

DIGITALISATION AND ECONOMIC GROWTH: AN EMPIRICAL STUDY

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ABSTRACT

Digitalisation, understood as the increasing penetration of internet connectivity, mobile telephony, and digital payment infrastructure into economic and social life, has been one of the defining structural changes in the Indian economy over the past decade. Flagship initiatives such as Digital India, the JAM trinity (Jan Dhan-Aadhaar-Mobile), the roll-out of affordable 4G data services, and the launch of the Unified Payments Interface (UPI) in 2016 have together transformed India into one of the largest and fastest-growing digital economies in the world. This paper empirically examines the relationship between digitalisation and economic growth in India using secondary time-series data for the period 2017-18 to 2023-24, drawing on statistics published by the Telecom Regulatory Authority of India (TRAI), the National Payments Corporation of India (NPCI), the Reserve Bank of India (RBI), and the Ministry of Statistics and Programme Implementation (MoSPI). Total internet subscribers and the volume of UPI transactions are used as proxy indicators of digitalisation, and their relationship with the real GDP growth rate is examined using descriptive statistics, Pearson correlation, and simple linear regression. The results show that digitalisation indicators, particularly UPI transaction volume, have grown at an extraordinary pace over this period, with UPI volume expanding at a compound annual growth rate of well over 100 per cent, while internet subscribers grew steadily at a more moderate pace. However, the simple contemporaneous statistical association between these digitalisation indicators and the annual GDP growth rate is found to be weak and not statistically significant, even though internet penetration and UPI adoption are themselves very strongly and significantly correlated with one another. The paper concludes that while digitalisation has fundamentally reshaped the payments and information landscape of the Indian economy, its translation into measurable aggregate output growth is likely to be gradual, sector-specific, and mediated by complementary factors such as financial inclusion, digital literacy, and enterprise-level technology adoption, rather than visible in a simple year-on-year statistical relationship.

KEYWORDS: Digitalisation, Digital India, UPI, Internet Penetration, Economic Growth, India, Correlation Analysis

1. INTRODUCTION

Digitalisation refers to the process by which digital technologies - the internet, mobile telephony, digital platforms, and electronic payment systems - become embedded in economic transactions, government service delivery, and everyday social life. Over the last decade, digitalisation has emerged as one of the most powerful drivers of structural change in economies around the world, altering how firms produce and market goods and services, how governments deliver welfare programmes, and how households save, borrow, and transact. For developing economies such as India, digital technologies offer the possibility of leapfrogging conventional stages of infrastructural development, extending financial services and market access to previously underserved populations, and improving the efficiency and transparency of economic transactions.

India's digital transformation gathered decisive momentum from the mid-2010s onward. The launch of the Digital India programme in 2015 set out an ambitious vision of a digitally empowered society and knowledge economy, built around three pillars: digital infrastructure, digital governance and services, and digital literacy. This was complemented by the JAM trinity - the linking of Jan Dhan bank accounts, Aadhaar biometric identity, and mobile phone numbers - which created the foundational architecture for direct benefit transfers and digital financial inclusion. The entry of low-cost 4G data services from 2016 onward dramatically reduced the price of mobile data and triggered

a rapid expansion in internet usage across urban and rural India alike. In parallel, the National Payments Corporation of India launched the Unified Payments Interface (UPI) in April 2016, a real-time payment system that has since grown to become the backbone of India's retail digital payments ecosystem and one of the largest real-time payment systems in the world by transaction volume.

The COVID-19 pandemic further accelerated digital adoption, as lockdowns and social distancing norms pushed consumers, small businesses, and government agencies to rely more heavily on digital channels for payments, commerce, education, and service delivery. Against this backdrop, India's real GDP growth over the same period has been volatile - moving from moderate growth in the late 2010s, through a sharp pandemic-induced contraction in 2020-21, to a strong post-pandemic recovery. This paper is motivated by the need to empirically examine whether the extraordinarily rapid growth of digital infrastructure and digital payments in India has been statistically associated with the country's economic growth performance, and to situate this relationship within the wider theoretical and empirical literature on the ICT-growth nexus.

