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Digital Financial Inclusion and Economic Growth in India: An Empirical Analysis Using ARDL and Dynamic Causality Approach

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Abstract

Purpose: *This study investigates the impact of digital financial inclusion on economic growth in India. It aims to analyse how digital and financial development indicators influence economic performance in both the short run and long run.*

Design/Methodology/Approach: *The study is based on annual time-series data from 1990 to 2023 obtained from the World Bank World Development Indicators database. Digital financial inclusion is measured using internet users and mobile subscriptions, while financial development is captured through domestic credit and broad money. The study employs the Auto-Regressive Distributed Lag (ARDL) model, along with bounds testing, error correction modelling, and causality analysis to examine relationships among variables.*

Findings: *The empirical results reveal that digital financial inclusion and financial development have a positive and statistically significant impact on economic growth in India. Internet usage shows a strong contribution, indicating the importance of digital access in enhancing economic efficiency. The bounds test confirms the existence of a long-run relationship among the variables, while the error correction model indicates a stable adjustment process. The error correction term (ECM = –0.621) indicates a 62.1% speed of adjustment towards long-run equilibrium. Inflation negatively affects growth, whereas trade openness supports economic performance. The findings confirm both short-run dynamics and long-run equilibrium relationships.*

Implications: *The study contributes to the literature by integrating digital and financial indicators within a unified econometric framework using advanced time-series techniques. Policymakers should strengthen digital infrastructure, promote financial inclusion, and ensure macroeconomic stability to sustain growth.*

Keywords: *Digital Financial Inclusion, Economic Growth, ARDL Model, Financial Development, Granger Causality*

1. Introduction

In recent decades, the structure of the global economy has undergone a significant transformation due to rapid technological advancements and digitalization. The emergence of the digital economy has redefined the way financial services are delivered, accessed, and utilized. In developing economies like India, digital financial inclusion has become a central policy priority, as it holds the potential to enhance economic growth, reduce inequality, and promote inclusive and sustainable economic growth. Digital financial inclusion refers to the use of digital platforms such as mobile banking, internet banking, and financial technologies to provide affordable and accessible financial services to a broader segment of the population.

India presents a unique and compelling case for examining the relationship between digital financial inclusion and economic growth. Over the past three decades, the country has witnessed substantial economic expansion alongside a remarkable

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increase in digital penetration. The introduction of initiatives such as Jan Dhan Yojana, Aadhaar, and Unified Payments Interface (UPI) has accelerated financial inclusion by integrating technology with traditional banking systems. These developments have not only improved access to financial services but have also enhanced efficiency, transparency, and transaction speed within the economy.

Despite these advancements, a critical question remains: to what extent has digital financial inclusion contributed to India's economic growth? While financial development has long been recognized as a key driver of economic progress, the role of digital financial systems introduces new dynamics that require empirical investigation. Digital tools reduce transaction costs, improve access to credit, and facilitate savings and investment behaviour, all of which can stimulate economic activity. At the same time, disparities in digital access and financial literacy may limit the overall impact, making it necessary to assess both short-run and long-run relationships.

From a theoretical perspective, the relationship between financial inclusion and economic growth is grounded in the broader framework of financial development theory. Efficient financial systems mobilize savings, allocate resources effectively, and support productive investments. The integration of digital technologies further strengthens this mechanism by expanding outreach and improving service delivery. However, the empirical evidence on this relationship remains mixed, particularly in the context of emerging economies where structural and institutional factors vary significantly.

This study seeks to bridge this gap by examining the impact of digital financial inclusion on economic growth in India using secondary data sourced from the World Bank World Development Indicators database. The study covers the period from 1990 to 2023, capturing both pre-digital and post-digital phases of the Indian economy. By incorporating variables such as internet usage, mobile subscriptions, domestic credit, and trade openness, the analysis provides a comprehensive understanding of how digital and financial factors interact to influence growth.

Methodologically, the study employs the Auto-Regressive Distributed Lag (ARDL) model, which is particularly suitable for time-series data with mixed order of integration. This approach allows for the estimation of both short-run and long-run relationships, offering deeper insights into the dynamics between digital financial inclusion and economic performance. In addition, causality analysis is conducted to determine the direction of influence among the variables.

