Survival Analysis Methods to Predict Loss Rates in Credit Card Portfolios

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Outline

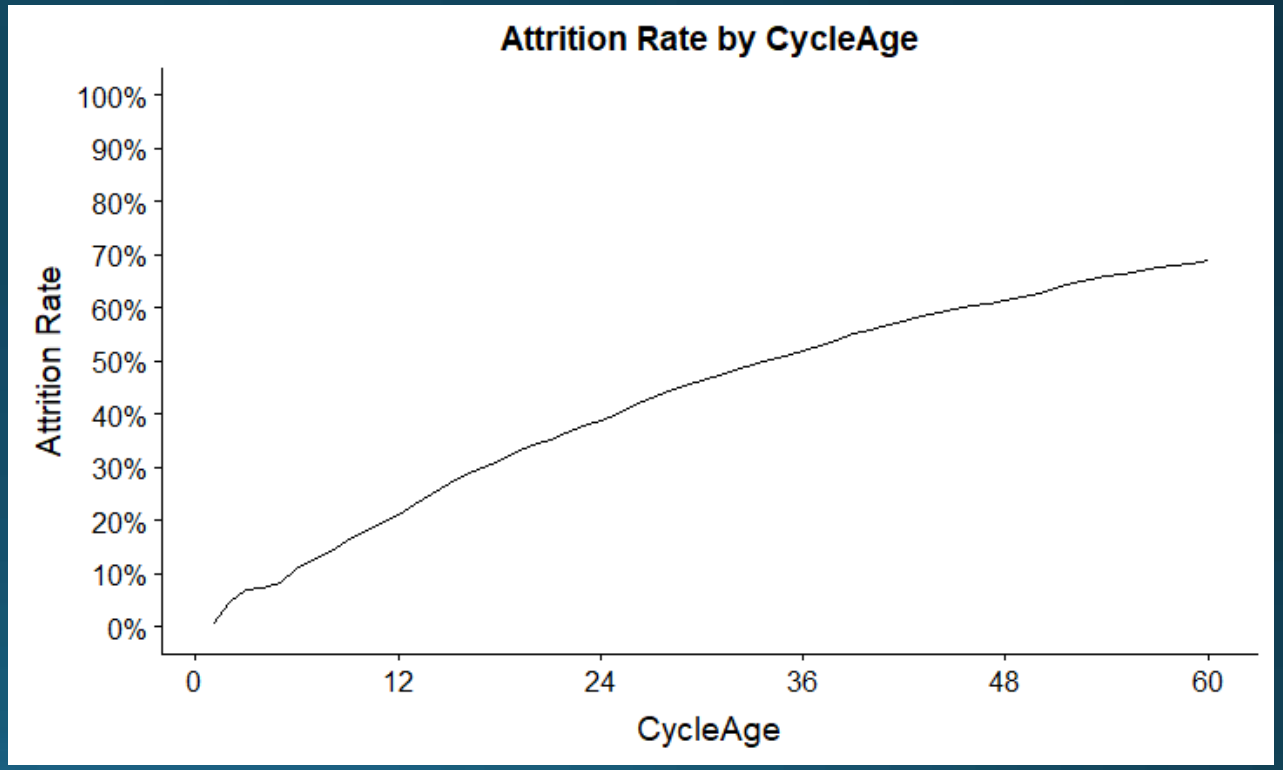
Goal: Determine an alternative method to model losses that occur in a credit card portfolio

Business Question: Is there a more statistical way to measure losses over a period of time?

- Introduction
- Survival Analysis
- Competing Risks
- Application

Loss Rates

- Two types of 'losses'
  - Closure: Balance is paid off and card is deactivated
    - Reasons include: didn't understand terms, not happy with credit line
  - Default: 6+ months delinquent, balance written off as bad debt and attempted to be collected on
    - Reasons include: spent too much on the card, lost a job



$Y = 1$ if account has either closed or defaulted in time

Survival Analysis

- Define Random Variable T such that

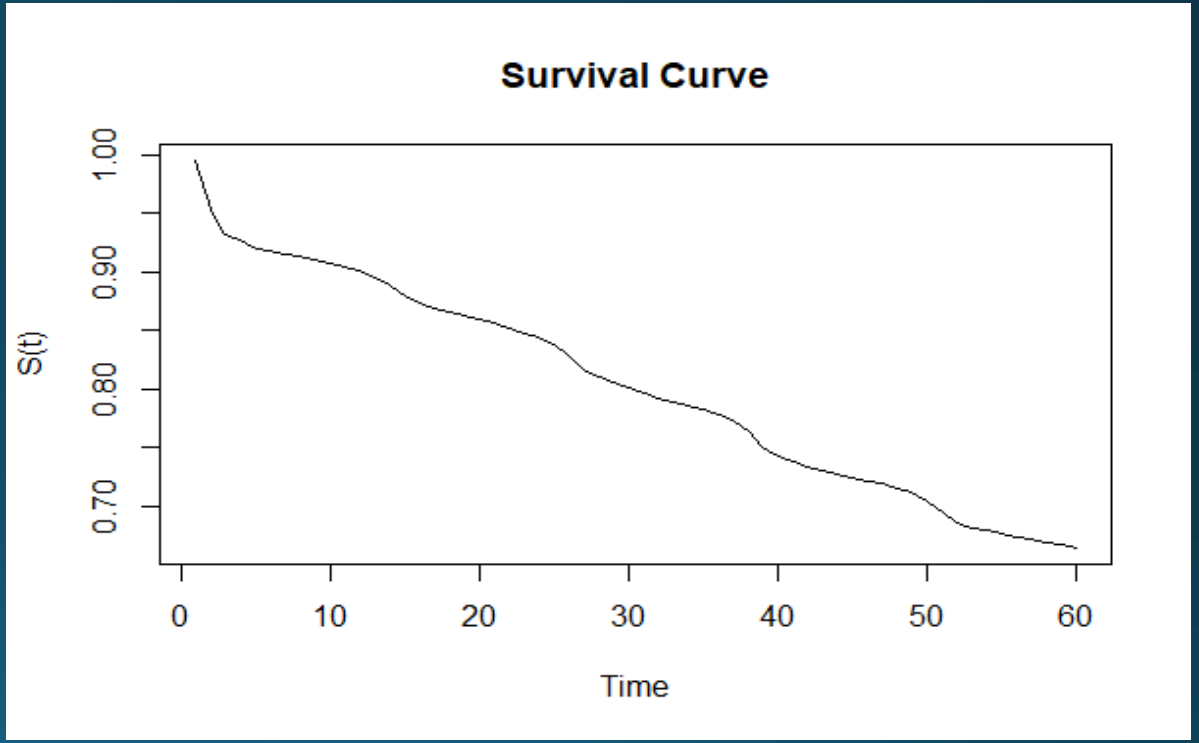
  T =Time until event of interest has occurred