2. REVIEW OF LITERATURE

The relationship between information and communication technology (ICT), digitalisation, and economic growth has attracted sustained scholarly attention over the past two decades, both in the general cross-country literature and in studies specific to India.

Qiang and Rossotto (2009), in a widely cited World Bank study, estimated that a ten percentage point increase in broadband penetration is associated with a meaningfully higher increment in GDP growth in developing countries than in developed ones, suggesting that the growth dividend from digital infrastructure may be particularly large in economies that are still building out their basic connectivity.

Czernich, Falck, Kretschmer and Woessmann (2011), using OECD panel data, found a statistically significant positive effect of broadband infrastructure penetration on per capita GDP growth, while cautioning that the direction of causality is difficult to establish conclusively because economic growth itself can spur demand for broadband.

Sassi and Goaid (2013), studying a panel of Middle East and North African countries, reported that while mobile telephony was positively associated with growth, the relationship between internet penetration and growth was more complex and depended on complementary institutional and human capital factors, reinforcing the idea that digital infrastructure alone is not sufficient to guarantee growth outcomes.

Niebel (2018) compared the growth effects of ICT across developed, emerging, and developing economies and found that while ICT capital contributes positively to growth across all groups, the magnitude and statistical robustness of the relationship vary considerably depending on the country group and the time period examined, cautioning against generalising results from one set of economies to another.

Vu, Hanafizadeh and Bohlin (2020), in a systematic review of the ICT-growth literature, concluded that although a majority of empirical studies report a positive relationship between ICT and growth, a non-trivial share of studies find weak, insignificant, or even negative associations, and that findings are highly sensitive to the choice of ICT indicator, country sample, time period, and econometric technique used.

In the Indian context, Ghosh (2016) examined the relationship between ICT diffusion and economic growth in India and found evidence of a long-run positive relationship, while also noting that the short-run dynamics were considerably weaker and that the effect of ICT on growth appeared to strengthen only after a threshold level of digital infrastructure had been achieved.

The Reserve Bank of India, in its periodic reports on digital payments, has documented the extraordinarily rapid rise of UPI since 2016 and its role in deepening financial inclusion, reducing the cost of transactions, and formalising a growing share of retail economic activity, while noting that translating higher digital payment volumes into measurable productivity gains requires complementary investment in digital literacy and last-mile infrastructure.

NITI Aayog and industry bodies such as the Internet and Mobile Association of India (IAMAI) have similarly highlighted that India's digital economy - encompassing e-commerce, digital payments, IT and IT-enabled services,

and digital public infrastructure - has grown considerably faster than the overall economy in recent years, though its share of aggregate GDP, while rising, remains a good deal smaller than that of the traditional services and industrial sectors.

Taken together, the literature suggests that the digitalisation-growth relationship, much like the FDI-growth relationship, is neither automatic nor immediate: it is shaped by the type of digital indicator considered, the presence of complementary human capital and institutional conditions, and the time horizon over which the relationship is measured. This provides the motivation for the present study to empirically examine the association for India using recent data on internet penetration and digital payments.

3. OBJECTIVES OF THE STUDY

- To study the trend and pattern of internet penetration in India during the period 2017-18 to 2023-24.
- To examine the trend and growth of digital payments (UPI transactions) in India over the same period.
- To study the trend of India's real GDP growth rate over the corresponding years.
- To empirically analyse the statistical relationship between digitalisation indicators and GDP growth in India using correlation and regression analysis.
- To examine the relationship between internet penetration and digital payment adoption as complementary dimensions of digitalisation.
- To offer policy suggestions for strengthening the growth-augmenting impact of digitalisation in India.

4. METHODOLOGY OF THE STUDY

The present study is descriptive and analytical in nature and is based entirely on secondary data. Data on total internet subscribers (in million) have been compiled from the quarterly and annual performance reports of the Telecom Regulatory Authority of India (TRAI). Data on the volume and value of Unified Payments Interface (UPI) transactions have been compiled from statistics published by the National Payments Corporation of India (NPCI) and periodic press releases of the Ministry of Finance and Ministry of Electronics and Information Technology, Government of India. Data on India's annual real GDP growth rate have been compiled from the National Accounts Statistics released by the Ministry of Statistics and Programme Implementation (MoSPI) and cross-checked with Reserve Bank of India estimates.

