days are followed by an increase in open interest, compared to 59.1 percent after gain-making days.

Behavioural Interpretation of Post-Loss Participation in Futures Markets

The empirical results indicate that futures market participation remains resilient following loss-making days, as reflected in stable or increasing open interest on the subsequent trading day (Securities and Exchange Board of India 2024).

This section interprets these findings through the lens of behavioural economics, focusing on psychological mechanisms that drive persistent participation despite widespread losses.

Prospect Theory and Risk Engagement after Losses

A central framework for interpreting the observed participation patterns is prospect theory, which posits that individuals evaluate outcomes relative to a reference point and exhibit loss aversion, with losses weighted approximately twice as strongly as equivalent gains (Kahneman and Tversky 1979).

An important implication of this framework is that individuals become more willing to accept risk when operating in the domain of losses. Consistent with this prediction, loss-making days are not followed by systematic reductions in open interest but by stabilisation or an increase in open interest, as the probability of an increase in open interest following losses exceeds 50 percent and the average percentile rank of the post-loss normalised open interest change remains close to the median of the overall distribution.

Loss Aversion and Risk-Seeking after Losses

For index futures, although the average normalised open interest change after losses is lower than after gains, it remains positive on average, with approximately 53 percent of loss-making days followed by an increase in open interest. This suggests that traders do not disengage from risk after adverse outcomes but maintain their exposure to such instruments.

Risk-seeking behaviour becomes more apparent in stock futures. Across stocks, the average normalised open interest change after losses exceeds that observed after gains, and the probability of open interest increasing after losses is roughly identical to open interest increasing after gains (approximately 59 percent).

Overconfidence and Persistent Participation

Approximately 75 percent of loss-making individual investors continued trading in the derivatives market despite consecutive years of losses (Securities and Exchange Board of India 2024). Traders may attribute losses to temporary market noise rather than flawed strategies, maintaining confidence in their ability to recover losses through continued participation. This persistence aligns with overconfidence-based explanations showing that poor performance does not reliably reduce trading frequency (Barber and Odean 2000; Barber and Odean 2001).

This mechanism helps explain the stronger post-loss participation observed in stock futures relative to index futures, as stocks exhibit greater volatility and are more likely to attract investors who believe they can exploit such movements (Barber and Odean 2000; Joshi 2021).

Linking SEBI Evidence and Open Interest Metrics

SEBI's findings show that over 90 percent of individual F&O traders incur losses, while participation nearly doubled between FY22 and FY24 (Securities and Exchange Board of India 2024).

The year-wise open interest dynamics observed in this study complement these findings by demonstrating how persistence manifests at the instrument level and is visible immediately after loss-making days.

Behavioural Interpretation in Summary

The empirical results suggest that:

- Losses do not systematically reduce futures market participation.
- Traders frequently remain exposed to risk even after adverse outcomes.
- Participation persistence is consistent with loss aversion and risk-seeking after losses.
- Leverage and margin-based trading further reinforce these behavioural tendencies.

Therefore, the observed participation dynamics following loss-making days align closely with the core predictions of behavioural economics.

CONCLUSION

This paper examined how traders in Indian futures markets respond after experiencing short-term trading losses by studying next-day changes in open interest and trading volume at the contract level. The evidence shows that losses do not generally lead to a withdrawal from futures markets. Instead, market participation often remains stable or even increases after loss-making days, with patterns that are broadly similar to those observed after gain-making days. This tendency is especially strong in stock futures, while trading volume responses are more uneven and less persistent.

The findings indicate that short-term losses do not discourage continued participation in leveraged futures markets. Traders frequently remain exposed to risk even after adverse outcomes, suggesting that losses alone are not sufficient to alter trading behaviour. Viewed through the lens of behavioural economics, these patterns are consistent with loss aversion, risk seeking in the domain of losses, and overconfidence, all of which may be amplified by leverage and margin-based trading. By providing market-level evidence on participation immediately following losses, this study adds to the literature on investor behaviour in derivatives markets and complements existing regulatory evidence. The results also highlight the importance of considering behavioural responses when designing investor protection and risk management policies in rapidly expanding futures markets.

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APPENDIX

Table 1

Futures Contracts Selected in the Study

Series	Market
Panel 1 : Index Futures Contracts	
NIFTY 50 Futures	NSE
NIFTY BANK Futures	NSE
NIFTY IT Futures	NSE
NIFTY MIDCAP Futures	NSE
Panel 2 : Stock Futures Contracts	
Adani Ports	NSE
DLF	NSE
Hindalco	NSE
ICICI Bank	NSE
Infosys	NSE
ITC	NSE
Jindal Steel	NSE
Maruti Suzuki	NSE
Reliance Industries	NSE
State Bank of India	NSE
Tata Motors	NSE
Tata Consultancy Services	NSE
Trent	NSE

Source: NSE India (n.d.).

Table 2*Year-wise Analysis of Open Interest and Trading Volume Behaviour in Indian Futures Markets*

Instrument	Year	Total Days	Loss Days	Gain Days	Avg OI Percentile After Loss	Avg OI Normalized Change After Loss	% OI Increase After Loss	Avg Volume Change (%) After	Avg OI Percentile After Gain	Avg OI Normalized Change After Gain
Panel 1: Index Futures Contracts										
NIFTY	2024	601	290	311	45.09	0.1783	58.97	33.76	46.55	0.176
BANK NIFTY	2024	583	288	295	41.52	0.1391	53.13	29.86	47.1	0.1988
FIN NIFTY	2024	392	175	216	38.68	0.1563	46.29	50.56	46.73	0.4188
MIDCP NIFTY	2024	576	256	319	48.91	0.5663	55.47	47.76	51.56	0.6198
Panel 2: Stock Futures Contracts										
ADANI PORTS	2022	597	310	286	51.94	1.2727	59.03	123.06	50.05	1.0626
	2024	601	339	262	48.14	0.3826	58.11	60.14	51.78	0.4987
DLF	2024	600	298	297	51.13	0.5376	57.38	49.14	47.88	0.4898
HINDALCO	2020	587	289	279	54.64	0.6208	59.17	45.55	51.24	0.5591
	2022	599	312	284	51.99	0.5103	60.9	43.73	47.74	0.3408
	2024	600	323	274	50.42	0.4727	56.97	46.62	50.48	0.4692
ICICIBANK	2024	601	283	317	52.57	0.515	58.66	38.3	51.33	0.5207
INFY	2020	602	291	307	50.76	0.6189	56.7	48.47	53.13	0.6645
	2024	601	307	293	51.91	0.4967	62.54	53.68	51.77	0.4485
ITC	2022	599	276	320	51.14	0.3379	62.32	33.22	45.82	0.2249
	2024	601	331	267	49.81	0.2964	60.73	49.76	49.06	0.3257
JINDAL STEEL	2024	596	295	301	52.71	0.6018	58.64	60.54	51.08	0.6098

Instrument	Year	Total Days	Loss Days	Gain Days	Avg OI Percentile After Loss	Avg OI Normalized Change After Loss	% OI Increase After Loss	Avg Volume Change (%) After Loss	Avg OI Percentile After Gain	Avg OI Normalized Change After Gain
MARUTI	2024	596	312	282	51.48	0.5549	60.58	50.85	49.92	0.5237
RELIANCE	2024	601	324	276	52.94	0.4518	59.88	41.41	52.3	0.3818
SBIN	2020	606	314	288	53.79	0.4385	63.06	33.39	51.01	0.3704
	2024	601	299	302	51.86	0.3851	60.87	40.9	48.05	0.286
TATA MOTORS	2022	599	339	258	50.77	0.3024	59.59	34.74	49.78	0.2199
	2024	601	344	257	50.79	0.2566	62.5	41.64	50.84	0.2951
TCS	2024	601	341	260	51.55	0.614	58.06	54.05	52.29	0.4198
TRENT	2022	503	239	250	50.02	0.8856	52.3	109.63	48.11	0.4941
	2024	599	295	303	47.51	0.3501	58.64	66.2	46.46	0.4059

Green Financing in India

Priyam Aggarwal

ABSTRACT

Green finance in recent times, has emerged as a critical tool for achieving climate resilience and sustainable economic development goals in a scenario where growing environmental concerns and global climate commitments such as the Paris Agreement, are aligning financial systems with ecological objectives. This paper provides a comprehensive empirical and contextual analysis of India's green finance landscape from 2015 to 2023, with a specific focus on renewable energy investments.

The study uses both quantitative and qualitative methods from regression analysis, hypothesis testing, correlation matrices, and policy dummy variables to qualitative insights from recent academic and policy literature. The relationships between green bond issuances, post-2020 reforms in green bonds, nominal GDP, and renewable energy investments are analysed.

The results indicate a strong positive and statistically significant relationship between green bond issuances and renewable energy investments, demonstrating how targeted

financial instruments effectively mobilise sustainable capital. Also, the analysis reveals that post-2020 policy reforms, for example, sovereign green bond framework and mandatory ESG disclosures (BRSR) have a positive correlation with renewable energy investments and the nominal GDP causes an increase in green financing.

This paper also identifies certain challenges, namely regulatory inconsistencies, limited investor awareness, and an underdeveloped secondary market based on which, it offers policy recommendations such as expanding the green bond market, improving disclosure standards, fostering public-private partnerships, and leveraging blockchain and AI technologies.

This research contributes to the ushering industry of green financial products by providing data driven results, and thus leading India towards achievement of its international green commitments and goals.

Keywords: Green finance, renewable energy, green bonds, sustainable development, climate finance, ESG disclosures, India.

JEL Classification Codes: G18; Q42; Q54; Q58; O13

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INTRODUCTION

Green finance has emerged as a key tool for achieving sustainable development in the scenario of rapidly increasing ecological degradation and climate change. The term "green finance" itself is self explanatory. It means financial investments that promote environmentally friendly outcomes, for example, clean transportation, climate-resilient agriculture, renewable energy, and biodiversity preservation.

Lately, there has been an increasing awareness about the impacts of traditional finance shifting toward more environmentally friendly options, like nations working to meet climate targets together by bilateral and multilateral agreements such as the Paris Agreement.

India, being the third-largest emitter of greenhouse gases and one of the fastest-growing economies, holds a significant place in the global climate agenda. As the nation commits to reaching net-zero emissions by 2070, India revised its renewable energy target to 450 GW by 2030 along with changing its financial architecture to raise the required funds. The International Finance Corporation (IFC) estimated that in order to achieve its sustainable development goals by 2030, India alone will need to at least invest \$3 trillion in climate initiatives. Also, a comprehensive understanding of the tools, regulations, and difficulties related to green finance in the Indian context has become more important as a result.

This paper thereby, seeks to explore the evolution and effectiveness of green finance in India, with a particular focus on renewable

energy investments. The study combines empirical data analysis with a critical review of policy developments to assess whether financial instruments such as green bonds and regulatory initiatives like BRSR disclosures have had a significant impact. Also, the research investigates the correlation between the macroeconomic indicator, nominal GDP and green investments, to explore if general economic growth is a sufficient driver of sustainable finance or not.

Through correlation analysis, hypothesis testing, and regression modeling, the paper quantifies the influence of financial and policy variables on green investment flows. The findings reveal that green bonds, and post-2020 policy shifts have significantly boosted renewable energy investments, also the nominal GDP has shown enough evidence in this context.

This research seeks to present policy recommendations to strengthen India's green financial system, thereby enriching the comprehension of sustainable finance and providing crucial support for India's transformation into a low-carbon, climate-resilient economy.

LITERATURE REVIEW

In recent years, green finance has gained significant attention in the academic and policy literature as a tool for ensuring sustainable development and addressing climate changes. Institutions like the World Bank and United Nations have also drawn upon the increased importance of re-aligning financial flows with climate goals in order to meet the Paris Agreement. In the aftermath of the Paris Agreement, many countries including India have

rapidly invested in green financing by formulating domestic policies as well as staying committed to international climatic pacts.

Green Financing is often seen as a tool for channelising the funds needed to ensure clean energy and low carbon infrastructure, encompassing a broad array of funds from renewable investments to biodiversity conservation funds. According to Kumar (2021), “Green finance entails mobilizing financial resources for sustainable development while mitigating environmental risks and climate change impacts.” It includes instruments like green bonds, green loans, equity in sustainable enterprises, climate-focused venture capital, and risk-sharing facilities for green projects. The International Finance Corporation (2017) has estimated that in order to fulfill global climate targets (example Paris Agreement), investment opportunities worth trillions of dollars can be generated. In India itself it is estimated to generate investment opportunities of over \$3 trillion by 2030. This has stirred the interests for researchers in unlocking the sources for such investments. In India such finances majorly come from the government itself. Recently a number of initiatives have been taken by the government in this direction which has changed the landscape to a large extent. The government has introduced a mix of regulatory framework, market mechanisms, and institutional innovations by its agencies like RBI and SEBI. Khemnar and Pandey (2024) provide a comprehensive overview of how government initiatives and market instruments have spurred renewable energy growth in India.