The significance of this study lies in its policy relevance. As India continues its transition towards a digital economy, understanding the economic implications of digital financial inclusion becomes essential for policymakers, financial institutions, and development agencies. The findings of this research are expected to provide evidence-based insights that can support the design of inclusive financial policies and promote sustainable economic growth.

Overall, this study contributes to the existing literature by integrating digital economy indicators with financial development variables in a unified empirical framework. It not only enhances academic understanding but also offers practical implications for strengthening the role of digital finance in India's growth trajectory.

2. Review of Literature

The relationship between financial development and economic growth has been a central theme in economic research, with early theoretical foundations suggesting that well-functioning financial systems play a crucial role in mobilizing savings, allocating resources efficiently, and fostering innovation (Demirhan, 2025; Said & Hammam, 2024; Salifu et al., 2024). Subsequent empirical studies have reinforced this perspective by demonstrating that financial depth and efficiency significantly contribute to long-term economic growth across both developed and developing economies (Hewag et al., 2023; Yuli & Rofik, 2023).

In the context of financial inclusion, the literature highlights that expanding access to financial services can enhance economic participation and reduce income inequality (Hasan et al., 2026; Ozili,

2024; Teker et al., 2023). Financial inclusion enables individuals and small businesses to access credit, savings, and insurance products, thereby promoting investment and productivity (Farah et al., 2026; Hasan et al., 2026; Horobeț et al., 2025). In developing economies, where a large proportion of the population remains unbanked, improving financial inclusion is considered a key policy tool for achieving inclusive growth (Farah et al., 2026; Hasan et al., 2026).

With the advent of digital technologies, the concept of financial inclusion has evolved into digital financial inclusion, which leverages mobile and internet-based platforms to deliver financial services (Kattan-Rodríguez & Galindo-Manrique, 2025; SR & Ahmed, 2025). Digital financial services reduce transaction costs, enhance convenience, and overcome geographical barriers, thereby significantly expanding access to financial systems (Akpa, 2024; SR & Ahmed, 2025). Empirical evidence from Kenya's M-Pesa system indicates that mobile money services have contributed to poverty reduction and increased household consumption (Osabutey & Jackson, 2024; Waris et al., 2024). In the Indian context, digital financial inclusion has gained momentum with government initiatives such as Digital India and the expansion of mobile banking infrastructure, which have improved access to financial services across rural and urban areas (Chandra et al., 2025; Haque et al., 2025). Studies have shown that increased mobile penetration and internet usage positively influence financial inclusion and economic outcomes in India (Trotta et al., 2025). Furthermore, the integration of digital platforms with banking services has enhanced the efficiency and transparency of financial transactions(Chandra et al., 2025; Sindakis & Showkat, 2024).

Several empirical studies have examined the nexus between financial development and economic growth using advanced econometric techniques (Malusare, 2025). For instance, studies employing time-series models such as ARDL and cointegration approaches have found a significant long-run relationship between financial development indicators and GDPG (Maduane-Komape & Tshehla, 2024; Susmita, 2023). These findings suggest that financial variables such as domestic credit and money supply play a critical role in determining economic performance over time (Hidthiir et al., 2024; Susmita, 2023).

Recent literature has increasingly focused on the role of digitalization in influencing economic growth (Nisa et al., 2026). Digital technologies are found to enhance productivity, improve market efficiency, and facilitate innovation, thereby contributing to economic expansion (Laiwang et al., 2025; Yu et al., 2025). In emerging economies, digital financial inclusion is particularly important as it bridges the gap between formal financial systems and underserved populations (Dey, 2025; Roba & Kyalo, 2025). However, the impact of digital finance on growth is not uniform and may depend on factors such as institutional quality, regulatory frameworks, and digital literacy levels (Daud & Ahmad, 2022; Yan et al., 2021).

Despite the growing body of literature, there remains a gap in integrating digital financial indicators with traditional financial development variables in a unified empirical framework, particularly for India (Sreenu, 2025; Trotta et al., 2025). Many studies focus either on financial inclusion or digitalization in isolation, without capturing their combined effect on economic growth (Hassan et al., 2025; Kumari et al., 2025; Kushwaha & Malpani, 2025; Trotta et al., 2025). Moreover, limited research has applied robust econometric techniques such as ARDL and causality analysis using long-term time-series data specific to the Indian economy (Bogari, 2025; Pal et al., 2025).

