



# Rensselaer

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# DeFi Survival Analysis: Risks and User Behaviors

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Oshani Seneviratne and Kristin Bennett | July 12, 2022



# IDEA

Rensselaer Institute for Data Exploration and Applications

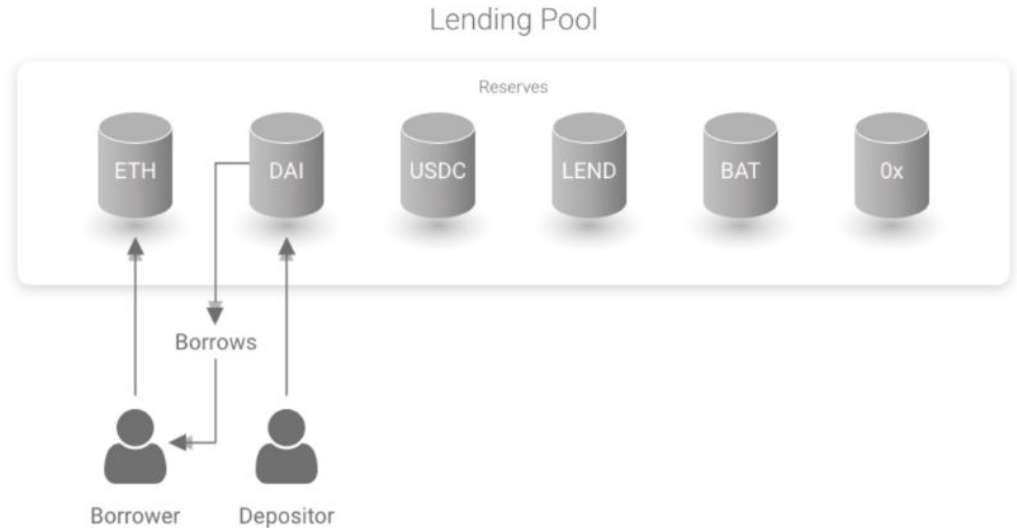
# What's to Come

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1. Brief DeFi Lending Protocol Introduction
2. Overview of Survival Analysis for DeFi questions
3. Explanation of data
4. Survey of insights gained using Survival Analysis

# DeFi Lending Protocols

- **Savings Account:**
  - Deposit various cryptocurrencies into account
  - Accrue interest on deposited funds
- **Smart-Contract Lending:**
  - Borrow cryptocurrency supplied by others' deposits
  - Use own deposits as collateral, at risk of **liquidation**



Source: [https://github.com/aave/aave-protocol/blob/master/docs/Aave\\_Protocol\\_Whitepaper\\_v1\\_0.pdf](https://github.com/aave/aave-protocol/blob/master/docs/Aave_Protocol_Whitepaper_v1_0.pdf)

# Survival Analysis For DeFi: An Introduction

- Data-driven method for time-to-event analysis
- Provides probabilities for occurrences of events through time
  - E.g. what is the probability that a user repays a loan in the first 100 days after borrowing money?

