

Configuration Manual

MSc Research Project
Financial Technology

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School of Computing
MSc Project Submission Sheet**



Student Name: Pushparaj Sampath

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Programme: MSc FinTech

Year: 2022/2023

Module: Research Project (MSCFTD1)

Lecturer: Victor del Rosal

Submission

Due Date: 14th August 2023

Project Title: Unlocking Opportunities: UPI replacing POS processing in Ireland to empower SMEs

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Signature: Pushparaj Sampath
.....

14th August 2023

Date:

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Configuration Manual

Student Name: Pushparaj Sampath
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1. Introduction

This configuration manual accompanies my MSC Fintech research submission and outlines the undertaken study procedures, technology implementations, and hardware setup. It serves to guide subsequent research endeavors, offering clear instructions for replicating the study's outcomes and aiding fellow researchers in reproducing the findings effectively.

2. System Specification

System Hardware

The research project was conducted on a hpWindows 11 home edition computer:

System Type - 64-bit operating system, x64-based processor

Processor: AMD Ryzen 5 5625U with Radeon Graphics - 2.30 GHz

RAM: 8GB

Storage: 476 GB

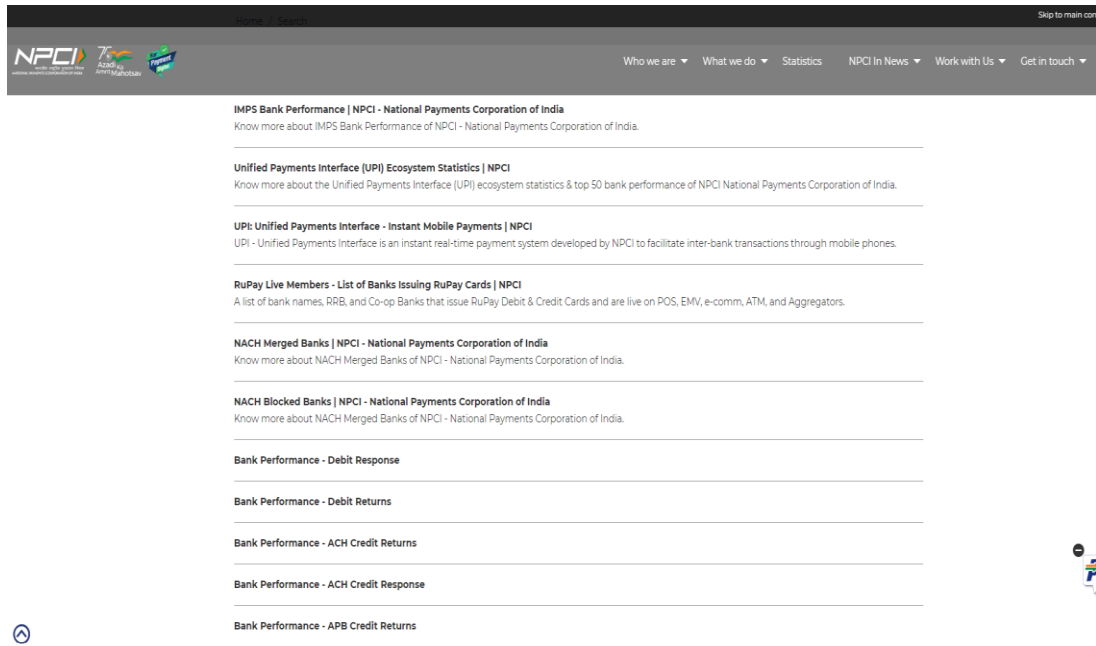
4. Software and Tools

4.1 Data Source

Microsoft Excel 2021: Microsoft Excel was used to extract the data from CBI (Central Bank of Ireland) and NPCI (National Payments Corporation of India) websites into Comma-Separated Value (CSV) file.

The screenshot shows the Central Bank of Ireland website. The main heading is "Credit and Debit Card Statistics". Below this, there is a notice stating that the monthly statistics are temporarily paused after the latest publication on 3rd May. A statistical release for "Credit and Debit Card Statistics March 2023" is listed as a PDF file (444 KB). Under "Related Data Set", two Excel files are shown: "Table A.13 Credit and Debit Card Statistics" (155 KB) and "Table A.13.1 Credit Card Statistics - Discontinued" (4257 KB). A "See Also" section lists "Daily Credit and Debit Card Statistics" and "Previous Monthly Credit and Debit Card Data". On the right side, there is a "In this Section" menu with various statistical publications listed.

