National College of Ireland

# Unlocking Opportunities: UPI (Unified Payments Interface) replacing POS processing in Ireland to empower SMEs

MSc Research Project
Financial Technology

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# Unlocking Opportunities: UPI (Unified Payments Interface) replacing POS processing in Ireland to empower SMEs

Pushparaj Sampath
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**Abstract**

This study investigate into how the deployment of the Unified Payments Interface (UPI) has altered the payments landscape. The study uses ANOVA testing to examine the impact of UPI on various industries, with a particular focus on Ireland's card-based economy. Significant pre- and post UPI differences in market dynamics, card transactions, POS operations, cash flow, loan interest, and UPI interactions are discovered through thorough variance analysis. The study highlights the full range of UPI's effects, showing how it affects consumer behaviour, transaction patterns, and economic situations. This study contributes to understanding UPI's multifaceted role in modernizing payment systems. In conclusion, this project offers a thorough UPI investigation, fusing theory, implementation, and empirical analysis. Unveiling UPI's adoption and impact nuances enriches digital payment discourse, advancing a seamless, secure, and efficient financial ecosystem.

Keywords: UPI (Unified Payments Interface), SMEs (Small Medium Enterprises), CBI (Central Bank of Ireland), NPCI (National Payments Corporation of India)

## 1. Introduction

The adoption of mobile phone banking holds immense significance for Small and Medium Enterprises (SMEs), offering substantial business prospects by transforming operations, brand promotion, customer communication, and competitive landscape (Canhoto, A.I. et al., 2021). In Ireland, SMEs play a pivotal role, constituting over 99% of active enterprises and contributing significantly to employment, GDP, and exports (CSO, 2022; CSO - central statistics office, 2017). However, the rise of payment cards has led to reduced cash and check transactions, burdening merchants with fees from payment service providers and banks, particularly related to POS transactions. These charges encompass setup, rental, transaction, and chargeback fees, impacting SME profitability.

This study's core objective is to evaluate the feasibility of integrating a Unified Payments Interface (UPI) into Ireland's banking infrastructure, empowering SMEs. Considering the surge in mobile-based financial transactions, we analyse UPI's potential implications, enabling real-time Peer-to-Peer (P2P) and Peer-to-Business (P2B) payments. By investigating UPI's integration to mitigate high fees from payment network service providers, we address the need for secure, efficient, GDPR-compliant mobile payment solutions.

Focusing on SME empowerment, this research explores UPI's viability to replace traditional Point of Sale (POS) processing in Ireland. Drawing insights from UPI's success in India, we examine its cost-effectiveness, efficiency, and accessibility. Assessing Ireland's current POS landscape, we identify challenges such as elevated transaction costs and limited financial access for SMEs. UPI's seamless digital payments could streamline operations and expand their

clientele. The study delves into the transition's implications for Ireland's financial infrastructure, security, data protection, and interoperability with existing systems.

The research underscores UPI's potential to empower SMEs, catalysing economic growth in Ireland.

### 1.1 Rationale of the study

The research on Unified Payment Interface (UPI) implementation carries substantial implications for economic growth, including enhanced financial inclusion, heightened consumption, SME empowerment, and reduced transaction costs. UPI-enabled digital payments foster transparency, aid tax collection, and bolster e-commerce and startup ecosystems. Its real-time insights contribute to effective monetary policies, attracting foreign investment and spurring economic development. This study offers a roadmap for policymakers, financial institutions, and businesses to comprehend UPI's potential, particularly in SME empowerment in Ireland's context.

Amidst the evolving retail payment systems landscape, emerging software-based players are challenging traditional card usage, necessitating a cautious approach to further regulatory interventions. The study addresses the growing significance of mobile payments and the need to assess UPI's impact on critical economic indicators like revenue, cash flow, and interest rates, especially concerning POS system replacement. Filling a gap in existing literature, the research employs statistical data from the Central Bank of Ireland and UPI transaction data from NPCI, India, to project economic indicators over a decade. The analysis employs the IBM SPSS tool to unveil potential UPI-induced market growth, alongside assessing challenges and opportunities tied to transitioning to UPI-based processing in Ireland.

### 1.2 Research Question

What are the potential benefits and implications of replacing traditional Point of Sale (POS) processing with Unified Payments Interface (UPI) technology in Ireland, specifically focusing on how this transition can empower Small and Medium Enterprises (SMEs) in the country?

### 1.3 Research Objective

- To assess the potential benefits and implications of replacing traditional Point of Sale (POS) processing with Unified Payments Interface (UPI) technology in Ireland.
- To explore how the adoption of UPI can empower Small and Medium Enterprises (SMEs) in Ireland by reducing transaction costs and enhancing their financial capabilities.
- To examine the impact of UPI implementation on SMEs' growth, competitiveness, and overall contribution to the Irish economy.

## 2. Related Work

According to Pal, A. et al. (2021), digital money, mobile wallets, and mobile payments are predicted to overtake debit and credit cards in terms of popularity. According to the Unified theory of acceptance and use of technology (UTAUT), UTAUT 2, comprehending individual acceptance and use of information technology is one of the most developed areas of information systems study. The theory holds that behavioural intention to use a technology is determined by enabling factors and behavioural intention, with effort expectancy and social influence acting as moderators. Additionally, according to Venkatesh et al. (2012), individual differences in age, gender, and experience influence a variety of UTAUT connections.

## 2.1 Mobile Technology user adoption

A thorough literature analysis is essential before diving into UPI adoption in Ireland in order to place the study within the larger context of technology adoption. This strategy guarantees a comprehension of digital trends and the variables affecting technological uptake. The Technology Acceptance Model (TAM) established by Davis (1989) and the Innovation Diffusion Theory (IDT) by Venkatesh and Davis (2000) are the two main models used to analyse the acceptance of mobile banking. TAM examines the inherent qualities, perceived value, and usability of technology. IDT focuses on the characteristics of innovation dissemination, including relative benefit, complexity, compatibility, trialability, and observability, all of which are pertinent to the uptake of mobile banking.

Ireland, which has a strong digital infrastructure, has seen a considerable increase in the use of mobile technology, which is partly due to the high rate of smartphone ownership in the country. This development makes it simple to access mobile services and applications. Furthermore, Ireland's dependable mobile networks and fast internet support the use of mobile technologies. According to Lambert and McGovern (2019), mobile banking, a development of electronic banking, offers consumers equivalent advantages and services to those of traditional internet banking and improves accessibility to banking "anywhere, anytime." The socio-economic ramifications of this technology revolution and its potential to alter consumer banking behaviour could be the subject of further study.

## 2.2 UPI user adoption (Indian Context)

In recent years, India, a significant emerging market, has witnessed a notable surge in the adoption of mobile payment services. This growth can be attributed to factors such as robust internet connectivity, accessible mobile data, a reliable wireless network, a positive disposition towards innovative technology, the implementation of the Digital India policy, and extensive efforts toward financial inclusion (Liébana-Cabanillas et al., 2020). A pivotal player in this transformation is the Unified Payments Interface (UPI), introduced by the National Payments Corporation of India (NPCI) in 2016. UPI enables instantaneous money transfers between banks via mobile devices, utilizing Virtual Payment Addresses (VPAs) as unique identifiers linked to users' bank accounts. This approach streamlines transactions by substituting bank account numbers and enhancing security. UPI employs the Immediate Payment Service (IMPS) for secure and swift fund transfers. The user-friendly nature of mobile payment services, including UPI, has significantly driven their expansion in India, with UPI transactions in 2019 surpassing the previous year's count by 214%, exemplifying the platform's widespread adoption and utilization (Abdullah & Khan, 2021).

## 2.3 Indian SMEs challenges and opportunities before and after UPI

Recognizing the need for tailored support in digital onboarding, NPCI has introduced a specific P2P-M category, exempting microenterprises from POS transaction charges (MDR). Despite the potential benefits of technology for MSMEs, including enhanced finance access and cost reduction, challenges like high machine rental costs and limited resources hinder digitalization benefits (Buteau, 2021; Harini et al., 2019). Unified Payments Interface (UPI) has addressed these concerns, offering a cost-effective alternative to POS systems. UPI's accessibility has empowered MSMEs to engage in digital transactions, mitigate cash dependence, and improve operational efficiency.

The ascent of mobile payments, especially UPI, has laid a sturdy foundation for India's digital transformation. UPI's user-friendly nature and availability have fuelled its widespread acceptance, with projections indicating continued substantial growth. The surge in UPI transactions, surpassing other cashless methods, underscores its popularity. Notably, fintech leaders like Google Pay, Phone Pe, and Paytm have been pivotal in driving P2P UPI payments. Forecasts from NPCI, RBI, and the Indian Banks Association foresee UPI transactions potentially reaching 60 billion annually by 2023 (NPCI, 2021c). This remarkable trajectory reflects UPI's role in propelling India's digital economy forward.

### 2.4 Irish SMEs business challenges

Irish small and medium-sized enterprises (SMEs) are grappling with formidable challenges arising from transaction charges and point-of-sale (POS) fees, significantly impacting their operations. Transaction fees, imposed by financial institutions and payment processors, are eroding the already slim profit margins of these enterprises. This problem is amplified as cashless transactions and online sales become more prevalent, intensifying the impact of such charges. Additionally, SMEs' limited transaction volumes hinder their ability to negotiate better rates with service providers, exacerbating the financial strain. The burden is further compounded by the high costs associated with setting up and maintaining POS systems, which include rental, service, and maintenance fees. The evolving payment technology landscape necessitates frequent upgrades, adding to the financial strain. Given the importance of SMEs to Ireland's economy, addressing these issues is crucial for their growth and the overall prosperity of the nation (Gherghina et al., 2020; Papadopoulos, 2019).

Irish SMEs have embraced mobile payment systems over the past decade, aligning with global digitalization trends in financial transactions. The convenience and efficiency of mobile payments have driven adoption, aided by smartphone advancements, increased availability of payment apps, and evolving consumer preferences. According to Statista, the mobile POS payments segment reached a transaction value of USD 1,363,783 million in 2020, projected to grow at an annual rate of 41.0% (CAGR 2020–2024), reaching USD 5,384,138 million by 2024. The user base for mobile POS payments is anticipated to reach 1754.6 million by 2024 (Statista market forecast, 2023). This upward trajectory underscores the growing significance of mobile payments in transforming the landscape of financial transactions worldwide.

