Verizon Case Study

Enhancing Precision in Customer Default Prediction

ASHES TO INSIGHT CONSULTING

Group 4 – 11/14/2024

Meet the Team

Data Scientist

Jazil

Front-End Developer

Campbell

Marketing Manager

Sakshi

Financial Analyst

Yichuan

Data Consultant

Wei

Executive Summary

Business Problem

Identify **high-risk customers** likely to default on contract payments to reduce financial losses associated with high-value phone sales.

Model Selection

Selected **XG Boost model** to accurately predict high-risk applicants.

Financial Impacts

Potential savings of **$122M per million applicants** by reducing defaults and increasing loyal customer retention.

Front-End Demo

Developed an **application interface** for Verizon staff to make real-time approval decisions

Business Problem

Verizon seeks a model to **identify high-risk applicants** in real-time, reducing defaulters while avoiding rejecting profitable customers.

Goal: Develop an ML model to predict customer defaults, minimizing financial losses.

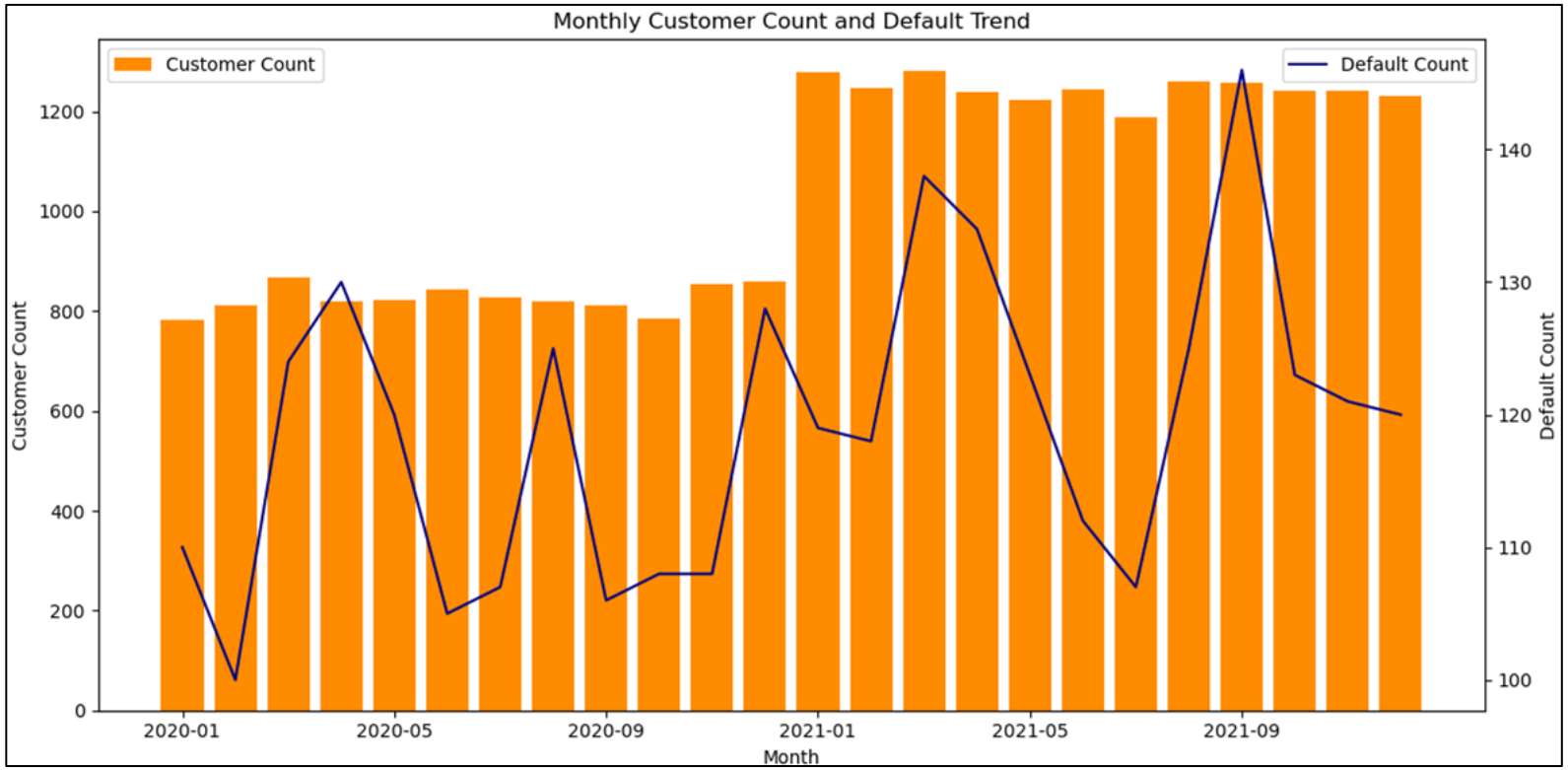

Figure 1: Monthly Customer Count and Default Trend

11.5%

Default Risk

- Customer enrollment surged post-2021
- 11.5% total customer defaulting in 2020 – 2021 on high-value phone contracts.