Cards Payments Transactions Data Extraction from CBI



UPI Transactions Data Extraction from NPCI, India

4.2 Data Preparation

Initially, the synthesized data from both origins was combined into a unified dataset, aligning diverse variables, and introducing two novel variables, namely "predict parameter" and "UPI adoption." Subsequently, a thorough data cleaning process was executed, involving the elimination of all missing values, irrelevant observations, and responses. Efforts were made to rectify structural inconsistencies and eliminate inaccuracies in labeling across the datasets. Furthermore, any outliers that emerged, often stemming from erroneous data entries, were carefully identified, and removed from the dataset. This meticulous approach aimed to safeguard the reliability and credibility of the analytical tool employed.

4.3 Data Simulation

Monte Carlo Simulation

In our study, we used Monte Carlo simulation to generate synthetic data spanning 10 years of data from 2023 to 2043. By modelling historical trends and parameters, we created diverse scenarios through iterative sampling. This simulated data allowed us to explore UPI's impact on retail payments, considering uncertainties. Applying statistical analyses, we inferred potential trends and effects. This method provided insights into UPI's long-term influence on transactions. We used python to generate simulated data.

1. Defining initial constraints such as market size, growth rates, transaction values, profit margins, etc.
2. Creating a function (this_month) to calculate and update values for each variable based on the defined constraints and the previous month's data.
3. Iterating over 120 months to generate and accumulate data, tracking variables like market size, revenue, transaction volumes, etc.
4. Storing the generated data in a DataFrame and saving it to a CSV file for further analysis.

```

simulation.ipynb
File Edit View Insert Runtime Tools Help Last saved at 03:02 PM
+ Code + Text
import pandas as pd

constraints = {
    'Market':49017805,
    'Market_growth':15/12,
    'Card_Capex':72,
    'Monthly_growth_in_card_industry':4/12,
    'POS':12.1,
    'POS_growth':0.0025,
    'Max_POS_growth':3,
    'Transaction_average':145,
    'Transaction_average_growth':2,
    'Profit_Margin':25,
    'Max_Interest':10,
    'Cash_flow_cycle':3,
    'CashFlow':100,
    'Max_Cash_flow':1500,
    'MSME':50000,
}

def this_month(constraints, temp_current_month):
    Current_month = {
        'Market': temp_current_month['Market'] * (1 + constraints['Market_growth']/100),
        'Card_Capex': min(95, temp_current_month['Card_Capex'] * (1 + constraints['Monthly_growth_in_card_industry']/100)),
        'POS': min(temp_current_month['POS'] * (1 + constraints['POS_growth']), constraints['Max_POS_growth']),
        'CashFlow': temp_current_month['CashFlow'],
        'Interest_on_loan': ((constraints['Max_Cash_Flow'] - temp_current_month['CashFlow'])/constraints['Max_Cash_flow']) * constraints['Max_Interest'],
        'Transaction_average': temp_current_month['Transaction_average'] * (1+constraints['Transaction_average_growth']/100)
    }
    Current_month['CashFlow'] = (temp_current_month['Revenue'] + Current_month['CashFlow']) * (constraints['Profit_Margin'] / 100)
    Current_month['Card_market'] = Current_month['Market'] * (constraints['Card_Capex']/100)
    Current_month['Volume'] = Current_month['Card_market'] / Current_month['Transaction_average']
    Current_month['Revenue_from_POS'] = Current_month['Card_market'] * Current_month['POS']/100
    Current_month['Revenue'] = ((Current_month['Market'] - Current_month['Revenue_from_POS'])/constraints['MSME'])
    return Current_month

[ ] df = pd.DataFrame(columns=['Market', 'Card_market', 'Card_Capex', 'POS', 'Revenue', 'Volume', 'Transaction_average', 'Revenue_from_POS', 'CashFlow', 'Interest_on_loan' ])
tempmonth = constraints
tempmonth['Revenue'] = 0
for i in range(120):
    Current_month = this_month(constraints,tempmonth)
    df = pd.concat([df, pd.DataFrame(Current_month,index=[0])], ignore_index = True)
    df.reset_index(drop=True)
    tempmonth = Current_month
pd.set_option('display.float_format', lambda x: '%.3f' % x)
df.to_csv('Card_monthly.csv',index=False)
df

Market Card_market Card_Capex POS Revenue Volume Transaction_average Revenue_from_POS CashFlow Interest_on_loan
0 49222045.854 35439873.015 72.240 2.105 969.519 772110.523 45.900 746097.927 25.000 9.333
1 49427137.712 35587539.153 72.481 2.111 973.521 760125.147 46.818 751079.685 975.769 9.833
2 49633084.119 35735820.566 72.722 2.116 977.540 748325.819 47.754 756094.706 1217.463 3.495
3 49839888.636 35884719.818 72.965 2.121 981.575 736709.650 48.709 761143.214 1281.906 1.884
4 50047554.839 36034239.484 73.208 2.126 985.627 725273.798 49.684 766225.430 1302.051 1.454
... ..
115 79401144.039 57168823.708 95.000 2.805 1555.946 127739.972 447.541 1603861.199 2063.273 -3.699
116 79731982.139 57407027.140 95.000 2.812 1562.348 125757.081 456.491 1614570.314 2071.764 -3.755
117 80064198.731 57646223.087 95.000 2.820 1568.777 123804.969 465.621 1625350.935 2080.289 -3.812
118 80397799.559 57886415.683 95.000 2.827 1575.232 121883.160 474.934 1636203.538 2088.849 -3.869
119 80732790.391 58127609.081 95.000 2.834 1581.713 119991.183 484.432 1647128.606 2097.444 -3.926
120 rows x 10 columns