- Survival Function:

$$S(t) = P(T > t)$$

Survival Function Estimator:

$$\widehat{S_{KM}}(t) = \prod_{j<t}\left[1 - \frac{d_j}{n_j}\right]$$



d_j = # of events in time period j

n_j = # of obs at risk in time period j

Data

- How data is laid out depends on question being asked

"Vintage"

ID	Year	Age	Event	X
1	1900	1	0	25
1	1901	2	0	34
1	1902	3	0	97
1	1903	4	0	54
1	1904	5	1	21
2	1900	1	0	5
2	1901	2	0	67
2	1902	3	0	81
2	1903	4	0	64
2	1904	5	0	15
2	1905	6	0	34

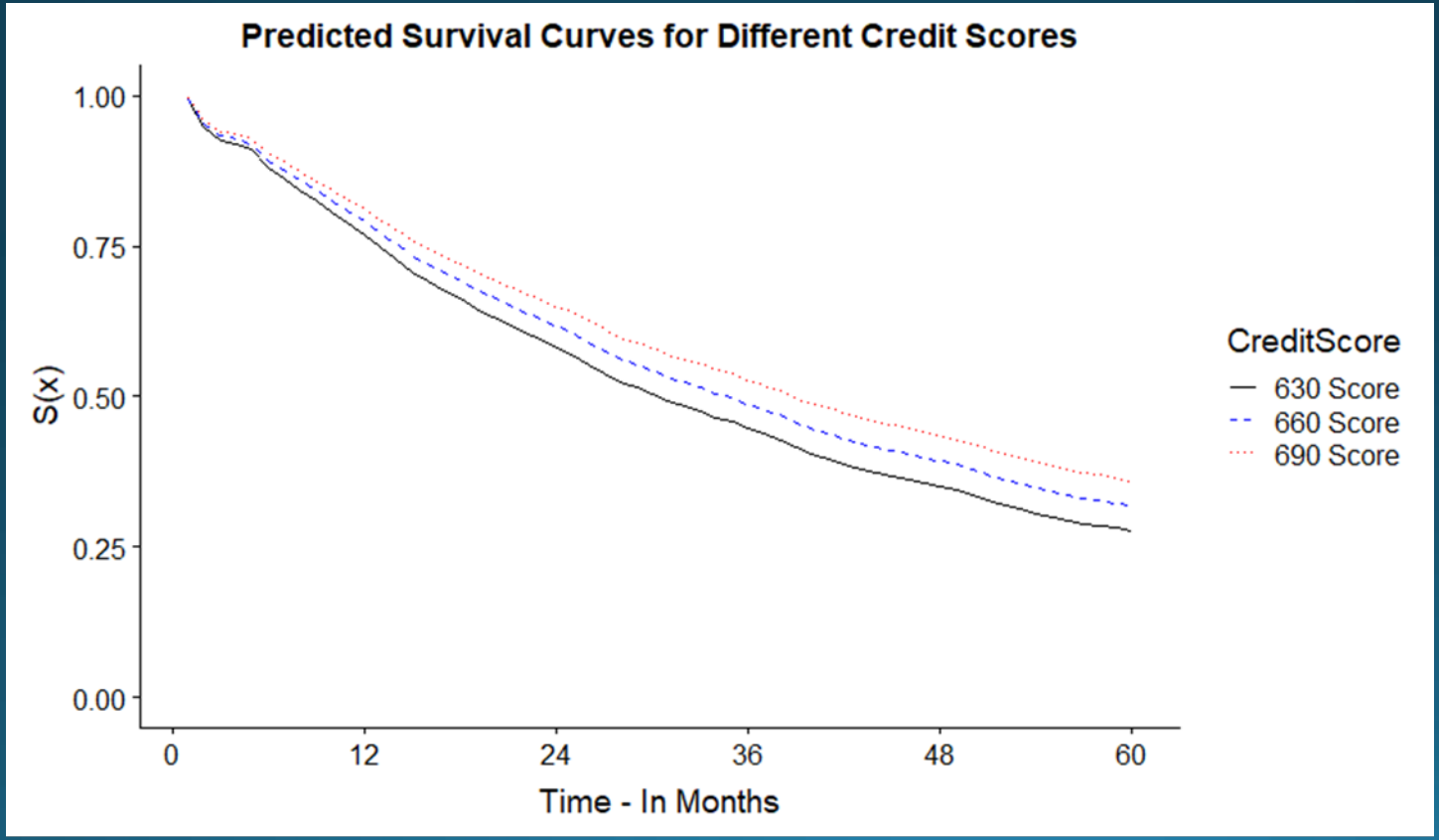
"Population"

ID	Year	Age	Event	X
1	1900	25	0	45
1	1901	26	0	67
1	1902	27	1	15
2	1900	49	0	90
2	1901	50	1	23
3	1900	18	0	14
3	1901	19	0	12
3	1902	20	0	48
4	1900	21	0	66
4	1901	22	0	25
4	1902	23	0	97