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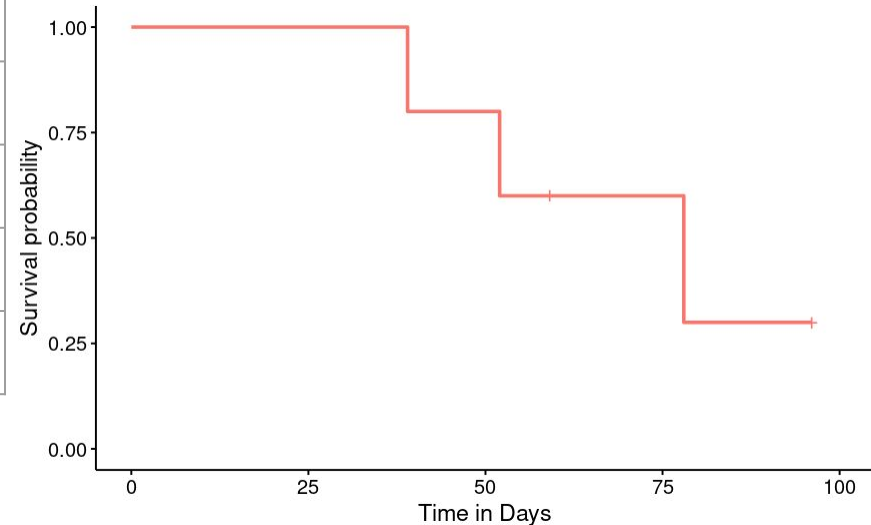
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96	No
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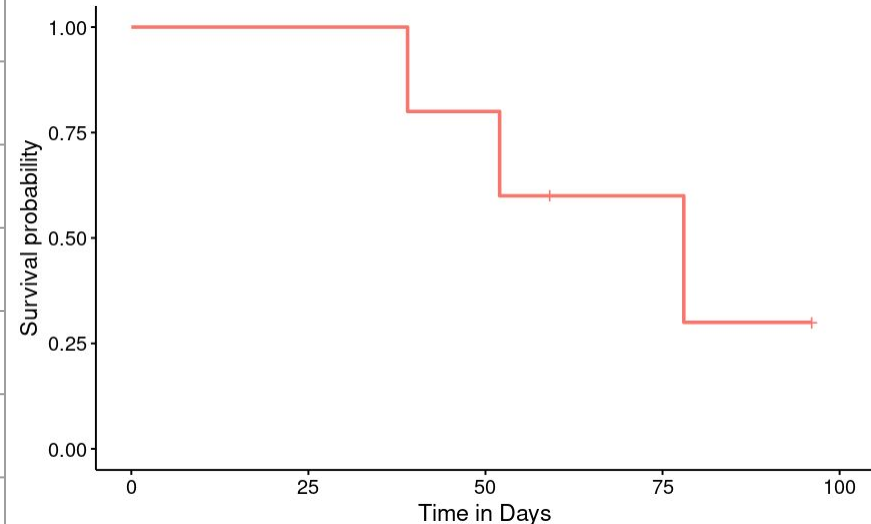
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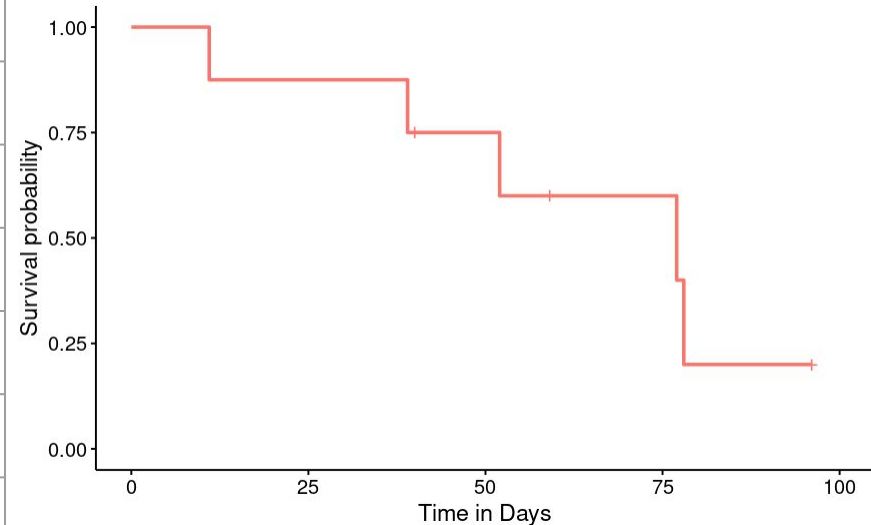
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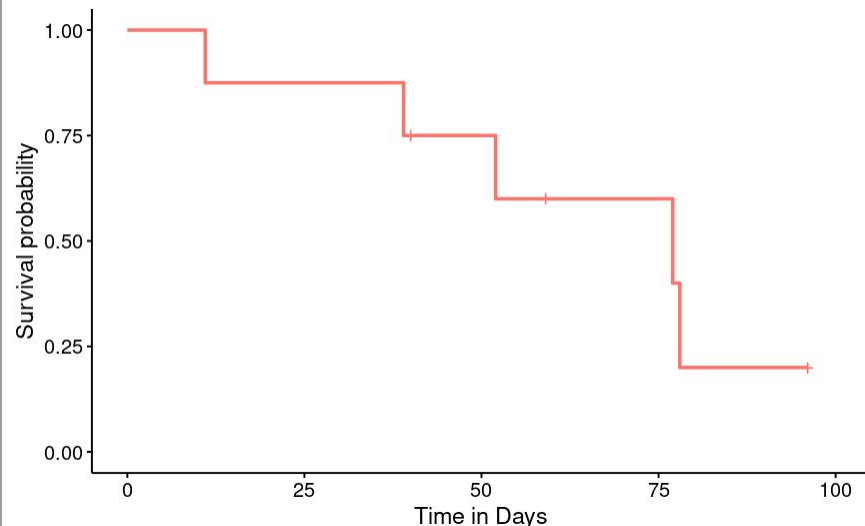