Model Selection

Aim: Correctly identify defaulters, $1,000 loss per default

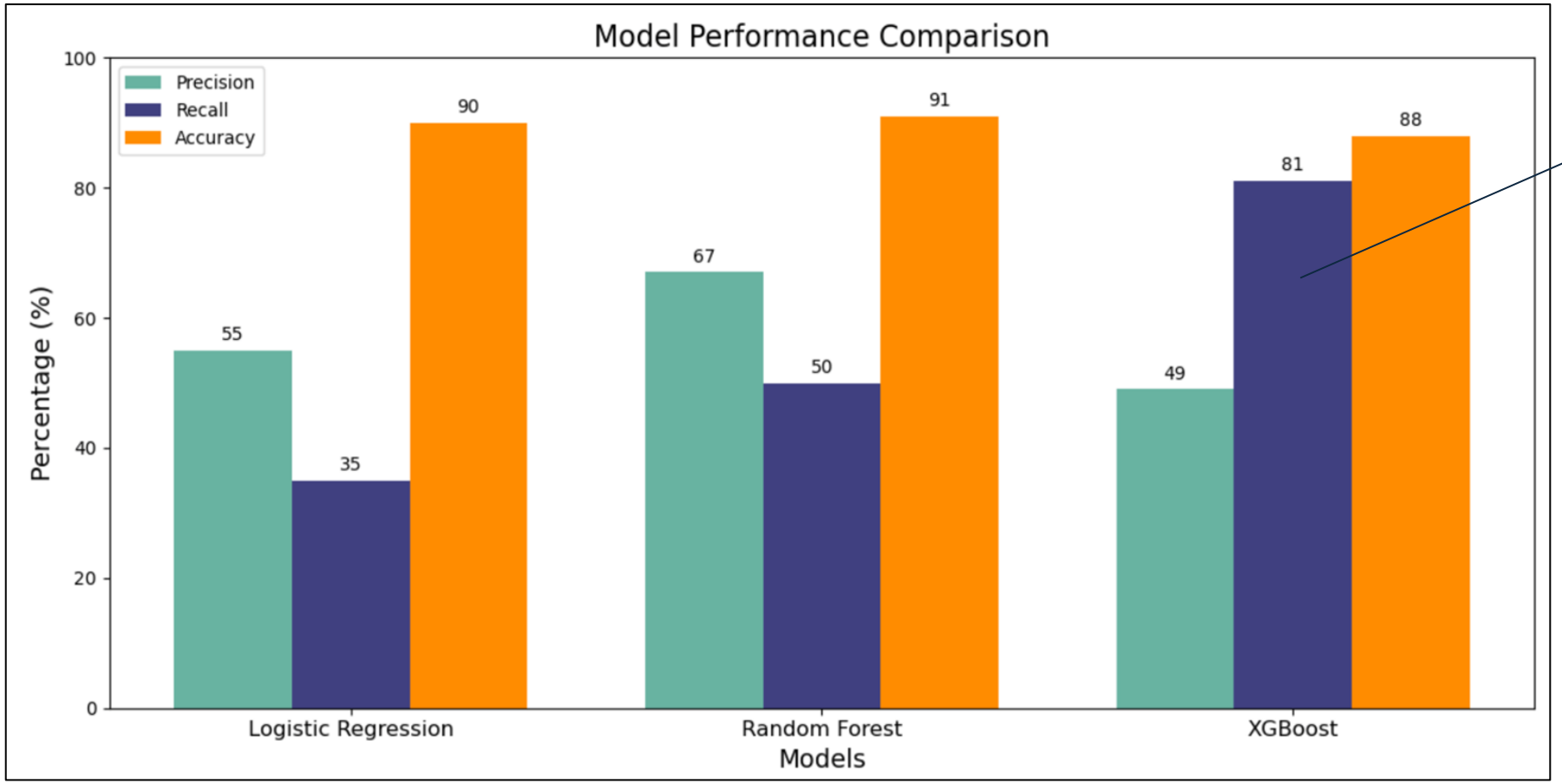

Figure 2: Model Performance Comparison

81%

Highest Recall

The model can successfully identify 81% of customers who will default

Model Selection: XGBoost

Model Metrics:

Base Model:

Recall - 35%

Our Model:

Recall - 81%

Benefit: Risk Mitigation

High recall reduces risk of financial loss due to default as the model accurately identifies likely defaulters

Confusion Matrix:

Verizon

Customer

	Offer Contract	Deny Contract
No Default	TN 3924 (not default, predicted as not default)	FP 472 (not default, predicted as default)
Default	FN 111 (default, predicted as not default)	TP 460 (default, predicted as default)

Financial Impacts

Paying customers * Customer LTV

Defaults Avoided * Cost of default

Value = Profit - Loss

Defaulting customers * Cost of default

Safe applicants denied * Customer LTV

Assumptions:

- Profit per Customer: $250
- Direct Loss per Defaulter: $1,000
- Service & Admin Cost per Default: $150
- Profit from renewal (50% prob.): $250
- Profit from additional purchase (50% prob.): $100

Service & Admin cost + Opportunity Cost spread over 6 years

Opportunity Cost spread over 6 years

Financial Impact per Customer:

Period	0	1	2	3	4	5	6
Defaults Among Approved	($1,000.00)	($220.83)	($70.83)	($70.83)	($70.83)	($70.83)	($70.83)
Safe Applicants Rejected		($70.83)	($70.83)	($70.83)	($70.83)	($70.83)	($70.83)
Defaults Avoided	$1,000.00	$150.00					
Paying Customers		$ 83.33	$83.33	$83.33	$91.67	$41.67	$41.67

Current contract profit over 3 years

Additional purchase at period 4 + Profit from renewal over 3 years

Profit from renewal over next 3 years

Project Value

Period	0	1	2	3	4	5	6
Defaults Among Approved	($22,266,800.40)	($4,917,251.76)	($1,577,231.70)	($1,577,231.70)	($1,577,231.70)	($1,577,231.70)	($1,577,231.70)
Safe Applicants Rejected		($6,706,787.03)	($6,706,787.03)	($6,706,787.03)	($6,706,787.03)	($6,706,787.03)	($6,706,787.03)
Defaults Avoided	$92,276,830.49	$13,841,524.57					
Paying Customers		$65,897,693.08	$65,897,693.08	$65,897,693.08	$72,487,462.39	$32,948,846.54	$32,948,846.54
Model Development & Consulting	($200,000.00)						
Front-End App Set-up & Operation	($50,000.00)	($10,000.00)	($10,000.00)	($10,000.00)	($10,000.00)	($10,000.00)	($10,000.00)
Server Set-up & Operation	($30,000.00)	($15,000.00)	($15,000.00)	($15,000.00)	($15,000.00)	($15,000.00)	($15,000.00)
Analytics Tools & Data Storage	($20,000.00)	($5,000.00)	($5,000.00)	($5,000.00)	($5,000.00)	($5,000.00)	($5,000.00)
Staff Training	($15,000.00)						
Undiscounted Cash Flow	$69,695,030.09	$68,115,178.87	$57,613,674.36	$57,613,674.36	$64,203,443.66	$24,664,827.82	$24,664,827.82
Discounted Factor		0.9580	0.9178	0.8793	0.8424	0.807102043	0.7732
Discounted Cash Flow	$69,695,030.09	$65,257,373.58	$52,880,670.39	$50,662,036.28	$54,088,019.58	$19,907,032.92	$19,071,823.72

Discounted on WACC = 4.38%

NPV: $332 Million over 6 years

Incremental NPV: $122 Million

(WACC Calculation, customer counts, and estimation of current system NPV could be accessed in appendix)

Dashboard Implementation

Real-Time Default Risk Assessment

Our **improved model** powers a **user-friendly tool**, enabling store clerks to **instantly assess** customer default risk with predictions, probability scores, and expected financial impact.

Actionable Insights for Negotiation

The front-end provides **key drivers of risk**, enabling clerks to **negotiate effectively** based on each customer's **unique profile**

Figure 3: Front-end dashboard

Click Here to View

Conclusion

Enhanced
Default Identification

Our improved model increases defaulter identification by **46%**, enabling Verizon to minimize costly defaults.

Increased
Economic Value

This model brings an estimated **$122M per million applicants** in financial value, balancing risks and benefits in customer approvals.

Quick
Implementation

Our solution can be fully implemented within **weeks** through a **front-end application**, empowering store clerks to make data-driven decisions in real time.