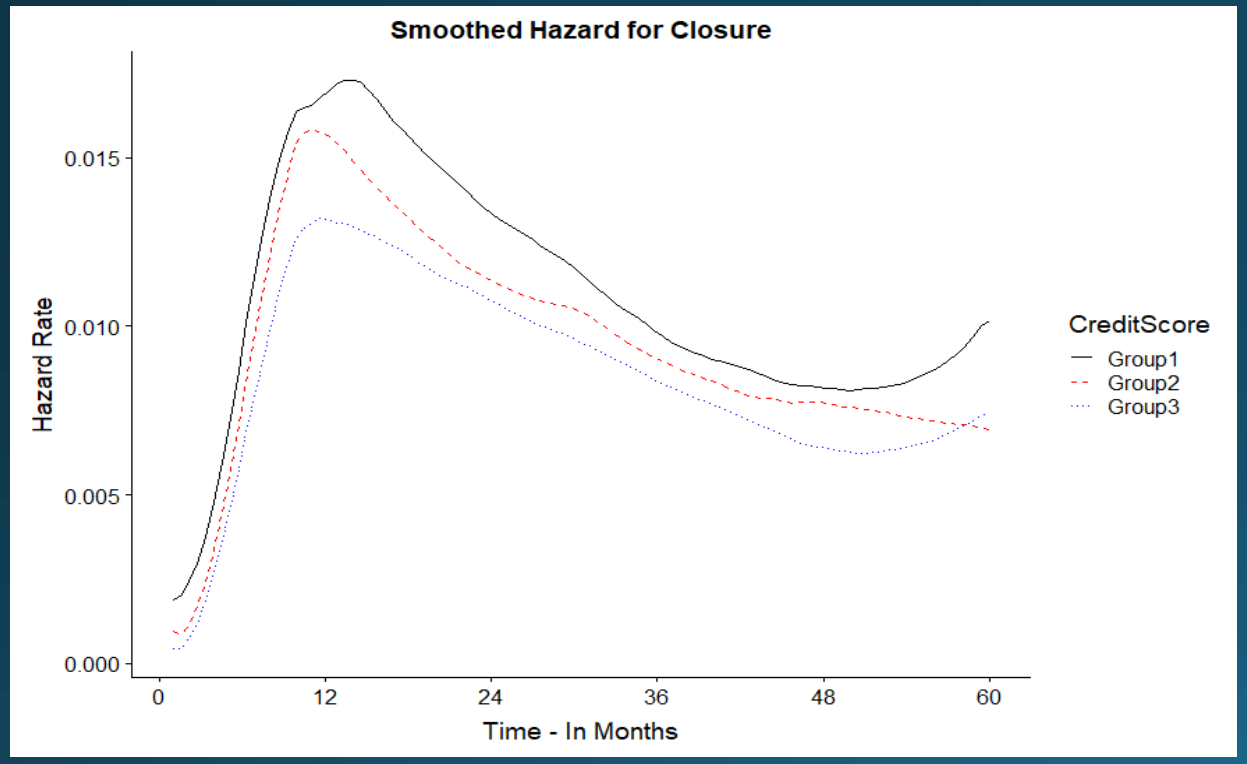
Cox Proportional Hazards Regression

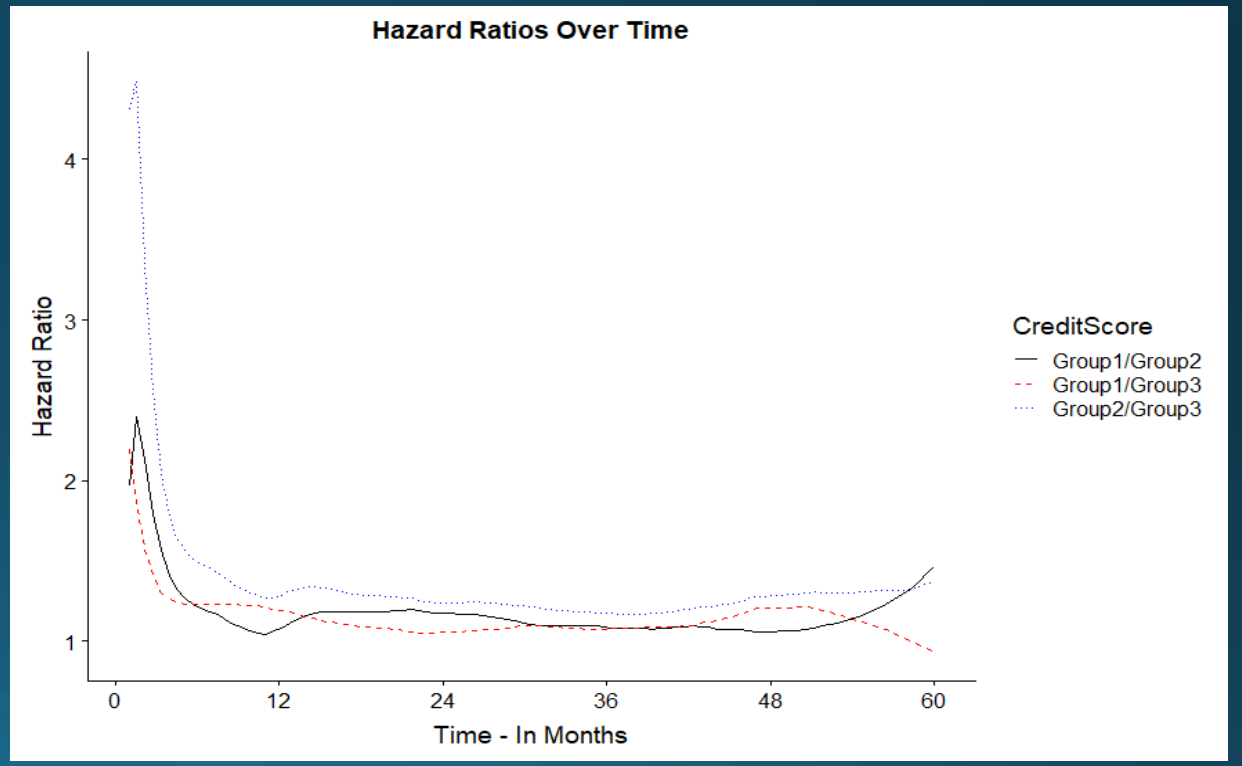
- Motivation: Use covariates to estimate survival curve