Their study reveals that the government policy framework for example NAPCC and the renewable purchase obligations for utilities create a conducive environment for capital flows into clean energy. It has also revealed that market-based instruments (e.g. carbon pricing, green bonds) and increased private sector participation have sped up the process by pulling down the cost of capital and bringing in a diversity of investors.

Jain and Kumar (2022) also observed that integrating financial instruments like green bonds, renewable energy funds, and concessional green loans significantly “enhanced the capital flow towards sustainable energy projects” in India as these tools not only reduce the cost of financing but also broadens the investors base by diversification. For example, the projects such as India’s Green Energy Corridor project and the sovereign green bond issuances have attracted large-scale renewable energy investments, thus providing financial support for risk mitigation.

There has been evidence of integration of ESG (Environmental, Social, Governance) in the Indian renewable energy market leading to enhanced sustainability outcomes. This is especially seen in the study of Sharma and Gupta (2021) as ESG integration led to an increase in renewable energy capacity, particularly in the solar and wind sector. They provide for a systematic argument for green financing as it not only leading to mobilising funds but also fostering innovation and technological advances in the renewable sector. Provisions such as BRSR regulations and and international efforts of United Nations Environment Programme (UNEP) have once again emphasised on the role

of public incentives in inducing sustainability goals being achieved by increased use of green bonds. UNEP stated *“channeling large sums into renewables should be seen as an economic opportunity rather than a risk, as the long-term benefits of energy security, job creation, and avoiding damage from climate change far outweigh the initial investment costs.”*

The International Renewable Energy Agency (IRENA) has also worked in this direction. It provides a convincing stance that clean energy investments will be more cost competitive. According to IRENA (2021), setting up solar power projects will be more viable in terms of cost than inviting in new coal-fired plants as clean energy deployment could generate 18 million jobs by 2030, contributing substantially to economic growth while greening the economy. The ideology that sustainable investments can propel future development is supported by these findings, which also support the economic case for green finance and have been held onto in Indian policy making.

This far, only the benefits of green financing have been discussed, but there exist challenges as well that hinder the growth of green finance in India. Bhatnagar et al. (2025) provides a granular analysis of these impediments, identifying 43 sub-barriers and 32 enablers of green finance in the Indian context. The major impediments revolve around regulatory and policy uncertainties. For instance, Mishra and Singh (2020) observed that India's regulatory framework for green finance which happens to be still improving, has significant gaps and

inconsistencies. An uneven playing field is present as environmental policies, and incentives vary across different states and sectors with an absence of a unified tax policy and standardized definition of what is regarded as a green financial product. This has led to confusion amongst investors as well as issuers, which slows down the market development as stakeholders are uncertain about the rules and regulations and the reporting standards.

Another critical barrier is the limited coordination amongst various regulatory bodies involved in finance and environmental governance such as SEBI and Interim government boards. Also blur work boundaries between institutions for example financial regulators, energy ministries, and environmental agencies have impeded the formulation of coherent green finance policies, which has slowed down the implementation process. This further hampers the markets to direct resources in the correct direction. Though the Indian green bond market has been growing steadily, it is still relatively smaller compared to its global counterparts. In terms of the Indian green bond market, Gupta and Jain (2021) assert that limitations such as a limited investor base, higher perceived risks for green projects, and lower liquidity in green financial instruments have hindered its broader adoption. Furthermore, Mishra and Singh (2020) argue that the scarcity of financial products tailored to specific environmental outcomes and risk profiles restricts the growth potential of green finance markets. According to Bhardwaj and Malik (2022), a lack of technical expertise and awareness about environmental risks and

sustainable opportunities has contributed to Indian banks' and investors' sluggish adoption of green finance practices. Therefore, green projects may be mispriced as a result of this capacity gap (for example charging greater interest as a result of unfamiliarity) or a preference for conventional investments. In a study on green finance developments in India, Chhaochharia (2021) comes to the conclusion that, although financing options and public awareness have somewhat improved, improved information management systems and stakeholder coordination are still required to lessen informational asymmetries and increase investor confidence in green assets.

Given such a backdrop, strong government initiatives have been and continue to be the most crucial positive factor. For instance, the establishment of institutions such as the Indian Renewable Energy Development Agency (IREDA) and the National Clean Energy Fund (2010), offered early financial support for clean energy projects. According to Reddy and Acharya (2020), regulatory support has aided in the advancement of green finance in India through measures like tax breaks for wind and solar investments or priority sector lending status for renewable energy.

Though the participation of the private sector in green finance is also on the rise, but it is majorly encouraged by the public sector. Given this context, the RBI has been supportive, often advising banks to take climate-related financial risks into account and encouraging them to integrate sustainability considerations into their lending practices.

Technological developments present additional opportunities to grow green finance. For example, artificial intelligence (AI) and blockchain technologies can increase the traceability and transparency of green investments, thereby boosting investor confidence in the credibility of green finance. Similarly, certain new financial products have opened up new avenues for investors to get involved in sustainable finance and many more are in the process of doing so. Examples include green equity indices, ESG-themed mutual funds, and sustainability-linked loans, where interest rates are based on the borrower's accomplishment of sustainability goals. Some researchers like Kumar (2021) believe that these methods have been successful in drawing in a larger investor base and continue to inspire more businesses to engage in ecologically friendly endeavors.

Reddy and Acharya (2020) point out that although India has made significant strides, the size and sophistication of its green finance market still lags behind world leaders like China and the European Union. For example, the green bond market in China is one of the biggest globally, supported by robust government support and extensive regulatory frameworks. A strong green taxonomy and strict disclosure regulations created by the EU have aided in directing institutional investments toward green projects on a large scale. India might gain from improving disclosure standards, enacting more precise definitions (to lessen "greenwashing"), and perhaps offering public guarantees or credit enhancements to encourage green investments, according to these comparisons.

Research Questions

Recently there has been an upsurge in ideas related to sustainable development and from it green financing has emerged as a pivotal tool for economic and environmental goals achievement. This paper explores the green financing situation in india based on a dataset compilation which pertains to the following questions:

1. What is the impact of green bond issuances on renewable energy investments in India?
2. How do policy frameworks, especially that of post-2020, influence green finance outcomes?
3. What is the relationship between macroeconomic indicator, the nominal GDP and renewable energy investments?

4. What trends exist in India’s green finance ecosystem, and how can these influence future strategies?

METHODOLOGY

This research paper uses both quantitative data analysis and qualitative insights from the literature review to analyse India’s green financing situation. The major quantitative analysis revolves around the dataset ranging from 2015 to 2023 (table 2) compiled from various government reports and disclosures. The table 1 below summarises the key variables taken into consideration:

Table 1
Definition of Variables

Variable	Definition	Source
Total Green Finance	The aggregate annual financing allocated to all green projects, including renewable energy, EVs, adaptation, and other climate-related sectors.	Sum of sectoral flows
Renewable Energy	Investments in solar, wind, hydro, and other renewable energy projects.	Ministry of New and Renewable Energy (MNRE) reports
Transports (EVs)	Funding for electric vehicles (EVs), charging infrastructure, and battery technologies.	Ministry of Heavy Industries’ FAME-II scheme reports and SEBI disclosures
Adaptation (Agriculture)	Financing for climate-resilient agriculture, water management, and disaster-risk reduction.	NABARD reports and CPI’s adaptation finance tracking
Green Bonds Issued	Value of sovereign/corporate green bonds issued in India to fund climate projects.	Climate Bonds Initiative reports and SEBI disclosure
BRSR Compliance (%)	Percentage of India’s top 1,000 listed companies complying with SEBI’s Business Responsibility and Sustainability Reporting (BRSR) guidelines.	SEBI’s annual ESG disclosure reports
Real GDP	It is an inflation-adjusted measure that reflects the value of all goods and services produced by an economy in a given year.	World Bank
Nominal GDP	It is the total value of all goods and services produced in an economy, measured using current market prices.	World Bank

In 2020, the government of India introduced certain provisions which led to revision in the renewable energy targets to 450 GW by 2023. This later led to the establishment of a sovereign green bond framework. SEBI also introduced new sustainability disclosure mandates (BRSR) for companies. To take account of this in the green bond issuances, a policy dummy has been introduced. Policy Dummy equals to zero before 2020, and equals to one since 2020. The splitting of the data by dummy separates the post 2020 policy push from the earlier years, which provides for a way to test whether 2020 policy changes led to a significant improvement in renewable energy investments.

A correlation Matrix has been constructed to analyse the nature of relationship between the variables. It explores the direction and the extent to which any two variables in a dataset move in that particular direction.

Multiple cases of hypothesis testing have been carried out to analyse the relationship between the dependent variable that is renewable energy investments, and the independent variables that are Nominal GDP, green bond insurances and dummy variable accounting for introduction of 2020 policies changes. The following Hypotheses have been formulated:

Hypothesis 1: Relationship between renewable investments and green bond issuances

Null Hypothesis

$H_0: \beta_1=0$ (Green bond issuances have no impact on renewable energy investments)

Alternative Hypothesis

$H_1: \beta_1 \neq 0$ (Green bond issuances have a significant impact on renewable energy investments)

Hypothesis 2: Relationship between renewable investments and Policy Dummy

Null Hypothesis

$H_0: \beta_2=0$ (Policy Dummy has no impact on renewable energy investments)

Alternative Hypothesis

$H_1: \beta_2 \neq 0$ (Policy Dummy has a significant impact on renewable energy investments)

Hypothesis 3: Relationship between renewable investments and Nominal GDP

Null Hypothesis

$H_0: \beta_3=0$ (Nominal GDP has no impact on renewable energy investments)

Alternative Hypothesis

$H_1: \beta_3 \neq 0$ (Nominal GDP has a significant impact on renewable energy investments)

To carry out hypothesis testing, the ordinary least squares (OLS) regression analysis is used. A multiple linear regression model with renewable energy as the dependent variable and other 3 variables as independent variables is set-up. The OLS regression model is given by:

$$\text{RenewableEnergy} = \alpha + \beta_1(\text{GreenBonds}) + \beta_2(\text{PolicyDummy}) + \beta_3(\text{NominalGDP}) + \varepsilon$$

(Equation 1)

The hypothesis tests conducted are two tail tests at a significance level (α) of .05 for rejecting the null. As the sample size is small ($n=9$), t-test is the most viable option for analysis. Additionally, scatter plots and box plot have also been generated to visualise the relationships between: (1) renewable energy and green bonds, (2) renewable energy and policy dummy, and (3) renewable energy and nominal GDP. The graphs give a visual insight about the data which helps in a better and quick understanding of the dataset.

Lastly, in order to enhance our interpretations, we add qualitative evidence from the literature to the quantitative findings. The literature review methodology consisted of snowballing from the references of pertinent papers and conducting a systematic search of academic databases and reports for keywords associated with green finance in India. The study offers contextual and empirical insights into green financing trends by combining these methodologies.

DATA ANALYSIS

The data analysis section consists of 3 sections, namely descriptive statistics, correlation matrix and regression model. Within the regression model, there are 3 further sections analysing the relationships between renewable energy investments and green bonds; renewable energy investments and policy dummy; renewable energy investments and nominal GDP. It

provides a comprehensive analysis of data thus making it the most reliable.

Descriptive Statistics

The below table highlights the investment across green products from 2015 to 2023. The total Green finance is the column representing the total investments in green products. It is the sum of the Renewable, Transport, and Adaptation other unlisted elements. There has been almost a 4 fold rise in green financing in the past decade, the causality for which will be explored in the next part of this paper. In all these years, renewable energy was the main driver of the rise in total green financing. It itself rose exponentially from just ₹320 billion in 2015 to ₹1500 billion in 2023. The Green Transportation sector has also grown significantly, this was majorly led by lithium

Table 2

Green Finance Dataset (2015-2023) (Values in Billion INR)

Year	Total Green Finance	Renewable Energy	Transport (EVs)	Adaptation (Agriculture)	Green Bonds Issued	BRSR Compliance (%)	Real GDP (₹ billion)	Nominal GDP (₹ billion)
2015	450	320	30	25	15	–	113,694	137,640
2016	510	370	40	30	20	–	121,960	152,537
2017	620	460	50	35	35	–	131,748	170,983
2018	780	580	70	40	55	–	139,819	189,712
2019	920	700	85	45	80	12	145,693	203,398
2020	1,050	820	100	50	110	18	135,128	198,009
2021	1,300	1,000	130	60	150	25	147,359	236,646
2022	1,600	1,250	160	70	200	40	157,601	273,075
2023	1,950	1,500	200	80	300	55	167,212	296,600

Source: Author's compilation of financial and governmental reports

Table 3*Correlation Matrix*

	Renewable_Energy	Green_Bond	Nominal_GDP	Policy_Dummy
Renewable_Energy	1	0.99	0.99	0.85
Green_Bonds	0.99	1	0.97	0.83
Nominal_GDP	0.99	0.97	1	0.79
Policy_Dummy	0.85	0.83	0.79	1

run Electric Vehicles (EV). The performance of the agriculture sector is satisfactory. Organic farming and horticulture have been driving sustainable agricultural practices. There has been an impressive increase in the green bond issuances. This has also paced up since 2019 when the BRSR compliances were made mandatory.