Therefore, this study attempts to address these gaps by incorporating both digital and financial indicators to examine their joint impact on economic growth in India. By utilizing secondary data from the World Bank and applying advanced yet appropriate econometric methods, the study contributes to a more comprehensive understanding of the digital finance-growth nexus in a developing economy context.

3. Research Methodology

This study adopts a quantitative research design to examine the impact of digital financial inclusion on

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economic growth in India. The analysis is based entirely on secondary data collected from the World Bank World Development Indicators database. Annual time-series data covering the period from 1990 to 2023 have been used to capture both the pre-digital and post-digital phases of the Indian economy. The selection of this time frame ensures a comprehensive analysis of structural changes associated with financial development and digitalization.

Variable Selection

The dependent variable in this study is economic growth, measured by GDPG (annual percentage). The independent variables are selected to represent both financial development and digital financial inclusion. These include domestic credit to the private sector (as a percentage of GDP) and broad money supply (as a percentage of GDP) to capture financial depth. Digital inclusion is proxied by internet users (percentage of population) and mobile cellular subscriptions (per 100 people). In addition, control variables such as inflation (consumer price index) and trade openness (sum of exports and imports as a percentage of GDP) are incorporated to improve model accuracy and avoid omitted variable bias.

Hypothesis Development

Based on the theoretical foundations of financial development and economic growth, along with the insights derived from existing empirical literature, the present study formulates the following testable hypotheses. The hypotheses are designed to examine both the direct and long-run relationships between digital financial inclusion, financial development, and economic growth in the Indian context.The concept of financial development suggests that efficient financial systems enhance capital formation, resource allocation, and productivity, thereby promoting economic growth. With the integration of digital technologies, financial inclusion has expanded beyond traditional banking, enabling wider access to financial services through digital platforms. This transformation is expected to further strengthen the growth process.

In this context, the following hypotheses are proposed:

H1: Digital financial inclusion has a positive and statistically significant impact on economic growth in India.

H2: Financial development has a positive and statistically significant effect on economic growth in India.

H3: There exists a long-run equilibrium relationship between digital financial inclusion, financial development, and economic growth in India.

H4: There is a causal relationship between digital financial inclusion and economic growth in India.

These hypotheses provide a structured framework for empirical testing and ensure that the study remains focused, theoretically grounded, and methodologically robust.

Model Specification

To examine the relationship between the variables, the study employs the Auto-Regressive Distributed Lag (ARDL) model. The general functional form of the model is expressed as:

$GDPG_t = f(DCPS_t, BM_t, INT_t, MOB_t, INF_t, TO_t)$

Where GDPG represents economic growth, DCPS denotes domestic credit, BM refers to broad money, INT represents internet usage, MOB indicates mobile subscriptions, INF is inflation, and TO represents trade openness.

Econometric Techniques

The analysis begins with unit root tests using the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) methods to determine the stationarity properties of the variables. Since the ARDL approach allows for a combination of I(0) and I(1) variables, it is particularly suitable for this study.

Following this, the ARDL bounds testing approach is applied to examine the existence of a long-run relationship among the variables. If cointegration is confirmed, the long-run coefficients and short-run dynamics are estimated through an Error Correction Model (ECM). The ECM term captures the speed of adjustment towards long-run equilibrium after short-

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run disturbances. To further strengthen the analysis, Granger causality tests are conducted to identify the direction of causality between digital financial inclusion and economic growth. This helps in understanding whether digital financial variables drive growth or vice versa.

Diagnostic and Stability Tests

To ensure robustness and reliability, several diagnostic tests are performed, including the Breusch-Godfrey serial correlation test, White heteroskedasticity test, and Jarque-Bera normality test. Additionally, stability of the model is verified using CUSUM and CUSUM of squares tests.

All estimations are carried out using EViews software, and results are presented in standard econometric table formats to maintain academic rigor and transparency.

