Determinants of Digital-to-Cash Ratio in India: An Analysis of ATM and PoS Utilization Trends

Submitted by:

Kanishk Upadhyay (232PGF008)

Bibek Mallick (232PGF008)

Subhash Kumar (232PGF026)

Meer Ghanee (232PGF013)

Abstract

This study examines the factors affecting Indian's Digital to cash ratio (DCR), Indicator of the transition from cash to digital payments. Employing time-series data from march 2022 to September 2024, regression analysis shows that inflation (-0.7282) and long-term interest rates (-1.5921) notably negatively affect DCR suggests that economic uncertainty & borrowing costs obstruct digital adoption. But online transactions while positively associated or correlated lacked statistical significance in the study period.

In depth examination of ATM and PoS usage rates hints at structural shifts & disruptions. ATM usage shows long term decline sharply impacted by demonetization (2016) and COVID-19 (2020) showing reduced cash reliance. PoS Usage grew prior pandemic but fluctuated after pandemic showing the interplay of technology adoption & policy shocks.

The findings emphasise the need for tailored policies to tackle macroeconomic constraints & strengthen digital infrastructure to encourage digital payment adoption. Future research delve into high frequency data for in-depth insights.

Introduction

The growing transition to digital payments has changed the environment of economies globally, offering ease, efficient and reduced dependency on cash. An important indication of this shift is the digital to cash ratio which displays the amount of digital transactions compared to cash withdrawals. In India where the government has actively promoted digital payments through initiatives like the Digital India program and demonetization, understanding the factors of this ratio is important for policymakers and financial institutions.

Macroeconomic factors such as inflation, interest rates and online transactions play a central role in shaping this ratio. In addition to that, payment infrastructure indicators like ATM utilization and PoS utilization rates give insight into the operational dynamics of cash and digital payment systems. By using data from reliable sources such as Reserve Bank of India, the Federal Reserve Economic Data (FRED) and the Ministry of Statistics and Programme Implementation (MoSPI) this study try to empirically analyze these factors over a defined time period.

This paper uses feature-engineered metrics such as ATM utilization, PoS utilization rates & the digital to cash ratio giving a nuanced structure of payment system which makes it efficient. By using Linear regression models along with logarithmic transformations for independent variables it explores how inflation, interest rates & online transactions which affect digital to cash ration. This evaluation aims to provide actionable deep understanding for stakeholders to optimize payment systems & to promote financial inclusion.

Literature Review

Evolution of Digital Payments and Determinants

Digital payment systems which have gained importance worldwide due to technological advancements & also government policies which aimed to reduce cash dependency (Arvidsson, 2019). Research studies such as Rogoff (2016) argue digitization of payments reduces costs connected with cash handling & improves transparency. In the developing economies such as India cash continues due to cultural preferences & infrastructures shortfall (Reddy & Reddy, 2021).

Role of Macroeconomic Factors

Inflation & interest rates are important macroeconomic factors of payment preferences. Inflationary pressures mainly increase the cost of holding cash, incentivizing digital payments (Baumol, 1952). Studies by Tobin (1956) highlight interest rates affect the opportunity cost of holding cash, fostering shifts toward the digital alternatives. The association between these variables and payment preferences has been restated in recent works (Kumari & Joshi, 2020).

Infrastructure and Utilization Rates

The availability and use of the payment infrastructure like ATMs & PoS terminals have been studied comprehensively. Agarwal et al. (2021) highlights that high ATM usage rates hint out dependency on cash whereas increased PoS utilization shows digital adoption. The elasticity between the transaction volumes & the terminal availability has been in a focus in recent literature (Chauhan & Kumar, 2022).

Digital Payment Adoption in India

India's effort toward the digital payments has been researched through the standpoint of policy interventions & technology diffusion. The demonetization which exists in 2016 as analyzed by Suri & Ranjan (2018) which provides a natural experiment to observe the transition in the digital to cash ratio. Studies of Mehra & Mehta (2020) highlight the importance of the government incentives to promote digital transactions.

Empirical Studies on Digital-to-Cash Ratios

Empirical research on digital to cash ratio has often used regression models to find out the factors. Using cross country data, Shaikh et al. (2019) which exhibit the impact of transaction costs & income levels for digital payment adoption. Singh & Gupta (2023) expanded this analysis to India, observing that online transactions significantly forces the digital to cash ratio reduces regional disparities.

Data and Methodology

- **Data sources:**

This study takes following variables into consideration from the following sources: -

ATM transaction, Number of ATMs, PoS transactions, Number of PoS terminals, and online transactions were sourced from RBI Handbook of statistics on Indian Economy.