### 2.5 India's UPI Success Story

UPI is a real-time payment method designed by the National Payments Corporation of India (NPCI) that allows customers to link multiple banks to a unified mobile app, allowing for fast money transfers among those accounts 24 hours a day, seven days a week. Let us now examine these graphs in the light of the UPI achievement and its influence on the nation's local and regional sectors.

| Year | Debit | Credit | Cash | UPI | total | growth | Total_round_off |
|---|---|---|---|---|---|---|---|
| 2015 | 379980.7 | 20726.22 | 290167.1 | 0 | 690874 | 24.87112 | 690874 |
| 2016 | 4,74,790.09 | 26726.22 | 388464.6 | 893.07 | 890874 | 28.94884 | 890874 |
| 2017 | 7,03,720.98 | 54239.36 | 575771.7 | 57020.87 | 1390752.93 | 56.11107 | 1390752.927 |
| 2018 | 10,18,244.88 | 109502.4 | 833109.5 | 585710.45 | 2546567.17 | 83.10709 | 2546567.174 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 2019 | 10,74,628.72 | 117232.2 | 879241.7 | 1836638.18 | 3907740.81 | 53.45131 | 3907740.809 |
| 2020 | 14,22,852.78 | 184786.1 | 1164152 | 3387744.72 | 6159535.85 | 57.62396 | 6159535.855 |
| 2021 | 20,34,430.38 | 1073893 | 1664534 | 7159285.8 | 11932143 | 93.71822 | 11932143 |
| 2022 | 20,11,149.35 | 4062928 | 1645486 | 12595076.7 | 20314639.9 | 70.25139 | 20314639.89 |

Table 1: India's Market Payments Distribution Year Wise (Source: NPCI)

The Table 1 shows a year-by-year analysis of different ways to pay (debit, credit, cash, and UPI) and transactional quantities. It also contains the overall quantity of transactions for each year, as well as growth rates and overall rounded-off total.

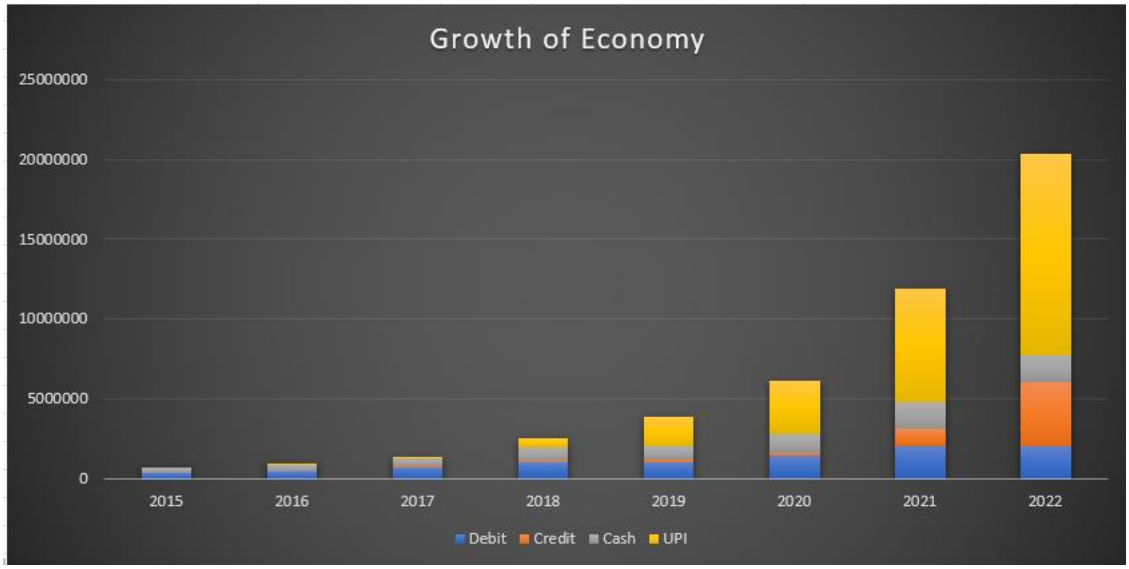
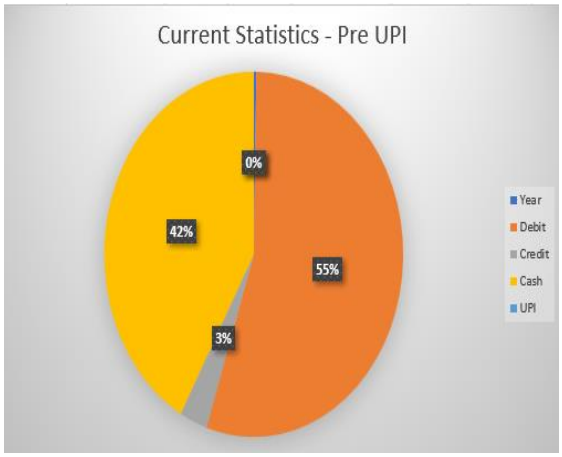



Fig 1: Impact of UPI in Indian Economy -Transactions quantities (Data Source – NPCI, India)

## 2.6 Micro-Economic Impact

The rapid rise in UPI transactions signals its growing popularity for both consumers and businesses, reflecting the shift towards electronic payments over traditional methods. UPI's significant share (62% of the Indian market) highlights reduced reliance on cash and cards.



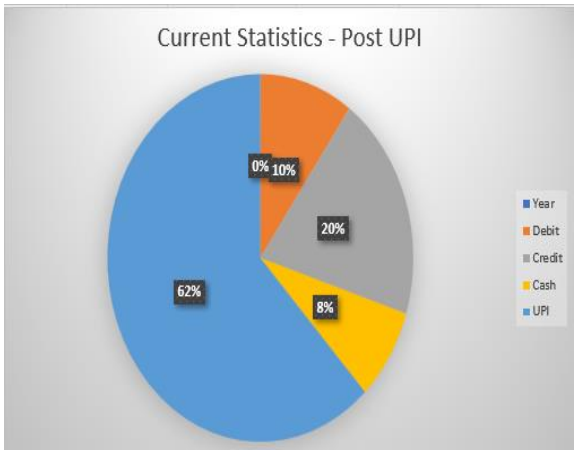




Fig 2 &3: Indian Payments Market Capture - Pre and Post UPI (Data Source – NPCI, India)

## 2.7 Macro-Economic Impact

UPI's adoption leads to an open and accountable banking system, curbing black money. It contributes to the digital economy, spurring tech advancements and fintech growth. UPI replaces cash payments, aiding tax compliance and formalizing transactions, while also promoting financial inclusion and reducing operational costs for organizations.

**Inference**: The information in fig:4 demonstrates UPI's effectiveness across India and its broad impact on the grassroots and macroscopic levels. UPI's quick expansion reflects its role to altering the banking environment, encouraging financial participation, lowering the shadow banking industry, and improving the Indian economy's general effectiveness and efficiency.

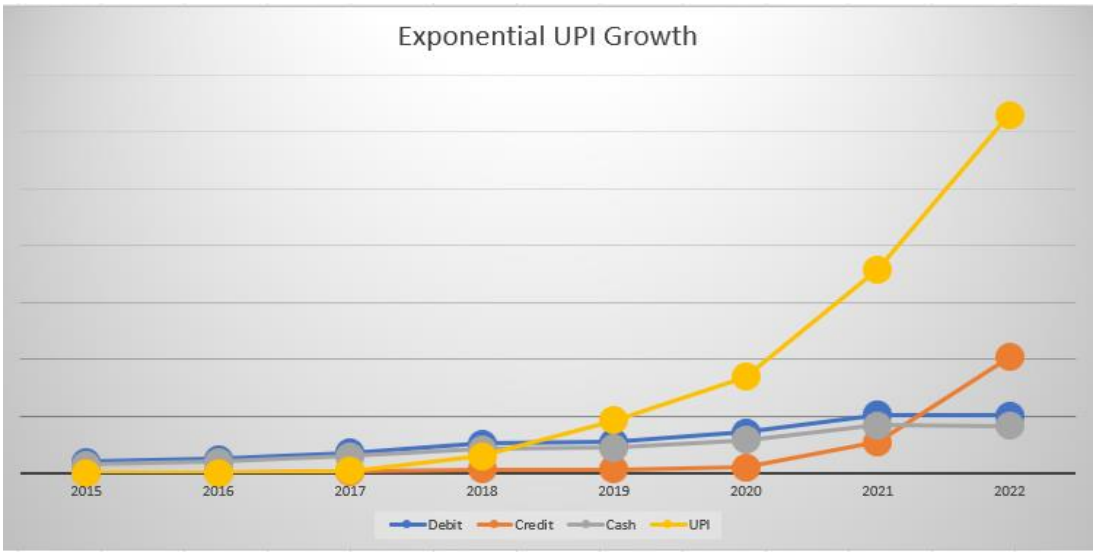



Fig 4: Exponential UPI Growth (Data Source: NPCI)

## 2.8 Irish Market - SMEs Concerns and Rising Problems with POS

The payments market in Ireland faces challenges due to limited interoperability and fragmented payment methods, lacking seamless interactions between different mechanisms. This complexity leads to inconvenience and delays for users, potentially causing errors and frustration. Furthermore, handling various payment methods increases transaction costs, with each method incurring its own expenses. For Irish SMEs, rising Point of Sale (POS) costs pose specific concerns:

- Increased operational expenses impact profitability
- Thin profit margins coupled with rising POS costs could lead to financial losses
- Financial sustainability and long-term growth potential are at risk
- Limited purchase alternatives may arise, hindering customer convenience
- Competition with larger businesses becomes difficult due to higher costs
- Uncertainty in accepting cards due to prohibitive fees could lead to revenue loss

| Year | Debit | Credit | Cash | Wallet | Total Market |
|---|---|---|---|---|---|
| 2022 | 3,14,03,561 | 39,86,794 | 1,34,50,498 | 176951.77 | 4,90,17,805 |
| 2021 | 3,15,07,931 | 43,26,867 | 1,26,71,119 | 179173.99 | 4,86,85,091 |
| 2020 | 2,26,30,318 | 37,06,205 | 1,32,79,258 | 131682.61 | 3,97,47,464 |
| 2019 | 2,26,30,318 | 37,06,205 | 1,96,72,522 | 131682.61 | 4,61,40,728 |
| 2018 | 2,06,28,778 | 36,07,910 | 1,99,26,679 | 121183.44 | 4,42,84,550 |
| 2017 | 1,76,71,489 | 33,55,343 | 1,90,99,381 | 105134.16 | 4,02,31,347 |
| 2016 | 1,53,43,633 | 32,38,142 | 1,90,55,914 | 92908.875 | 3,77,30,598 |
| 2015 | 1,27,25,851 | 30,59,340 | 1,84,62,028 | 78925.955 | 3,43,26,145 |