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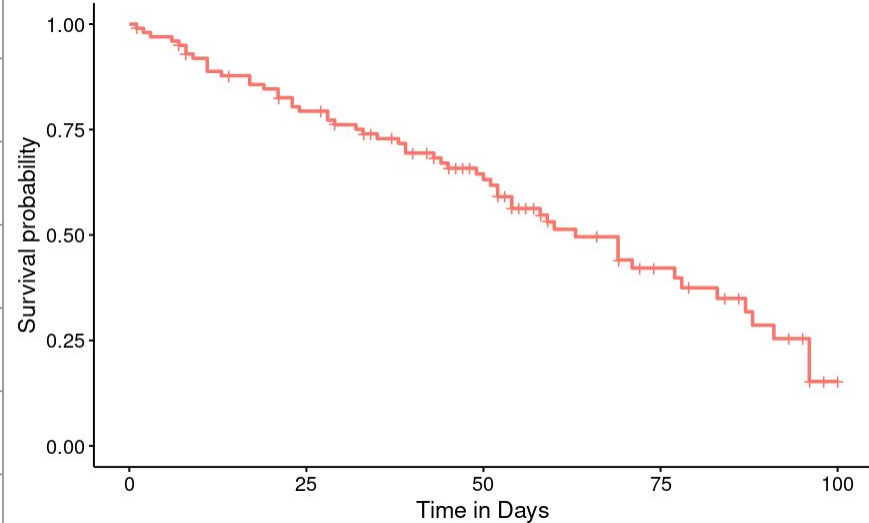


← + 92 rows (100 total)

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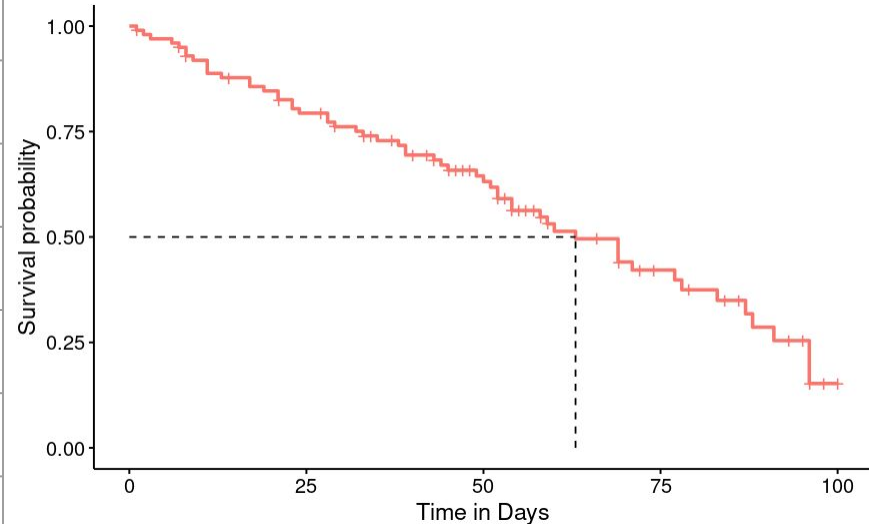


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# Survival Analysis with Categorical Comparison