$$h_i(t) = h_0(t)e^{X_i(t)\beta}$$



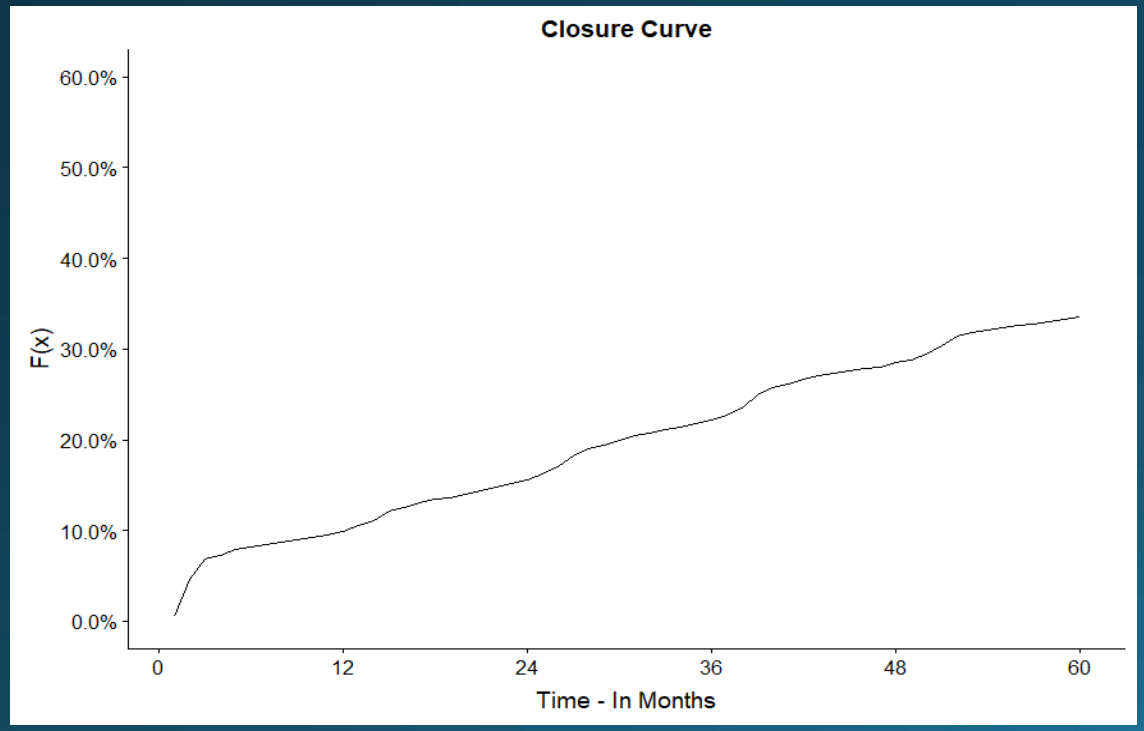
Proportional Hazards

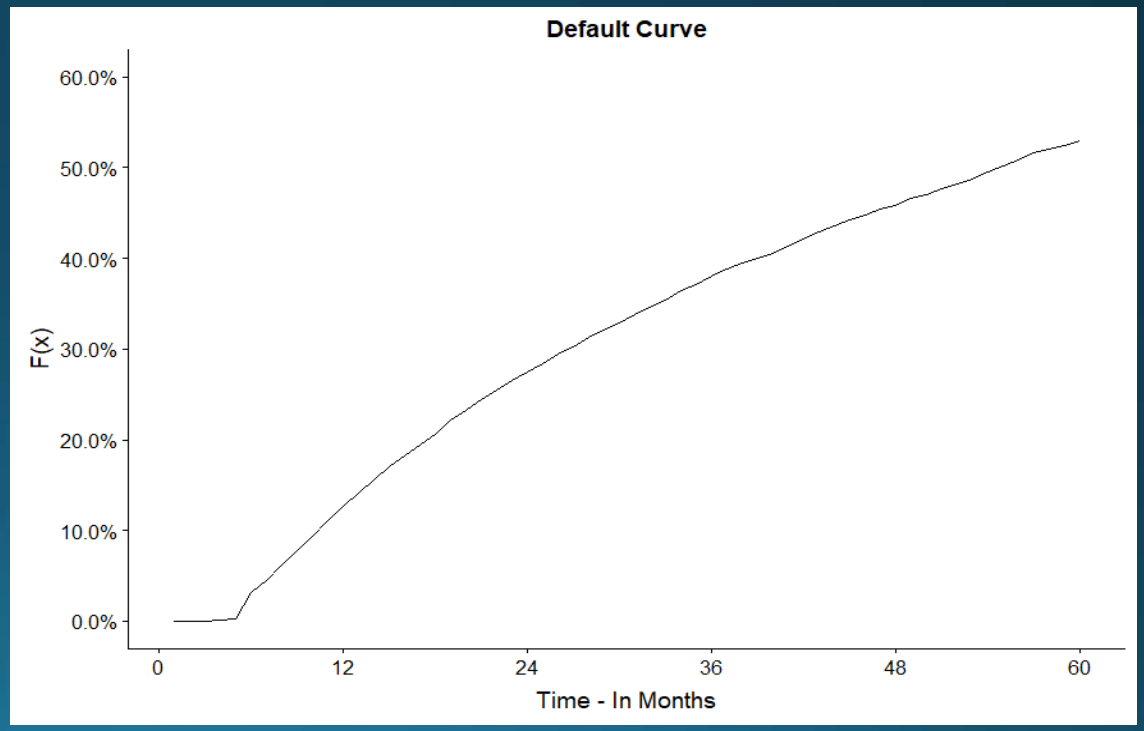