```

Simulated Data

4.4 SPSS (IBM)

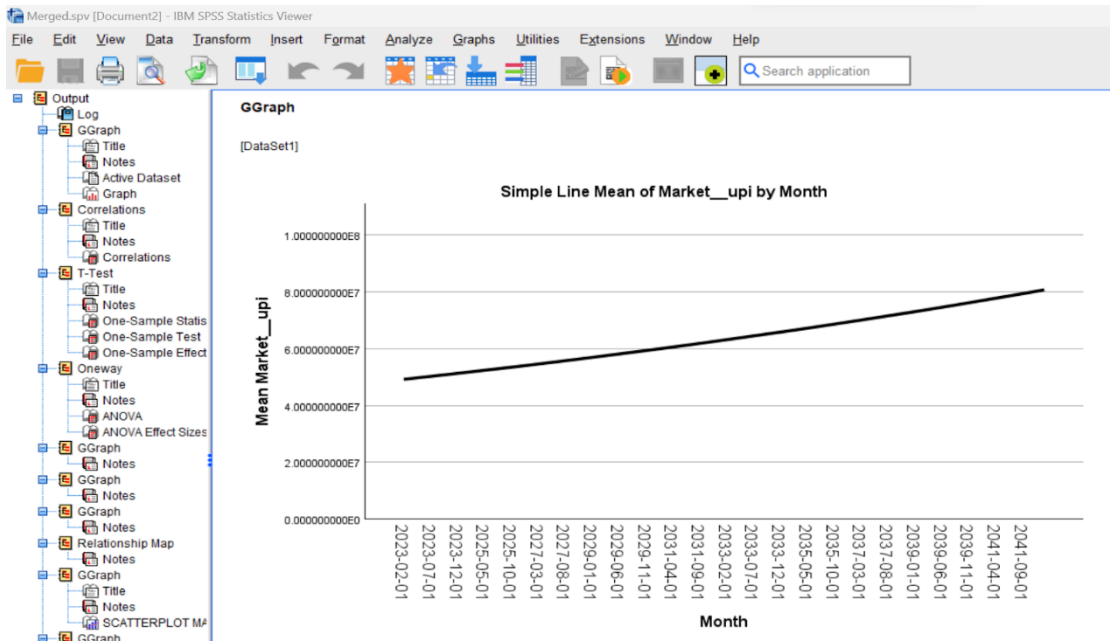
SPSS: For the analysis of statistical data, we employed the Statistical Package for the Social Sciences (IBM SPSS). This software was utilized to analyse data derived from a simulation technique, combining statistical data from the central bank of Ireland and UPI transaction data sourced from NPCI, which was exported into CSV format in Excel.