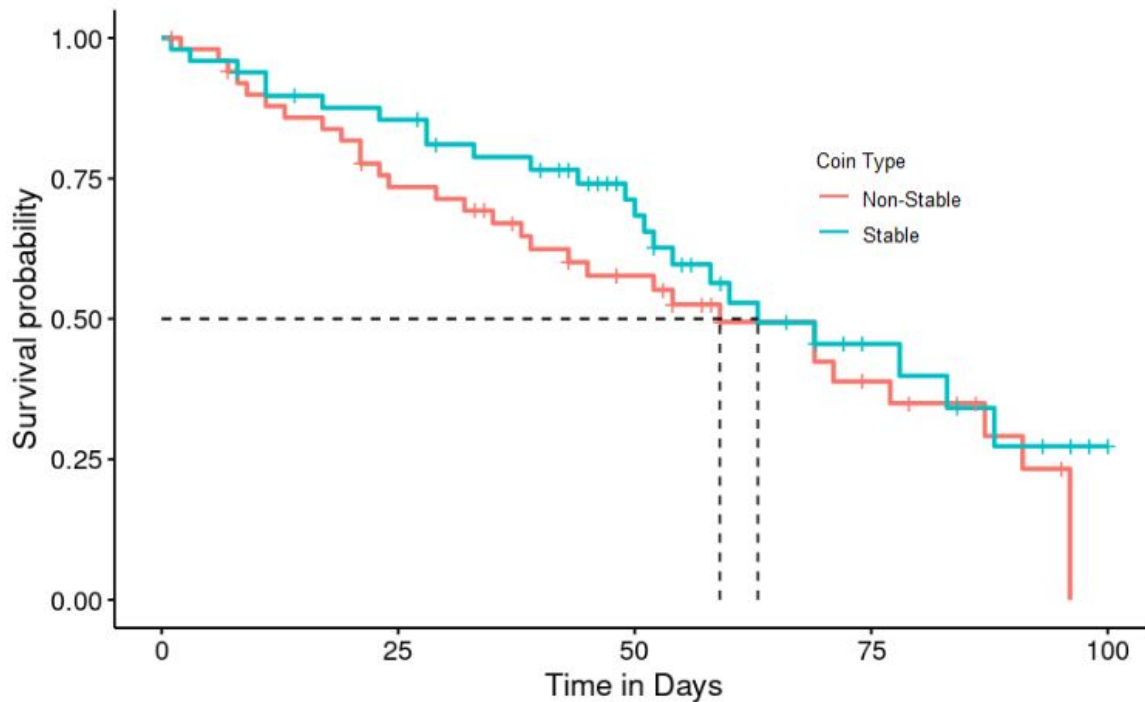
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# Survival Analysis with Categorical Comparison

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- One of the largest lending protocols:
  - First deployed on Ethereum blockchain in November 2020
  - Now deployed on seven networks, with 13 different markets
  - ~\$10 billion USD worth of assets locked across all markets (July 2022)
  - Over 50 cryptocurrencies allowed for usage on main Ethereum market



Ethereum



Arbitrum



Harmony



Ethereum AMM



Avalanche



Optimism



Polygon



Fantom

## Transaction-Level Data

- All 1,198,624 basic transactions since AAVE launched (November 30, 2020 - June 15, 2022)
- Data acquired from TheGraph.com, where AAVE developers manage subgraphs for various deployments

Date and Time	Transaction Type	User	Currency	Amount	...
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December 1, 2020 05:15:30	Borrow	<ID>	XSUSHI	15.52	...
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Transaction Type	Occurrences	Mean Value (USD)	Median Value (USD)
Borrow	158,376	\$372,676.30	\$14,114.86
Collateral	385,178	NA	NA
Deposit	302,561	\$707,152.60	\$14,181.75
Redeem	218,216	\$929,436.40	\$28,667.74
Repay	110,537	\$503,630.70	\$25,140.80
Swap	3,095	NA	NA

Transaction Type	Occurrences	Mean Principal (USD)	Mean Collateral (USD)
Liquidation	20,661	\$47,895.19	\$51,034.52

# Real-Data Example

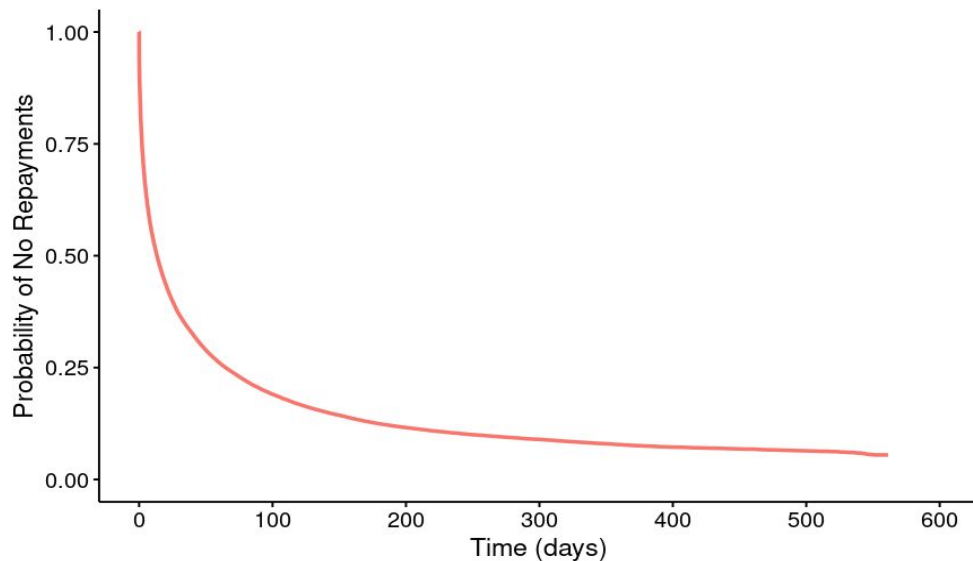
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- Each transaction is a candidate for index and outcome events:
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- Index event: borrow transactions
- Outcome event: repay transactions