Multiple Events

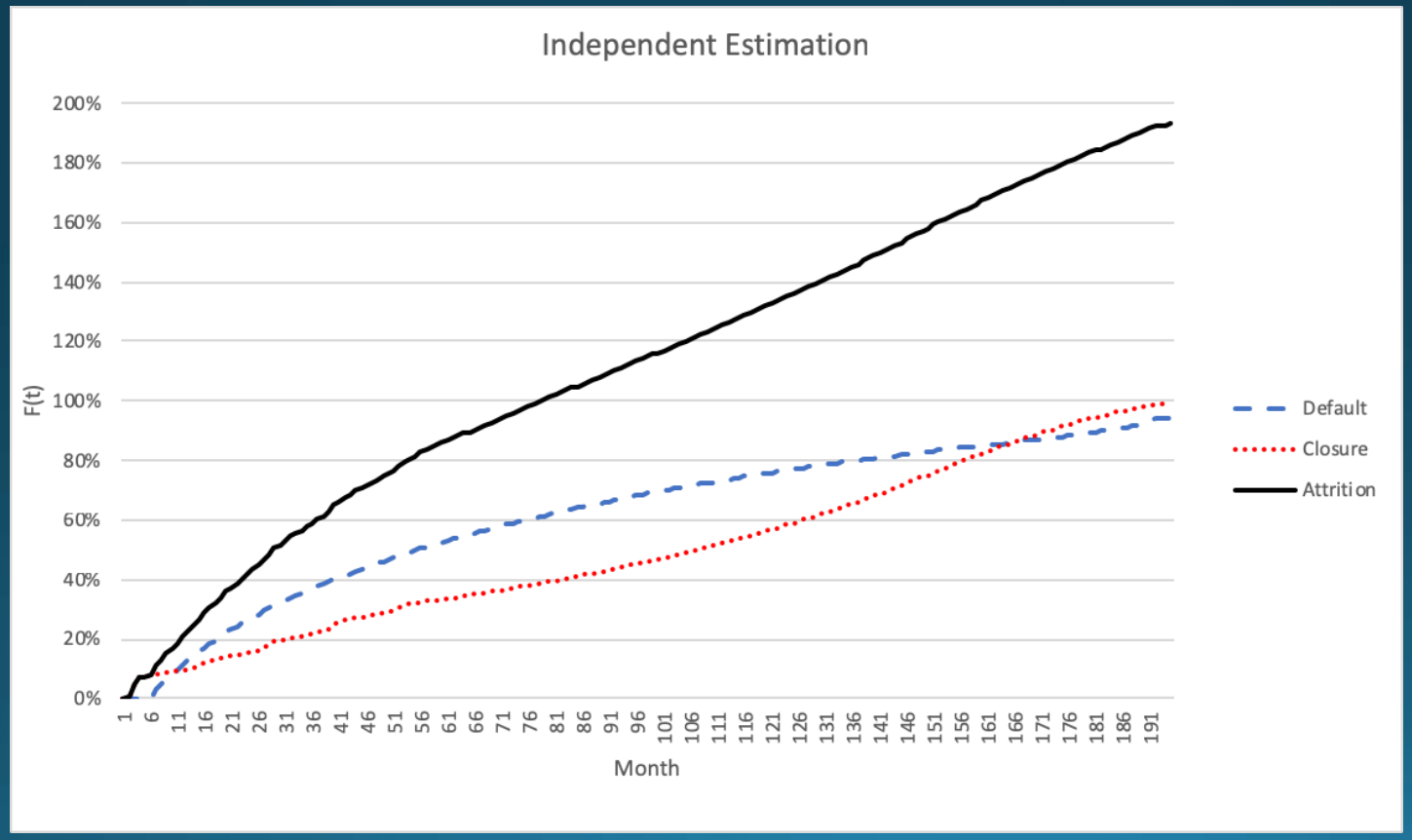
- Instead of looking at overall loss rates, what if we look at Closure and Defaults separately?