Q & A

Appendix

11.5% Customer Default Rate

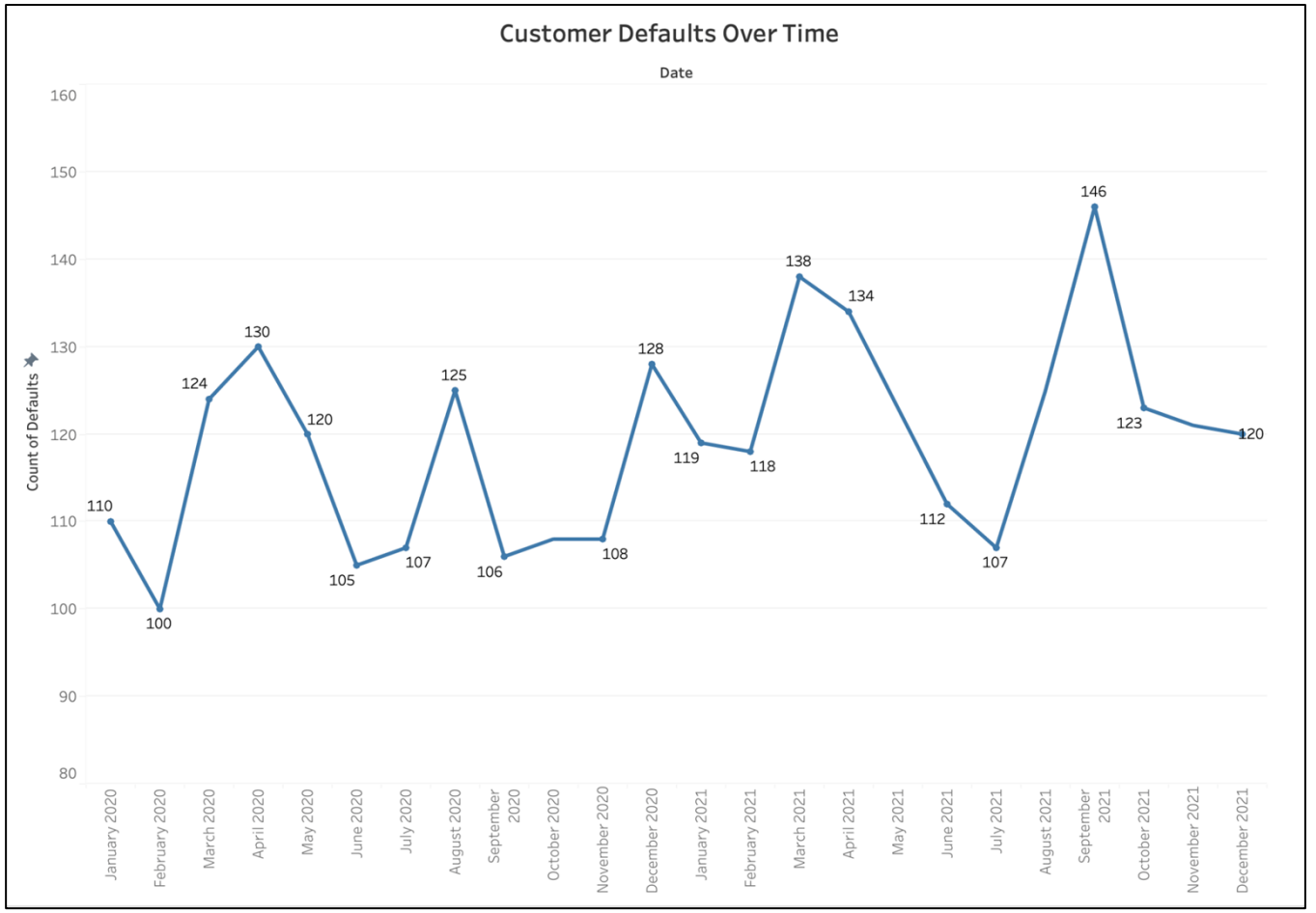

Figure 4: Customer Default Rate

EDA - Payment Type

Credit Payments have the highest default rate

Credit payments had a **24% default rate**, 8% higher than the next closest payment type.

Store Gift Card and Debit Payments exhibit the lowest default rates

Upfront payments had **lower default** rates than others.