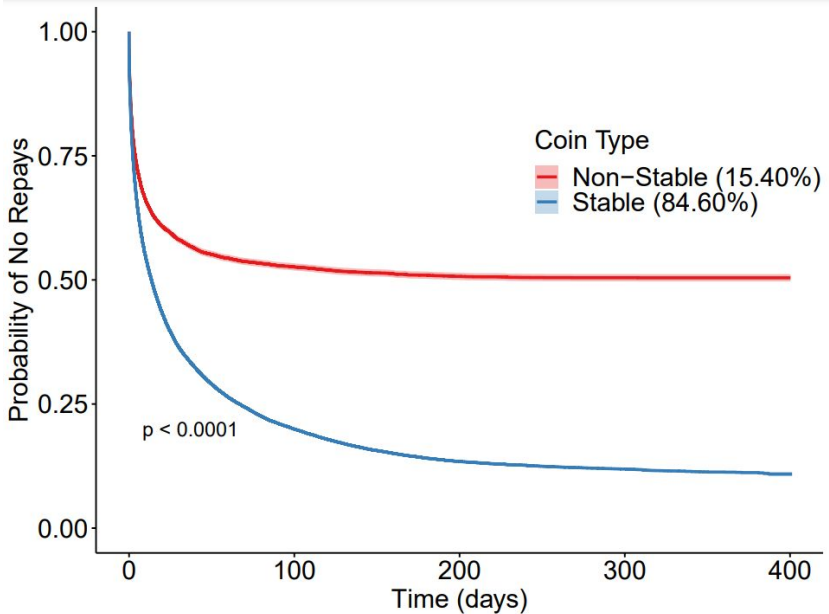
# Effect of Coin Type on Loan Outcomes

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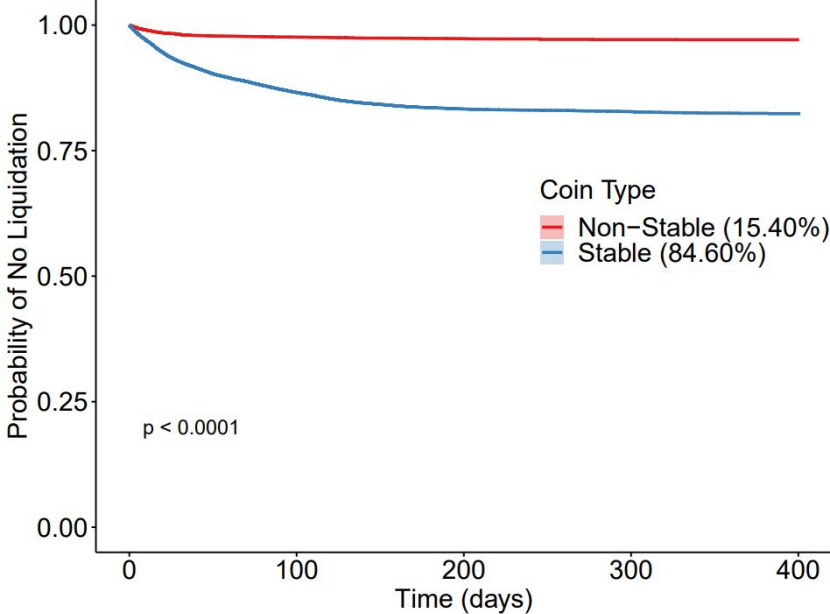
- What are the differences in loan outcome timings (repayments, liquidations) for stable coins versus non-stable coins?

# Effect of Coin-type on Loan Outcomes

- Outcome event: repayment



- Outcome event: liquidation



# Principal: Collateral Combinations and Liquidations

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- More than just single repays can be used as outcomes for borrow events:
  - Liquidation
  - Repay in full
  - Redeem (withdrawal)