The correlation matrix shows a strong relationship between variables pertaining to green financing and macroeconomic indicator, as shown in the above table. Notably the correlation between green bonds and renewable energy is very high (0.99), which suggests that a higher investment in renewable energy is closely associated with increase in green bond issuances thus also re-enforcing financial support for environmentally friendly infrastructure.

A strong correlation is also witnessed between renewable energy and nominal GDP (0.99), this shows that growth in renewable energy is

becoming more and more closely associated with our economic performance. Green bonds also show a close relation with the economic indicator, nominal GDP (0.97). This also reinforces that green financial products started to become prevalent in the macroeconomic environment. In the post 2019 period when the BRSR compliances were made mandatory, the policy dummy which takes value 1 from the next year displays a strong correlation with Green Bonds (0.83) and Renewable Energy (0.85), which indicates the association of policy developments and green financing.

Its correlation with nominal GDP is 0.79, which is somewhat weaker but it still aligns with economic output indicators. Overall, this matrix reflects a strong relationship between green finance variables and economic indicator, with especially high correlations amongst Renewable Energy, Green Bonds, and GDP measure. While these correlations do not imply causality, they still indicate that these variables tend to move together.

Regression Analysis

Using equation 1 of the regression model and Table 2 containing the dataset, the regression coefficients have been found using R Studio, for which the summary statistics table has been prepared. In order to carry out the hypothesis testing on the 3 relationships as defined before in the methodology section, this section will further be divided into 3 sections to analyse the relationship and causality. Graphs for each analysis have also been computed using R Studio.

Multiple R-squared: 0.999,
Adjusted R-squared: 0.998,
F-statistic: 1.34e+03 on 3 and 5 DF,
p-value: 1.11e-07

1) Green Bonds and Renewable Energy

From hypothesis 1 and table 4, $\beta_1=170$ ($t=5.60$, $p\text{-value}=0.02431$). This leads to the rejection of the null hypothesis at $\alpha=.05$, therefore the data is significant.

This reveals that there exists a positive relation between the two variables, with increase in green

bonds investments defining the increase in renewable energy investments. Rather, ₹1 billion of increase in green bonds leads to approximately ₹170 billion increase in renewable energy funding.

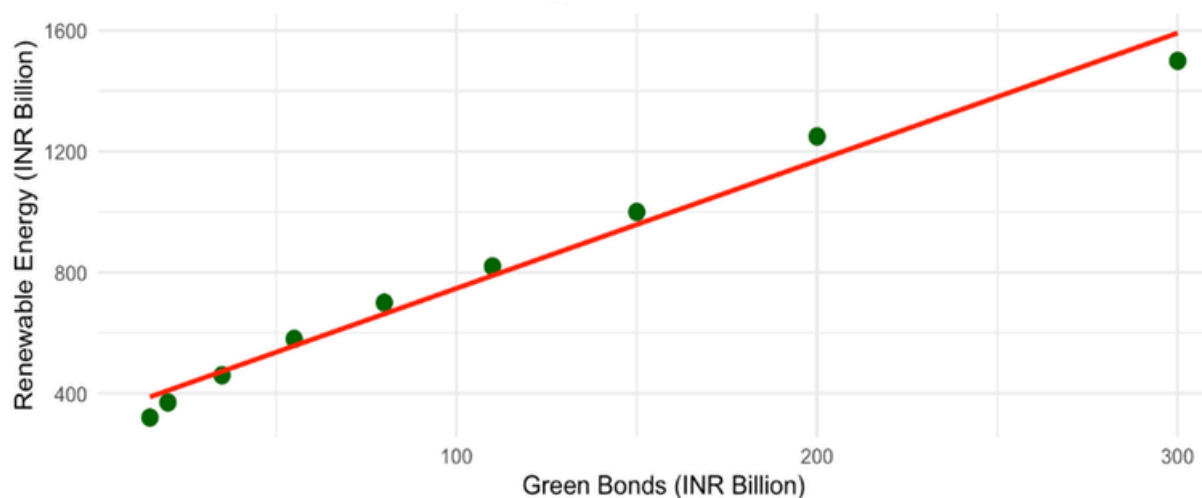
In figure 1 (Next Page) , the data points in colour green remain in a very close proximity of the best fitted line in red. This also reinforces the significance of the relationship between the variables. This Result also aligns with the literature review of green bonds providing new opportunities for capital in the economy, thus supplementing traditional sources of finance for renewable energy investments.

The green bond issuances which particularly happen by large entities like NTPC, Indian Railways have directly financed solar parks, wind farms, and other renewable projects, which could be another reason for this relationship. This result highlights the significance of expanding the green bond market, as suggested by other studies that highlight advantages like reduced capital costs and the ability to reach new investor classes through green bonds.

Table 4
Summary Statistics

Variable	Estimate Std.	Error	t value	p value
(Intercept)	-239	75	-3.19	0.02431 *
Green_Bonds	170	0.304	5.6	0.00250 **
Policy_Dummy	95.2	21.5	4.42	0.00689 **
Nominal_GDP	0.00383	0.000502	7.64	0.00061 ***

Significance. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
Residual standard error: 18.1 on 5 degrees of freedom

Figure 1*Green Bonds vs. Renewable Energy*

2) Policy Impact (Pre-2020 vs Post-2020)

From hypothesis 2 and table 4, $\beta_2 = 95.2$ ($t = 4.42$, $p\text{-value} = 0.00689$). This leads to the rejection of the null hypothesis at $\alpha = .05$ as well as at $\alpha = .01$, therefore the data is statistically significant.

This indicates a strong positive relationship between the policy dummy and renewable energy investments, with the post-2020 period (Policy Dummy = 1) associated significantly with higher levels of funding. On average, post-2020 policies lead to an approximate ₹95.2 billion increase in renewable energy investment, holding other factors constant.

From figure 2 (Next Page) it is visible that there is a huge difference between the means of the two time periods. The mean of the post 2020 period is way larger than the pre 2020 period, by which it can be graphically concluded that 2020 reforms had a significant impact on renewable energy investments.

This result is consistent with the substantial rise observed in renewable energy finance after 2020

and aligns with the literature emphasizing the critical role of policy in unlocking climate-related capital.

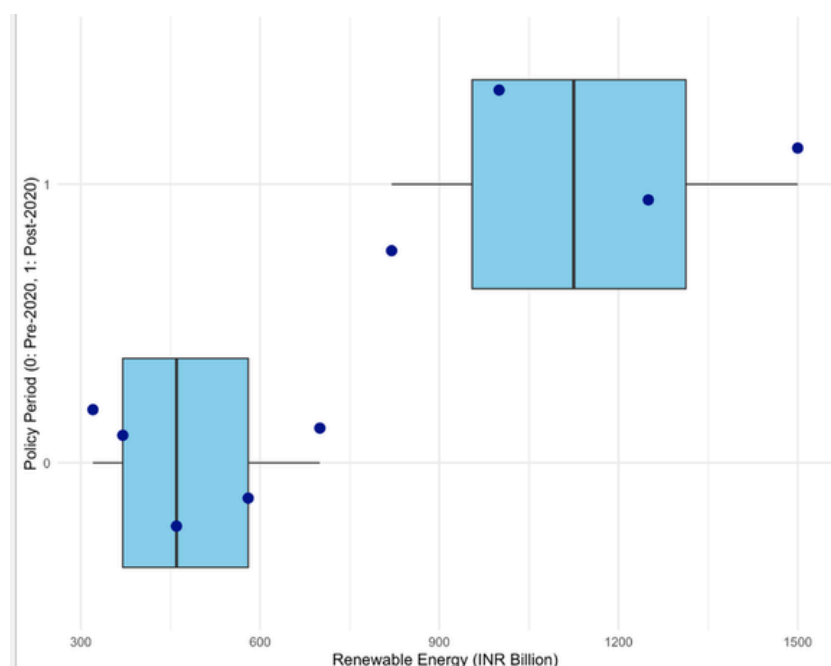
Key reforms around 2020, including enhanced renewable energy targets, fiscal allocations, preparations for sovereign green bond issuance, and international climate finance flows contribute to this jump. This reinforces the view that robust policy backing plays a pivotal role in catalyzing green investment and achieving long-term energy transition goals.

3) Nominal GDP and Renewable Energy

From hypothesis 3 and table 4, $\beta_3 = 0.00383$ ($t = 7.64$, $p\text{-value} = 0.00061$). This leads to the rejection of the null hypothesis at not only $\alpha = .05$ but also at $\alpha = .01$, therefore the data is highly significant.

This reveals a strong positive relation between the two variables, with increase in nominal GDP showing a huge influence on renewable energy investments. Rather, ₹1 billion increase in

Figure 2
Policy Impact (Pre-2020 vs. Post-2020)



increase in nominal GDP leads to approximately ₹0.00383 billion increase in renewable energy funding. In figure 3, the data points in colour brown show a close proximity to the best fitted line in blue, indicating a strong association. This result may suggest that increase in nominal GDP, which includes inflationary effects, has a major role in influencing renewable energy investments.

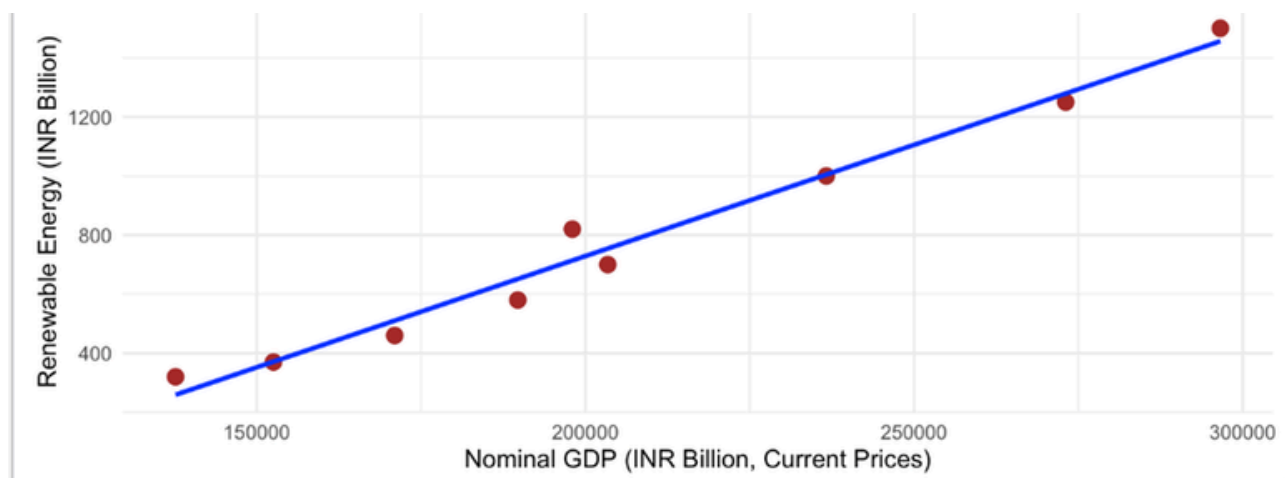
In figure 3 (Next Page), the data points in colour brown show a close proximity to the best fitted line in blue, indicating a strong association. This result may suggest that increase in nominal GDP, which includes inflationary effects, has a major role in influencing renewable energy investments.

RECOMMENDATIONS

This far, a clear picture of the green financing situation in India has been represented. Based on this, some suggestions and policy recommendations have been made as follows:

1) Expansion of Green Bond Market

The regression analysis shows a strong positive correlation and causality between Green Bonds issuances and renewable energy investments. To harness this relation, more efforts can be made to expand the green bonds market. The government can offer tax incentives to investors to increase their participation and returns. It can provide incentives to private corporations, public sector undertakings, and municipal bodies to issue green bonds while avoiding greenwashing. Also a separate green bond trading platform could be launched in order to enhance the liquidity in the secondary market.