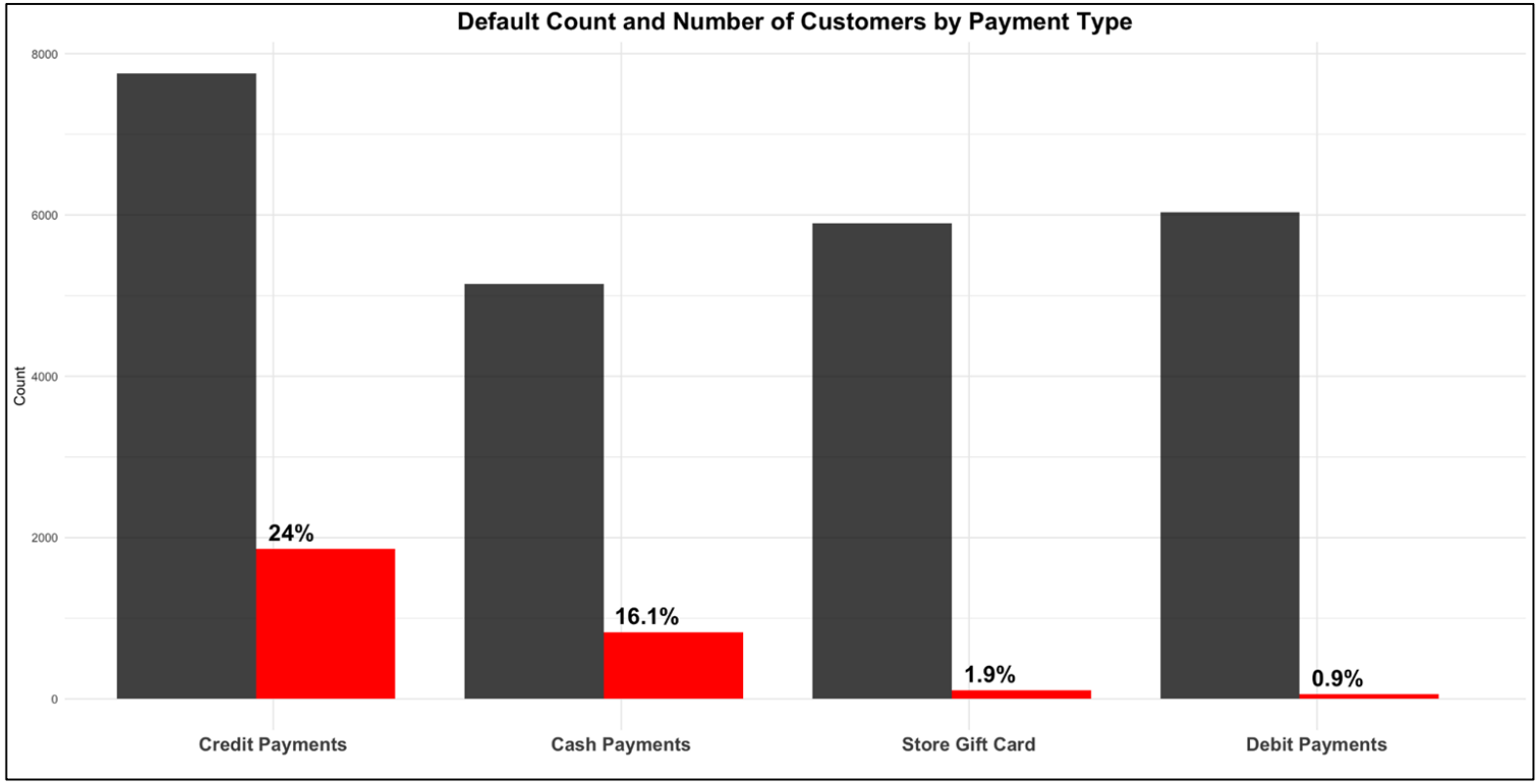

Figure 5: Default by Payment Type

EDA - Credit Score

Low Credit Scores have largest default rates

The bottom two credit scores **make up a majority** of defaults.

High Credit Scores have little default

No credit score above 4 has default rate above 1%.