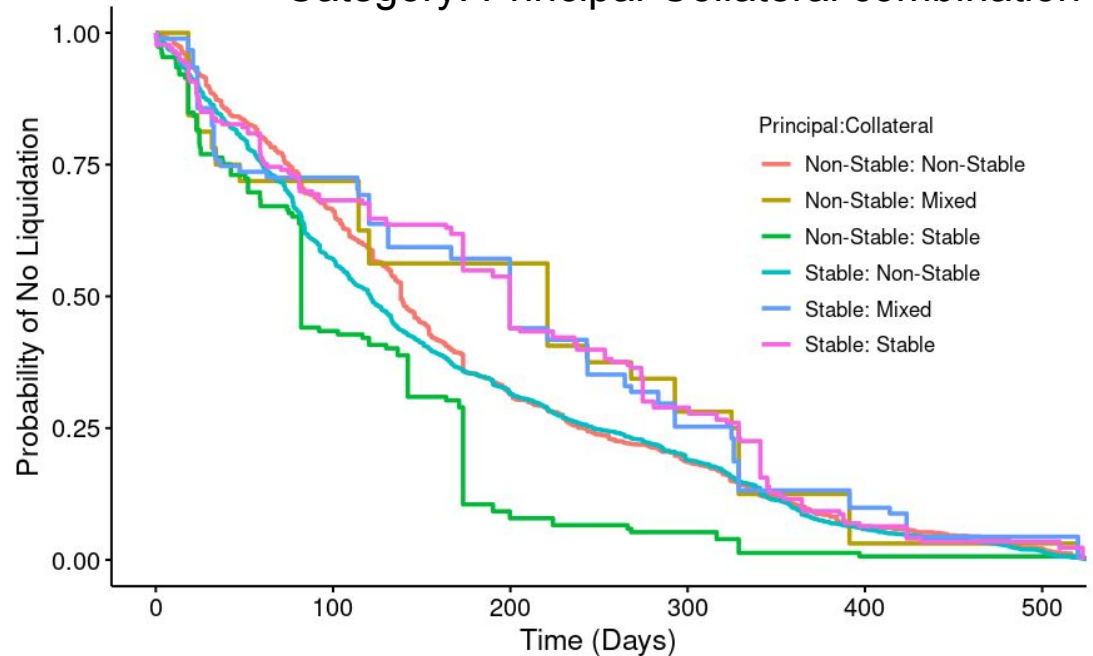
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- Outcome event: loan liquidation
  - Category: Principal-Collateral combination