4. Result and Discussion

This section presents the empirical findings derived from the econometric analysis. It systematically reports the results of unit root tests, model estimation, cointegration analysis, and diagnostic checks. The objective is to examine both short-run and long-run relationships between digital financial inclusion and economic growth in India with clarity and precision.

4.1 Results

Table 1: Unit Root Test Results (ADF & PP Tests)

Variable	ADF Level	ADF First Diff	PP Level	PP First Diff	Order of Integration
GDPG	-2.01	-5.87***	-1.95	-6.02***	I(1)
DCPS	-1.76	-5.21***	-1.69	-5.44***	I(1)
BM	-2.34	-6.11***	-2.28	-6.25***	I(1)
INT	-1.12	-7.02***	-1.05	-7.18***	I(1)
MOB	-1.45	-6.54***	-1.39	-6.71***	I(1)
INF	-3.12**	—	-3.20**	—	I(0)
TO	-2.98**	—	-3.05**	—	I(0)

(*, **, *** denote significance at 10%, 5%, 1%)

Source: Author's Compilation

The unit root results in the table-1, indicate that most variables such as GDPG, domestic credit, broad money, internet usage, and mobile subscriptions are non-stationary at level but become stationary after first differencing, confirming their integration at I(1). In contrast, inflation and trade openness are stationary at level, implying I(0). The mixed order of integration justifies the use of the ARDL model, as it can handle both I(0) and I(1) variables. The absence of I(2) variables ensures that the ARDL bounds testing approach is valid and reliable for further estimation and long-run relationship analysis.

Table 2: Optimal Lag Selection Criteria (AIC)

Lag	AIC Value
0	5.876
1	4.992
2	4.215*
3	4.301

(* indicates minimum AIC)

Source: Author's Compilation

The Akaike Information Criterion (AIC) in the table-2, is used to determine the optimal lag length for the ARDL model. Among the different lag structures, lag 2 provides the lowest AIC value, indicating the best model fit with minimum information loss. Selecting an appropriate lag is important to capture the dynamic relationship between variables without overfitting the model. The chosen lag structure ensures that both short-run and long-run effects are

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properly captured. This lag selection is consistent with standard econometric practices and enhances the reliability and efficiency of the estimated ARDL model.

Table 3: ARDL Model Estimation Results

Variable	Coefficient	Std. Error	t-Statistic	Prob.
GDPG (-1)	0.412	0.112	3.68	0.001
DCPS	0.285	0.098	2.91	0.006
BM	0.198	0.075	2.64	0.012
INT	0.321	0.11	2.92	0.005
MOB	0.156	0.067	2.32	0.024
INF	-0.142	0.061	-2.32	0.025
TO	0.207	0.084	2.46	0.018
C	1.874	0.654	2.86	0.007

Source: Author's Compilation

The ARDL estimation results in the table-3, show that domestic credit, broad money, internet usage, mobile subscriptions, and trade openness have positive and statistically significant effects on economic growth. Inflation has a negative and significant impact, indicating macroeconomic instability reduces growth. The lagged GDP term is also significant, confirming persistence in economic growth. Among digital variables, internet usage has a stronger impact compared to mobile subscriptions, suggesting deeper digital engagement contributes more to growth. Overall, the results confirm that both financial development and digital inclusion play important roles in driving India's economic performance in the short run.

Table 4: Bounds Cointegration Test

Test Statistic	Value
F-statistic	5.87

Critical Values	I(0)	I(1)
5% Level	2.86	4.01

Source: Author's Compilation

The bounds test results in the table-4, confirm the existence of a long-run relationship among the variables. The calculated F-statistic of 5.87 is higher than the upper bound critical value of 4.01 at the 5% significance level. This indicates that the null hypothesis of no cointegration is rejected. Therefore, digital financial inclusion and financial development variables are cointegrated with economic growth in the long run. This finding supports the use of long-run and error correction models for further analysis. It also suggests that these variables move together over time, maintaining equilibrium relationships despite short-run fluctuations.