5. Techniques Used

5.1 Descriptive Statistics

We began with descriptive analysis as our initial technique. This approach allowed us to comprehensively understand the dataset's characteristics, patterns, and trends before proceeding to quantitative analysis. Descriptive analysis provided a foundation for data exploration, enabling us to summarize and visualize key features, relationships, and distributions within the data. This preliminary step facilitated a better grasp of the dataset's nuances, ensuring a solid base for subsequent quantitative analysis techniques.

Step 1: Following data entry, we employed descriptive analysis. To do this, selected suitable Analyse on the SPSS software, then opted for "Descriptive statistics" before choosing "Frequencies". The figure below illustrates this.



Step 2: Correlation Analysis

Correlation analysis was conducted in SPSS as part of our study to explore relationships between variables, helping identify potential dependencies and patterns in the data. This analysis aids in understanding how changes in one variable might relate to changes in another, contributing to informed decision-making and insights.

The figure shows a Correlations matrix in SPSS. The variables included are 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, and CashFlow_upi. The matrix displays Pearson Correlation coefficients and Sig. (2-tailed) values for each pair of variables. For example, the correlation between Market_card and Card_market is 1.000, and the correlation between Market_upi and UPI_market is 0.912.

| | 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 | |
|-----------------------|-----------------------|-------------|----------|------------|-----------------------|---------------|------------|------------|-----------|---------|-------------|---------|----------------------|--------------|-------|
| Market_card | Pearson Correlation 1 | 1.000 | 1.000 | .957 | -.870 | .912 | 1.000 | 1.000 | .996 | -.996 | 1.000 | 1.000 | -.919 | .919 | |
| | Sig. (2-tailed) | <.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 | |
| Card_market | Pearson Correlation | 1.000 | 1 | 1.000 | .957 | -.870 | .912 | 1.000 | 1.000 | .996 | -.996 | 1.000 | 1.000 | -.919 | .919 |
| | Sig. (2-tailed) | <.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 | |
| POS_card | Pearson Correlation | 1.000 | 1.000 | 1 | .964 | -.874 | .914 | 1.000 | 1.000 | .994 | -.994 | 1.000 | .999 | -.921 | .921 |
| | Sig. (2-tailed) | <.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 | |
| Card_Capex | Pearson Correlation | .957 | .957 | .964 | 1 | -.859 | .890 | .957 | .957 | .930 | -.930 | .957 | .954 | -.896 | .896 |
| | Sig. (2-tailed) | <.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 | |
| Interest_on_loan_card | Pearson Correlation | -.870 | -.870 | -.874 | -.859 | 1 | -.961 | -.870 | -.870 | -.854 | .854 | -.870 | -.868 | .960 | -.960 |
| | Sig. (2-tailed) | <.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 | |
| CashFlow_card | Pearson Correlation | .912 | .912 | .914 | .890 | -.961 | 1 | .912 | .912 | .900 | -.900 | .912 | .911 | -1.000 | 1.000 |
| | Sig. (2-tailed) | <.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 | |
| Market_upi | Pearson Correlation | 1.000 | 1.000 | 1.000 | .957 | -.870 | .912 | 1 | 1.000 | .996 | -.996 | 1.000 | 1.000 | -.919 | .919 |
| | Sig. (2-tailed) | <.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 | |
| UPI_market | Pearson Correlation | 1.000 | 1.000 | 1.000 | .957 | -.870 | .912 | 1.000 | 1 | .996 | -.996 | 1.000 | 1.000 | -.919 | .919 |
| | Sig. (2-tailed) | <.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 | |
| UPI_Capex | Pearson Correlation | .996 | .996 | .994 | .930 | -.854 | .900 | .996 | .996 | 1 | -1.000 | .996 | .997 | -.907 | .907 |
| | Sig. (2-tailed) | <.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 | |
| POS_upi | Pearson Correlation | -.996 | -.996 | -.994 | -.930 | .854 | -.900 | -.996 | -.996 | -1.000 | 1 | -.996 | -.997 | .907 | -.907 |
| | Sig. (2-tailed) | <.001 | <.001 | <.001 | <.001 | <.001 | <.001 | <.001 | <.001 | <.001 | <.001 | <.001 | <.001 | <.001 | |