The study period, 2017-18 to 2023-24, has been chosen because it represents the phase of most rapid expansion of UPI and low-cost mobile internet in India following the initial 2016 roll-out, includes the structural shock and recovery associated with the COVID-19 pandemic, and represents the most recent seven-year window for which complete annual data are available at the time of writing.

Tools of Analysis

- Descriptive statistics (trend values, compound annual growth rate) to examine the pattern of internet penetration and digital payment growth.
- Pearson's product-moment correlation coefficient to measure the strength and direction of the linear association between digitalisation indicators and GDP growth rate, and between the digitalisation indicators themselves.
- Simple linear regression, with GDP growth rate as the dependent variable and UPI transaction volume as the independent variable, to estimate the direction and statistical significance of the relationship.

All computations have been carried out using standard statistical procedures. The level of significance adopted for hypothesis testing is 5 per cent ($p < 0.05$).

Limitations of the Study

The study is based on macro-level annual time-series data covering seven observations, which limits the statistical power of the analysis and the ability to control for other determinants of growth such as investment, exports, government expenditure, and global business-cycle conditions. Internet subscriber and UPI figures are used as proxy indicators of the much broader phenomenon of digitalisation, and the analysis does not capture other dimensions such as e-commerce, digital public infrastructure usage, or enterprise-level digital adoption. The analysis captures contemporaneous statistical association and does not, by itself, establish causation.

5. DATA ANALYSIS AND INTERPRETATION

Table 1 presents the year-wise total internet subscribers, UPI transaction volume, UPI transaction value, and the corresponding real GDP growth rate for the period 2017-18 to 2023-24.

Table 1: Digitalisation Indicators and GDP Growth Rate in India (2017-18 to 2023-24)

Financial Year	Internet Subscribers (Million)	UPI Transaction Volume (Crore)	UPI Transaction Value (₹ Lakh Crore)	Real GDP Growth Rate (%)
2017-18	493.96	92	1.0	6.8
2018-19	636.73	535	8.77	6.5
2019-20	718.74	1,254	21.3	3.9
2020-21	792.90	2,233	41.0	-5.8
2021-22	811.00	4,597	84.2	9.1
2022-23	881.25	8,375	139.2	7.0
2023-24	954.00	13,114	200.0	8.2

Source: Compiled by the author from TRAI performance reports, NPCI statistics, Ministry of Finance / MeitY press releases, and MoSPI National Accounts Statistics (various issues). UPI figures for 2017-18 to 2019-20 are approximate, based on officially reported cumulative and annual figures.

Trend of Internet Penetration

The data indicate that total internet subscribers in India grew steadily from about 494 million in 2017-18 to 954 million in 2023-24, registering a compound annual growth rate of approximately 11.6 per cent over the seven-year period. Growth was particularly rapid between 2017-18 and 2019-20, a phase associated with the entry of low-cost 4G data services, before moderating somewhat in the following years as the more easily reached urban and semi-urban markets approached saturation and further growth increasingly depended on extending connectivity into rural and remote areas.