Table 2: Ireland's Current market

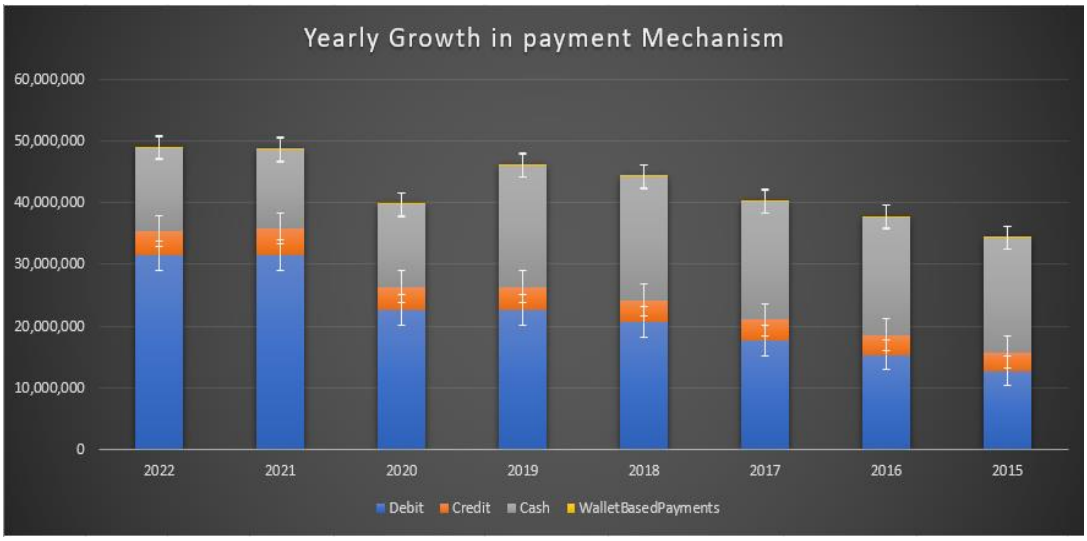



Fig 5: Annual Payment Growth Mechanism (Data Source: Central Bank of Ireland)

**Inference**: In the absence of a UPI-like structure, the financial environment may become scattered and convoluted, affecting the client experience, and possibly leading to increased transaction expenses. Expanding POS fees can have a negative impact on small and medium-sized through rising operational expenses, decreasing economic viability, and generating disadvantages in the marketplace. A system for making payments that is smooth and interconnected, such as UPI, can ease these challenges and foster a more effective and welcoming society.

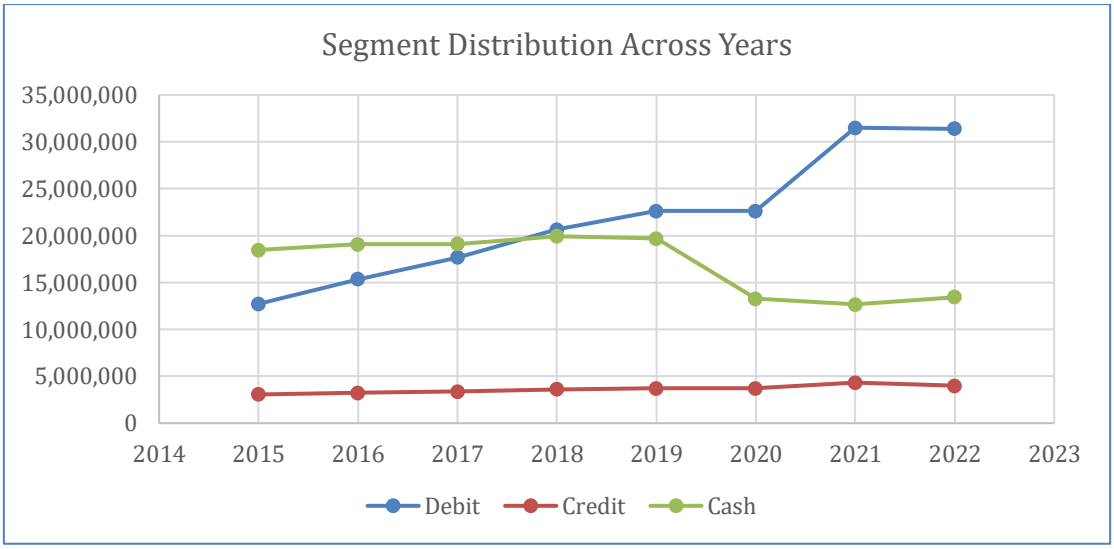



Fig 6: Distribution of Payment Options in Irish Market (Data Source: Central Bank of Ireland)

## 3. Research Methodology

The research methodology adopted a comprehensive approach by integrating both Qualitative and Quantitative techniques. The primary aim was to investigate research hypotheses and establish validation. To achieve this, a dataset spanning from 2015 to 2022 was extracted from the Central Bank of Ireland, comprising debit and credit card retail payments. Additionally, transaction data from 2016 to 2022 was sourced from the National Payments Corporation of India (NPCI) for UPI transactions. Utilizing this dataset, the study employed the Monte Carlo simulation technique. By doing so, monthly transaction data from 2023 to 2043 was generated. This simulated data was then subjected to a descriptive analysis, revealing the inherent characteristics of both the collected and simulated datasets. Further analysis involved a correlation examination, which delved into the intricate relationships between various variables within the derived data. In addition, a one-sample test was conducted to compare a specific sample mean against a known or hypothesized population mean. Notably, an ANOVA test was performed to scrutinize means across multiple groups, facilitating a comprehensive comparison – particularly before and after the UPI implementation. The combined use of these methodologies provided a thorough exploration of the research objectives, enabling the study to draw meaningful insights and conclusions.

According to Eldabi, Irani, Paul, J., and Love (2002), quantitative research often has a logical and linear structure, with the hypothesis taking the form of predictions about the likely incidental linkages between the constituent concepts specified in the hypothesis.

### 3.1 Data Extraction

The process of data acquisition for this study involved collecting two distinct datasets. The first dataset was obtained from the Central Bank of Ireland and covered the period from 2015 to 2022. This dataset encompassed debit and credit card retail payments, providing valuable insights into the financial landscape during those years. The second dataset was sourced from the National Payments Corporation of India (NPCI) and covered the timeframe from 2016 to 2022. This dataset specifically focused on transaction data related to the Unified Payments Interface (UPI), offering a comprehensive view of digital payment trends and patterns.

### 3.2 Hypothesis Formulation and Parameters for Simulation

The formulated hypotheses and simulation parameters in our study serve to systematically analyse UPI's impact on the payments market. These hypotheses guide our investigation by testing acceptance rates, cost reductions, transaction shifts, and SMEs cash flow improvement. The inclusion of negative and alternate hypotheses ensures comprehensive evaluation. Simulation parameters create a realistic model, allowing us to quantitatively assess UPI's effects and predict potential outcomes. By doing so, we enhance our decision-making, provide evidence-based insights, and proactively plan for UPI implementation's implications on various aspects of the payment's ecosystem.

**Hypothesis**

***H0 (Negative Hypothesis):***

**UPI Consumption Have Increased:**

H0: When contrasted with conventional card-based structures, the implementation of UPI does not showcase significant enhancement to the rate of acceptance.

**UPI reduces expenses in the following ways:**

H0: When compared with conventional payment methods, transactions made using UPI do not result in considerable cost reductions for customers or companies.

**Redistribution of Transactions Quantity:**

H0: Deployment of UPI is unlikely to result in a major shift in the number of transactions away from card-based transactions and towards UPI.

**Cash Flow Improvement for MSMEs:**

H0: UPI payments do not enhance cash flow significantly for small and medium-sized businesses (MSMEs).

***Alternate Hypothesis H1:***

**UPI Usage Has Increased:**

H1: When contrasted with conventional card-based systems, the implementation of UPI dramatically boosts the rate of acceptance.

**UPI reduces costs in the following ways:**

H1: When contrasted with conventional payment techniques, UPI payments result in considerable cost reductions for consumers and enterprises.

**Distribution of Transactions Quantity:**

H1: The implementation of UPI leads in a considerable shift in the number of transactions away from card-based transactions and towards UPI.

**Cash Flow Improvement for MSMEs:**

H1: UPI payments enhance the flow of cash significantly for micro, small, and medium-sized enterprises (MSMEs).

**Hyper Parameters**

| Parameters | Constraints Without UPI | Constraints for UPI |
|---|---|---|
| Market | 49,017,805 | 49,017,805 |
| Market Growth | 5/12 | 5/12 |
| Card Capex | 72 | 72 |
| UPI Capex | | 5 |
| Monthly Growth in Card Industry | 4/12 | 12/12 |
| Monthly Growth in UPI Industry | | 12/12 |
| POS | 2.1 | 0.01 |
| POS Growth | 0.0025 | 0.005 |
| Max POS Growth | 3 | 3 |
| Transaction Average | 45 | 27 |
| Transaction Average Growth | 2 | 3 |
| Profit Margin | 25 | 25 |
| Max Interest | 7.5 | 10 |
| Cash Flow Cycle | 1 | 1 |
| Cashflow | 100 | 100 |
| Max Cash Flow | 5000 | 5000 |
| SMEs | 50,000 | 50,000 |

Table 3: Hyper-Parameter Table

### 3.3 UPI Analysis Parameters are Essentials

### 3.4 Industry and expansion:

In all instances, the 'Market' element indicates the whole size of the market under consideration. 'Market growth' represents the market's overall growth rate, which sets the rate for a rise in activities as time passes.

### 3.5 Card and UPI Capital Expenditures:

The terms 'Card_Capex' and 'UPI_Capex' denote the capital investment necessary for card-based and UPI-based structures, respectively.

When these expenses are examined, ideas concerning the economics of installing UPI vs sustaining card-based systems may emerge.

### 3.6 Every month, Increase in the Card/UPI Business:

Annual rates of expansion in the debit card and UPI sectors are represented by 'Monthly_growth_in_card_industry' and 'Monthly_growth_in_UPI_industry', respectively.

By analysing the increase in costs, you're able to speculate on whether the UPI rate of adoption will accelerate or decelerate in contrast to the credit sector.