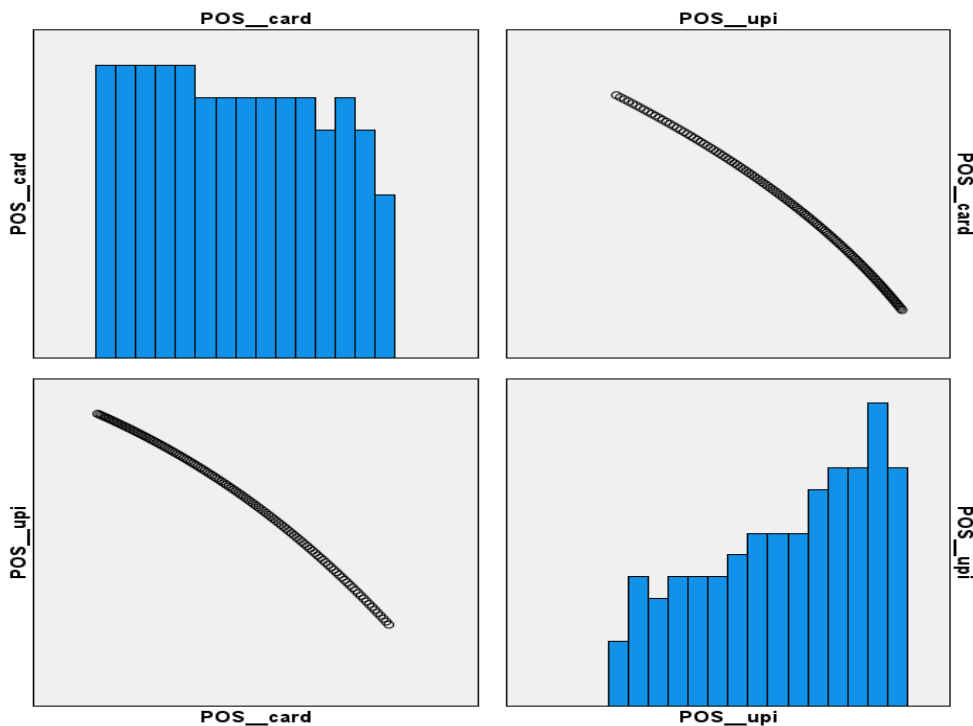
Step 3: One Sample Test

A sample test analysis was conducted using SPSS in our study to assess the statistical significance of a specific variable. This analysis aimed to determine its impact on the overall UPI adoption trend, providing valuable insights into potential influencing factors.

