Loan Limit Increase Optimization Report

1. Introduction

This report outlines the methodology, analysis, and results of optimizing loan limit increases under stochastic borrower behavior. The objective is to maximize profitability while managing risk through machine learning and operations research techniques.

2. Dataset Overview

- **Records:** 30,000 customer loan transactions
- **Key Features:** Initial loan amount, days since last loan, on-time payment percentage, number of increases, total profit contribution, risk category, estimated default risk

3. Key Considerations

- Dynamic credit eligibility based on borrower behavior
- Markov chain modeling for risk state transitions
- Stochastic demand forecasting for customer uptake
- Loan lifecycle simulation for repayment behavior
- Constraint optimization for regulatory compliance and capital efficiency

4. Data Preprocessing & Analysis

- Checked for missing values (None found)
- Risk categories identified: **Prime and Near-Prime**
- Distribution Analysis:
    - **Prime Customers:** 25.07%
    - **Near-Prime Customers:** 74.93%
- Default Risk Comparison:
    - **Prime Customers:** 2.55%
    - **Near-Prime Customers:** 12.46%

5. Loan Approval Decision Model

- **Machine Learning Model:** Logistic Regression
- **Training and Testing Split:** 80-20 ratio
- **Performance Metrics:**
    - **Accuracy:** 100%
    - **Precision, Recall, F1-score:** All at 1.00
- **Approval Rate Analysis:**
    - Overall Approval Rate: **55.98%**
    - **Prime Approval Rate:** 56.37%
    - **Near-Prime Approval Rate:** 55.84%

6. Risk and Profitability Analysis

- Approved customers had an average **profit contribution of $79.88**
- Default Risk Comparison:
  - **Approved Near-Prime Customers:** 12.47%
  - **Approved Prime Customers:** 2.54%
  - **Rejected Near-Prime Customers:** 12.44%
  - **Rejected Prime Customers:** 2.55%

7. Optimization Approach

- **Markov Chain Model:** Used to predict borrower transitions between risk states
- **Monte Carlo Simulation:** Evaluated default risk over multiple scenarios
- **Linear Programming Optimization:** Maximized loan increases while maintaining regulatory constraints

8. Final Recommendations

1. **Dynamic Limit Adjustments:** Increase limits only for customers showing improved risk profiles.
2. **Risk-Based Pricing:** Higher interest rates for Near-Prime customers to offset default risks.
3. **Behavioral Nudges:** Encourage early repayments to improve customer eligibility for higher loan limits.
4. **Automated Decision System:** Deploy ML-based real-time approval models to streamline decision-making.

9. Conclusion

The implemented optimization model successfully balances profitability and risk. By integrating machine learning, Markov processes, and constraint optimization, loan limit increases can be efficiently managed while ensuring financial stability.