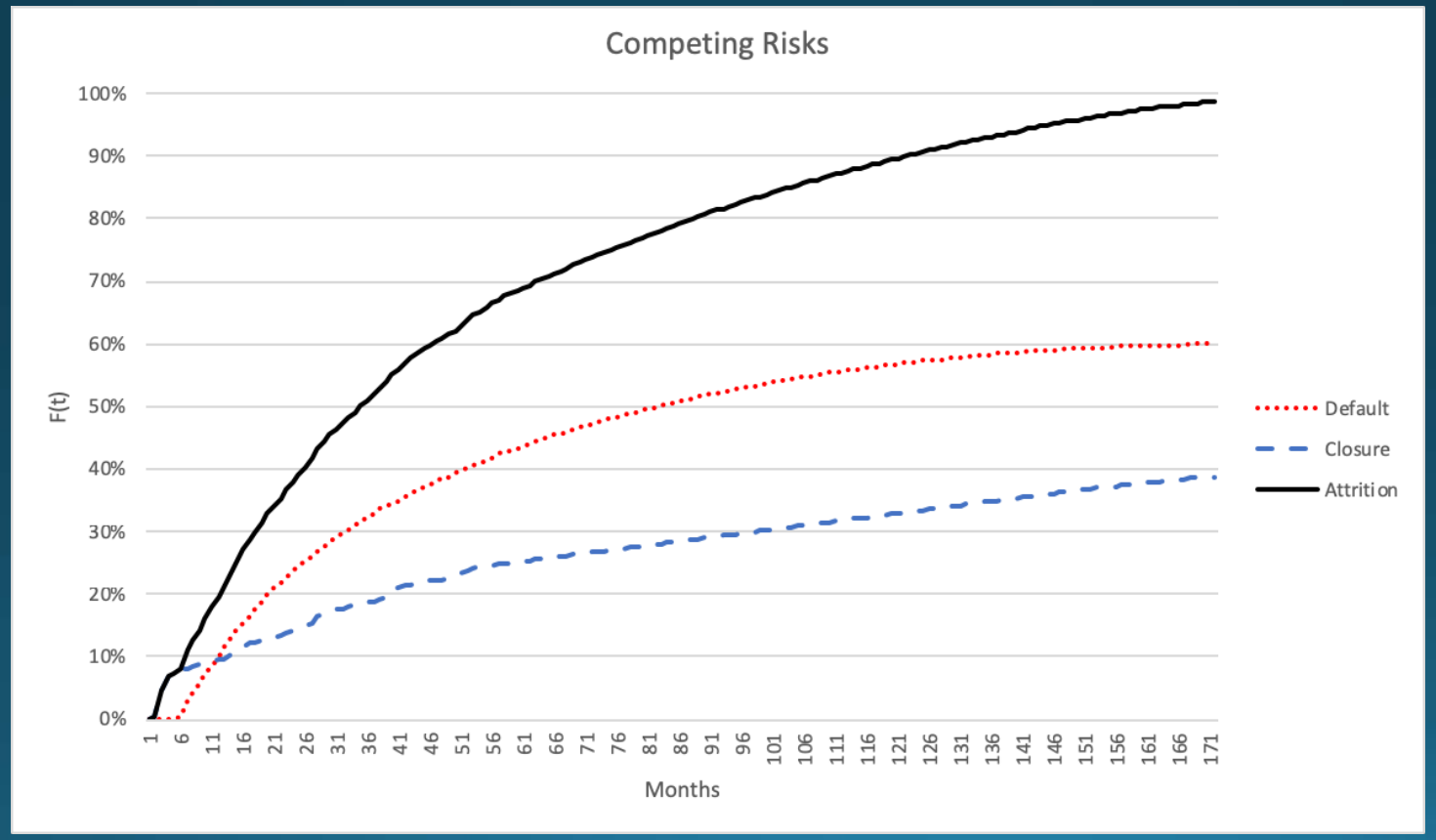
Solution?

- Could look at each event independently
- Over Represented "Non-Event" groups



Competing Risks

- Another solution that addresses mutually exclusive events
  - If an account is closed, it cannot be defaulted or current



Competing Risks Proportional Hazard Regression

- Like before, we can use covariates to estimate survival curves with competing risks

Model Specification:

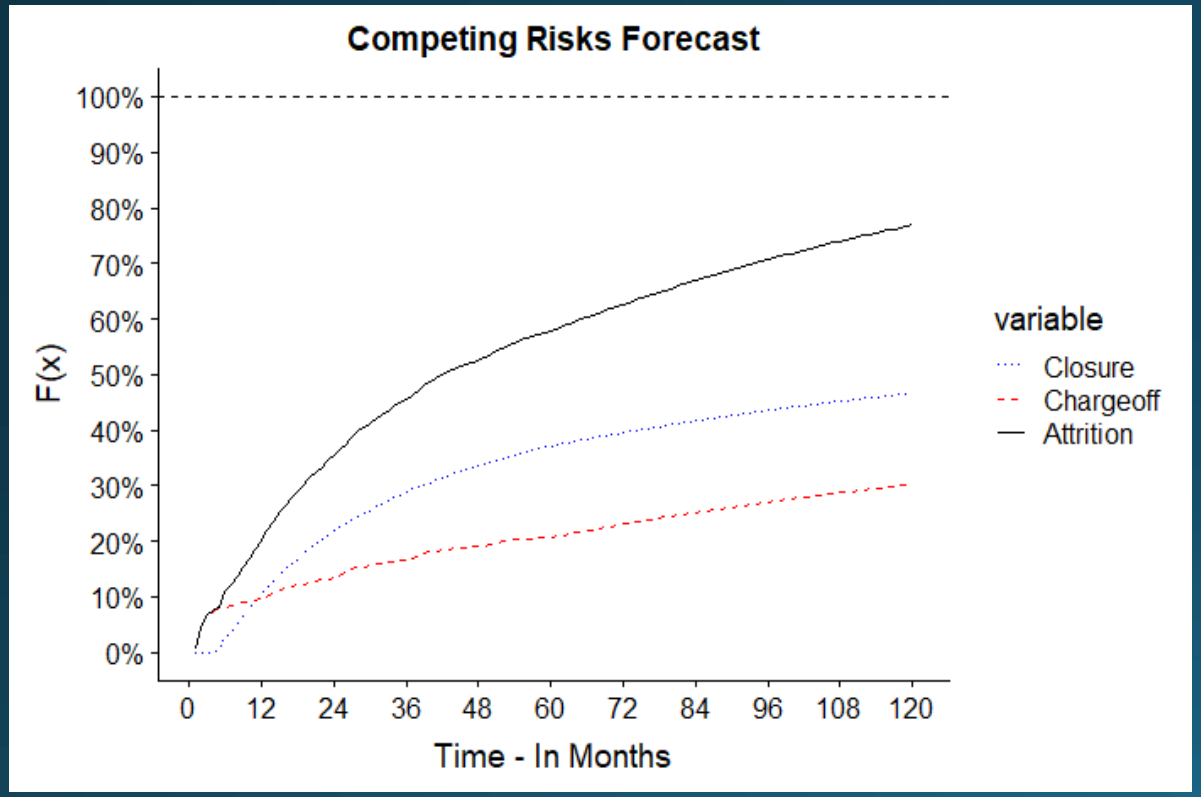
$$\lambda_j(t\,|X) = \lambda_{0j}(t)\exp(X\beta)$$