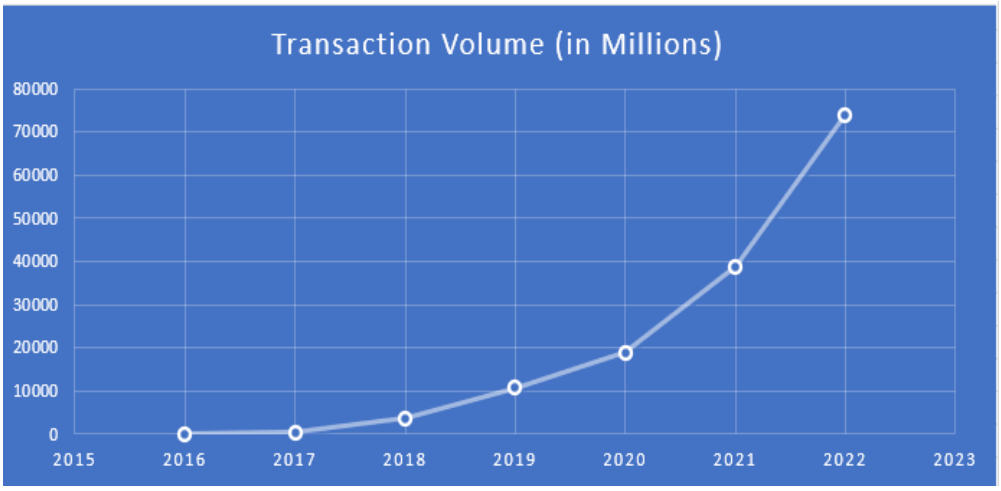



Fig 7: UPI Transaction Volume in Millions (Data Source: NPCI, India)

### 3.7 POS and POS Expansion

The terms 'POS' and 'UPI_POS' denote the POS percentage of the market for cards and UPI-based transactions, correspondingly.

These parameters impact payment mode dispersion and may be used to build predictions regarding the move of cards to UPI payment methods.

### 3.8 Maximum POS Rate and Median Transactions

The terms 'Max_POS_growth' and 'Transaction_average' denote the highest possible POS expansion rate and the mean value of the transaction, accordingly.

You can make assumptions regarding POS expansion scalability and how modifications to transaction value affect overall revenue.

### 3.9 Average Transaction Volume and Revenue Margin

'Transaction_average_growth' reflects the purchase average's rate of expansion.

The option 'Profit_Margin' helps test theories about how revenue varies when transactional averages shift.

#### 3.9.1 Cycle of Maximum Income and Cash Flow

'Max_interest' limits the fascination rate, which might lead to speculation regarding the economic viability of transactions via UPI.

The 'cash_flow_cycle' function can be utilised to investigate the payment schedule and its consequences for business and longevity.

#### 3.9.2 Cash Flow and Maximum Cash Flow

'Cashflow' indicates the starting cash flow, and 'Max_Cash_flow' indicates the maximum cash flow.

These factors may be used to establish hypotheses about how to handle cash flows, development, and durability.

### 3.9.3 SMEs

The field 'SMEs' reflects the overall number of micro, small, and medium-sized businesses.

Because UPI adoption may change the nature of transactions and expenses, this metric may lead to assumptions concerning the effect of UPI on small and medium-sized.

## 4. Research Design Specification

Quantitative Research: Involves analysing numerical data using statistical methods (e.g., ANOVA, correlation) for measurable variables like transaction volume.

Simulation Methodology: Utilizes Monte Carlo simulation with historical and parameter data to generate numerous outcomes, exploring trends.

Data Integration: Combines historical Central Bank of Ireland and NPCI India UPI transaction data (2015-2022), adding simulated data for analysis (2023-2043).

Comparison and Impact Assessment: Compares metrics before and after UPI, analysing statistical differences for significance.

Interpretation and Conclusion: Interprets statistical findings and simulation results to draw conclusions on UPI's impact on retail payments.

Reporting and Recommendations: Presents insights via reports and visuals, offering data-driven strategic recommendations.

## 5. Descriptive Statistical Analysis

```
Data written to the working file.
24 variables and 120 cases written.
Variable: Month              Type: String  Format : A10
Variable: Market__card       Type: Number  Format : F18.9
Variable: Card_market        Type: Number  Format : F18.9
Variable: Card_Capex         Type: Number  Format : F17.14
Variable: POS__card          Type: Number  Format : F18.16
Variable: Revenue__card      Type: Number  Format : F18.13
Variable: Volume__card       Type: Number  Format : F18.11
Variable: Transaction_average__card  Type: Number  Format : F18.15
Variable: Revenue_from_POS__card  Type: Number  Format : F18.10
Variable: CashFlow__card     Type: Number  Format : F18.13
Variable: Interest_on_loan__card  Type: Number  Format : F18.16
Variable: Market__upi        Type: Number  Format : F18.9
Variable: UPI_market         Type: Number  Format : F18.10
Variable: UPI_Capex          Type: Number  Format : F18.16
Variable: POS__upi           Type: Number  Format : F18.16
Variable: Revenue__upi       Type: Number  Format : F18.13
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Variable: Interest_on_loan__upi  Type: Number  Format : F18.16
Variable: UPI_POS            Type: Number  Format : F20.18
Variable: predictive_param   Type: Number  Format : F1
Variable: UPI_adoption       Type: Number  Format : F1
```

Fig 8: Variables

## Correlation Analysis

**Correlations**

| | | Market__card | Card_market | POS__card | Card_Capex | Interest_on_loan__card | CashFlow__card | Market__upi | UPI_market | UPI_Capex | POS__upi | Revenue__upi | UPI_POS | Interest_on_loan__upi | CashFlow__upi | UPI_adoption |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Market__card | Pearson Correlation | 1 | 1.000** | 1.000** | .957** | -.870** | .912** | 1.000** | 1.000** | .996** | -.996** | 1.000** | 1.000** | -.919** | .919** | .786** |
| | Sig. (2-tailed) | | <.001 | <.001 | <.001 | <.001 | <.001 | <.001 | <.001 | <.001 | <.001 | <.001 | <.001 | <.001 | <.001 | <.001 |
| | N | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 |
| Card_market | Pearson Correlation | 1.000** | 1 | 1.000** | .957** | -.870** | .912** | 1.000** | 1.000** | .996** | -.996** | 1.000** | 1.000** | -.919** | .919** | .786** |
| | Sig. (2-tailed) | <.001 | | <.001 | <.001 | <.001 | <.001 | <.001 | <.001 | <.001 | <.001 | <.001 | <.001 | <.001 | <.001 | <.001 |
| | N | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 |
| POS__card | Pearson Correlation | 1.000** | 1.000** | 1 | .964** | -.874** | .914** | 1.000** | 1.000** | .994** | -.994** | 1.000** | .999** | -.921** | .921** | .796** |
| | Sig. (2-tailed) | <.001 | <.001 | | <.001 | <.001 | <.001 | <.001 | <.001 | <.001 | <.001 | <.001 | <.001 | <.001 | <.001 | <.001 |
| | N | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 |
| Card_Capex | Pearson Correlation | .957** | .957** | .964** | 1 | -.859** | .890** | .957** | .957** | .930** | -.930** | .957** | .954** | -.896** | .896** | .867** |
| | Sig. (2-tailed) | <.001 | <.001 | <.001 | | <.001 | <.001 | <.001 | <.001 | <.001 | <.001 | <.001 | <.001 | <.001 | <.001 | <.001 |
| | N | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 |
| Interest_on_loan__card | Pearson Correlation | -.870** | -.870** | -.874** | -.859** | 1 | -.961** | -.870** | -.870** | -.854** | .854** | -.870** | -.868** | .960** | -.960** | -.700** |
| | Sig. (2-tailed) | <.001 | <.001 | <.001 | <.001 | | <.001 | <.001 | <.001 | <.001 | <.001 | <.001 | <.001 | <.001 | <.001 | <.001 |
| | N | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 |
| CashFlow__card | Pearson Correlation | .912** | .912** | .914** | .890** | -.961** | 1 | .912** | .912** | .900** | -.900** | .912** | .911** | -1.000** | 1.000** | .727** |
| | Sig. (2-tailed) | <.001 | <.001 | <.001 | <.001 | <.001 | | <.001 | <.001 | <.001 | <.001 | <.001 | <.001 | <.001 | <.001 | <.001 |
| | N | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 |
| Market__upi | Pearson Correlation | 1.000** | 1.000** | 1.000** | .957** | -.870** | .912** | 1 | 1.000** | .996** | -.996** | 1.000** | 1.000** | -.919** | .919** | .786** |
| | Sig. (2-tailed) | <.001 | <.001 | <.001 | <.001 | <.001 | <.001 | | <.001 | <.001 | <.001 | <.001 | <.001 | <.001 | <.001 | <.001 |
| | N | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 |
| UPI_market | Pearson Correlation | 1.000** | 1.000** | 1.000** | .957** | -.870** | .912** | 1.000** | 1 | .996** | -.996** | 1.000** | 1.000** | -.919** | .919** | .786** |
| | Sig. (2-tailed) | <.001 | <.001 | <.001 | <.001 | <.001 | <.001 | <.001 | | <.001 | <.001 | <.001 | <.001 | <.001 | <.001 | <.001 |
| | N | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 |
| UPI_Capex | Pearson Correlation | .996** | .996** | .994** | .930** | -.854** | .900** | .996** | .996** | 1 | -1.000** | .996** | .997** | -.907** | .907** | .745** |
| | Sig. (2-tailed) | <.001 | <.001 | <.001 | <.001 | <.001 | <.001 | <.001 | <.001 | | <.001 | <.001 | <.001 | <.001 | <.001 | <.001 |
| | N | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 |
| POS__upi | Pearson Correlation | -.996** | -.996** | -.994** | -.930** | .854** | -.900** | -.996** | -.996** | -1.000** | 1 | -.996** | -.997** | .907** | -.907** | -.745** |
| | Sig. (2-tailed) | <.001 | <.001 | <.001 | <.001 | <.001 | <.001 | <.001 | <.001 | <.001 | | <.001 | <.001 | <.001 | <.001 | <.001 |
| | N | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 |
| Revenue__upi | Pearson Correlation | 1.000** | 1.000** | 1.000** | .957** | -.870** | .912** | 1.000** | 1.000** | .996** | -.996** | 1 | 1.000** | -.919** | .919** | .786** |
| | Sig. (2-tailed) | <.001 | <.001 | <.001 | <.001 | <.001 | <.001 | <.001 | <.001 | <.001 | <.001 | | <.001 | <.001 | <.001 | <.001 |
| | N | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 |
| UPI_POS | Pearson Correlation | 1.000** | 1.000** | .999** | .954** | -.868** | .911** | 1.000** | 1.000** | .997** | -.997** | 1.000** | 1 | -.918** | .918** | .780** |
| | Sig. (2-tailed) | <.001 | <.001 | <.001 | <.001 | <.001 | <.001 | <.001 | <.001 | <.001 | <.001 | <.001 | | <.001 | <.001 | <.001 |
| | N | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 |
| Interest_on_loan__upi | Pearson Correlation | -.919** | -.919** | -.921** | -.896** | .960** | -1.000** | -.919** | -.919** | -.907** | .907** | -.919** | -.918** | 1 | -1.000** | -.732** |
| | Sig. (2-tailed) | <.001 | <.001 | <.001 | <.001 | <.001 | <.001 | <.001 | <.001 | <.001 | <.001 | <.001 | <.001 | | <.001 | <.001 |
| | N | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 |
| CashFlow__upi | Pearson Correlation | .919** | .919** | .921** | .896** | -.960** | 1.000** | .919** | .919** | .907** | -.907** | .919** | .918** | -1.000** | 1 | .732** |
| | Sig. (2-tailed) | <.001 | <.001 | <.001 | <.001 | <.001 | <.001 | <.001 | <.001 | <.001 | <.001 | <.001 | <.001 | <.001 | | <.001 |
| | N | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 |
| UPI_adoption | Pearson Correlation | .786** | .786** | .796** | .867** | -.700** | .727** | .786** | .786** | .745** | -.745** | .786** | .780** | -.732** | .732** | 1 |
| | Sig. (2-tailed) | <.001 | <.001 | <.001 | <.001 | <.001 | <.001 | <.001 | <.001 | <.001 | <.001 | <.001 | <.001 | <.001 | <.001 | |
| | N | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 |