Figure 3*Nominal GDP vs. Renewable Energy*

2) Strengthen Policy Frameworks for Long-Term Impact

It is seen from the data analysis section that post-2020 policies have had a positive impact on the investments. Therefore, there is a need for more such policy frameworks to expand the investments in the long run. For this, there needs to be a national level effort to unify definitions, reporting standards etc in order to come up with a comprehensive and centralized green finance policy. These could especially be aligned with India's 2070 Net Zero target, thus setting clear interim milestones to guide green investment flows. The policy could focus on accelerated depreciation benefits, concessional tax rates, and viability gap funding for green projects apart from renewable energy, for example, green hydrogen and sustainable agriculture.

3) Improve Disclosure Standards and Reporting Transparency

India should adopt the global standards from its counterpart nations like the European Union for example, standardized taxonomy for green

financial products to ensure clarity and comparability. Also, stricter Business Responsibility and Sustainability Reporting (BRSR) guidelines, including third-party verification of ESG claims and green bond use-of-proceeds reporting should be introduced. For transparency, public dashboards tracking the green finance mobilisation can be deliberated about.

4) Foster Public-Private Collaboration

As of now, the major investments pertaining to green financing have been done by the government sector. Considering the changing dynamics, more efforts need to come from the private sector. In the initial stage, the government could give the private sector a push by promoting public-private partnerships (PPPs) in green infrastructure, particularly in emerging sectors like EV infrastructure, offshore wind etc. Also establishing Green Finance Development Banks can offer credit enhancements, guarantees, and blended finance instruments to

de-risk private investments thus promoting its participation.

5) *Leverage Technology for Credibility and Scale*

To address challenges like information asymmetry and investor skepticism implementing blockchain solutions for traceability of green bond proceeds and real-time monitoring of project outcomes can help. AI tools can also be used for ESG scoring, risk assessment, and predictive analytics to make green investments more trustworthy and data-driven. Adding to the previous suggestion of a nation green bonds trading platform, a national digital platform integrating project developers, investors, and regulatory bodies for fast-tracking green project approvals and fundings can be considered.

6) *Awareness in the Financial Sector*

More awareness in the financial sector can be introduced. This can be especially done by institutions like RBI and SEBI in collaboration with institutions like NISM and IIBF, to design mandatory certification for bankers, analysts, and credit officers focused on green finance. Also an annual green financing, awareness campaign, can be introduced, targeting institutional and retail investors, thus emphasizing on the financial and environmental benefits of sustainable investing.

7) *International Collaboration and Climate Finance Mobilisation*

Given India's growing climate finance needs, engaging proactively in multilateral development banks, international climate funds, and foreign institutional investors can attract concessional

finance and technical expertise from other developed nations. Also issuing green sovereign bonds globally in multiple currencies can diversify the investor base. India could harness its partnerships like G20 and G7, in this direction and could lead with its initiatives like the International Solar Alliance (ISA).

8) *Incentivise Innovation in Sustainable Finance Instruments*

To broaden the spectrum of green financial instruments, developing pilot projects for transitional bonds, nature-based solutions finance, catastrophe bonds, and sustainability-linked insurance can be worked on. Creation of fintech startups focusing on climate finance innovations, offering new solutions can be encouraged.

CONCLUSION

This study explores the green financing scenario in India based on the dataset from 2015 onwards. It uses both qualitative and quantitative analysis with qualitative literature review and correlation matrices, OLS regression, and policy dummy variables for quantitative analysis.

The research reveals 3 critical insights. First, there exists a strong relationship which is statistically significant between the green bond issuances and renewable energy investment. The regression analysis reiterates this fact and proves that green bond issuances have been successful in mobilising capital for green financing. It strengthens the global consensus that financial innovation should be worked upon based on the fact that green bonds innovative policies have pulled large-scale private and institutional investments for climate resilient projects.

Second, it is revealed that policy frameworks have played a crucial role in promoting green financial flows, particularly post 2020 reforms as it is seen that the investments in renewable energy were positively impacted by post-2020 policies like the creation of the sovereign green bond framework and BRSR mandates. It emphasizes that a proactive regulatory framework and sustained policy will foster investor confidence and coordinate domestic initiatives with international climate goals.

Third, the study concludes that macroeconomic measures like GDP have a positive correlation with investments in renewable energy, and they substantially stimulate green investment. It means that economic growth leads further to the green agenda. Therefore, strategies that go beyond traditional economic trends by increasing the economic output are needed to expand green finance in India.

Therefore, there still exist issues in spite of some encouraging trends. The ambiguous regulations, inconsistent ESG reporting guidelines, disjointed green taxonomy, and low investor awareness have impacted the system negatively. Also the ecosystem is further limited by the undeveloped secondary market for green financial instruments accompanied by shortage of skilled professionals.

Coordination between the government, financial institutions, regulators, and the private sector is needed to address these issues. India needs to take a multifaceted approach that includes growing the market for green bonds, stringent enforcement of disclosure requirements, improving policy stability, encouraging

technological advancement, and fostering international cooperation. Along with it, green financing should not be just limited to the energy sector, rather it should encompass areas like biodiversity, climate-resilient urban infrastructure, and sustainable agriculture.

In conclusion, green finance has the potential to significantly impact India's ability to meet its climate goals and achieve sustainable economic growth. However, achieving this potential necessitates both the creation of green financial tools and structural changes backed by strong political will, open governance, and capacity building. India's goal of being net-zero by 2070 requires green financing to be changed from being a specialized industry to a major force behind inclusive, climate-resilient growth.

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APPENDIX

R Code

```
install.packages(c("tidyverse", "patchwork"))
library(tidyverse)
library(patchwork)

# Dataset
green_data <- data.frame(
  Year = c(2015, 2016, 2017, 2018, 2019, 2020,
           2021, 2022, 2023),
  Renewable_Energy = c(320, 370, 460, 580, 700,
                       820, 1000, 1250, 1500),
  Green_Bonds = c(15, 20, 35, 55, 80, 110, 150,
                  200, 300),
  Real_GDP = c(113694, 121960, 131748,
               139819, 145693, 135128, 147359, 157601,
               167212),
  Nominal_GDP = c(137640, 152537, 170983,
                  189712, 203398, 198009, 236646, 273075,
                  296600)
) %>%
  mutate(Policy_Dummy = ifelse(Year >= 2020,
                                1, 0))

# Regression Model
model <- lm(Renewable_Energy ~ Green_Bonds
            + Policy_Dummy + Nominal_GDP,
            data = green_data)
summary(model)

# plots
plot_green_bonds <- ggplot(green_data, aes(x =
Green_Bonds, y = Renewable_Energy)) +
  geom_point(size = 3, color = "darkgreen") +
  geom_smooth(method = "lm", se = FALSE,
             color = "red") +
  labs(
    title = "Green Bonds vs. Renewable Energy",
    x = "Green Bonds (INR Billion)",
```

```
y = "Renewable Energy (INR Billion)"
  ) +
  theme_minimal()

plot_policy_dummy <- ggplot(green_data, aes(y
= factor(Policy_Dummy), x =
Renewable_Energy)) +
  geom_boxplot(fill = "skyblue") +
  geom_jitter(width = 0.1, color = "darkblue", size
= 3) +
  labs(
    title = "Policy Impact (Pre-2020 vs. Post-
2020)",
    x = "Renewable Energy (INR Billion)",
    y = "Policy Period (0: Pre-2020, 1: Post-2020)"
  ) +
  theme_minimal()
```

```
plot_nominal_gdp <- ggplot(green_data, aes(x =
Nominal_GDP, y = Renewable_Energy)) +
  geom_point(size = 3, color = "brown") +
  geom_smooth(method = "lm", se = FALSE,
             color = "blue") +
  labs(
    title = "Nominal GDP vs. Renewable Energy",
    x = "Nominal GDP (INR Billion, Current
Prices)",
    y = "Renewable Energy (INR Billion)"
  ) +
  theme_minimal()
```

```
combined_plots <- (plot_green_bonds) /
(plot_nominal_gdp) / (plot_policy_dummy)
```

```
combined_plots
```

```
# correlation matrix
```

```
correlation_matrix <- green_data %>%
  select(-Year, -Real_GDP) %>%
  cor() %>%
  round(2)
```

```
print(correlation_matrix)
```

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RESEARCH ARTICLES

Governance via Digital IDs: Aadhaar's Hidden Exclusion Trap

Aditi Arya

This article discusses unexpected outcomes of implementing the Aadhaar-based digital governance framework in India, specifically regarding inclusion errors in social welfare provision. While the Aadhaar framework has helped reduce leakages in government schemes through Direct Benefit Transfer systems, problems related to technological rigidity, infrastructure inadequacy, and socio-economic vulnerability still leave millions of Indians excluded from benefits, especially in states like Bihar. The research uses secondary sources, including CAG audits, UIDAI reports, and NSSO and PLFS surveys.

A daily wage earner named Ramu from rural Bihar waits for his phone to scan, his calloused fingers, again, unable to pass the biometric scan. The wages for his MGNREGA work, intended to lift his family out of poverty, are stuck in digital limbo. Ramu is forced to turn to local moneylenders at 36% interest (Kumar, 2025). This anecdote represents the governance paradox: the supposed efficiency of India's digital welfare system via Aadhaar conceals the exclusion of millions, who lose out on trillions of dollars of growth. This human story from Bihar takes centre stage in our analysis because the state exemplifies Aadhaar's exclusion paradox: with 40% rural poverty, a 30% migrant workforce, and some districts showing 126% ghost-ID saturation, Bihar amplifies national trends into a local crisis demanding urgent scrutiny. (UIDAI, 2025; IndiaStat, 2025).

INTRODUCTION

Imagine being denied a meal because your fingerprint scanner doesn't recognise you, for the third time this month. For 10-15% of rural Indians, especially manual labourers and landless farmers, this is no longer science fiction but reality under Aadhaar every day. Aadhaar, rolled out in 2010, currently connects 142 crore distinct IDs (UIDAI, 2025) to essential services such as PDS ration, MGNREGA payments, scholarships, and pensions. It has reduced LPG subsidy ghosts by 58% nationally and DBT leakages by ₹2.74 lakh crore by March 2025 (UIDAI, 2025; CAG, 2025).

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PDS ration, MGNREGA payments, scholarships, and pensions. It has reduced LPG subsidy ghosts by 58% nationally and DBT leakages by ₹2.74 lakh crore by March 2025 (UIDAI, 2025; CAG, 2025).

However, this efficiency is achieved at the cost of humanity. Biometric verification fails 5-7% of the time (UIDAI, 2025), rising to 12-20% in the weathered hands of rural Indians, disqualifying 20+ million DBT claims every year. In Bihar, where 40% of the population is below the poverty line and 30% are seasonal migrants, this is only the beginning: 126% saturation in districts such as Kishanganj (UIDAI, 2025; IndiaStat, 2025) indicates widespread existence of ghost IDs (only 1.15 crore IDs have been deactivated against an estimated 16 crore deaths) and failed linkages increase welfare leakage by ₹2-3 billion every year (India Today, 2025).

This article analyses the “exclusion trap” of Aadhaar, where digital compulsions to achieve flawless governance end up fragmenting equity.

Using NSSO time-use studies, PLFS employment statistics, and 2025 CAG audits, we

expose how biometric hurdles distort economic multipliers, sustain informality, and widen rural-urban gaps.

Bihar’s economy, which relies heavily on migrants, makes this pressing: Will the JAM trinity (Jan Dhan- Aadhaar-Mobile) scale inclusivity or require an urgent overhaul?

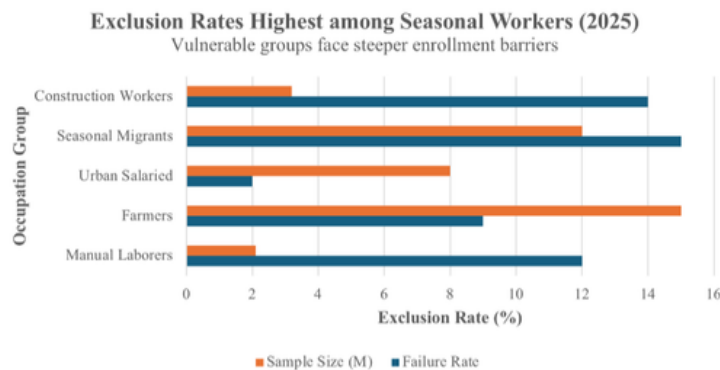
THE CORE PAIN POINT: EXCLUSION TRAP EXPOSED

The technical brilliance of Aadhaar, its de-duplication through iris/fingerprint, spectacularly goes wrong in the field. Fingerprints of labourers wear off due to soil exposure; construction workers’ irises get damaged by dust and migrants’ biometric data goes out of sync when they change addresses. This leads to 5-12% failure rates in authentication, touching 20% in Bihar’s Seemanchal region (UIDAI, 2025).

Immediate Effects:

- PDS Rationing: 4-6% of households affected by denial of monthly quotas, leaving 12 million hungry, NFHS-5 correlations.
- MGNREGA: 10-15% delay in wages for 15 million workers, leading to informal borrowing at 36% rural rates.