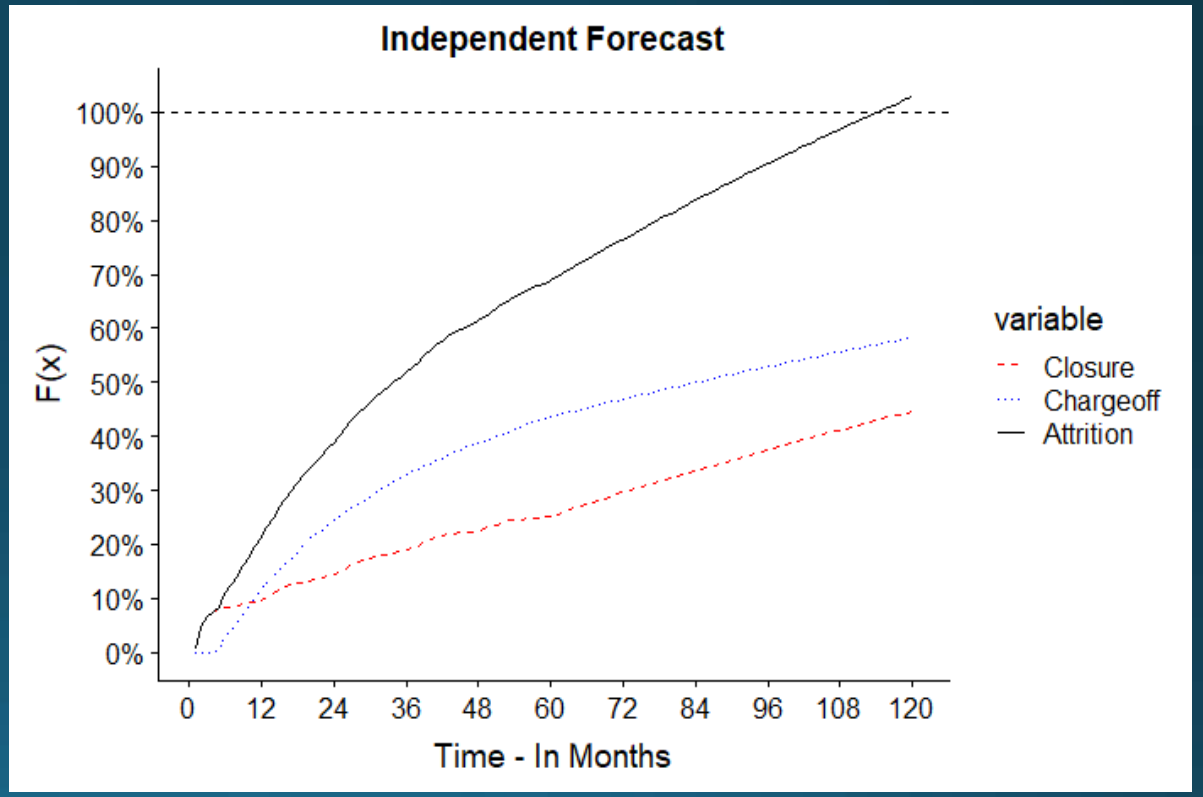
- Results in *j* sets of coefficient estimates
- Can obtain predicted cumulative event curves for each event *j*

$$\widehat{F_{ij}}(t\,|X) = \exp(-\widehat{H_{0j}}(t)\exp(X_i\beta))$$

*Implementation of this in R can be done using Terry Therneau's "Survival" package