**. Correlation is significant at the 0.01 level (2-tailed).

Fig 9: Correlation Analysis (2-tailed)

### Strong Positive Correlations:

Parameters: Market__card, Card_market, POS__card, Card_Capex, Interest_on_loan__card, Cashflow__card, Market__upi, UPI_market, UPI_Capex, POS__upi, Revenue__upi, UPI_POS, Interest_on_loan__upi, Cashflow__upi, and UPI_adoption all exhibit a perfect positive correlation (Pearson correlation coefficient of 1) with themselves, as expected.

### Strong Negative Correlations:

Parameters within each time period: Interest_on_loan__card, Interest_on_loan__upi, and UPI_adoption have a strong negative correlation (close to -1) with themselves, as expected.

**Inference**: substantial beneficial associations across metrics show that these indicators likely to rise or fall together, implying an organised change in multiple parts of the economy. The high negative associations among measures such as POS__upi and UPI_adoption suggest an adverse link. A rise in POS__upi (point-of-sale UPI transactions) might indicate a drop in UPI_adoption.

## 6. Inferential Statistical Analysis

### 6.1 T-Test

we conducted T-Tests as part of our inferential analysis. The T-Test allowed us to compare means between two groups or conditions, such as transactions before and after UPI implementation. By analysing the statistical differences in means, we were able to infer whether the observed changes were significant and not likely due to random chance. This helped us assess the impact of UPI on various metrics, providing valuable insights into the effectiveness and significance of UPI adoption in the payments market.

One-Sample Statistics

| | N | Mean | Std. Deviation | Std. Error Mean |
|---|---|---|---|---|
| POS__card | 120 | 2.4515885174 | .21277146106 | .01942328814 |
| CashFlow__card | 120 | 1645.0370853 | 284.00526829 | 25.926015316 |
| Interest_on_loan__card | 120 | 5.0574124251 | .47129526819 | .04302317494 |
| POS__upi | 120 | 2.2586663736 | .08268158335 | .00754776138 |
| CashFlow__upi | 120 | 1757.6475216 | 303.17154093 | 27.675648627 |
| Interest_on_loan__upi | 120 | 6.4847049568 | .60634308187 | .05535129725 |
| UPI_POS | 120 | .01372489530 | .00237409694 | .00021672441 |
| predictive_param | 120 | 5.03 | 1.411 | .129 |
| UPI_adoption | 120 | .68 | .470 | .043 |

Fig 10: One-Sample Statistics

One-Sample data: These data include the median, variance, and standard deviation of the mean for multiple variables in the two types of card-based and UPI-based economies.

POS__card: The average number of point-of-sale transactions within a card-based business following UPI implementation is around 2.45, with an ordinary deviation of roughly 0.21.

CashFlow__card: The average cash flow for card-based payments following UPI implementation is roughly 1645.04, with an average variation of approximately 284.01.

Interest_on_loan__card: The average interest rate on mortgages for card-based payments following UPI implementation is around 5.06 percent, with an ordinary variation of roughly 0.47 percent.

POS__upi: The mean number of transactions at the POS for UPI-based payments following UPI implementation is around 2.26, with an acceptable deviation of approximately 0.08.

One-Sample Test

| | Test Value = 0 | | | | | | |
|---|---|---|---|---|---|---|---|
| | t | df | Significance One-Sided p | Significance Two-Sided p | Mean Difference | 95% Confidence Interval of the Difference Lower | 95% Confidence Interval of the Difference Upper |
| POS__card | 126.219 | 119 | <.001 | <.001 | 2.4515885174 | 2.4131284670 | 2.4900485679 |
| CashFlow__card | 63.451 | 119 | <.001 | <.001 | 1645.0370853 | 1593.7009855 | 1696.3731850 |
| Interest_on_loan__card | 117.551 | 119 | <.001 | <.001 | 5.0574124251 | 4.9722222417 | 5.1426026085 |
| POS__upi | 299.250 | 119 | <.001 | <.001 | 2.2586663736 | 2.2437210522 | 2.2736116949 |
| CashFlow__upi | 63.509 | 119 | <.001 | <.001 | 1757.6475216 | 1702.8469732 | 1812.4480700 |
| Interest_on_loan__upi | 117.155 | 119 | <.001 | <.001 | 6.4847049568 | 6.3751038599 | 6.5943060536 |
| UPI_POS | 63.329 | 119 | <.001 | <.001 | .01372489530 | .01329575932 | .01415403127 |
| predictive_param | 39.012 | 119 | <.001 | <.001 | 5.025 | 4.77 | 5.28 |
| UPI_adoption | 15.721 | 119 | <.001 | <.001 | .675 | .59 | .76 |

Fig 11: One-Sample Test

One-Sample Effect Sizes

| | | Standardizer[a] | Point Estimate | 95% Confidence Interval Lower | 95% Confidence Interval Upper |
|---|---|---|---|---|---|
| POS__card | Cohen's d | .21277146106 | 11.522 | 10.048 | 12.993 |
| | Hedges' correction | .21412430052 | 11.449 | 9.984 | 12.911 |
| CashFlow__card | Cohen's d | 284.00526829 | 5.792 | 5.035 | 6.547 |
| | Hedges' correction | 285.81102519 | 5.756 | 5.003 | 6.506 |
| Interest_on_loan__card | Cohen's d | .47129526819 | 10.731 | 9.356 | 12.103 |
| | Hedges' correction | .47429184880 | 10.663 | 9.297 | 12.026 |
| POS__upi | Cohen's d | .08268158335 | 27.318 | 23.844 | 30.785 |
| | Hedges' correction | .08320728782 | 27.145 | 23.694 | 30.591 |
| CashFlow__upi | Cohen's d | 303.17154093 | 5.798 | 5.039 | 6.553 |
| | Hedges' correction | 305.09916046 | 5.761 | 5.007 | 6.512 |
| Interest_on_loan__upi | Cohen's d | .60634308187 | 10.695 | 9.325 | 12.062 |
| | Hedges' correction | .61019832093 | 10.627 | 9.266 | 11.986 |
| UPI_POS | Cohen's d | .00237409694 | 5.781 | 5.025 | 6.535 |
| | Hedges' correction | .00238919188 | 5.745 | 4.993 | 6.494 |
| predictive_param | Cohen's d | 1.411 | 3.561 | 3.074 | 4.046 |
| | Hedges' correction | 1.420 | 3.539 | 3.055 | 4.020 |
| UPI_adoption | Cohen's d | .470 | 1.435 | 1.178 | 1.689 |
| | Hedges' correction | .473 | 1.426 | 1.171 | 1.678 |

a. The denominator used in estimating the effect sizes.
Cohen's d uses the sample standard deviation.
Hedges' correction uses the sample standard deviation, plus a correction factor.

Fig 12: One-Sample Effect

Cashflow__upi: After the launch of UPI, the average revenue for UPI-based payments is roughly 1757.65, with a deviation from the mean of roughly 303.17.

Interest_on_loan__upi: The average income on mortgages for UPI-based activities following UPI implementation is around 6.48 percent, with an average deviation of approximately 0.61 percent.

UPI_POS: After the launch of UPI, the average point-of-sale payment for UPI-based payments is roughly 0.014, with a deviation from the mean of around 0.002.

predictive_param: The mean for this value is 5.03, with a standard deviation of 1.41.

UPI_adoption: The mean for this metric is 0.68, with a standard deviation of 0.47.

## 6.2 ANOVA (Analysis of Variance)

In our study, ANOVA tests were employed for inferential analysis. ANOVA enabled simultaneous comparison of means across multiple groups, aiding assessment of UPI's impact on various aspects. By analysing variances, we determined statistically significant differences, offering comprehensive insights into UPI's effects on different segments and time periods. This enhanced our understanding of UPI's overall influence in the payments market.

Market and Card: The strong F-statistics and extremely small the p-value (0.001) for both "Market__card" and "Card_market" indicate that there were substantial variations in market and card variables prior to and after UPI implementation. This might imply that the advent of UPI had a significant influence on both general economic conditions and card-based payments.

POS and Revenue_from_POS: The small p-values for "POS__card" and "Revenue_from_POS__card" indicate that there have been substantial variations in transactions made at POS and income from POS activities prior to and after UPI implementation. This might signify a shift in customer behaviour or the acceptance of new means of payment.