| Month | Market_card | Card_market | Card_Capex | POS_card | Revenue_card | Volume_card | Transaction_average_card | Revenue_from_POS_card |
|---------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------------|-----------------------|
| 1 2023-02-01 | 48222045.854166664 | 35439873.015000000 | 72.240000000000001 | 2.1052500000000000 | 969.5189585503676 | 772110.52320261440 | 45.900000000000000 | 746097.9266482875 |
| 2 2023-03-01 | 49427137.711892380 | 35587539.152562500 | 72.480000000000002 | 2.1105131250000000 | 973.5211805442604 | 760125.14743394540 | 46.818000000000000 | 751079.6846793452 |
| 3 2023-04-01 | 49633084.119025245 | 35735820.565698180 | 72.722402666666668 | 2.1157894078124997 | 977.5397882540263 | 748325.81916495540 | 47.754360000000000 | 756094.7063292228 |
| 4 2023-05-01 | 49839888.636187850 | 35848719.818055250 | 72.964810675555558 | 2.1210788813320307 | 981.5749084500384 | 736709.95040340780 | 48.709447200000000 | 761143.2136859388 |
| 5 2023-06-01 | 50047554.838838640 | 36034239.483963820 | 73.208026711140777 | 2.1263815785353610 | 985.6265881697262 | 725273.79798701510 | 49.683636144000000 | 766225.4303523221 |
| 6 2023-07-01 | 50256086.317333795 | 36184382.148480330 | 73.452053466884459 | 2.1316875324816990 | 989.6948947188178 | 714015.46288754350 | 50.677308866880000 | 771341.5914029037 |
| 7 2023-08-01 | 50465486.676989354 | 36335150.407432330 | 73.6968939 | | | | | 776491.8934203960 |
| 8 2023-09-01 | 50675759.538143480 | 36486546.867463306 | 73.9425495 | | | | | 781676.5945004218 |
| 9 2023-10-01 | 50886908.536219075 | 36638574.146077730 | 74.1890251 | | | | | 786895.9142616171 |
| 10 2023-11-01 | 51098937.321786660 | 36791234.871686390 | 74.4363216 | | | | | 792150.083858015 |
| 11 2023-12-01 | 51311849.60627430 | 36944531.683651745 | 74.6844425 | | | | | 797439.3359782136 |
| 12 2025-01-01 | 51525648.933796710 | 37098467.23233630 | 74.9333910 | | | | | 802733.9048778182 |
| 13 2025-02-01 | 51740339.137687530 | 37253044.179135020 | 75.1831696 | | | | | 808124.0263676792 |
| 14 2025-03-01 | 51955923.884094560 | 37408285.196548080 | 75.4337796 | | | | | 813519.9378354050 |
| 15 2025-04-01 | 52172406.900278285 | 37564132.968200360 | 75.6852255 | | | | | 818951.8782536602 |
| 16 2025-05-01 | 52389791.929029440 | 37720650.188901190 | 75.9375096 | | | | | 824420.0881907494 |
| 17 2025-06-01 | 52608082.728733730 | 37877819.564688290 | 76.1906346 | | | | | 829924.8098212732 |
| 18 2025-07-01 | 52827283.073436790 | 38035643.812874490 | 76.4446034 | | | | | 835466.2869368505 |
| 19 2025-08-01 | 53047396.752909440 | 38194125.662094800 | 76.6994168 | | | | | 841044.7649569185 |
| 20 2025-09-01 | 53268427.572713230 | 38353267.852353530 | 76.9558035 | | | | | 846660.4909395995 |
| 21 2025-10-01 | 53490379.354286210 | 38513073.135071665 | 77.2116004 | | | | | 852313.7135926441 |
| 22 2025-11-01 | 53713255.934908980 | 38673544.273134460 | 77.4689724 | | | | | 858004.6832844449 |
| 23 2025-12-01 | 53937061.167971100 | 38834684.040939190 | 77.7272023 | | | | | 863733.6520551252 |
| 24 2027-01-01 | 54161798.922837645 | 38996495.224443100 | 77.98629305945276 | 2.2296897929501527 | 1065.8459609841989 | 538776.86745201820 | 72.379676226385140 | 869500.8736277015 |
| 25 2027-02-01 | 54387473.085016130 | 39158980.621211610 | 78.24624736965094 | 2.2352640174325280 | 1070.2433296319360 | 530413.50104549170 | 73.827269750912850 | 875306.6034193197 |
| 26 2027-03-01 | 54614087.556203700 | 39322143.040466666 | 78.50706819421546 | 2.2408521774761088 | 1074.6587291530227 | 522179.95813710586 | 75.303815145931110 | 881151.098525675 |
| 27 2027-04-01 | 54841646.254354550 | 39485985.303135280 | 78.76875942153052 | 2.2464543079197990 | 1079.0922327297540 | 514074.22348282070 | 76.809891448849740 | 887034.6178668610 |
| 28 2027-05-01 | 55070153.113747890 | 39650510.241899336 | 79.03132094960229 | 2.2520704436895980 | 1083.5439138363556 | 506094.31318682420 | 78.346088272826740 | 892957.4219299094 |

Step 4: Exploratory Data Analysis (EDA)

Exploratory Data Analysis (EDA) was conducted using SPSS in our study to uncover patterns, trends, and insights within the data, aiding in understanding the underlying structure and informing subsequent analysis decisions.



Step 5: ANOVA Test (Analysis of Variance)

ANOVA (Analysis of Variance) test analysis was conducted using SPSS in your project to assess statistical significance by comparing means of three or more groups. This helped determine if variations among groups were due to genuine differences or random chance, aiding informed decision-making.

| | | 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 | | | | |

6. Conclusion

The configuration manual describes the process followed for testing the UPI hypothesis use case in the context of Ireland's economy. Further the potential reduction of transaction charges however without further increasing the available bank interest rate or decreasing the existing cashflow. Further the proposed UPI not only increases the cash inflow but also increases the possibility of faster economic growth prospect keeping the correct form of credit and cash inflow in the market.