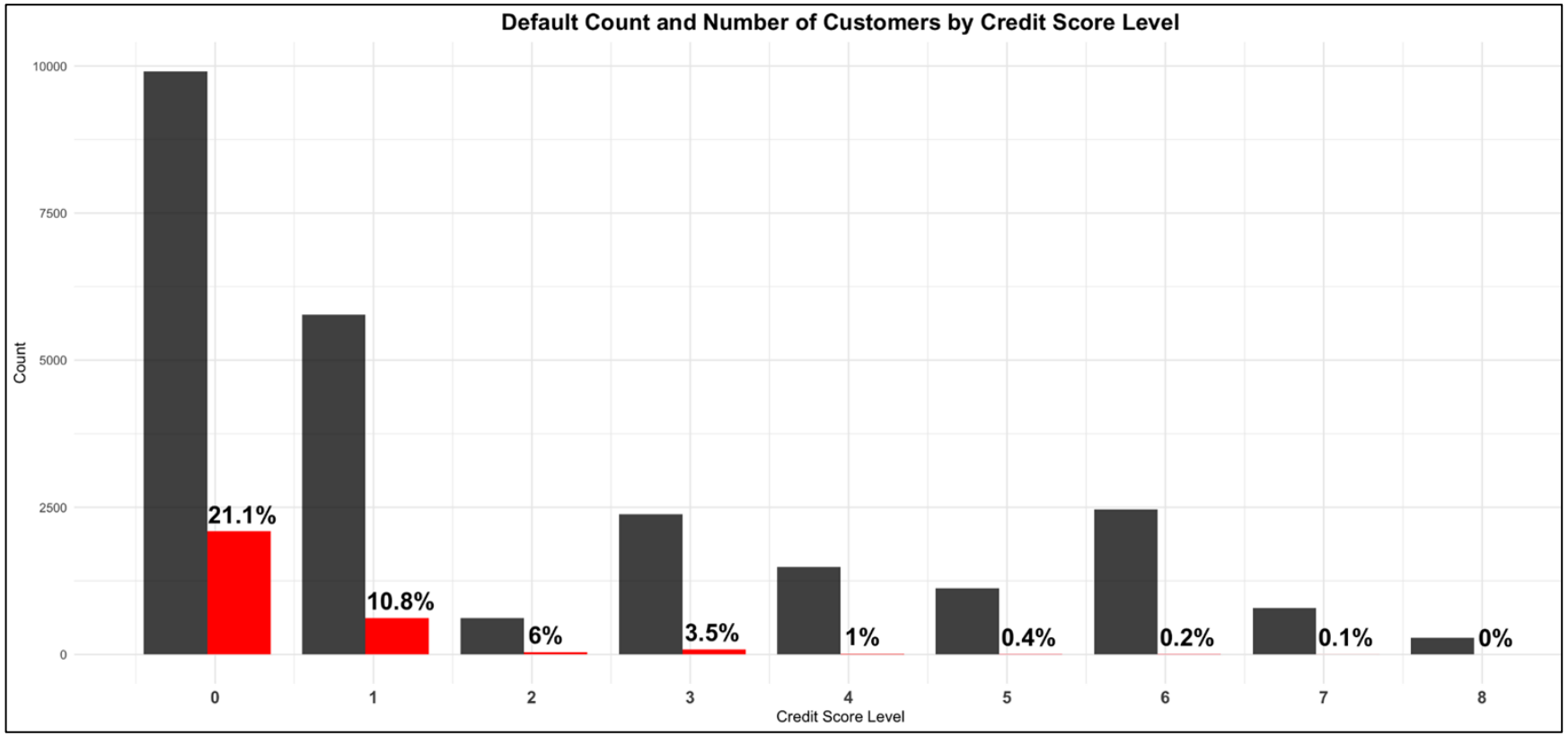

Figure 6: Default by Credit Score

Data Assessment

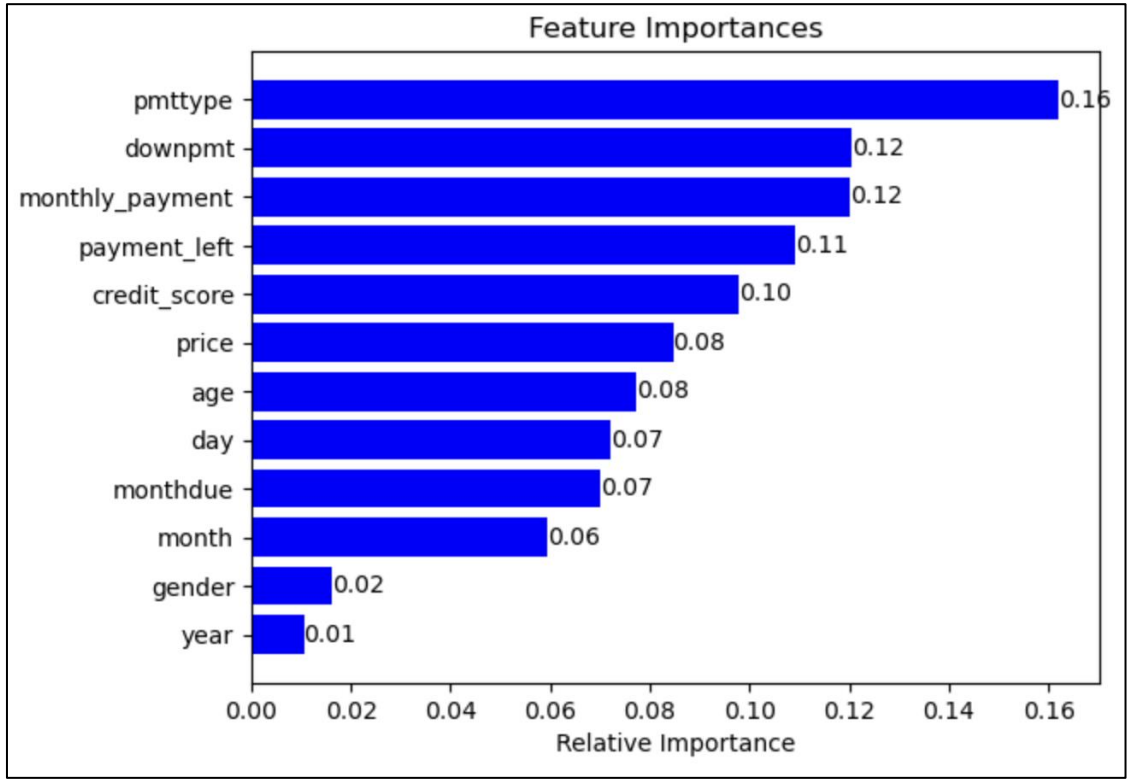

Figure 7: Feature Importance

Variable	Outliers	% of data
Age	age = 99	<1%
Price	price < 50 and price > 4000	<1%
Down Payment	downpmt < 50 and downpmt > 4000	<1%

Classification Report - Logistic Regression

TN 4257 (not default, predicted as not default)	FP 154 (not default, predicted as default)
FN 364 (default, predicted as not default)	TP 192 (default, predicted as default)

	precision	recall	f1-score	support
0	0.92	0.97	0.94	4411
1	0.55	0.35	0.43	556
accuracy			0.90	4967
macro avg	0.74	0.66	0.68	4967
weighted avg	0.88	0.90	0.88	4967

Classification Report - Random Forest

TN 8493 (not default, predicted as not default)	FP 279 (not default, predicted as default)
FN 584 (default, predicted as not default)	TP 578 (default, predicted as default)

	precision	recall	f1-score	support
0	0.94	0.97	0.95	8772
1	0.67	0.50	0.57	1162
accuracy			0.91	9934
macro avg	0.81	0.73	0.76	9934
weighted avg	0.91	0.91	0.91	9934

Classification Report - XGBoost

TN 3924 (not default, predicted as not default)	FP 472 (not default, predicted as default)
FN 111 (default, predicted as not default)	TP 460 (default, predicted as default)

	precision	recall	f1-score	support
0	0.97	0.89	0.93	4396
1	0.49	0.81	0.61	571
accuracy			0.88	4967
macro avg	0.73	0.85	0.77	4967
weighted avg	0.92	0.88	0.89	4967

Financial Impacts (Cost Details)

Assumptions:

- Profit per Customer: $250
- Direct Loss per Defaulter: $1,000
- Service & Admin Cost per Default: $150
- Profit from renewal (50% prob.): $250
- Profit from additional purchase (50% prob.): $100

Service & Admin cost + Opportunity Cost spread over 6 years:

150 + [250 + (250+100) * 50%] / 6

Opportunity Cost spread over 6 years:

[250 + (250+100) * 50%] / 6

Current contract profit over 3 years: **250/3**

Additional purchase at period 4 + Profit from renewal over 3 years: **(250 / 3 + 100) * 50%**

Profit from renewal over next 3 years: **250 / 3 * 50%**

Financial Impact per Customer:

Period	0	1	2	3	4	5	6
Defaults Among Approved	($1,000.00)	($220.83)	($70.83)	($70.83)	($70.83)	($70.83)	($70.83)
Safe Applicants Rejected		($70.83)	($70.83)	($70.83)	($70.83)	($70.83)	($70.83)
Defaults Avoided	$1,000.00	$150.00					
Paying Customers		$ 83.33	$83.33	$83.33	$91.67	$41.67	$41.67

WACC

1. Determining the Cost of Debt (Rd)

Step 1: Calculate Total Debt

From the Consolidated Balance Sheet for years ended December 31, 2021:

- **Debt maturing within one year (Short-term debt):** $7,443,000,000
- **Long-term debt:** $143,425,000,000

Total Debt (D):

D = Short-term debt + Long-term debt = $150,868,000,000

Step 2: Find Interest Expense

From the Consolidated Statements of Income for years ended December 31, 2021:

- **Interest expense:** $3,485,000,000

Step 3: Calculate Pre-Tax Cost of Debt

Pre-Tax Cost of Debt (Rd)

= Interest expense / Total debt = 0.02310 or 2.31%

Step 4: Calculate After-Tax Cost of Debt

First we calculate the effective tax rate from Statement of Income:

Effective tax rate = Provision for income taxes / income before provision for income taxes = $6,802,000,000 / $29,420,000,000 = 0.2312 or 23.12%

After-Tax Cost of Debt

= Rd * (1 - Effective tax rate) = 0.02310 * (1 - 0.2312) = **0.01776 or 1.78%**

WACC - Continued

2. Determining the Cost of Equity (Re)

We will use the CAPM: Cost of Equity (Re) = Rf + β * (Rm−Rf)

Step 1: Risk-Free Rate (Rf)

- We will use the yield on 10-year U.S. Treasury bonds as of December 31, 2021, **1.50%** (https://fred.stlouisfed.org/series/DGS10).