Figure 1
Aadhar Exclusion Rates by Occupation



Source: CAG (2025) & UIDAI (2025)

Note: The chart clearly reveals manual labourers at 12% failure vs. urban salaried at 2%.

- Scholarships/ICDS: 8% exclusion rates associated with a 15% increase in stunting due to ration deficits (Government of India, 2021)

Bihar bleeds the most: 30% of rural migrants do not have updated mobiles for OTP fallback (CAG, 2025). At the same time, the JAM trinity of access assumes everyone has digital access; yet 45% of panchayats claim < 20% internet penetration. CAG audits in 2025 point to errors in exclusion tripling, with state leakages of ₹2-3 billion. (CAG, 2025).

Microeconomics sheds light on the cruelty: the poor face asymmetric verification costs (a ₹500 return ticket to block centres), while the state saves on administrative costs. There is also behavioural friction, where loss aversion prevents people from re-enrolling (only 60% attempt again after failure), leading to self-reinforcing cycles of exclusion. Gini ratios increase by 1-2 points in blocks with high failure rates (Kumar, 2025)

EVIDENCE FROM DATA: BIHAR'S BLEEDING EDGE

PLFS 2025 shows that Bihar's FLPR is stagnant at 22%, partly because welfare differentials push women into unpaid care work rather than formal employment. NFHS-6 shows Aadhaar exclusion is associated with a 15% increase in child stunting due to PDS gaps, costing human capital (Government of India, 2021).

UIDAI (2025) shows 284 crore monthly authentications, but rural delivery drop-offs reach 10-12%, with overlaps in Assam/Bihar NRCs freezing biometric data for 2 million (India Today, 2025). There are econometric trends: exclusion is -0.6 correlated with district wage growth in labour-intensive blocks (Author's calculation based on UIDAI, 2025; PLFS, 2025), locking away 2-3% of state GDP in informality. NSSO time-use surveys confirm that excluded households spend 18% more-time queuing for alternatives, slashing national productivity by 0.8% of GDP. (India Today, 2025).

Politicians come and go, but the problem stays. They pick a problem before elections, debate its reality, but post-election, the problem stays as it was.

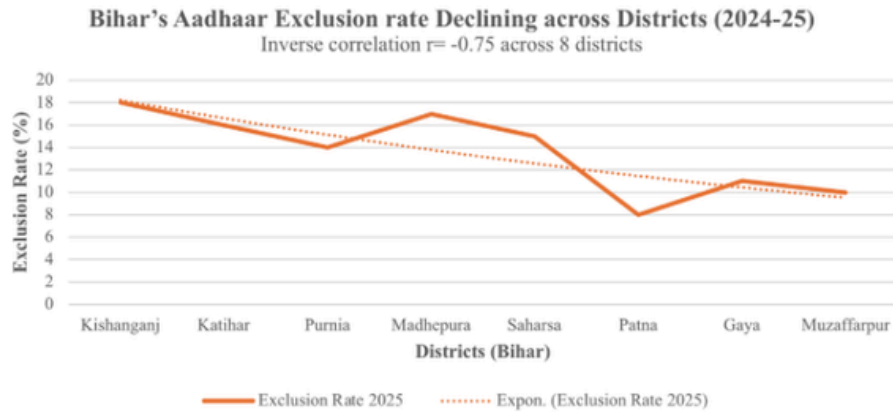
Table 1
Aadhar Exclusion Costs

Scheme	Exclusion Rate	Annual Cost (National, ₹ Cr)	Bihar Impact (₹ Cr)	Affected Population
PDS	4-6%	8,000	1,200	4.2M households
MGNREGA	10-15%	12,000	2,000	3.5M workers
DBT Total	7-10%	25,000	3,500	8-10M individuals

Source: UIDAI (2025); CAG (2025) Data

This isn't a mere tech failure; it's governance reshaping economic outcomes through digital attrition.

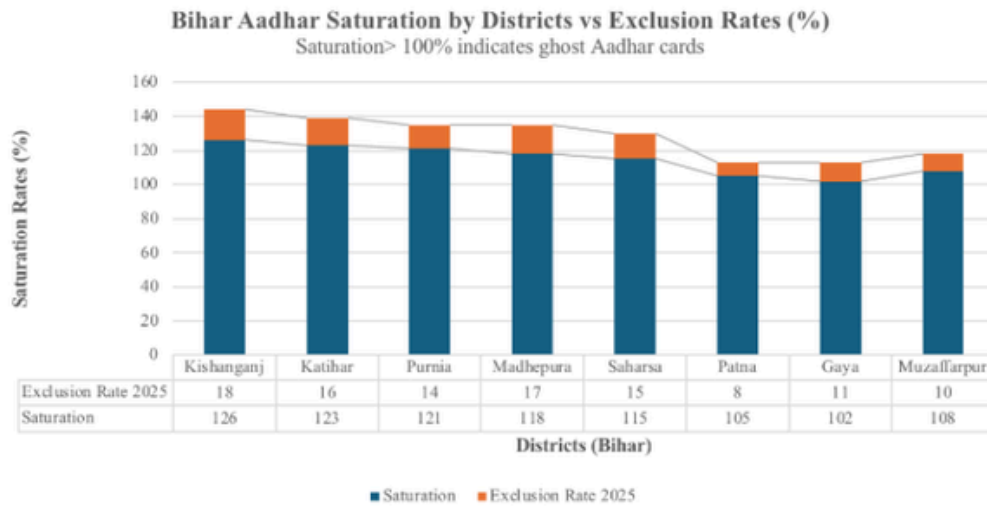
Figure 2
Bihar Aadhaar Declining Exclusion Rates



Source: IndiaStat/UIDAI Saturation Report 2024 & CAG (2025) Audits

The declining line chart depicts Bihar's bleeding edge with its exclusion rates across districts.

Figure 3
Bihar Aadhaar Saturation by Districts



Source: UIDAI Saturation Report 2024

Saturation > 100% inversely correlates with DBT success (r = -0.75). The declining exclusion rate, along with the saturation % in the respective districts of Bihar reveals the reality.

ECONOMIC IMPLICATIONS: BEYOND LEAKAGES

The ₹25,000 crore national exclusion drag translates to a 0.8% loss in GDP due to unused labour and malnutrition. This locks in 80% of the workforce into informality, reducing tax multipliers by 1.5 times, halving them due to errors. (PLFS, 2025)

Long-term: Human capital degradation due to stunted children denied ICDS impacts the demographic dividend. Behavioural economics shows enrolment persistence with a 60% dropout after failure due to hassle costs (CAG, 2025). Spatial mismatch is accentuated: Urban India captures JAM gains while Bihar funds “ghost” rations.

Policy Roadmap: Escaping the Trap

1. Tiered Verification: OTP fallback mandatory (Jharkhand pilot: 40% increase in uptake).
2. Offline Aadhaar: QR-code camps in 50K panchayats (₹5,000 Cr investment, 5 times ROI).
3. Bihar Migrant Portal: NITI Aayog-linked updates to reduce exclusion by 50%.
4. Agency Incentives: ASHA incentives for successful enrolments (20% error rate reduction).

CONCLUSION

Aadhaar boasts savings of ₹2.74 lakh crores, but Ramu’s empty plate shows the human side of the exclusion trap, a problem of digital governance racing ahead of equity. The migrant crisis in Bihar requires immediate, multi-tiered changes that translate the promise of biometrics into reality. India needs to ask: efficiency for whom? Will India’s biometric infrastructure support its digital ambitions for people with low incomes? Empathetic design will now ensure growth for all 142 crores.

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DEVELOPING ECONOMIES & CARBON TAX: A MIDDLE GROUND

Anantinee Mishra

Carbon taxes can work in developing economies, but only with careful tailoring and complementary policy supports that balance environmental objectives with varied socio-economic realities. The net economic impact would depend more on the revenue usage design that arises out of these taxes, as they would have a greater role in a country's continued economic growth.

INTRODUCTION

In the twenty-first century, wherein sustainable development- ensuring that future generations inherit the same earth that we did, in terms of quality AND quantity of resources- has become crucial, climate change has come up as the biggest threat to it. The problem is at its most potent when intersected with high poverty and limited fiscal capacity, which often causes a trade-off between economic development and environmental safeguarding. This dynamic is present in spades throughout developing economies.

In such a scenario, carbon tax has come under policy consideration as a tax on the carbon content of fossil fuels to internalize the external costs of greenhouse gas (GHG) emissions.

Carbon taxation is a part of Pigouvian economics, which had been conceptualized by Arthur Pigou, to align private costs with social costs. The Economics of Welfare, written in 1920, gave the theoretical model on using taxation to correct market failures of non-addressal of environmental/other social costs. Since then, multiple cases have shown that carbon taxes can indeed reduce emissions while balancing economic growth, such as:

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- Nordic countries like Sweden and Finland in 1990s, which became the first countries to adopt the carbon tax, managed to record significant decrease in fossil fuel consumption. However, it is important to note that only 0.3% of world's carbon consumption took place here.
- Japan introduced a modest carbon tax in 2012 ("Tax for Climate Change Mitigation"), which improved energy efficiency.

However, these successes have been testimonial to carbon taxation in developed economies only. Developing economies, with their own structures- and constraints like administrative capacity, fiscal provisioning and need for higher energy to develop quickly without heavy installation costs- have more complications in policy transfer.

While one can certainly see the economic benefits of it, via correcting the negative externality of pollution, encouraging carbon-efficient investment due to taxes and generating revenue, its implementation, especially in developing countries without undermining growth, remains a question mark. This paper aims to examine the theoretical framework of these carbon taxes, rooted in developing economies, via empirical evidence of application, keeping in mind the developmental goals.

ANALYSIS

Keeping in line with Pigouvian economics, carbon taxation at its core aims to align the social costs of pollution and environmental degradation via the marginal harms caused by carbon dioxide emission with the private costs of production involving carbon. Theoretically, the

tax should be the difference between said social cost and private cost, to attain efficiency. In practice, carbon tax is put on fossil fuels' carbon content or on industrial emissions.

Such taxation has emerged as the preferred method over command-and-control regulations which limit carbon usage, as it puts a price on emissions. This creates a market for the right to pollute, and encourages maximum decrease in carbon usage to avoid taxes, all the while allowing firms flexibility in how they go about the actual reduction. This automatically makes it more conducive for developing economies, wherein industries have the autonomy to decide the level of carbon they wish to work with. According to economist Gilbert Metcalf, carbon taxes provide predictable price signals that can foster long-term shifts in consumption and investment patterns.

EMPIRICAL EVIDENCE STRUCTURING

The studies done on the implementation and success of carbon taxation in achieving desired objectives has displayed both promise and complexity.

World Bank in a 2022 report "State and Trends of Carbon Pricing" gave an overview of Sweden's carbon tax trajectory and impact, with the insight that they did indeed lead to reduction in emissions. Further, evidence from various regional programs such as Canada's British Columbia indicated reduction in fossil fuel extraction as well. However, the same literature also mentioned that the net economic impact would depend more on the revenue usage design that arises out of these taxes, as they would have a greater role in a country's continued economic growth. The taxes can be

used to reduce other discretionary taxes to balance overall taxation or subsidize clean technologies, for crucial consideration by developing economies.

Distributional equity is also a concern when it comes to carbon taxation. A poorer household which spends a larger portion of its income on essential energy goods will face a regressive and adverse effect of a carbon tax. Studies like 'Microsimulation Studies of Carbon Tax on Households' by Linden and Sologon (2026) showed that this regressive nature, exacerbated without any supplementary rebates, can be mitigated by social transfers (such as transferring lump-sum amounts) to protect low-income groups and ensure net welfare. This is extremely relevant in developing economies, wherein a large portion of the people would be relevant to the rebate system.

Developing economies often rely heavily on energy-intensive industries and have limited administrative capacity to manage complex tax systems. Research including the 2022 World Bank report suggests that carbon taxes may raise production costs for energy-intensive sectors unless accompanied by transitional support measures. Furthermore, export markets may impose carbon tariffs (e.g., EU's Carbon Border Adjustment Mechanism) which can affect competitiveness if domestic carbon pricing is absent or lower. Institutional constraints including limited emissions data, weak enforcement mechanisms, and constrained fiscal capacity pose additional challenges. The hallmark of a successful carbon tax design would align with the existing tax structure and of the implementing country.

DESIGN PROPOSAL

Several design principles have been recommended by scholars to ensure an equitable and effective taxation plan and implementation. Keeping continued economic growth particularly in mind, the revenue from the tax must be used not just to offer rebates to affected low-income groups, but also to fund tax reductions in other areas and subsidize clean energy technologies that shall ultimately replace carbon. Moreover, carbon taxes should be supported by renewable alternatives, public investment and policy support for sustainable infrastructure, and energy efficiency programs to expand low-carbon production. For example, The United Nations' Handbook on Carbon Taxation for Developing Countries provides detailed guidance on these complementary measures.