**ANOVA**

| | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| Market__card | Between Groups | 6.210E+15 | 1 | 6.210E+15 | 190.454 | <.001 |
| | Within Groups | 3.848E+15 | 118 | 3.261E+13 | | |
| | Total | 1.006E+16 | 119 | | | |
| Card_market | Between Groups | 3.219E+15 | 1 | 3.219E+15 | 190.454 | <.001 |
| | Within Groups | 1.995E+15 | 118 | 1.690E+13 | | |
| | Total | 5.214E+15 | 119 | | | |
| Card_Capex | Between Groups | 5475.718 | 1 | 5475.718 | 357.781 | <.001 |
| | Within Groups | 1805.952 | 118 | 15.305 | | |
| | Total | 7281.670 | 119 | | | |
| POS__card | Between Groups | 3.417 | 1 | 3.417 | 204.626 | <.001 |
| | Within Groups | 1.970 | 118 | .017 | | |
| | Total | 5.387 | 119 | | | |
| CashFlow__card | Between Groups | 5075454.349 | 1 | 5075454.349 | 132.414 | <.001 |
| | Within Groups | 4522965.748 | 118 | 38330.218 | | |
| | Total | 9598420.098 | 119 | | | |
| Revenue_from_POS__card | Between Groups | 4.833E+12 | 1 | 4.833E+12 | 170.612 | <.001 |
| | Within Groups | 3.343E+12 | 118 | 28327416846 | | |
| | Total | 8.176E+12 | 119 | | | |
| Interest_on_loan__card | Between Groups | 12.959 | 1 | 12.959 | 113.490 | <.001 |
| | Within Groups | 13.474 | 118 | .114 | | |
| | Total | 26.432 | 119 | | | |
| Market__upi | Between Groups | 6.210E+15 | 1 | 6.210E+15 | 190.454 | <.001 |
| | Within Groups | 3.848E+15 | 118 | 3.261E+13 | | |
| | Total | 1.006E+16 | 119 | | | |
| UPI_market | Between Groups | 1.553E+13 | 1 | 1.553E+13 | 190.454 | <.001 |
| | Within Groups | 9.619E+12 | 118 | 81518773055 | | |
| | Total | 2.514E+13 | 119 | | | |
| UPI_Capex | Between Groups | 724.668 | 1 | 724.668 | 147.259 | <.001 |
| | Within Groups | 580.682 | 118 | 4.921 | | |
| | Total | 1305.350 | 119 | | | |
| POS__upi | Between Groups | .452 | 1 | .452 | 147.212 | <.001 |
| | Within Groups | .362 | 118 | .003 | | |
| | Total | .814 | 119 | | | |
| CashFlow__upi | Between Groups | 5857064.652 | 1 | 5857064.652 | 136.034 | <.001 |
| | Within Groups | 5080580.352 | 118 | 43055.766 | | |
| | Total | 10937645.005 | 119 | | | |
| Interest_on_loan__upi | Between Groups | 23.428 | 1 | 23.428 | 136.034 | <.001 |
| | Within Groups | 20.322 | 118 | .172 | | |
| | Total | 43.751 | 119 | | | |
| UPI_POS | Between Groups | .000 | 1 | .000 | 183.661 | <.001 |
| | Within Groups | .000 | 118 | .000 | | |
| | Total | .001 | 119 | | | |

Fig 13: ANOVA Test

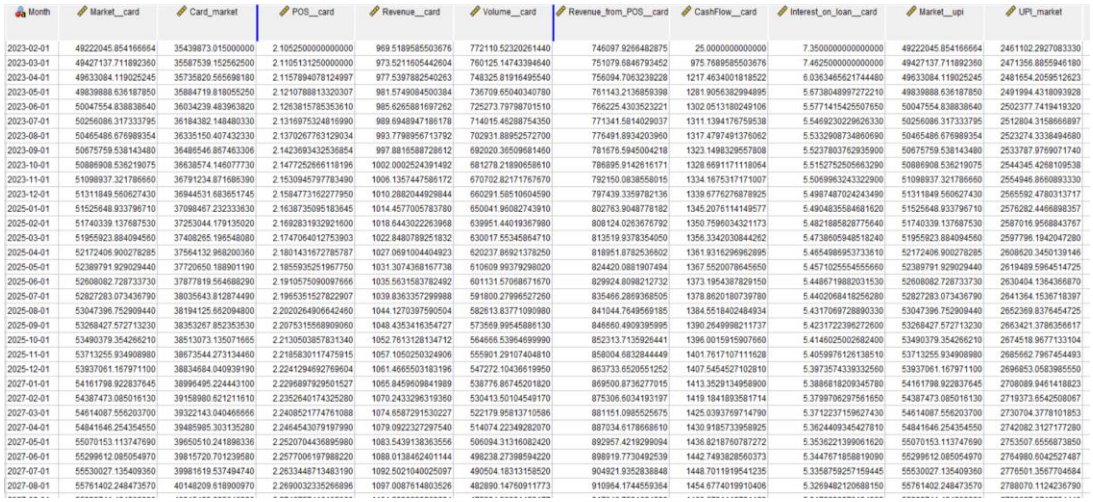
Interest_on_loan, Cashflow, UPI_market, UPI_Capex, Cashflow__upi, and Interest_on_loan__upi: The small p-values for these factors imply that there's substantial variations in the flow of cash and interest on loans for both card-based and UPI-based transactions prior to and following UPI implementation. This might be a result of shifts in lending practises, borrowing habits, or economic situations.

UPI_POS: The relatively small the p-value for "UPI_POS" indicates that there's considerable variations in point-of-sale transactions, particularly UPI-based interactions, prior to and following UPI implementation. This demonstrates the effect of UPI on purchases from retailers.

In a nutshell the ANOVA findings show that the implementation of UPI has resulted in considerable changes in several sectors of Ireland's card-based business. The factors you investigated have varying degrees of effect on those alterations.

## UPI Forecast

The hyperparameter discussed in the methodology section gives rise to the UPI exchange forecast. The data postulates the month-on-month gradual changes in the economy of Ireland with respect to the reduction of POS charges, ease of transaction, increase in volumes and other eminent factors bifurcating the market into card and UPI based systems. Finally, the UPI system also sustains the interest on loan parameter on which the SMEs take the loan to expand and grow by the forecast of May 2029.



| Month | Market__card | Card_market | POS__card | Revenue__card | Volume__card | Revenue_from_POS__card | CashFlow__card | Interest_on_loan__card | Market__upi | UPI_market |
|---|---|---|---|---|---|---|---|---|---|---|
| 2023-02-01 | 49222045.8541666640 | 35439873.0150000000 | 2.1052500000000000 | 969.5189585503676 | 772110.5232026144 | 746097.9266482875 | 25.0000000000000 | 7.3500000000000000 | 49222045.8541666640 | 2461102.2927083330 |
| 2023-03-01 | 49427137.7118923600 | 35587539.1525625000 | 2.1105131250000000 | 973.5211605442604 | 760125.1474339464 | 751079.6846793452 | 975.7689585503676 | 7.4625000000000000 | 49427137.7118923600 | 2471356.8855946180 |
| 2023-04-01 | 49633084.1190252450 | 35735820.5656981800 | 2.1157894078124997 | 977.5397882540263 | 748325.8191495540 | 756094.7063239228 | 1217.4634001818522 | 6.0363465621744480 | 49633084.1190252450 | 2481654.2059512623 |
| 2023-05-01 | 49839888.6361878500 | 35884719.8180552500 | 2.1210788813320307 | 981.5749084500384 | 736709.6504034078 | 761143.2136859398 | 1281.9056382994895 | 5.6738048997272210 | 49839888.6361878500 | 2491994.4318093928 |
| 2023-06-01 | 50047554.8388386400 | 36034239.4839638200 | 2.1263815785353610 | 985.6265881697262 | 725273.7979701510 | 766225.4303523221 | 1302.0513180249106 | 5.5771415425507650 | 50047554.8388386400 | 2502377.7419419320 |
| 2023-07-01 | 50256086.3173337950 | 36184382.1484803300 | 2.1316975324816990 | 989.6948947186178 | 714015.4628754350 | 771341.5814029037 | 1311.1394176759538 | 5.5469230229626330 | 50256086.3173337950 | 2512804.3158666897 |
| 2023-08-01 | 50465486.6769893540 | 36335150.4074323300 | 2.1370267763129034 | 993.7798956713792 | 702931.8895257270 | 776491.8934203960 | 1317.4797491378062 | 5.5332908734860690 | 50465486.6769893540 | 2523274.3338494680 |
| 2023-09-01 | 50675759.5381434800 | 36486546.8574633060 | 2.1423693432536854 | 997.8816588728612 | 692020.3650968146 | 781676.5945044218 | 1323.1498329557808 | 5.5237803762935900 | 50675759.5381434800 | 2533787.9769071740 |
| 2023-10-01 | 50886908.5362190750 | 36638574.1460777300 | 2.1477252666118196 | 1002.0002524391492 | 681278.2189065810 | 786895.9142616171 | 1328.6691171118064 | 5.5152752505663290 | 50886908.5362190750 | 2544345.4268109538 |
| 2023-11-01 | 51098937.3217866600 | 36791234.8716863900 | 2.1530945797783490 | 1006.1357447586172 | 670702.8217176767 0 | 792150.0838558015 | 1334.1675317171007 | 5.5069963243322900 | 51098937.3217866600 | 2554946.8660893330 |
| 2023-12-01 | 51311849.5606274300 | 36944531.6836551745 | 2.1584773162277950 | 1010.2882044929844 | 660291.5851060459 0 | 797439.3359782136 | 1339.6776276878925 | 5.4987487024243490 | 51311849.5606274300 | 2565592.4780313717 |
| 2025-01-01 | 51525648.9337967100 | 37098467.2323333630 | 2.1638735095183645 | 1014.4577005783780 | 650041.9608274391 0 | 802763.9048778182 | 1345.2076114149577 | 5.4904835584681620 | 51525648.9337967100 | 2576282.4466898357 |
| 2025-02-01 | 51740339.1376875300 | 37253044.1791350200 | 2.1692831932921600 | 1018.6443022263968 | 639951.4401936798 0 | 808124.0263676792 | 1350.7596034321173 | 5.4821885828775640 | 51740339.1376875300 | 2587016.9568843767 |
| 2025-03-01 | 51955923.8840945600 | 37408265.1965480800 | 2.1747064012753903 | 1022.8480789251832 | 630017.5534586471 0 | 813519.9378354050 | 1356.3342030844262 | 5.4738605948518240 | 51955923.8840945600 | 2597796.1942047280 |
| 2025-04-01 | 52172406.9002782850 | 37564132.9682003600 | 2.1801431672785787 | 1027.0691004404923 | 620237.8692137825 0 | 818951.8782536602 | 1361.9316299962895 | 5.4654986953733610 | 52172406.9002782850 | 2608620.3450139146 |
| 2025-05-01 | 52389791.9290294400 | 37720650.1889011900 | 2.1855935251967750 | 1031.3074368167738 | 610609.9937929802 0 | 824420.0881907494 | 1367.5520078645650 | 5.4571025554555660 | 52389791.9290294400 | 2619489.5954514725 |
| 2025-06-01 | 52608082.7287337300 | 37877819.5646882900 | 2.1910575090097666 | 1035.5631583782492 | 601131.5706867167 0 | 829924.8098212732 | 1373.1954387829150 | 5.4486719882031530 | 52608082.7287337300 | 2630404.1364366870 |
| 2025-07-01 | 52827283.0734367900 | 38035643.8128744900 | 2.1965351527822907 | 1039.8363357299988 | 591800.2799652726 0 | 835466.2869368505 | 1378.8620180739780 | 5.4402068418256280 | 52827283.0734367900 | 2641364.1536718397 |
| 2025-08-01 | 53047396.7529094400 | 38194125.6620948000 | 2.2020264906642460 | 1044.1270397590504 | 582613.8377109098 0 | 841044.7649569185 | 1384.5518402484934 | 5.4317069728890330 | 53047396.7529094400 | 2652369.8376454725 |
| 2025-09-01 | 53268427.5727132300 | 38353267.8523535300 | 2.2075315568909060 | 1048.4353416354727 | 573569.9954588613 0 | 846660.4909395995 | 1390.2649998211737 | 5.4231722396272600 | 53268427.5727132300 | 2663421.3786356617 |
| 2025-10-01 | 53490379.3542662100 | 38513073.1350716650 | 2.2130503857831340 | 1052.7613128134712 | 564666.5396469999 0 | 852313.7135926441 | 1396.0015915907660 | 5.4146025002682400 | 53490379.3542662100 | 2674518.9677133104 |
| 2025-11-01 | 53713255.9349089800 | 38673544.2731344600 | 2.2185830117475915 | 1057.1050250324906 | 555901.2910740481 0 | 858004.6832844449 | 1401.7617107111628 | 5.4059976126138510 | 53713255.9349089800 | 2685662.7967454493 |
| 2025-12-01 | 53937061.1679711000 | 38834684.0409391900 | 2.2241294692769604 | 1061.4665503183196 | 547272.1043661995 0 | 863733.6520551252 | 1407.5454527102810 | 5.3973574339332560 | 53937061.1679711100 | 2696853.0583985550 |
| 2027-01-01 | 54161798.9228376450 | 38996495.2244431000 | 2.2296897929501527 | 1065.8459609841989 | 538776.8674520182 0 | 869500.8736277015 | 1413.3529134958900 | 5.3886818209345780 | 54161798.9228376450 | 2708089.9461418823 |
| 2027-02-01 | 54387473.0850161300 | 39158980.6212111610 | 2.2352640174325280 | 1070.2433296319360 | 530413.5010459 0170 | 875306.6034193197 | 1419.1841893581714 | 5.3799706297561650 | 54387473.0850161300 | 2719373.6542508067 |
| 2027-03-01 | 54614087.5562037000 | 39322143.0404666666 | 2.2408521774761088 | 1074.6587291530227 | 522179.9581371058 6 | 881151.0985525675 | 1425.0393769714790 | 5.3712237159627430 | 54614087.5562037000 | 2730704.3778101853 |
| 2027-04-01 | 54841646.2543545550 | 39485985.3031352800 | 2.2464543079197990 | 1079.0922327297540 | 514074.2234928207 0 | 887034.6178668610 | 1430.9185733958925 | 5.3624409345427810 | 54841646.2543545550 | 2742082.3127177280 |
| 2027-05-01 | 55070153.1137476900 | 39650510.2418983360 | 2.2520704436895980 | 1083.5439138363556 | 506094.3131608242 0 | 892957.4219299094 | 1436.8218760787272 | 5.3536221399061620 | 55070153.1137476900 | 2753507.6556873850 |
| 2027-06-01 | 55299612.0850549700 | 39815720.7012395800 | 2.2577006197988220 | 1088.0138462401144 | 498238.2739859422 0 | 898919.7730492539 | 1442.7493828560373 | 5.3447671858819090 | 55299612.0850549700 | 2764980.6042527487 |
| 2027-07-01 | 55530027.1354093600 | 39981619.5374947400 | 2.2633448713483190 | 1092.5021040025097 | 490504.1831315852 0 | 904921.9352838848 | 1448.7011919541235 | 5.3358759257159445 | 55530027.1354093600 | 2776501.3567704684 |
| 2027-08-01 | 55761402.2484735700 | 40148209.6189009700 | 2.2690323335266896 | 1097.0087614803526 | 482890.1476091177 3 | 910964.1744559364 | 1454.6774019910406 | 5.3269482120688150 | 55761402.2484735700 | 2788070.1124236790 |