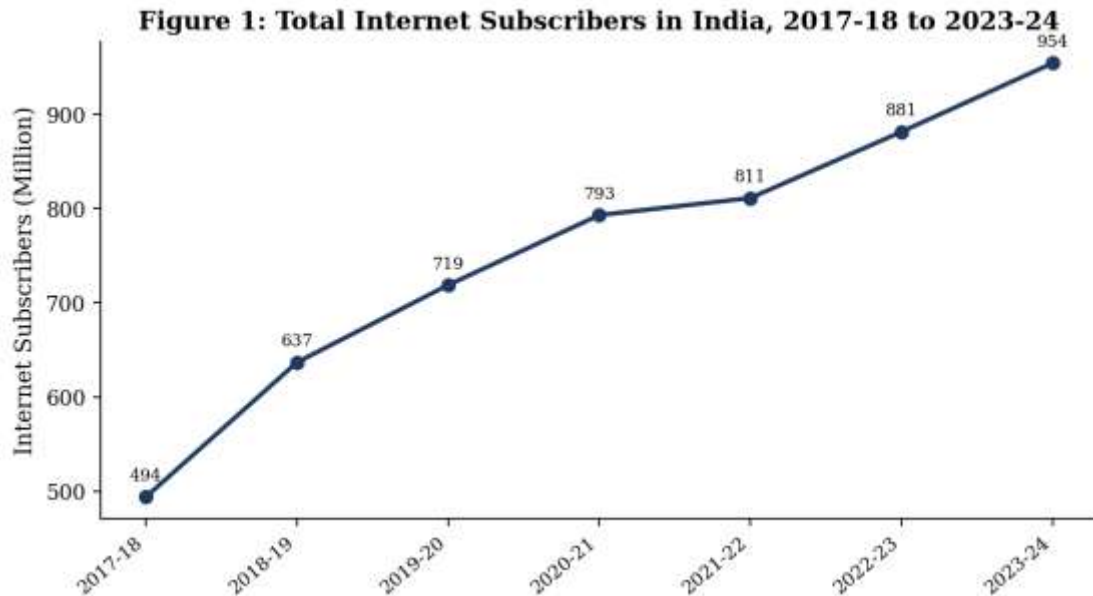
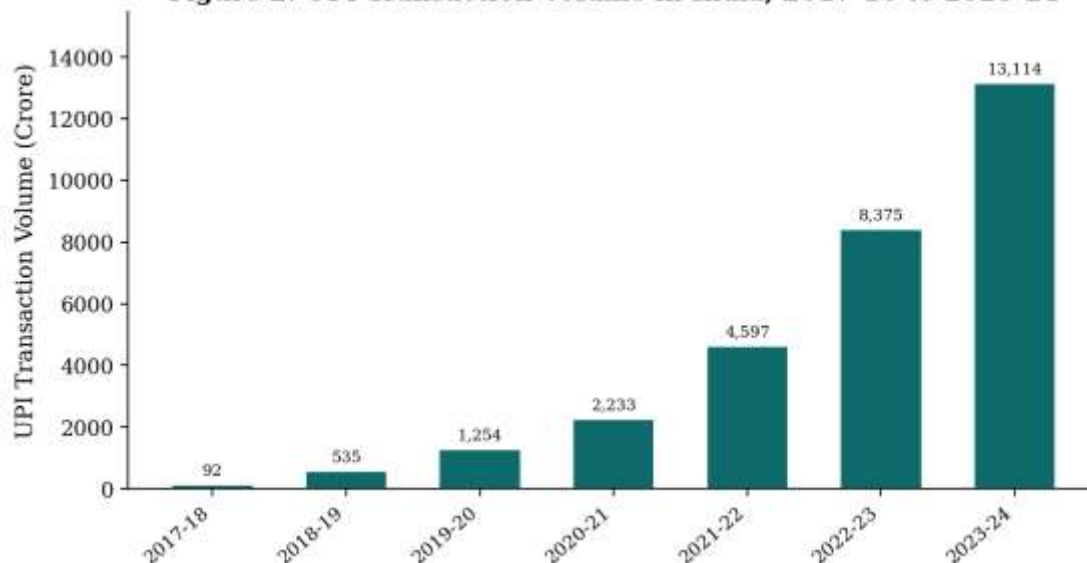