Developing economies have also suffered from the lack of a reliable measurement instrument, and as such investment in emissions measurement systems should be strengthened.

The measure of efficiency of any plan is dependent, more than anything else, on a successful implementation of it. For the same, a transparent bureaucratic system needs to be put into place.

CONCLUSION

Carbon taxes are a powerful economic tool for reducing greenhouse gas emissions and promoting sustainable development. The theoretical foundations in Pigouvian economics and empirical evidence from various jurisdictions suggest that when well-designed, carbon taxes can align environmental goals with economic efficiency.

However, the effectiveness of carbon taxes in developing economies hinges critically on policy design that addresses equity, competitiveness, and administrative feasibility.

In conclusion, carbon taxes can work in developing economies, but only with careful tailoring and complementary policy supports that balance environmental objectives with varied socio-economic realities.

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Behavioural Interventions in the Jal Jeevan Mission: Assessing Alignment with OECD's BASIC Framework

Neha Mahesh

Over the past two decades, Behavioural Insights has emerged as a compelling alternative to traditional public policy design, drawing on economics, psychology, and behavioural sciences to frame realistic models of human decision-making. The Organisation of Economic Cooperation and Development (OECD)'s BASIC Toolkit (2019) provides a structured framework for designing and evaluating behaviourally-informed governance programmes. In India, NITI Aayog's Behavioural Insights Unit released the 2022 Behavioural Diagnostic Report, applying BI to the Jal Jeevan Mission (JJM). This article asks: to what extent does JJM's behavioural documentation align with the OECD's BASIC framework, and how far do global standards in behavioural intervention design find reflection in India's emerging practice?

INTRODUCTION

In public policy, Behavioural Insights (BI) are tools that influence individual decisions and actions by shaping the context in which choices are made. From an economic perspective, BI acknowledges that the conceptualisation of the 'rational man', or Homo Economicus, is highly unrealistic. BI aims to ensure development in the world of the Homo Psychologicus, who is prone to cognitive biases, misjudgements, emotional impulses and social pressures. If well-designed, behavioural interventions (often known as 'nudges') can play a significant role in improving economic outcomes in an efficient and cost-effective manner. In India, the use of BI has grown as a complement to traditional policy design. Insights from psychology and behavioural economics are increasingly being employed to evaluate and improve policy performance. NITI Aayog has highlighted BI as a key mechanism to enhance citizen engagement and programme efficiency.

Many frameworks have emerged for designing and evaluating behavioural interventions. One such framework is BASIC, developed by the Organisation for Economic Co-operation and Development (OECD). The BASIC Toolkit, released in 2019, provides a structured five-stage

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model (Behaviour - Analysis - Strategy - Intervention - Change) for identifying, analysing, and implementing behavioural interventions, and for assessing their long-term impact.

The Jal Jeevan Mission (JJM) was launched in 2019 with the objective of providing safe and adequate drinking water through individual household tap connections in rural India. By encouraging communities to adopt water-conserving behaviours and actively manage household water use, it aims to improve health outcomes, reduce time burdens, and strengthen local governance. In November 2022, the Behavioural Insights Unit (BIU) of India, NITI Aayog, along with the Department of Drinking Water & Sanitation (DDWS), Ministry of Jal Shakti, published the 'Jal Jeevan Mission Behavioural Diagnostic Report'.

This report identified key behavioural objectives, barriers, and levers to guide intervention design. One year later, BIU published the 'Jal Jeevan Mission Compendium of Behavioural Best Practices', which aimed to provide replicable strategies and guidance for practitioners.

This article asks whether the design and implementation of BI in JJM aligns with the stages outlined in the OECD BASIC framework. Using JJM as a case study, it aims to evaluate this alignment and highlight potential gaps in publicly available documentation.

BASIC AS A LENS TO EXAMINE THE JAL JEEVAN MISSION

Behaviour

The first stage of the BASIC framework is 'Behaviour', which involves identifying the behavioural aspects of a policy problem. This is done through behavioural reduction, where the general policy area is plotted and connected to

relevant domains, culminating in concrete behaviours. A priority filter is then applied to select target behaviours, and the crucial decision points are identified. DDWS and BIU's 'JJM Behavioural Diagnostic Report' (2022) identifies a few broad behavioural objectives that correspond to the stated policy objectives of the Jal Jeevan Mission. The representative themes include Ownership, Payment, Maintenance, Consumption, and Grey Water Management. Target behaviours are stated to be defined based on 'the policy process cycle, literature review, stakeholder consultation and field study' (p.36). Publicly available documentation does not explicitly state the criteria which prioritised specific behaviours over others. The Best Practices Compendium emphasises providing practitioners with templates for replicable interventions, rather than the rigorous procedure of behavioural reduction, target filtering and decision-point mapping envisioned in BASIC.

Analysis

The second step, 'Analysis', examines the target behaviours and the choice architectures embedded within them. The aim is to understand why people act as they do. The BASIC Toolkit does this using the ABCD framework, which suggests that behavioural problems may be analysed through four aspects: attention, belief formation, choice, and determination. To understand the motivating factors behind target behaviours, triangulation is recommended along with on-ground qualitative data collection. Work on the Jal Jeevan Mission shows substantial engagement with the BASIC framework in this stage, given the agent-centric interpretation of the policy issue. Based on the data sample, the diagnostic report aims to understand why the respective actors may not be undertaking desirable actions. This information is framed in

terms of 'behavioural barriers' which influence the target behaviours. For instance, the section on Judicious Water Consumption analyses why individuals are not willing or able to use water in an efficient manner. The report identifies three key barriers. The first is future discounting. The perceived gratification that individuals are likely to receive from the present consumption of water is likely to be greater than the future perceived benefit of water conservation. The second is low opportunity cost, where individuals may feel that the price of acquiring clean water is now lower due to its increased accessibility. Fixed user charges also play a role, where costs paid regardless of household consumption disincentivise mindful water use. Acknowledging the role of such cognitive mechanisms is foundational for the later stages.

Strategy

While stages 1 and 2 focus on identifying and evaluating the policy problem from a behavioural lens, stage 3, 'Strategy', focuses on understanding the behavioural insights that can help design a suitable intervention. Using the hypotheses generated in Behavioural Analysis, each diagnostic domain is linked to potential strategies. Similar to the earlier framing of 'Behavioural Barriers', the JJM Behavioural Diagnostic Report identifies 'Behavioural Levers'. These are specific insights derived from the barriers, observed to encourage individuals to develop desirable habits. Based on the earlier example of judicious water consumption, the corresponding behavioural levers are listed. These are strategies that enhance risk perception, implementing a pay-as-you-use model, improving communication of salience, and reinforcing the availability heuristic. The direct linkage between diagnostic barriers and implementation design reflects considerable alignment between the conceptualisation of strategies for JJM and the theoretical framework

provided by OECD's BASIC.

Intervention

The fourth stage is 'Intervention', which involves testing the effectiveness of the strategies developed using behavioural analysis. With a specific focus on an experimental approach, this stage deals with the iterative process of posing hypotheses, designing and evaluating the strategies based on changes in the target behaviour. In BIU's work on the Jal Jeevan Mission, Monitoring and Evaluation (M&E) is emphasised as an important part of the Behavioural Intervention Cycle. The compendium makes a distinction between monitoring (process indicators) and evaluation (outcome measurement), recommending context-specific M&E plans to assess efficiency, scalability, and behavioural change. It outlines structured indicator selection and a wide range of methods, from surveys and participatory tools to performance tracking and impact evaluations. Thus, JJM shows strong conceptual alignment with BASIC's 'Intervention' stage through structured M&E plans, indicator frameworks, and evaluation methodologies comprising experimental and quasi-experimental approaches.

Change

The final stage under the BASIC framework is 'Change'. Here, the objective is to inform public policies about the findings from the project and ensure that society gains the broadest possible value from the insights gained. This requires the entire project to be revisited contextually, the setting up of systems to monitor long-term effects, and the dissemination of information. The presence of the M&E systems ensures that the Jal Jeevan Mission continues to build on community-level behavioural changes. Revisiting the project will involve expanding the physical and digital

infrastructure supporting JJM, along with knowledge dissemination among both policymakers and the general public. In the long-term, the selection, tailoring, implementation or monitoring exercises will have to be undertaken by individual stakeholders.

CONCLUSION

The use of behavioural interventions in the Jal Jeevan Mission was examined using the OECD BASIC framework. Each stage of BASIC was mapped against the JJM Behavioural Diagnostic Report and BIU's Compendium of Behavioural Best Practices. This article aims to provide an analytical perspective on how behavioural thinking is incorporated into a major Indian policy initiative. While existing sources on the behavioural interventions support practitioners, it provides limited guidance on behavioural reduction, priority filtering, or decision-point mapping. This gap suggests an opportunity to strengthen the design and targeting of behavioural interventions in India. Overall, the Jal Jeevan Mission demonstrates promising institutionalisation of behavioural insights. It offers a foundation upon which evidence-driven, scalable, and context-sensitive interventions can be built in the future.

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Error! Face Does Not Match: **An Assessment of the Poshan Tracker App** **in India's Nutrition Policy**

Sahaj Jaggi

Nutrition, often limited to a health issue, remains a persistent developmental challenge, costing the country economically. India's response to this included the launch of Poshan Tracker, the world's largest nutrition monitoring mobile-based application. The article through field reports, research papers and government data critically assesses the Poshan Tracker App, its impact on anganwadi workers as well as beneficiaries, and the implementation of the Facial Recognition System of the app. The article concludes that though the app advances real-time monitoring, it also generates exclusion of communities and regions.

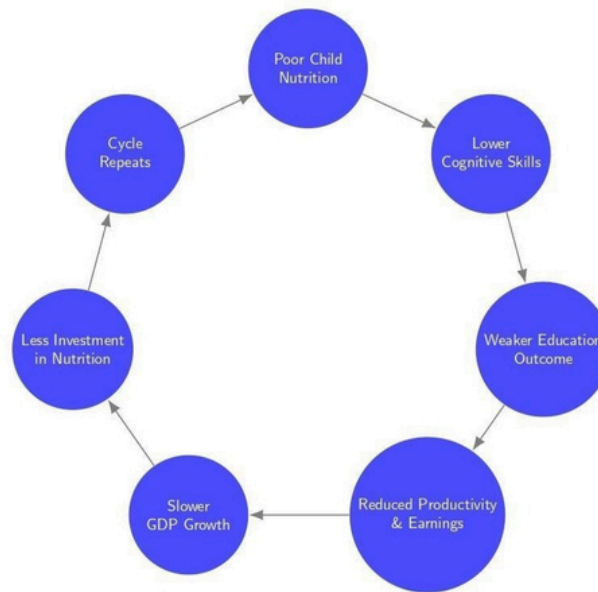
INTRODUCTION

Nutrition is often seen as a health issue, an issue to be solved for creating a more healthy population. But, it is much more than that. Nutrition remains a developmental and economic issue costing the world economy over a trillion each year. It does not exist as a health issue in isolation, rather, creates a greater burden on the system in the long run, leads to a lower productivity amongst the labour force, which hence reduces the production possibilities of a nation having an impact on macroeconomic factors. The commitment to reduce hunger and malnutrition is hence not only an ethical imperative but also an economic investment.

Research shows that malnutrition and related diseases cause India a reduction in its GDP between 0.8 and 4.0 percentage points. For a country like India, that has a huge demographic dividend, the advantages of this dividend end up not being utilised due to the issue of low labour productivity, often attributed to reasons of nutrition deficiencies. Several studies have also shown the direct link between lack of nutrition with lower wages and diminished lifetime earnings.

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Figure 1
The Nutrition-Productivity Trap Cycle



Source: Observer Research Foundation

Nutrition, or the lack of it plays a key role in pushing individuals into the vicious cycle of poverty. Reduced nutrition leads to several health risks - diminished energy for work, reduced maternal health and anemia, hence reducing physical as well as cognitive performance.

In such a situation it becomes relevant to assess India's flagship nutrition programme —the POSHAN Abhiyaan 2.0. The article provides a comprehensive overview of Poshan Abhiyaan 2.0 with a specific focus on the Poshan Tracker App. The app has been a digital intervention that has come under criticism and screening by several researchers and economists. This article aims to analyse the different features of the app, understand the policy gaps and hence the areas where it can be improved to ensure delivery of take home rations (THR) to as many beneficiaries as possible.