Fig 14: UPI Forecast Output Data

A comparative Market capitalization for the next 5 years is showcased in the below graph, which vividly represents the growing market of the UPI transaction medium.

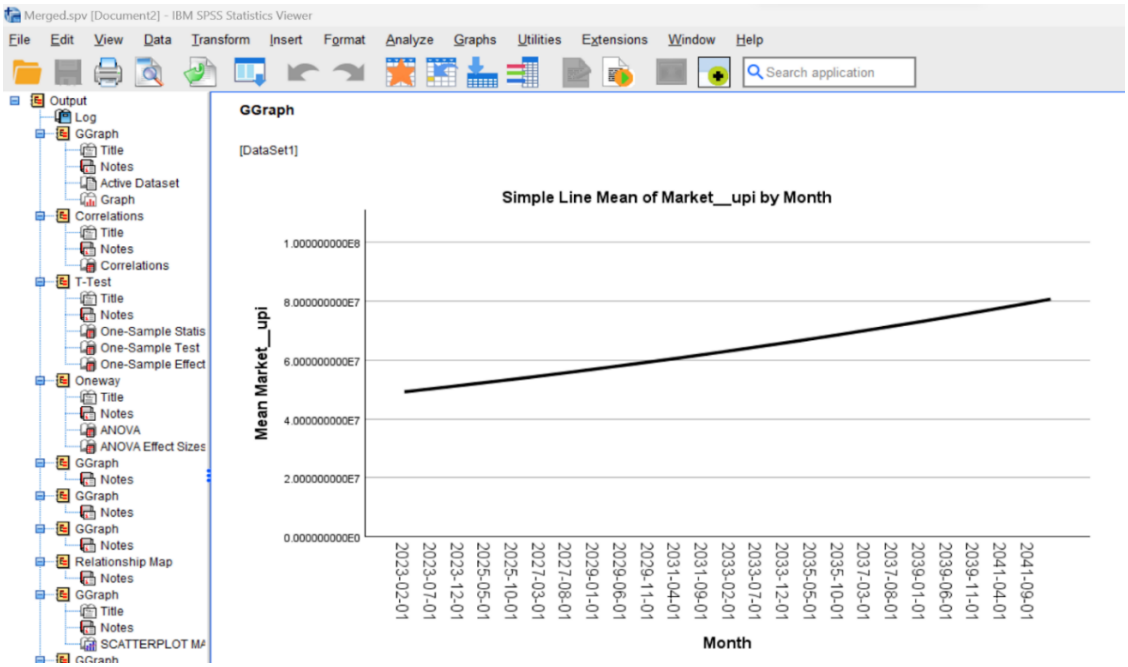
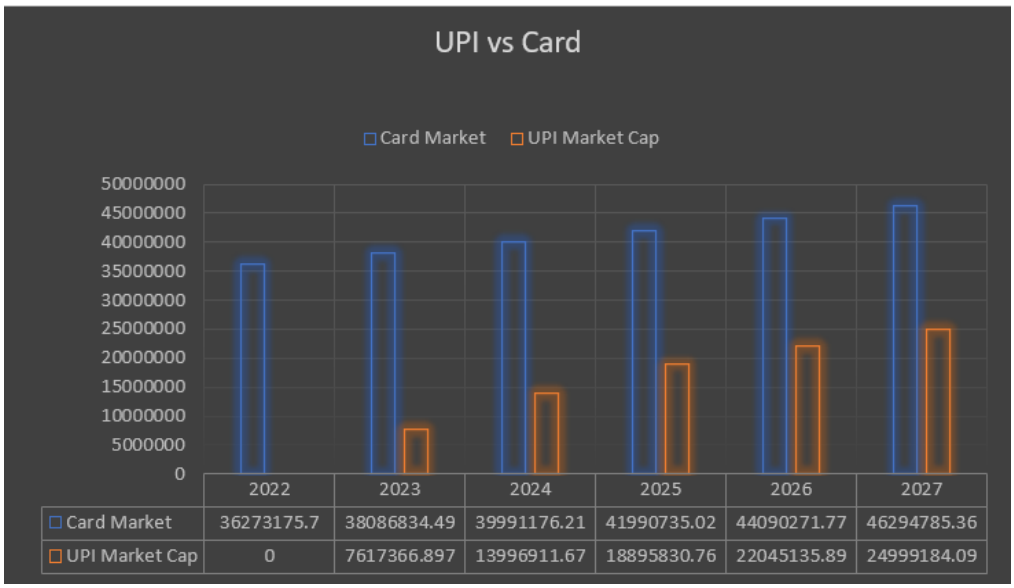



Fig 15: Market Forecast of UPI by month (5% growth) (Data Source: NPCI, India)

Further on, the chart illustrates the rate of growth for UPI is greater than the rate of growth for card. Which further becomes explanatory where the UPI based credit interest equates to the card based traditional credit interest rates.




| | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 |
|---|---|---|---|---|---|---|
| Card Market | 36273175.7 | 38086834.49 | 39991176.21 | 41990735.02 | 44090271.77 | 46294785.36 |
| UPI Market Cap | 0 | 7617366.897 | 13996911.67 | 18895830.76 | 22045135.89 | 24999184.09 |

Fig 16: Projected Market Capitalization (Data Sources: NPCI, India & Central Bank of Ireland (CBI))

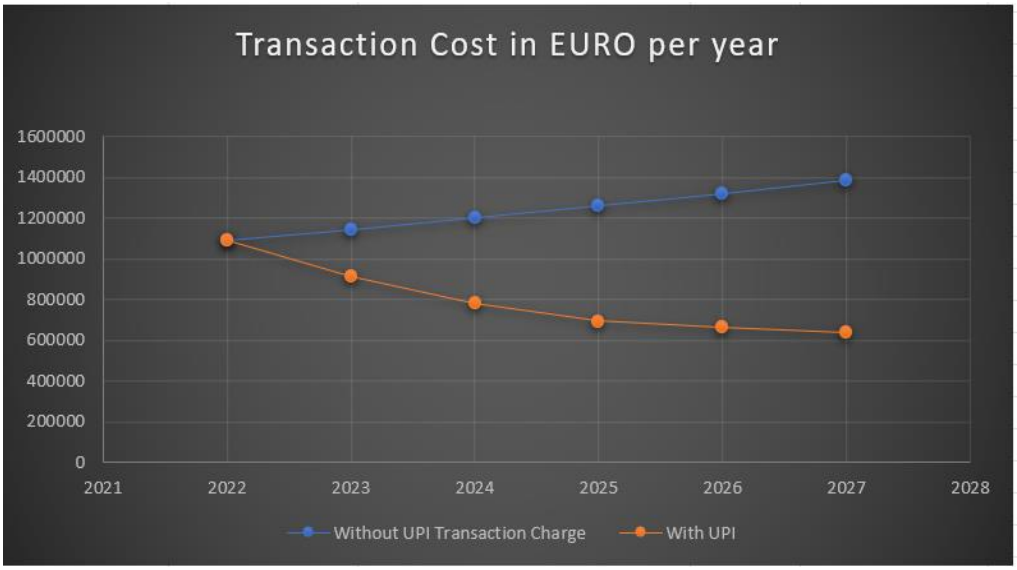



Fig 17: Projected POS transaction charges before and after UPI (Data Sources: NPCI, India & CBI)

The graph illustrates the Transaction costs spent within the Irish consumer market and compares the general or linear increase within the POS in contrast to a UPI based architecture so that the POS charges linearly decrease over time. And only within a forecast of 5 years it has reduced by 33% of the POS charges of 2022.