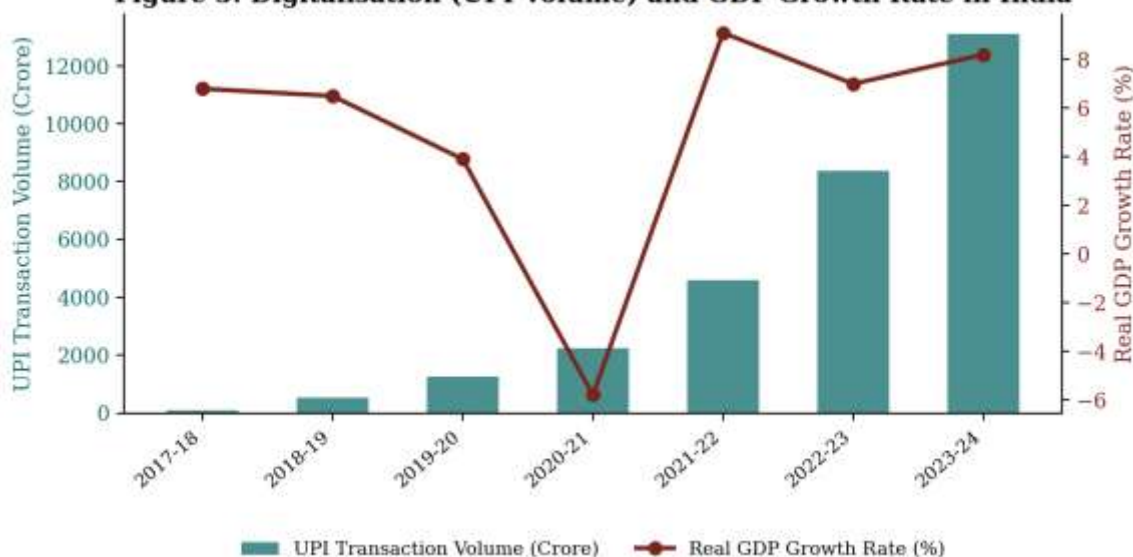
Figure 1: Total Internet Subscribers in India, 2017-18 to 2023-24 (Million). Source: TRAI.

Trend of Digital Payments (UPI)

The growth of UPI transaction volume over the same period has been extraordinary, rising from about 92 crore transactions in 2017-18 to over 13,114 crore transactions in 2023-24, a compound annual growth rate of approximately 129 per cent. The corresponding value of UPI transactions rose from about Rs.1 lakh crore to Rs.200 lakh crore over the same period. This exceptionally rapid expansion reflects both the network effects of a widely adopted, interoperable, zero-merchant-discount-rate payment system and the compounding influence of rising smartphone and internet penetration, expanding merchant acceptance infrastructure, and behavioural shifts in payment habits accelerated further by the COVID-19 pandemic.

Figure 2: UPI Transaction Volume in India, 2017-18 to 2023-24**Figure 2: UPI Transaction Volume in India, 2017-18 to 2023-24 (Crore). Source: NPCI.****Trend of GDP Growth**

India's real GDP growth rate moderated from 6.8 per cent in 2017-18 to 6.5 per cent in 2018-19 and further to 3.9 per cent in 2019-20 amid domestic and global slowdown, before contracting sharply by 5.8 per cent in 2020-21 due to the COVID-19 pandemic and the associated nationwide lockdowns. The economy rebounded strongly, growing by 9.1 per cent in 2021-22 on a low base, and subsequently stabilised at 7.0 and 8.2 per cent in 2022-23 and 2023-24 respectively. Notably, the period of GDP deceleration between 2017-18 and 2019-20 coincided with precisely the years in which UPI adoption was growing fastest in percentage terms, illustrating that rapid digitalisation and headline GDP growth need not move together in the short run.

Figure 3: Digitalisation (UPI Volume) and GDP Growth Rate in India**Figure 3: Digitalisation (UPI Transaction Volume) and GDP Growth Rate in India, 2017-18 to 2023-24 (Combined View).**

Correlation and Regression Analysis

The Pearson correlation coefficient between UPI transaction volume and the real GDP growth rate for the period 2017-18 to 2023-24 works out to $r = 0.34$ ($p = 0.45$), which is statistically insignificant at the 5 per cent level. The correlation between total internet subscribers and GDP growth rate is even weaker, at $r = 0.02$ ($p = 0.96$), indicating virtually no linear association. A regression of GDP growth on UPI transaction volume yields a coefficient of determination (R^2) of approximately 0.12, meaning that UPI transaction volume, on a simple contemporaneous basis, explains only about 12 per cent of the year-to-year variation in GDP growth, and the estimated slope coefficient is not statistically significant ($p > 0.05$). When the pandemic-affected year 2020-21 is excluded, the correlation between UPI volume and GDP growth rises somewhat to $r = 0.51$ but remains statistically insignificant ($p = 0.30$) given the very small number of remaining observations.