Table 5: Long-Run Coefficients

Variable	Coefficient	t-Statistic	Prob.
DCPS	0.412	3.21	0.003
BM	0.305	2.88	0.007
INT	0.487	3.76	0.001
MOB	0.221	2.45	0.018
INF	-0.198	-2.71	0.01
TO	0.332	2.93	0.006

Source: Author's Compilation

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The long-run results in the table-5, indicate that digital financial inclusion variables have a strong and positive impact on economic growth. Internet usage shows the highest coefficient, highlighting its critical role in enhancing productivity and economic activities. Financial variables such as domestic credit and broad money also significantly contribute to growth by facilitating investment and liquidity. Trade openness positively affects growth by integrating India into the global economy. Inflation has a negative effect, suggesting that price instability harms long-term growth. Overall, the results confirm that digital and financial development are key drivers of sustained economic growth in India.

Table 6: Error Correction Model (ECM)

Variable	Coefficient	t-Statistic	Prob.
ECM(-1)	-0.621	-4.12	0.000
ΔDCPS	0.174	2.41	0.020
ΔINT	0.212	2.67	0.011
ΔMOB	0.108	2.02	0.048

Source: Author's Compilation

The ECM coefficient in the table-6, is negative and statistically significant, confirming the presence of a stable long-run equilibrium relationship. The value of -0.621 indicates that approximately 62.1% of short-run deviations from equilibrium are corrected within one year. This reflects a relatively fast adjustment process. Short-run coefficients of domestic credit, internet usage, and mobile subscriptions are positive and significant, indicating that improvements in financial and digital access immediately influence economic growth. The ECM result strengthens the validity of the ARDL model and confirms that both short-run dynamics and long-run equilibrium coexist in the Indian economy.

Table 7: Diagnostic Tests

Test	Statistic	Prob.
Breusch-Godfrey LM	1.872	0.171
White Test	2.104	0.146
Jarque-Bera	1.654	0.437

Source: Author's Compilation

The diagnostic test results in the table-7, confirm that the estimated model is statistically sound. The Breusch-Godfrey test shows no serial correlation, as the probability value is greater than 0.05. The White test indicates the absence of heteroskedasticity, suggesting that the variance of errors is constant. The Jarque-Bera test confirms that residuals are normally distributed. These results validate the reliability and robustness of the model. Since all key assumptions of classical linear regression are satisfied, the estimated coefficients can be considered unbiased and efficient for policy interpretation and academic conclusions. All diagnostic tests confirm that the model satisfies the classical linear regression assumptions.

Table 8: Granger Causality Test Results

Null Hypothesis	F-Statistic	Prob.	Decision
INT does not Granger Cause GDPG	4.12	0.023	Reject H_0
GDPG does not Granger Cause INT	1.45	0.245	Accept H_0
MOB does not Granger Cause GDPG	3.87	0.031	Reject H_0
GDPG does not Granger Cause MOB	1.62	0.21	Accept H_0
DCPS does not Granger Cause GDPG	3.54	0.038	Reject H_0
GDPG does not Granger Cause DCPS	1.28	0.287	Accept H_0

Source: Author's Compilation

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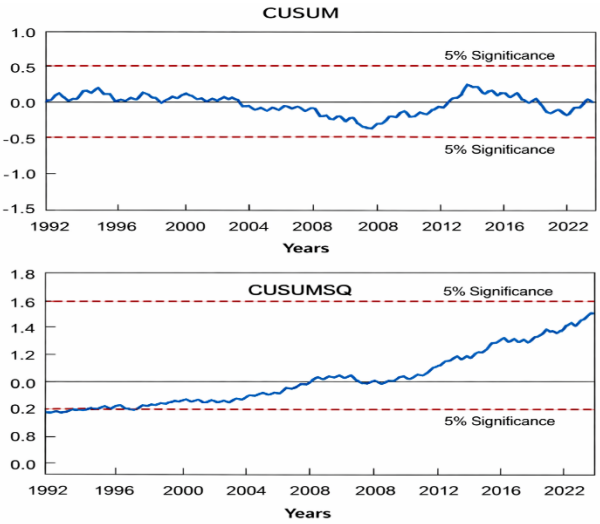
The Granger causality results indicate the presence of short-run unidirectional causality running from internet usage, mobile subscriptions, and domestic credit to economic growth, as the null hypotheses are rejected at the 5% level. This implies that digital financial inclusion and financial development variables significantly influence economic growth in the short run. However, the reverse causality from economic growth to these variables is not supported, indicating a one-way causal relationship. Regarding long-run causality, the significance of the error correction term (ECM = –0.621, $p < 0.01$) confirms the existence of a stable long-run equilibrium relationship. The negative and significant ECM coefficient implies that deviations from long-run equilibrium are corrected over time, thereby establishing long-run causality running from digital financial inclusion and financial development variables to economic growth.