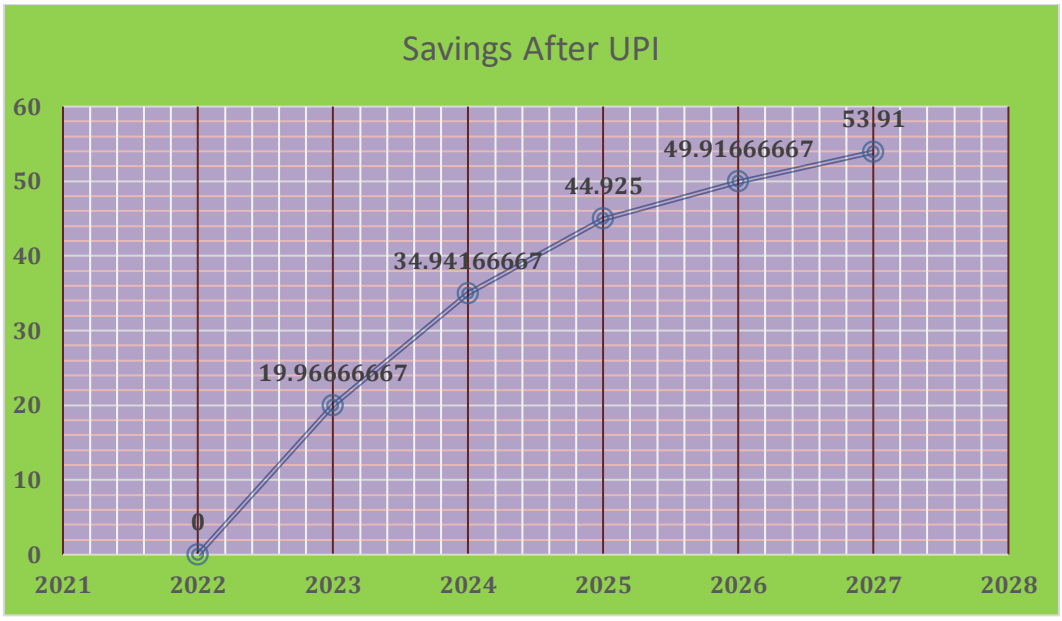



Fig 18: Overall projected savings by UPI replacing POS in Irish SMEs sector (Data Sources: NPCI, India & CBI)

The above graph illustrates how the inclusion of UPI brings about the percentage change that happens year on year for saving the POS charges. The available amount can be used as follows:

A. For Growth purposes for the SME sector
B. For Development of economical prices for customers of SME's
C. For Loan and different innovation purposes for large companies.

This concludes the results and discussion section on the Forecast of UPI based Ireland market.

**UPI Adherence to EU Compliance**

If UPI were implemented in Ireland, the following considerations and infrastructure adoptions are essential:

**GDPR**

Processing of Data and Permission: UPI administrators must specify how individual information is handled, archived, and distributed within the financial system. They would additionally require user permission to handle data. To secure private and financial information, UPI providers would have to apply stringent data security procedures. It would be critical to use encryption, access restrictions, and secure communication methods.

Data Transfer Beyond the EU: If UPI information is moved to nations beyond the EU, processes must be in place to guarantee that GDPR privacy regulations are met.

Users Privileges: UPI users would be granted privileges that include being able to view their information, the option to correct faulty data, or the option to withdraw their personal information.

**PCIDSS**

PCI DSS is a collection of security rules intended to guarantee that all businesses that receive, store, manage, or transfer data from credit cards operate in an encrypted setting.
Transaction Security of Data: UPI providers must adhere to the Payment Card Industry DSS regulations while processing payment data. It involves safe merchant information storage, encrypting it frequent security audits, and handling vulnerabilities. In regard to accessibility control, Payment's access to information will be controlled according to the rule of minimising privilege. Accessibility to critical financial data would be restricted to authorised individuals only.
Periodic Inspections required to be performed to guarantee that they meet PCI DSS requirements, UPI administrators will need to undertake periodic security evaluations and inspections (PCI Security Standards Council. (2023, July 14).

## 7. Evaluation

The evaluation of the UPI project entailed a rigorous analysis employing diverse statistical methods to assess its impact on Ireland's card-based system. Utilizing t-tests, ANOVA, and correlational analysis, economic variables were scrutinized before and after UPI integration. Leveraging data from the Central Bank of Ireland and contextualizing it with the Indian UPI instance bolstered the study's credibility.

Significant variations emerged from t-tests across subgroups and time periods, highlighting notable shifts in metrics such as POS transactions, cashflow, and UPI adoption. ANOVA reinforced these variations, emphasizing market segment divergence. Interconnections between economic metrics over time implied UPI-induced modifications, though caution was urged in ascribing causation solely to correlations.

The amalgamation of statistical analyses, realistic parameters, and an Indian case study facilitated a holistic grasp of UPI's impact on Ireland's card-based industry. This insight aids policymakers, analysts, and businesses. However, findings indicate trends rather than causation, warranting further research.

The study also illuminated UPI's potential to mitigate cashflow and interest rate challenges through transactions. Projections suggest UPI could rival card utility within six years, bridging the gap for SMEs.

To conclude, the research proposes UPI as a remedy for Ireland's costly credit-based system, foreseeing reduced POS expenses, sustained cash flow, and competitive interest rates. This innovative payment solution has potential to bolster economic growth, SMEs, and consumer interactions while adhering to data compliance standards.

## 8. Conclusions and Discussion

This research looked into the consequences of introducing the Unified Payment Interface (UPI) on Ireland's card-based economic system. We intended to identify shifts and interconnections among economic variables by using a variety of statistical approaches such as t-tests, ANOVA, and correlational analysis. The study's context and authenticity were enhanced by actual data from the Central Bank of Ireland, which, along with insights derived from the UPI's Indian case study.

The t-tests revealed substantial variations in various key indicators, including POS transactions, cashflow, Interest on Loan, and UPI acceptance, both before and after UPI installation. These studies highlight the significant impact of UPI on a variety of economic factors. Furthermore, the ANOVA analysis revealed significant differences between distinct market sectors and variables, highlighting the need to take market structure into consideration when assessing UPI's influence on the card-based system. It's significant that the plausible selection of variables gives credence to these observed fluctuations, strengthening the robustness of the inferences made.

A relationship matrix's interconnections with other indicators of the economy throughout time found notable relationships, both positive and negative. This suggests that the installation of UPI led to systematic changes and connections between these indicators. But caution is advised, and Pearson correlation coefficients alone should not be used to draw hasty conclusions about causal links.

The comprehensive application of t-tests, ANOVA, and correlational analysis, alongside realistic parameters, and an Indian case study, facilitated a nuanced comprehension of UPI's influence on Ireland's card-based industry. This amalgamation of approaches furnishes valuable insights for policymakers, analysts, and businesses. It is crucial to acknowledge that while these findings highlight connections and trends, establishing causative linkages necessitates further research and scrutiny.

The analysis delved into how the adoption of UPI could potentially reshape Ireland's economic landscape. The transition towards the UPI-based model was shown to not only mitigate the inherent costs of POS charges but also address issues related to cashflow and interest rates on loans. Notably, in contrast to the relatively stable credit verification mechanism of card-based systems, UPI offers a more dynamic and flexible platform. While its volatility might raise concerns, the study suggests that a reasonable volume of transactions could alleviate the absence of a credit-based system in SMEs. Projections indicate that by May 2029, the UPI's transaction volume threshold could sufficiently match the established card utility narrative, thereby equalizing the playing field within six years of its existence.

The study concludes that Ireland's existing credit-based backbone system incurs substantial transaction expenses, yet concurrently facilitates quicker loans and lower interest rates for vendor SMEs, fostering growth. In light of these observations, we advocate for the adoption of UPI. Drawing insights from an Indian case study, the UPI exhibits potential to reduce costs associated with the card-based economy, including POS charges, while maintaining robust cash flow and competitive interest rates. This revolutionary payment system, poised to be one of the finest innovations of the century, holds promise not only for accelerating Irish economic growth but also for influencing SMEs' product strategies, consumer interaction costs, and marketing capital.

## 9. Contributions to Knowledge

This project contributes to knowledge by rigorously analysing the impact of the Unified Payment Interface (UPI) adoption on Ireland's card-based system. Through t-tests, ANOVA, and correlational analysis, it unveils significant changes in economic variables pre- and post-UPI, emphasizing its potential to reduce POS costs while maintaining cashflow and interest rates. The study's unique blend of Irish data and insights from the Indian case study offers

actionable insights for policymakers, analysts, and businesses, showcasing UPI's transformative potential in driving economic growth and compliance with data regulations.

## 10. Suggestions for further study

Further research could explore the long-term effects of UPI adoption on specific sectors, consider additional economic indicators, and assess the scalability of UPI within diverse economies. Comparative studies with other countries' payment systems would provide broader insights, and a qualitative analysis of SME experiences with UPI could offer practical perspectives on its impact. Investigating potential policy implications and conducting a cost-benefit analysis for businesses transitioning to UPI would also contribute to a comprehensive understanding of its implications.

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