Step 2: Beta (β)

- We had chosen an industry average Beta for Telecom service **β = 0.78** (https://pages.stern.nyu.edu/~adamodar/New_Home_Page/datafile/Betas.html).

Step 3: Market Risk Premium (Rm - Rf)

- We had chosen the standard US equity risk premium **6.00%** (https://evaluationdata.pwc.de/en/telecommunications/)

Step 4: Calculate Cost of Equity

Re = 1.50% + 0.78 * 6.00% = **6.18%**

3. Determining the Capital Structure

Step 1: Calculate Market Value of Equity (E)

- **Share Price:** $51.96 (Based on the closing share price of Verizon on the NYSE on the last trading day for the fiscal year ending December 31, 2021)
- **Shares Issued:** 4,291,433,646; **Treasury Shares:** 93,634,725

E = Share Price * Shares Outstanding = $51.96 * (4,291,433,646 - 93,634,725) = $218,117,631,935

Step 2: Calculate Total Capital (V)

V = E + D = $50,868,000,000 + $218,117,631,935 = $368,985,631,935

Step 3: Calculate Weight of Debt (Wd) and Weight of Equity (We)

Wd = D / V = **40.89%**

We = E / V = **59.11%**

WACC - Continued

4. Calculating the Weighted Average Cost of Capital (WACC)

WACC = (We * Re) + (Wd * Rd * (1−Tax Rate))

Plugging in the values obtained earlier:

- **Equity Component:**

We * Re = 59.11% * 6.18% = 3.65%

- **Debt Component:**

Wd * After-tax Rd = 40.89% * 1.78% = 0.73%

WACC:

WACC = 3.65% + 0.73% = **4.38%**

Customer Counts of XG Boost Model

Confusion Matrix from the test data			
	Predicted Non-Default (N)	Predicted Default (P)	
Actual Non-Default	3942	472	4414
Actual Default	111	460	571
	4053	932	4985

Customer Count (Rate)	
Non-Default Rate	88.55%
Default Rate	11.45%
TN Rate	89.31%
FP Rate	10.69%
FN Rate	19.44%
TP Rate	80.56%
Customer Count (Number)	
Customer Base	1,000,000
Total Non-Defaulters	885,456
Approved Non-Defaulters (TN)	790,772
Rejected Non-Defaulters (FP)	94,684
Total Defaulters	114,544
Approved Defaulters (FN)	22,267
Rejected Defaulters (TP)	92,277
Defaults Among Approved	22,267
Safe Applicants Rejected	94,684
Defaults Avoided	92,277
Paying Customers	790,772

NPV of Current System

Customer Count (Rate)	
Applicants Approved Rate	80%
Default Rate among Approved	5%
Default Rate among Rejected	20%
Customer Count (Number)	
Customer Base	1,000,000
Defaults Among Approved	40,000
Safe Applicants Rejected	160,000
Defaults Avoided	40,000
Paying Customers	760,000

Period	0	1	2	3	4	5	6
Defaults Among Approved	($40,000,000.00)	($8,833,333.33)	($2,833,333.33)	($2,833,333.33)	($2,833,333.33)	($2,833,333.33)	($2,833,333.33)
Safe Applicants Rejected		($11,333,333.33)	($11,333,333.33)	($11,333,333.33)	($11,333,333.33)	($11,333,333.33)	($11,333,333.33)
Defaults Avoided	$40,000,000.00	$6,000,000.00					
Paying Customers		$63,333,333.33	$63,333,333.33	$63,333,333.33	$69,666,666.67	$31,666,666.67	$31,666,666.67
Undiscounted Cash Flow	$0.00	$49,166,666.67	$49,166,666.67	$49,166,666.67	$55,500,000.00	$17,500,000.00	$17,500,000.00
Discounted Factor		0.9580	0.9178	0.8793	0.8424	0.807102043	0.7732
Discounted Cash Flow	$ -	$47,103,855.38	$45,127,590.34	$43,234,240.45	$46,755,826.72	$14,124,285.75	$13,531,694.51

Discounted on WACC = 4.38%

NPV: $210 Million over 6 years