POSHAN ABHIYAN 2.0: AN OVERVIEW

India has consistently ranked low in indicators of malnutrition, nutrition, child healthcare, infant mortality rates, and others. For this, the government launched ICDS, Integrated Child Development Services Scheme in 1975. The scheme, through Anganwadi centres and Anganwadi workers provided supplementary nutrition, pre-school education, nutrition & health education, immunization, health check-up and referral services. During this period, improvement was seen in many statistics, but the challenge of malnutrition still remained at large, and hence, the Poshan Abhiyaan scheme was launched by the government in 2018, along with support provided by the World Bank.

Developing further, in 2021, the structure of India's nutrition plan was revised, reorganized, and launched under the Mission Saksham

Anganwadi and POSHAN 2.0. This initiative subassumed three schemes under its umbrella—the ICDS, Poshan Abhiyaan scheme and the Scheme for Adolescent Girls. These three components are as follows:

1) Anganwadi Services:

Earlier under the ICDS scheme, Anganwadi services form a major component of Mission 2.0 and is the major tool through which essential services are dispersed. Anganwadis provide the eligible beneficiaries with the following services: supplementary nutrition, pre-school education, nutrition & health education, immunization, health check-up and referral services. Three services out of the above, namely, immunization, health check-up, and referral services are provided by the National Health Mission and Public Health Infrastructures.

2) Scheme for Adolescent Girls (SAG):

The scheme for adolescent girls was launched in 2010, and was carried out independently for 11 years. In 2021, with the launch of Poshan Abhiyaan 2.0, the scheme was subassumed under the mission and revamped. Target beneficiaries under this scheme are adolescent girls in the age group of 14-18 years in the aspirational districts of states and the Northeast regions. The aim is to provide nutritional support to adolescent girls in the identified areas of the country and improve their health and nutritional status.

3) Poshan Abhiyaan:

This was launched in 2018 and is India's flagship scheme to improve nutritional outcomes among children, adolescents, pregnant women and lactating mothers. The key components of

the scheme are: convergence, use of technology, community mobilization and behavioral change, Jan Andolan, capacity building, innovation, incentives and awards. The aspect of Jan Andolan focuses on awareness through SHGs, Panahchat and Public Participation.

The Nutritional focus in Mission Poshan 2.0 has also changed significantly, the focus is now on diet diversity, food fortification and popularizing the use of millets. To reduce malnutrition and anemia in women and children arising due to deficiency of micro nutrients like Iron, Folic Acid and Vitamin B-12, under Supplementary Nutrition Programme of Anganwadi Services, fortified rice was allocated to 21 States/UTs during the 2nd quarter of FY 2021-22 and from the 3rd quarter of FY 2021-22 onwards only fortified rice is being allocated to all the State/UTs.

Increasing attention is also being given to digital interventions in nutrition programmes, this was followed with the launch of ICDS-CAS system, which was then dismantled and replaced by the Poshan Tracker App under Mission Poshan 2.0.

POSHAN TRACKER: FEATURES, FUNCTIONING AND FRAMEWORK

Poshan Tracker is a digital governance tool rolled out on 1st March 2021 and is the largest mobile phone-based nutrition surveillance system in the world. It is a mobile based application launched with support from National E Governance Division (NeGD) and enables real-time monitoring of services through AWCs and provides a comprehensive view of beneficiaries. The app replaced the manual registers maintained by Angwadi helpers and instead, information is now stored digitally within the app.

Efforts have been made to make the Poshan Tracker app more inclusive. It is accessible in 24 languages and training is being provided to anganwadi workers to learn how to use it.

Moreover, it works both online and offline—Anganwadi workers are allowed to access the app offline, and use it to enter data, which is then backed up into the system when wifi connection is restored. However, the data can only be entered for up to three days when offline. Further, despite the digital mandate, Anganwadi's in areas of low connectivity are still required to maintain their old physical registers along with the daily entry on Poshan Tracker app for cross verification leading to a double burden.

Following a government order on 30th May, 2025, a system of Face Recognition has also been recently introduced within the app. The Union Ministry of Women and Child Development has made the FRS mandatory for pregnant and lactating women to access take home rations (THR) starting July 1st, 2025.

The system works as follows—the worker first takes a live photo of the beneficiary, which is then matched in the app with a registration photo according to which ration is given and the distribution is recorded in real time as digital proof. The app also involves a one time e-KYC procedure, for which Aadhar number needs to be linked with mobile number through OTP. The facial recognition system detects faces even in offline mode, but the data is loaded only in online mode.

The same order of May 30th introduced a system of liveliness detection for children between the

age group of 3 to 6 years. Liveliness Detection is used in security systems to ensure an entity possessing a biometric is a live human being and not a fake image or recording. Here, it is used to ensure that the beneficiary of Poshan Abhiyaan is a real person and not a fake representation to ensure that resources are efficiently utilized. The mandate of liveliness detection requires the pictures of young children to be updated when they enter the category of 3 to 6 years.

Several independent researchers have pointed out that network failures are a common feature in remote parts of the country, this hampers the process of THR and reduces the number of people that can access them. This has been pointed out to be a direct violation of the National Food Security Act which says that supplementary nutrition is a legal entitlement for children from 6 months to 6 years of age and for all pregnant and lactating women which is to be provided free of charge through anganwadi centres.

The All India Federation of Anganwadi Workers and Helpers (AIFAWH) have called for an immediate rollback of the FRS system, calling it a direct violation of the food security act. Anganwadi workers across the country have risen up in protests against this system, reporting the complications of the process, delays and connectivity issues. Often the process of facial recognition takes up to thirty minutes for each individual which becomes difficult to complete by the angwadi workers for the entire beneficiaries in the village. Further, several times the system does not work and angwandi workers have to call the beneficiaries and or visit them repeatedly to complete the process. It has also been reported that sometimes the photos do not get uploaded, there are also issues of internet connectivity due to which beneficiaries have to

be called again and again. This creates a trade off for the anganwadi workers between conducting FRS or using that time to teach the students.

Further, several beneficiaries cannot afford to show up again and again to complete the process because women often have to give up on their day's earnings to do so. This was pointed out by an angwadi worker in Bhalswa Dairy, Delhi, "Women who come to the centre have to forgo their daily wage or leave their infants in someone else's care. It's not easy for them to keep making rounds. On an average, we spend 20 minutes trying to upload the photo, but the application keeps crashing." In the past few weeks, she said that she had to visit a beneficiary's house at least four times for a task that could have been completed in a single trip.

The Delhi State Anganwadi Workers and Helpers Union President, Shivani, said "Facial recognition is not only increasing the workload, but also impacting the beneficiaries. For instance, a growing child's facial features keep changing, so the app fails to recognise the child's face when a worker tries to upload it, which causes the beneficiaries to lose out on the benefits."

Government data shows that as on 5th August 2025, face capturing and e-KYC of 3.69 crore THR beneficiaries out of the 4.91 crore eligible beneficiaries registered for Take Home Ration (THR) has been completed. This makes up almost 75.12% of the beneficiaries. For the rest 25% who could earlier receive ration by simply signing their names, exclusion has entered the process which is one, self inflicted and the other, by the system.

Many beneficiaries opt out of the system because of the complications involved, the tedious process and the delays. The other occurs because identification takes a long time, and sometimes does not connect the photo of the beneficiary with the registered photo. At various times in remote areas, and amongst underprivileged communities, the task of e-KYC becomes impossible to conduct because they do not have an active Aadhar linked mobile number because it involves a cost of up to 1000 per month, unaffordable to a major proportion of the population. Further, in order to access ration, the pregnant/lactating mother shall be the one going to the centre to get their face matched rather than before, when a relative could take the ration on the behalf of the beneficiary. The act of a mother having to go to the centre has many complications in itself; health-wise, social as well as cultural which vary in different regions.

ANALYSIS & ASSESSMENT

A 2024 study titled "India's Poshan Tracker: data-driven tool for maternal and child nutrition" analysed the NFHS-5 data between 2019-2021 with the 2023 Poshan Tracker data. The findings indicated that Poshan Tracker often estimates a lower prevalence of undernutrition than the subset of children in NFHS-5 who report having their data measured at an AWC in the past year. The study suggests a difference in data across regions and other variables as well. Possible reasons for this finding are also stated, one of which states that Poshan Tracker has resulted in improved delivery of intervention services, though further evaluations are needed to different scales being used by NFHS-5 and AWCs, where a SECA digital scale is used by the former and springs scales by AWCs. Moreover, the study also states that there may be a bias in reporting of data for Poshan Tracker.

Concluding the study points out that, “While not a replacement for routine population-based surveys, real-time community-based monitoring such as the Poshan Tracker can provide a snapshot of the current situation thus allowing for timely identification of areas that require improvement and the potential need to adjust programmatic action to achieve the stated targets.”

The above study indicates the trade off that arises in between reliable data and real time data through the Poshan Tracker app. Overburdened anganwadi workers, that often end up having to maintain both digital records as well as their old physical registers on top of the added tasks of ongoing home visits, assessing immunization, and learning how the new system of digitalisation works often leads to wrong data entries and sometimes even a bias in data entry by workers because of the increased workload and pressure.

In August 2025, researchers Jayshree Sharma and Dr. Manish Sharma conducted a survey in the Jaipur district to assess its effectiveness in performance monitoring and identifying the challenges involved in adoption. With 50 respondents, comprising both anganwadi workers and supervisors, the questionnaire covered the role of poshan tracker, success of the app, and challenges ahead. Though the statement on “ease of use” saw a general consensus with only 18% of the respondents pointing out that it is difficult to use, and 60% affirming that it was sufficient and easy to use, the statement on technical difficulties saw a different response, with a total of 60% responses (40% agree; 20% strongly agree) acknowledging facing such

issues. This indicates how technical glitches and poor connectivity remain a concern which hinders efficiency and real time data entry even in urban cities, which points to a more troubling concern for remote areas.

CONCLUSION

The Comprehensive Annual Modular Survey (CAMS) data shows that in 2023, 71 percent of rural households and 87 percent of urban households had internet access. As of April 2024, 95.15 percent of villages have access to the internet with 3G/4G mobile connectivity. India’s estimated population is 1.45 billion, while the digital population is estimated around 800 million. In view of these statistics, the goal of expanding nutrition, dietary diversity, reducing malnutrition, and improving maternal health through digital interventions becomes disillusionary. The gaps in policy become visible when viewed on a wider scale in the background of a huge gap in digital literacy, which disproportionately affects women, and rural women much more.

Hence, the policy of Poshan Tracker, visionary as hailed by the world bank, lacks in implementation. Though increasing data monitoring and end-to-end data entry, it places an overburden on the workers, fails in the face of challenges of digital illiteracy, and reduces the number of beneficiaries that access the benefits of India’s flagship nutrition policy.

As stated by the workers itself, there is a need to address the technical glitches, the system of facial recognition and the overburden on Angwanwadi workers. Looking ahead, the Poshan Tracker needs to be improved through recommendations from the frontline workers, experts and assessments through pilot experiments. There

needs to be an increased investment in bridging the digital gap, ensuring equitable access to smartphones, as well as expenditure on training to accompany any digital intervention to ensure it is utilised well and not treated from an aversive perspective. Data collection, entry and monitoring are not the goals of development, rather, improving nutrition outcomes, building material health, reducing stunting, anemia, malnutrition and other indicators are. It's important that this is what is centered along with the voices of the Anganwadi workers and beneficiaries in policy making.

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Crime, Unemployment and Incentives: A Labour Market Perspective

Raka Banerjee

This article examines crime as a labour market outcome shaped by unemployment, informality, and income instability. Building on the economic theory of crime, it conceptualises criminal behaviour as an occupational choice driven by relative returns and opportunity costs. Using evidence from urban India, particularly during the COVID-19 pandemic, the study shows how labour market disruptions altered incentives by reducing expected gains from legal work while lowering the effective costs of illegal activities. The findings highlight the limited effectiveness of deterrence-only policies and emphasise the role of stable employment, income security, and formalisation in reducing crime through incentive-based mechanisms rather than punitive enforcement alone.

INTRODUCTION

Crime is often seen as a failure of law, morality, or governance. This view leads to responses focused on surveillance, policing, and punishment. While these methods address the legal side of crime, they often ignore how incentives and constraints shape behaviour. In situations where stable jobs are scarce and income is uncertain; individuals have limited choices that affect how they divide their time between legal and illegal activities.

Crime, in this view, is not separate from productive life; it is woven into labour markets, wage structures, and institutional settings. When legitimate jobs don't offer enough or reliable pay, crime can become an alternative source of income, especially for those on the margins of formal work. This perspective matches the economic theory of crime, which sees criminal behaviour as a response to relative payoffs rather than just a result of moral choices.

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This article argues that crime can be viewed as a labour market outcome driven by unemployment, informality, and income instability. It draws on labour economics and theories of occupational choice to see crime as a function of opportunity cost, expected returns, and risk. Evidence from urban India, especially during the economic upheaval caused by the COVID-19 pandemic, shows how shocks reshape incentives, making crime a rational response, even if it is socially undesirable. Viewing crime this way reveals the limits of policies focused solely on deterrence and highlights the need for stable employment and income to prevent crime.