The data for Inflation rates were sourced from Ministry of Statistics and Programme Implementation (MoSPI).

The data for Long-Term Government Bond Yields (10 years) was sourced from the Federal Reserve Economic Data (FRED).

- **Feature Engineering:**

We used feature engineering technique to create the following variables.

1. ATM Utilization Rate: Volume of ATM transactions/No. of ATMs.
2. PoS Utilization Rate: Volume of PoS transactions/No. of PoS terminals.
3. Digital-to-Cash-Ratio: Volume of Digital Transactions/ ATM withdrawals

- **Methodology:**

We employed linear regression technique with Digital-to-Cash-Ratio, and the independent variables were Inflation, Interest Rates (Long-Term Government Bond Yields) and online transaction by transforming them into natural logarithm to scale each of them appropriately.

We also visually inspected ATM Utilization rate and PoS Utilization rate to interpret trends, seasonality, and residuals.

Empirical Analysis and Results

In this section we will be talking about the empirical analysis of the factors that influence Digital-to-Cash-Ratio by employing a linear regression model. The model will investigate the impact of inflation, interest rates, and online transaction volumes on Digital-to-Cash-Ratio. Also, we will visually inspect trends, seasonality, and residuals of ATM utilization rate and PoS Transaction. The results will offer insights to the key factors of digital adoption.

$$\textbf{Digital-to-Cash Ratio} = \beta_0 + \beta_1 \cdot \ln(\textbf{Inflation}) + \beta_2 \cdot \ln(\textbf{Interest Rates}) + \beta_3 \cdot \ln(\textbf{Online Transactions}) + \epsilon$$

Table 1: Linear Regression Results

Variables	*Coefficients*	*T-stat*	*P-Value*
Ln_Inflation	-0.7282	-5.760	0.000
Ln_Interest_Rate	-1.5921	-2.158	0.040
Ln_Online_Transactions	0.6388	0.985	0.334
Intercept	-4.3809	-0.406	0.688
	R^2 *= 0.782*	**P-Value** = 4.58e-09	
	Adjusted R^2 *= 0.757*	**F-Statistics** = 32.20	

Source: Author's Calculation

From the table we can observe that our model explains 78.2% of variation in the Digital-to-Cash-Ratio. After adjusting for the degrees of freedom, the adjusted R-square of 0.757 suggests that our model is robust even after inclusion of independent variables. Our overall model is statistically significant with a very small p-value of 4.58e-09, which means that the independent variables in our model together have captured a meaningful impact on the dependent variables.

Inflation has a negative coefficient of -0.7282, and it is statistically significant. This indicates that when inflation increases by 1%, the Digital-to-Cash-Ratio decreases by 0.7282 units, keeping other factors constant. The negative relationship suggests that higher inflation rates influence the consumers to prefer cash transactions over digital methods, potentially due to increase in price sensitivity or uncertainty regarding the future.

The Interest Rate (10-year govt bond yield), has a coefficient of -15921 and it is statistically significant as well. This indicates that when 10-year govt bond yield increases by 1%, the Digital-to-Cash-Ratio decreases by 1.5921 units, keeping other factors constant. The negative relationship shows that digital transactions become less attractive when interest rates are high, as increase in borrowing costs may influence consumer spending behaviour and savings preferences.

The online transaction is not statistically significant even though it has a coefficient of 0.6388. This suggests that online transactions don’t have a significant impact on Digital-to-

Cash-Ratio. Hence, it is not a key factor to influence Cash-to-Digital Ratio in the given period.

Visual analysis of Trends, Seasonality, and Residuals in ATM Utilization Rate:

Figure 2: Visual Inspection of ATM Utilization Rate

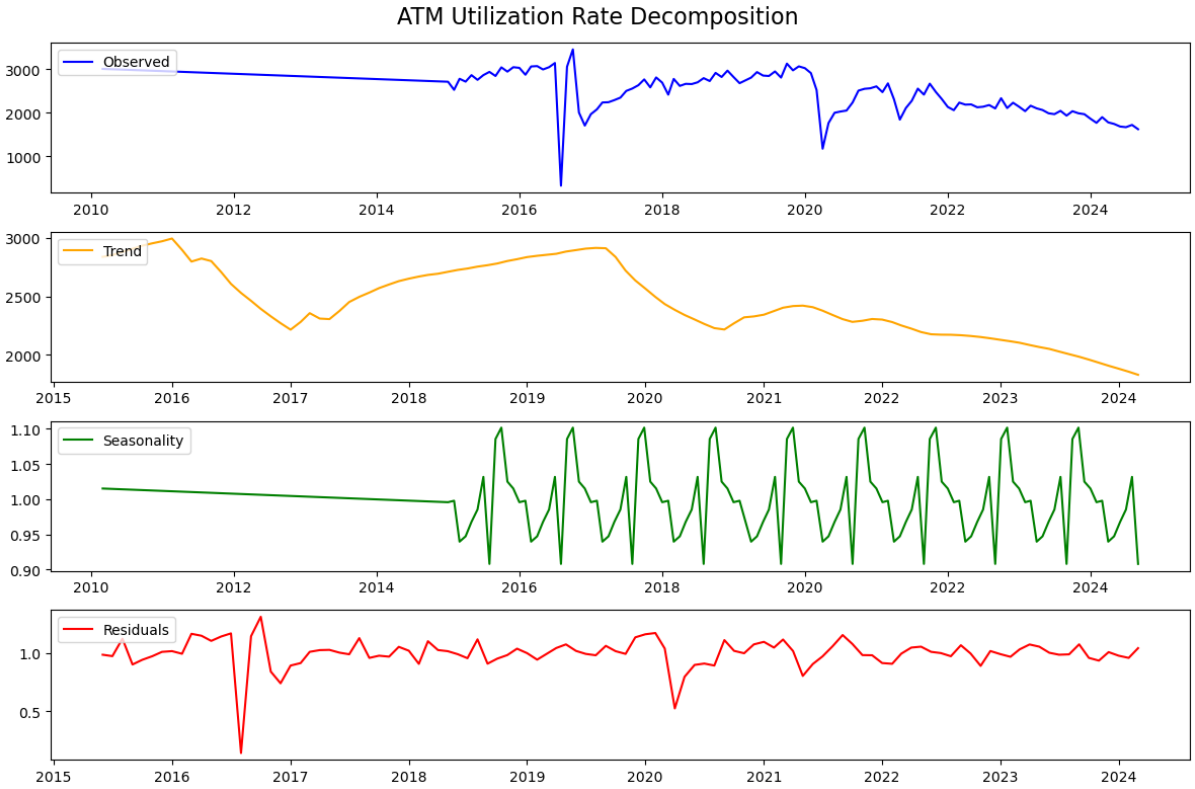


Figure 1: Source Author's Calculation

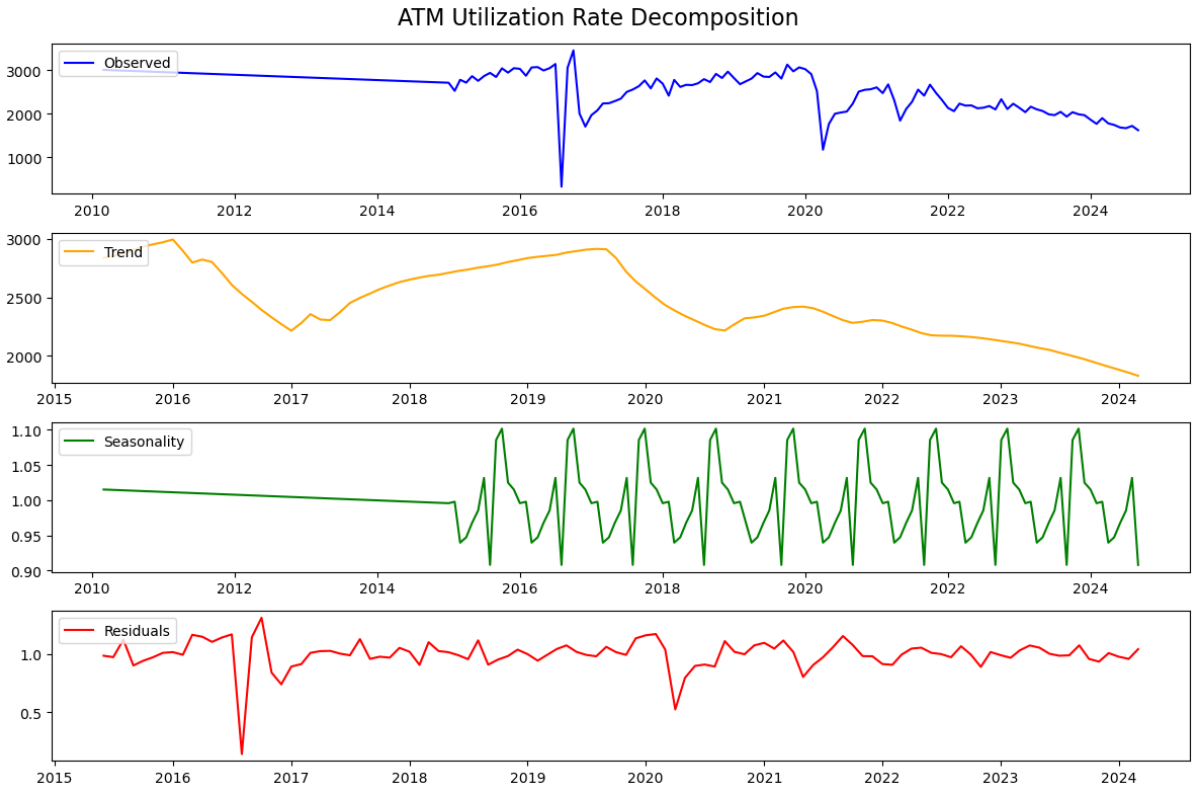
Decomposition of PoS Utilization Rate:

We decomposed PoS Utilization rate in order to gather insights related to trends, seasonality, and residual components from Jan 2015 to Sep 2024.

- **Observed Data:** While visually inspecting the graph we can see that there has been an upward movement till 2019 but after that it experienced a significant decline and after that it experienced fluctuations from 2020. This indicates that with the onset of COVID-19 pandemic, consumer behavior and transaction patterns were disrupted.
- **Trend Component:** It reflects the long-term movement of PoS utilization for the given time-frame. We can see the rate increased steadily initially, but a decline in trend was observed from 2020, which suggests structural changes. This indicates a shift towards digital payment methods or potentially a decline in transactions which are dependent on cash.
- **Seasonality Component:** While visualizing the graph we can see recurring pattern every year, as regular peaks and troughs are clearly evident. This periodic fluctuation is probably due to economic cycles or festival season that could affect transactions.
- **Residual Component:** This component shows noise or unexplained variation in the data. We can see a spike in 2020, this indicates that during uncertain time like

COVID-19 pandemic, lockdown reduced economic activity, which weren't captured by trend or seasonality component.

Figure3: Visual Inspection of ATM Utilization Rate



Source: Author's Calculation

We decomposed ATM Utilization rate in order to gather insights related to trends, seasonality, and residual components from Jan 2015 to Sep 2024.

- **Observed Data:** While observing the data for ATM utilization Rate, we observe that it experienced sharp decline during 2016 and 2020. The decline in 2016 can be explained by demonetization which affected availability of cash, and 2020's decline can be explained by COVID-19 pandemic, where nationwide lockdown reduced cash transactions and economic slowdown was prominent.
- **Trend Component:** While visually inspecting the graph, we see a steady decline in ATM utilization post 2020. This downward movement shows an increase in adoption of digital payments and a reduction in cash transactions.
- **Seasonality Component:** This component shows a recurring fluctuation on yearly basis, as periodic peaks and troughs can be seen. This can be due to festival season or other socio-economic activities that affects consumer cash spending and withdrawal behavior.
- **Residual Component:** This component shows noise or variations that is not captured by the trend or seasonality. The chart clearly shows volatility during the period of demonetization and pandemic, which indicates a significant shock to ATM usage.

Conclusion

This study identifies the main macroeconomic factors affecting India's Digital to Cash Ratio (DCR), shows that inflation and interest rate have significant negative influence on digital adoption. These findings indicate that economic uncertainty & borrowing costs will make consumers more aware about shifting to digital transactions, emphasizing the importance of a firmly fixed macroeconomic conditions to promote digital payments.

The evaluation of ATM & PoS use rates shows a gradual move from cash but this trend has made by important events like demonetization & the COVID-19 pandemic. Declining ATM usage hints to a structural shift toward digital payments while seasonal fluctuations in PoS usage shows change in consumer habits which is influenced by socio-economics factors.

Overall, the research highlights the importance of a stable economic conditions, supportive policies & robust digital infrastructure in affecting the payment behaviors. Policymaker should emphasize on mitigating uncertainty building trust in digital systems and improving access to digital platforms to force the shift to a cashless economy.

Overall, the research emphasizes the importance of stable economic conditions, supportive policies, and robust digital infrastructure in influencing payment behaviors. Policymakers should focus on reducing uncertainty, building trust in digital systems, and improving access to digital platforms to drive the shift toward a cashless economy.

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