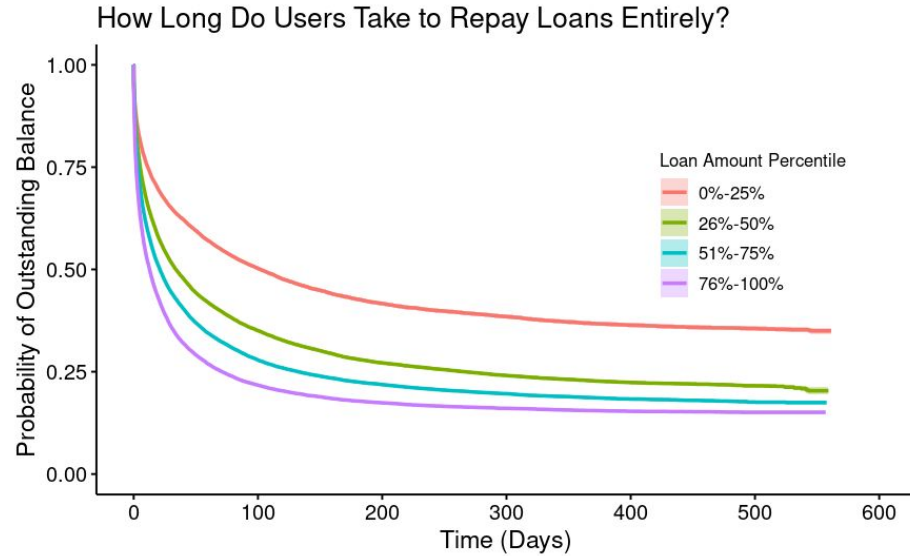


# Understanding Effects of Loan Size

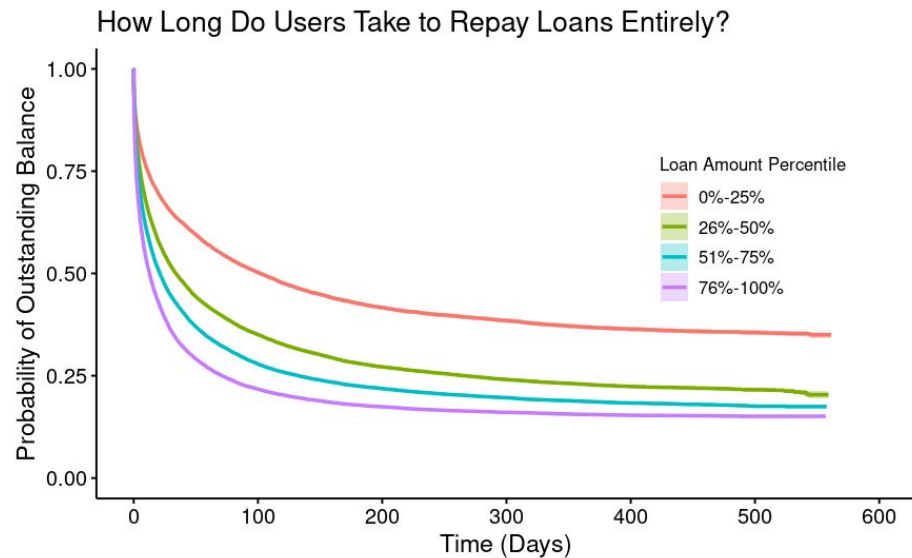
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- How does loan size affect repayment schedules?

# Understanding Effects of Loan Size

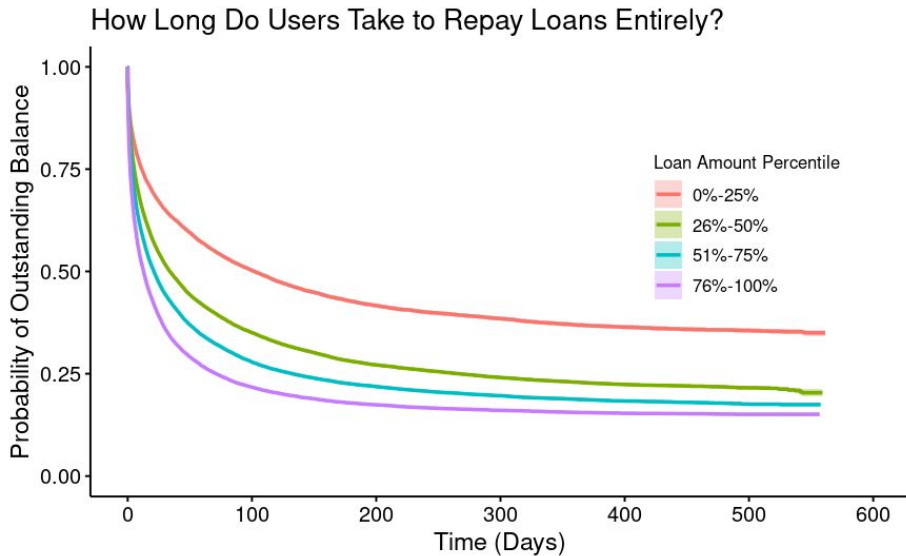


# Understanding Effects of Loan Size



- Larger loans get repaid more quickly!

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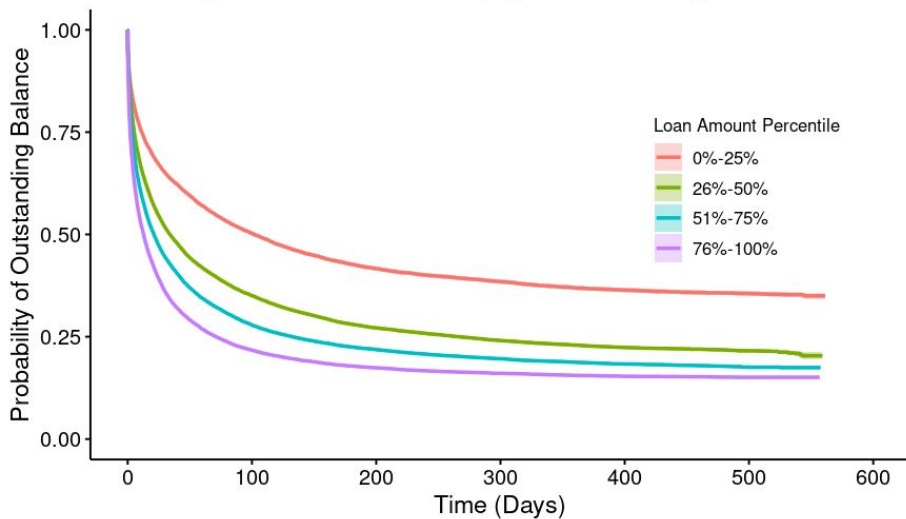


- How does riskiness vary with loan size?

- Larger loans get repaid more quickly!