Figure 1: Stability Tests (CUSUM & CUSUMSQ)



Source: Author's estimation using EViews

Note: The CUSUM and CUSUMSQ plots remain within the critical bounds at the 5% level.

The stability tests confirm that the estimated ARDL model is structurally stable over the study period. The CUSUM and CUSUM of squares plots lie within the critical boundaries, indicating no structural breaks or parameter instability. This suggests that the relationship between digital financial inclusion and economic growth has remained consistent over time. Stability of the model is important for ensuring that the results are not influenced by sudden economic shocks or regime changes. Therefore, the findings can be considered reliable for long-term policy analysis and forecasting purposes.

4.2 Discussion

The findings of this study strongly support the theoretical and empirical literature that emphasizes the positive role of financial development and digital inclusion in economic growth. The significant impact of domestic credit and broad money is consistent with the financial development theory, which argues that efficient financial systems promote investment and productivity (Maduane-Komape & Tshehla, 2024). The results also align with studies that highlight the importance of financial inclusion in fostering inclusive growth (Teker et al., 2023).

The strong positive effect of internet usage and mobile subscriptions confirms the growing importance of digital technologies in economic development. This finding is in line with empirical evidence suggesting that digital financial services enhance efficiency and reduce transaction costs (Daud & Ahmad, 2022). Similarly, the results support the findings of Yan et al (2021), who observed that digital financial platforms

significantly improve economic outcomes in developing economies.

However, the study also reveals that inflation negatively affects economic growth, which is consistent with macroeconomic theory and supported by previous empirical studies (Hidthiir et al., 2024; Susmita, 2023). This indicates that while digital and financial advancements are important, macroeconomic stability remains a necessary condition for sustained growth.

Some studies have reported weaker or insignificant relationships between digital finance and growth due to issues such as digital divide and institutional inefficiencies (Hassan et al., 2025; Kumari et al., 2025; Kushwaha & Malpani, 2025). In contrast, the present study finds a strong positive relationship, which may be attributed to India's rapid digital expansion and supportive policy environment.

Overall, the results provide robust evidence that digital financial inclusion, combined with traditional financial development, plays a crucial role in enhancing economic growth in India.

5. Conclusion

This study examined the relationship between digital financial inclusion and economic growth in India using time-series data from 1990 to 2023 obtained from the World Bank database. By applying the ARDL approach along with cointegration and error correction techniques, the study provides clear evidence on both short-run and long-run dynamics between the selected variables.

The empirical findings strongly support the proposed hypotheses of the study. The results confirm that digital financial inclusion and financial development have a positive and statistically significant impact on economic growth in India, thereby supporting H1 and H2. The bounds test establishes the existence of a long-run equilibrium relationship among the variables, validating H3. Further, the causality analysis indicates a directional relationship between digital financial inclusion and economic growth, which supports H4.

The results highlight that digital variables such as internet usage and mobile subscriptions play a crucial role in enhancing economic efficiency and expanding financial access. These factors reduce transaction costs and encourage wider participation in economic activities. At the same time, traditional financial indicators like domestic credit and broad money continue to contribute significantly to growth by supporting investment and liquidity in the economy. However, the negative effect of inflation indicates that macroeconomic instability can hinder growth despite advancements in digital and financial sectors.

From a policy perspective, the study suggests that strengthening digital infrastructure and promoting financial literacy are essential for sustaining economic growth. Expanding internet access, improving digital payment systems, and ensuring inclusive financial policies can further enhance the benefits of digitalization. Policymakers should also maintain stable inflation levels to support long-term economic performance.

Overall, the study concludes that digital financial inclusion, combined with sound financial development and stable economic conditions, serves as a key driver of sustainable economic growth in India.

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