In contrast, the correlation between UPI transaction volume and total internet subscribers is very strong and statistically significant, at $r = 0.86$ ($p = 0.01$), confirming that the expansion of internet connectivity and the growth of digital payments have moved closely together over this period, as would be expected given that internet and smartphone access is a necessary precondition for UPI usage. This pattern – a strong relationship between the digitalisation indicators themselves, but a weak relationship between either indicator and aggregate GDP growth – suggests that while digital infrastructure and digital payments have expanded together as parts of a coherent digital ecosystem, their translation into measurable aggregate output growth is not immediate or mechanical. This is consistent with Ghosh (2016) and Vu, Hanafizadeh and Bohlin (2020), and points to the likelihood that the growth effects of digitalisation in India operate gradually, through channels such as financial inclusion, formalisation of economic activity, reduction in transaction costs, and productivity gains at the firm level, rather than showing up as a strong same-year statistical correlation with GDP growth. The unusually large GDP contraction in 2020-21, driven by an exogenous public-health shock even as digital adoption accelerated, further complicates any simple year-on-year reading of the relationship.

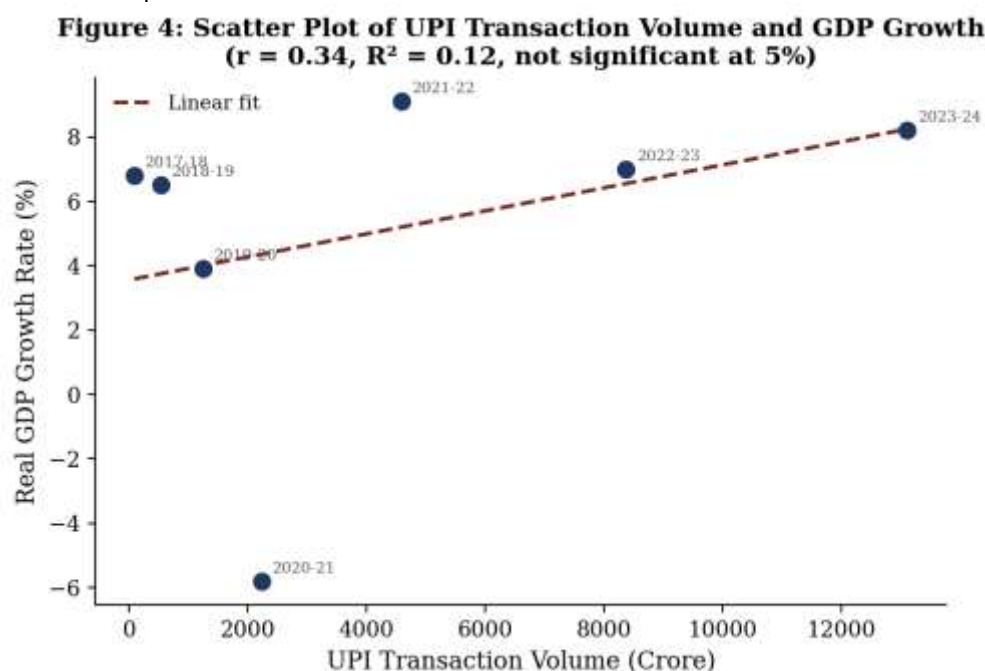


Figure 4: Scatter Plot of UPI Transaction Volume and GDP Growth Rate with Linear Trend Line.