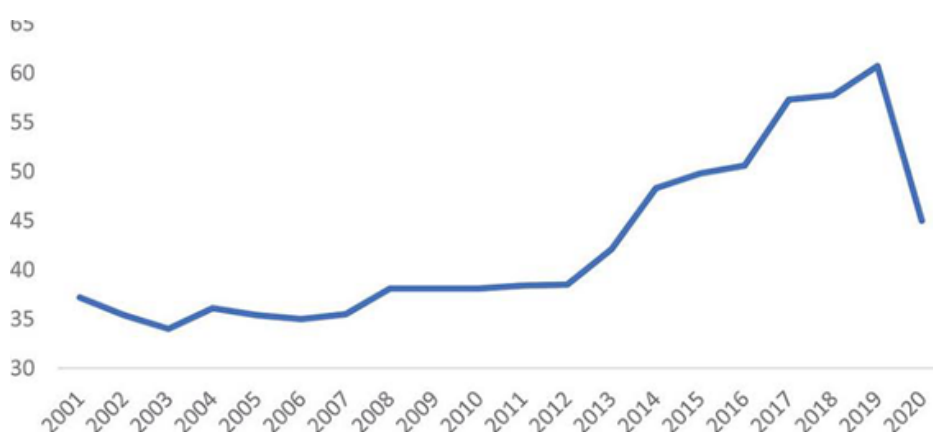
A BRIEF REVIEW OF LITERATURE

The economic analysis of crime originates in the work of Becker, who conceptualises criminal behaviour as a rational response to incentives, where individuals weigh expected benefits against potential costs (Becker, 1968). This framework is extended by Ehrlich, who models participation in illegal activities as an occupational choice under uncertainty, emphasising the role of risk and expected returns (Ehrlich, 1973).

Subsequent contributions place greater emphasis on labour market conditions, with Freeman arguing that weak employment prospects and low wages reduce the opportunity cost of crime, particularly among low-skilled workers (Freeman, 1999). Empirical evidence supports this relationship, as studies identify a positive association between unemployment and crime rates, especially property crimes (Raphael and Winter-Ebmer, 2001).

At the same time, the role of deterrence has been examined extensively, with findings suggesting that while policing and enforcement can reduce crime, their effects may be subject to diminishing returns and institutional constraints (Chalfin and McCrary, 2013). More recent contributions highlight the importance of economic shocks, showing how sudden

Figure 1
Crime Rate in India (%)



Source: National Crime Records Bureau (NCRB), *Crime in India Report (2001-2020)*

disruptions to income and employment can reshape criminal incentives in systematic ways (Ferraz et al., 2022).

However, much of the existing literature is grounded in developed country contexts and often treats labour market variables in isolation. There remains limited work examining how informality, income instability, and labour market disruptions jointly influence criminal behaviour in developing economies. This article addresses this gap by situating crime within a labour market framework in the context of urban India.

This article aims to answer two broad research questions:

1. How do unemployment, informality, and income instability shape criminal behaviour when crime is viewed as a labour market outcome?
2. To what extent did the economic disruptions during the COVID-19 pandemic alter criminal incentives by changing the relative returns to legal and illegal activities in urban India?

WHY CRIME COMPETES WITH WORK: INCENTIVES, OPPORTUNITY COST & CRIMINAL BEHAVIOUR

The division of labour between legal and illegal activities can be understood through occupational choice. Individuals weigh the expected returns from legal work against those from illegal activities, considering risk and uncertainty. When wages are low, jobs are unstable, or work is hard to find, the cost of committing crimes decreases. On the other hand,

when labor markets provide stable jobs and real chances for advancement, the appeal of crime lessens. This perspective aligns with Gary Becker's economic model of crime, which treats criminal activity as a choice shaped by expected returns, opportunity costs, and the likelihood of punishment. Crime competes with legal work as an alternative use of time and effort, especially when labor markets cannot productively absorb workers. Importantly, this view does not assume that people always think perfectly rationally.

Those experiencing economic hardship may overlook future punishments, underestimate risks, or choose immediate income over long-term consequences. Still, the core mechanism remains the same. Crime becomes more likely not because people disregard legal norms, but because economic limitations restrict their available choices.

INFORMALITY & THE ECONOMICS OF INCOME RISK

Labour markets in developing countries are marked by widespread informality and limited social support. In India, about 90% of workers are thought to be in the informal sector, facing unstable income, no contracts, and little access to social safety nets. Informal workers earn much less and have more variable income than those in formal jobs, reducing the long-term benefits of legal work.

Income instability significantly affects criminal incentives. Surveys show many informal workers lack savings or insurance, leaving families vulnerable to even minor income losses. When legal work does not guarantee steady earnings, individuals might seek multiple income sources,

including illegal ways. Low-skill and low-capital crimes, especially property crimes, may serve as substitutes for missing job opportunities rather than as rare exceptions.

Unemployment makes this situation worse. Economic downturns lower expected returns from legal work and heighten uncertainty. In urban India, where living costs are high and informal jobs are prevalent, the lack of consistent income options significantly changes the incentives for vulnerable workers.

However, much of the existing literature is grounded in developed country contexts and often treats labour market variables in isolation. There remains limited work examining how informality, income instability, and labour market disruptions jointly influence criminal behaviour in developing economies. This article addresses this gap by situating crime within a labour market framework in the context of urban India.

URBAN LABOUR MARKET DISRUPTIONS AND CRIME DURING THE COVID-19 PANDEMIC: A CASE STUDY

The COVID-19 pandemic provides a clear example of crime as a labour market outcome. The national lockdown in 2020 caused an immediate contraction of economic activity that hit urban and informal workers hard, especially in construction, retail, transportation, and personal services. Labour force data reveal that India's urban unemployment rate soared past 20% in mid-2020, compared to much lower levels before the pandemic.

At the same time, estimates indicate that over 100 million informal workers faced job losses or significant income cuts during the early lockdown months. For these workers, the expected returns from legal employment dropped

Figure 2
Unemployment Rate in India (%)



Source: World Bank, World Development Indicators (2024)

sharply, while basic needs remained urgent. With limited savings and fragile coping mechanisms, the opportunity cost of participating in illegal activities significantly decreased.

Crime patterns observed during this time reflect these changes in incentives. While lockdowns temporarily reduced certain types of violent crime, data from the National Crime Records Bureau show that reported theft and economic offenses increased in several urban areas after restrictions eased. In 2021, property-related crimes made up more than one-third of all reported cognizable offenses, highlighting the income-driven nature of these actions.

The pandemic also changed the expected costs of crime. Law enforcement was inundated, judicial processes slowed down, and case backlogs grew, reducing the chances of timely punishment.

This led to a shift in both parts of the incentive structure: the returns to legal work weakened while the costs of illegal activity fell. As economic activity resumed and job opportunities gradually improved, crime trends stabilized in various cities, reinforcing the link between labor market recovery and crime.

The labour market shock induced by the COVID-19 pandemic reshaped criminal incentives in a manner consistent with economic reasoning rather than moral breakdown. In 2020, total cognizable crimes declined or moved unevenly across several major states despite elevated unemployment, reflecting the effects of strict mobility restrictions, administrative disruption, and under-reporting during prolonged

lockdowns. As economic activity resumed in 2021, unemployment rates improved only modestly while income insecurity and informality remained widespread. During this phase, total crimes increased across many states, often exceeding pre-pandemic levels, suggesting that restored mobility combined with weakened employment quality lowered the effective opportunity cost of criminal activity. This temporal pattern indicates that crime responded not to unemployment levels alone but to the interaction between labour market distress and institutional constraints, reinforcing the view of crime as an outcome shaped by incentives within disrupted labour markets.

DETERRENCE VERSUS EMPLOYMENT: PUNISHMENT OR PAYCHECKS?

Typical crime policy heavily focuses on deterrence through policing and punishment. Although deterrence can influence behavior by raising expected costs, its success depends on credible enforcement and institutional strength. In situations where the chances of getting caught are low or uneven, simply increasing punishment severity often brings diminishing returns.

Improving labour market outcomes offers a more sustainable path to reducing crime. Creating jobs boosts expected returns from legitimate work, raising the cost of crime. Research suggests that areas with higher job growth and better access to public employment programs see slower growth rates in property-related crimes over time.

Policies that support formal work, skill training, and income stability directly change the incentives behind criminal choices.

This does not mean law enforcement is unnecessary. Instead, it indicates that deterrence should work alongside labor market improvements. When jobs remain insecure, punitive methods may only address symptoms instead of the root causes.

There is a divergence between improvements in deterrence and overall crime outcomes, indicating diminishing marginal returns to punishment when enforcement gains are incremental and uneven. Although conviction rates rise over time, total cognizable crimes do not decline in a sustained manner, suggesting that increases in the expected cost of crime alone are insufficient to alter behaviour at scale. In contrast, changes in labour market conditions align more closely with shifts in crime levels. The employment shock during the COVID-19 period reduced the opportunity cost of illegal activity, and once mobility and reporting constraints eased, total crime increased despite a recovery in conviction rates. This pattern indicates that weakened employment quality and income instability exert a stronger influence on criminal choices than moderate improvements in deterrence, underscoring the importance of secure employment in shaping crime outcomes.

CONCLUSION: FROM PUNISHMENT TO OPPORTUNITY

Seeing crime as a labour market outcome provides a clear framework for understanding why criminal activity changes with economic conditions. When labour markets fail to provide stable and rewarding jobs, people respond predictably to limited choices by shifting their labor toward illegal activities.

The labour shock caused by the COVID-19 pandemic illustrates this concept well. By

disrupting employment and income stability, it altered incentives in ways that made crime more appealing for vulnerable groups. The larger lesson is clear: preventing crime cannot be separated from employment policies.

An approach based on incentives shifts focus from punishment to opportunity and from surveillance to stability. In doing so, it reframes crime not as an isolated social problem, but as a result embedded in labor markets—one that can be reduced through inclusive growth, job resilience, and institutional support.

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APPENDIX

Table 1*Unemployment Rate and no. of crimes across major states in the COVID-19 period*

State/UT	Unemployment Rate (2019)	No. of crimes (2019)	Unemployment Rate (2020)	No. of crimes (2020)	Unemployment Rate (2021)	No. of crimes (2021)
Andhra Pradesh	9.4	145,751	10.5	238,105	8	222,199
Assam	6.9	132,783	10.9	121,609	4.9	133,239
Bihar	10.7	269,109	6.4	257,512	5	282,083
Chattisgarh	6.5	96,561	8.1	103,173	9.2	110,633
Delhi	11.3	316,261	11.6	266,070	8.2	306,389
Gujarat	3.6	431,066	3	699,619	3.4	731,738
Haryana	12.3	166,336	8.7	192,395	8.6	206,431
Himachal Pradesh	9	19,924	6.9	20,630	8	18,833
Jharkhand	8	62,206	9.1	63,570	8.8	60,765
Karnataka	5.5	163,691	5.7	150,080	3.7	163,697
Kerala	11.8	453,083	16.7	554,724	16.8	524,960
Madhya Pradesh	8.7	395,619	10.1	428,046	7.8	475,918
Maharashtra	9.2	509,433	8.5	539,003	7.7	540,800
Odisha	11.9	121,525	11.6	134,230	8.9	155,420
Punjab	9	72,855	11	82,875	9	73,581
Rajasthan	9.1	304,394	8.1	260,378	8.2	284,569
Tamil Nadu	9.9	455,094	10.1	1,377,681	10	756,753
Telangana	10.4	131,254	8.9	147,504	6.1	158,809
Uttar Pradesh	9.1	628,578	8.5	657,925	7.5	608,082
West Bengal	7.2	188,063	9.3	182,367	6.8	181,821
Jammu & Kashmir	7.2	25,408	9.2	28,911	8.5	31,675

Source: Periodic Labour Force Survey (PLFS) Annual Report (2019-2020 to 2021-2022), National Crime Record Bureau (NCRB) Annual Report (2019-2021)

Table 2*Deterrence, Unemployment and Crime in India*

Year	Total cognizable crimes	Unemployment Rate (%)	Conviction Rate (%)
2015	4751282	5.6	46.9
2016	4898130	5.5	47.2
2017	5009475	5.4	48
2018	5156172	5.3	49.4
2019	5156172	5.3	50.4
2020	4250700	6.4	47.2
2021	6025600	4.8	56.5
2022	5857600	4.2	54.8

Source: Periodic Labour Force Survey (PLFS) Annual Report (2017-2018 to 2022-2023), National Crime Record Bureau (NCRB) Annual Report (2015-2022)

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