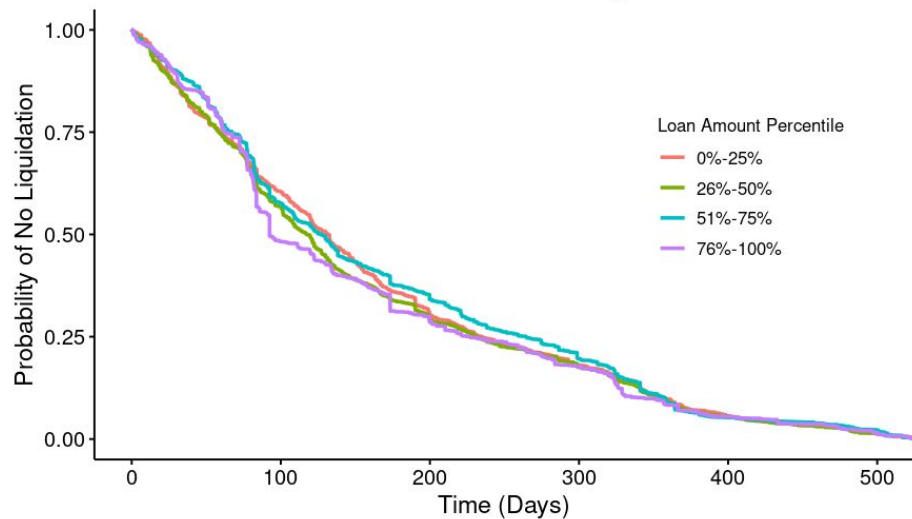
# Understanding Effects of Loan Size

## How Long Do Users Take to Repay Loans Entirely?



- Larger loans get repaid more quickly!

## How Does Loan Amount Affect Time to Liquidation?



- Loan size has little to no effect on riskiness!

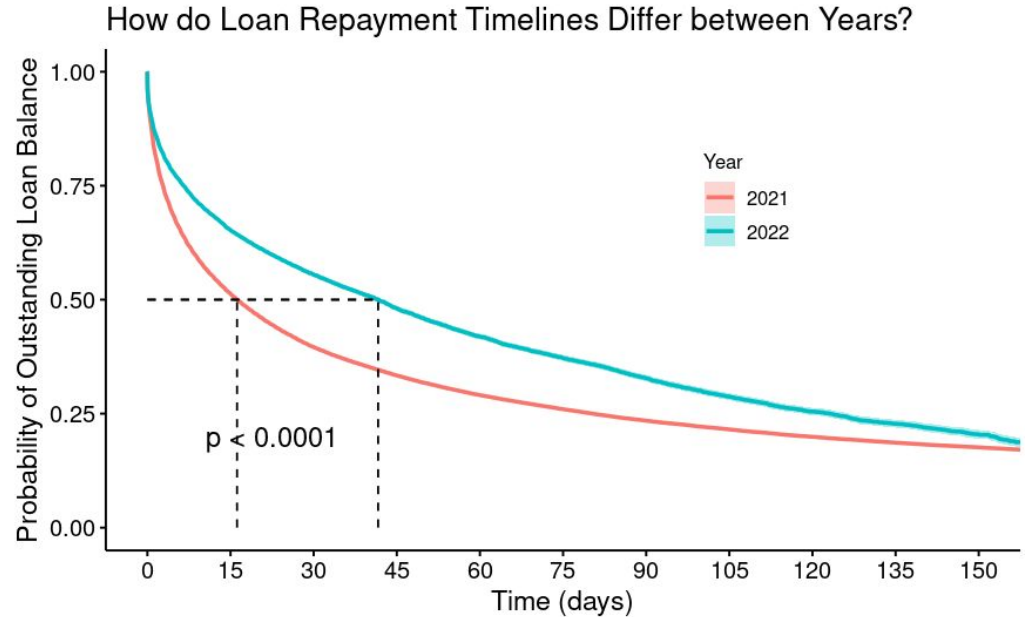
# Changing Time-Windows

- Another way to segment survival curves is by time-frame of index or outcome events:
  - E.g. how have repayment timelines differed between a predominantly bull market (2021) and a predominantly bear market (2022)?

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- Outcome event: full repayment
  - Category: year borrow was made



# Takeaways

- Survival Analysis can be applied to transactions in DeFi protocols to yield meaningful insights about user behavior and risk
  - Myriad options for index/outcome events, categories for comparison
  - Huge data expansion opportunities to compare findings across DeFi protocols
- Open-source R code demonstrating pipeline for conversion from transactional to survival data
  - Code uses the free **survminer** library
  - <https://bit.ly/DeFiSurv>





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