Sectoral Dimensions of Digitalisation

Descriptively, India's digital economy extends well beyond payments and connectivity to encompass e-commerce, digital public infrastructure such as Aadhaar-enabled direct benefit transfers, the Open Network for Digital Commerce, and the account aggregator framework, as well as a large and globally competitive IT and IT-enabled services sector. Industry estimates suggest that India's digital economy has grown considerably faster than the overall economy in

recent years and is expected to account for a rising share of GDP going forward, though the sector-wise translation of digital adoption into output and productivity gains varies considerably, being more clearly visible in financial services, retail, and IT-enabled exports than in agriculture and unorganised manufacturing, where digital penetration remains comparatively shallow.

6. FINDINGS OF THE STUDY

- Total internet subscribers in India grew from about 494 million in 2017-18 to 954 million in 2023-24, a compound annual growth rate of approximately 11.6 per cent.
- UPI transaction volume grew from about 92 crore transactions in 2017-18 to over 13,114 crore transactions in 2023-24, a compound annual growth rate of approximately 129 per cent, making it one of the fastest-growing digital payment systems in the world.
- India's real GDP growth moderated between 2017-18 and 2019-20, contracted sharply in the pandemic year 2020-21, and recovered strongly thereafter, following a pattern largely independent of the pace of digital adoption.
- The simple Pearson correlation between UPI transaction volume and GDP growth for 2017-18 to 2023-24 is weak and positive ($r = 0.34$) and not statistically significant at the 5 per cent level.
- The correlation between internet subscribers and GDP growth is even weaker ($r = 0.02$) and statistically insignificant, indicating no meaningful linear association on a year-to-year basis.
- Excluding the pandemic-distorted year 2020-21, the correlation between UPI volume and GDP growth strengthens to $r = 0.51$ but remains statistically insignificant given the small sample size.
- Internet subscribers and UPI transaction volume are very strongly and significantly correlated with each other ($r = 0.86$, $p < 0.05$), confirming that connectivity expansion and digital payment adoption have moved closely together as complementary dimensions of India's digital transformation.
- The weak aggregate statistical association between digitalisation indicators and GDP growth does not rule out a positive growth impact operating through longer-run channels such as financial inclusion, formalisation of economic activity, and reduced transaction costs, which are not fully captured by a simple bivariate annual correlation.

7. CONCLUSION

This study set out to empirically examine the relationship between digitalisation and economic growth in India over the period 2017-18 to 2023-24, a period marked by the rapid expansion of internet connectivity, the extraordinary growth of UPI-based digital payments, and the disruption and subsequent recovery associated with the COVID-19 pandemic. While internet subscribers and UPI transaction volumes have both grown substantially - the latter at a truly exceptional pace - the simple statistical analysis undertaken here finds only a weak and statistically insignificant contemporaneous association between these digitalisation indicators and the real GDP growth rate.

This finding should not be read as evidence that digitalisation is unimportant to the Indian economy; rather, it cautions against overly simplistic, single-equation interpretations of the digitalisation-growth nexus. The strong and significant correlation observed between internet penetration and UPI adoption confirms that India's digital ecosystem has expanded in a mutually reinforcing manner, with connectivity, financial inclusion, and payment digitisation advancing together. The weaker link with aggregate GDP growth is consistent with the broader international literature, which suggests that the growth dividends of digitalisation are conditional on complementary factors - digital literacy, enterprise-level technology adoption, formalisation of economic activity, and supportive regulatory infrastructure - and are likely to materialise gradually and unevenly across sectors, rather than showing up as a strong year-on-year statistical correlation.

For digitalisation to make a stronger and more measurable contribution to India's economic growth, policy efforts need to move beyond expanding the volume of digital transactions towards deepening their productive use. In particular, continued investment in rural broadband and digital infrastructure, expansion of digital and financial literacy programmes, integration of digital payment rails with formal credit and insurance products for small businesses, strengthening of India's digital public infrastructure stack, and closer alignment of digital adoption with productivity-enhancing investment in manufacturing and agriculture would help translate India's digital transformation into more broad-based and durable economic growth. Future research using a longer time series, sector-disaggregated data, and more sophisticated econometric techniques such as vector autoregression or panel

cointegration would help to further clarify the direction, magnitude, and lag structure of the digitalisation-growth relationship in India.

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