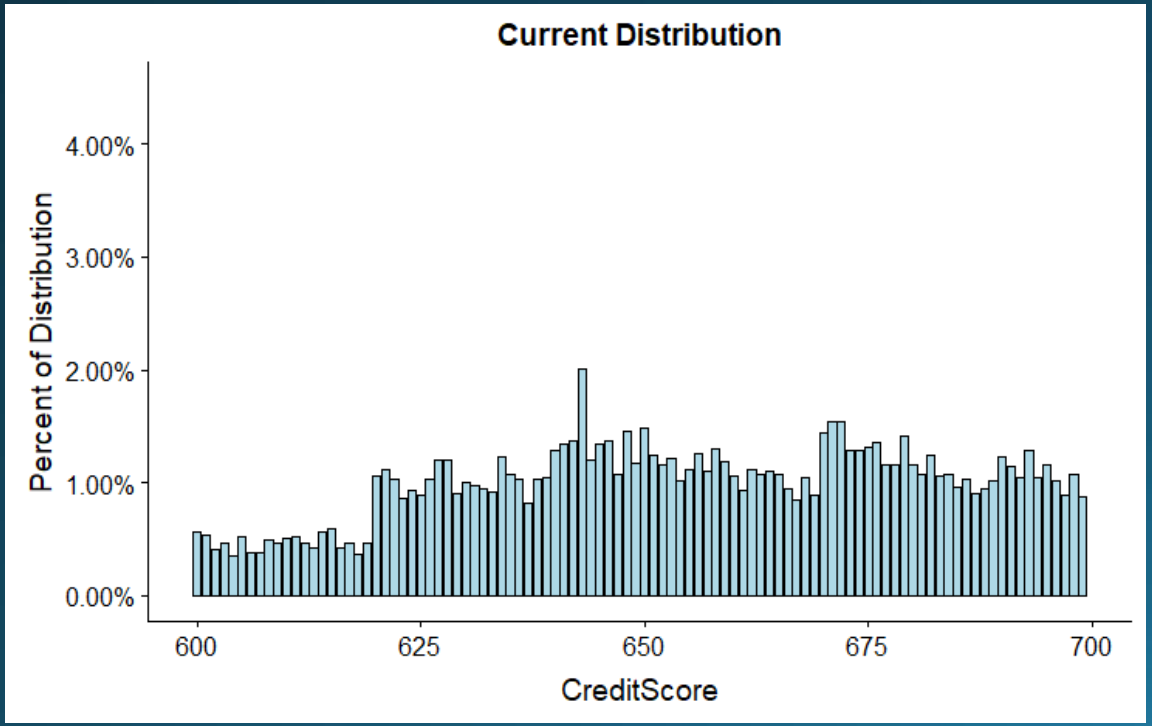
Competing Risks Regression

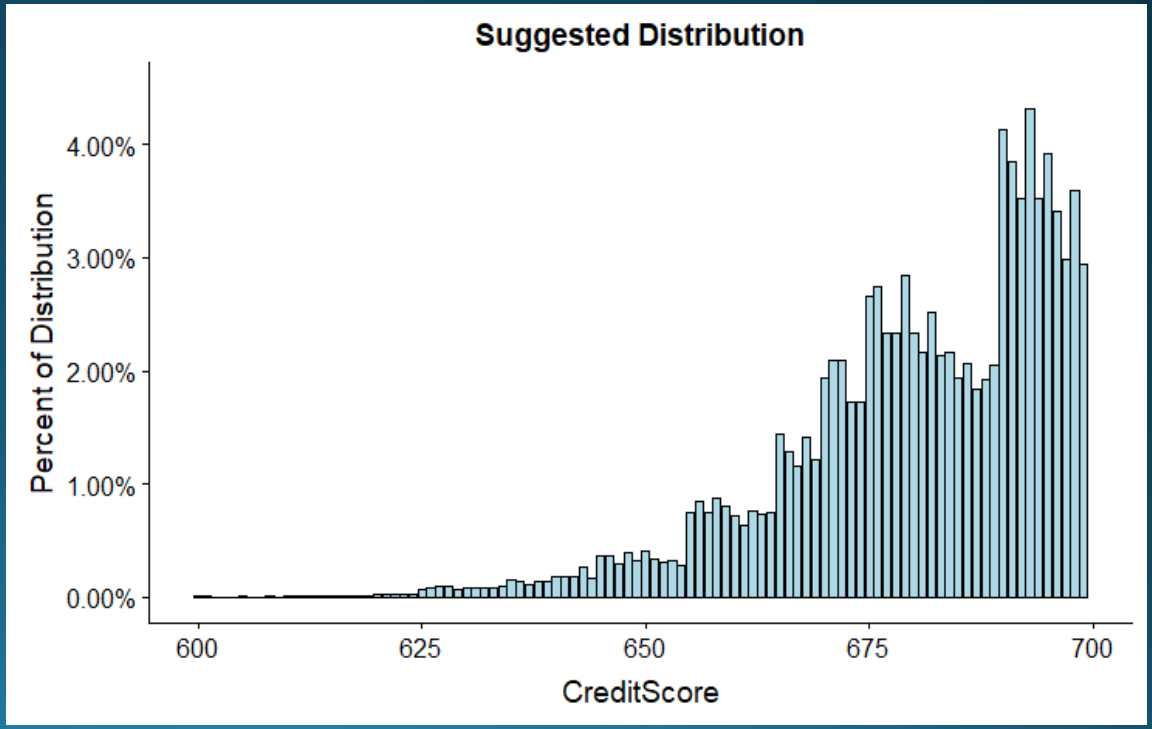




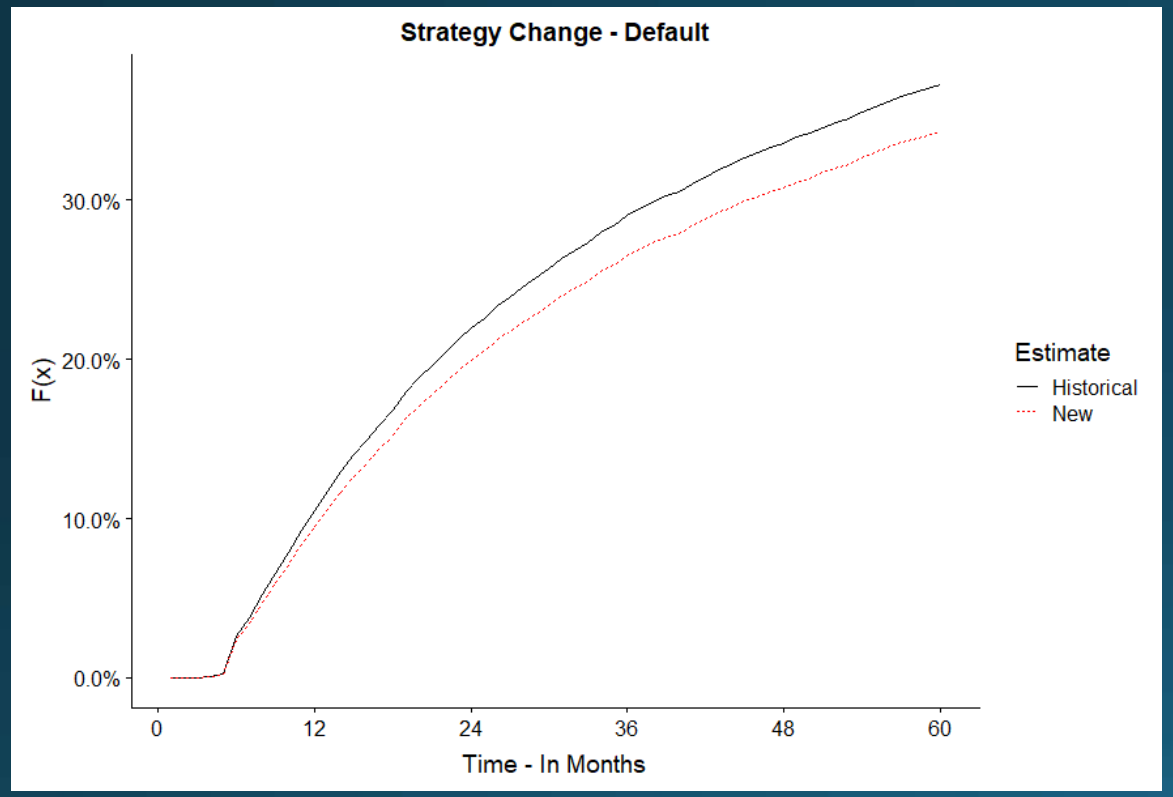
Application

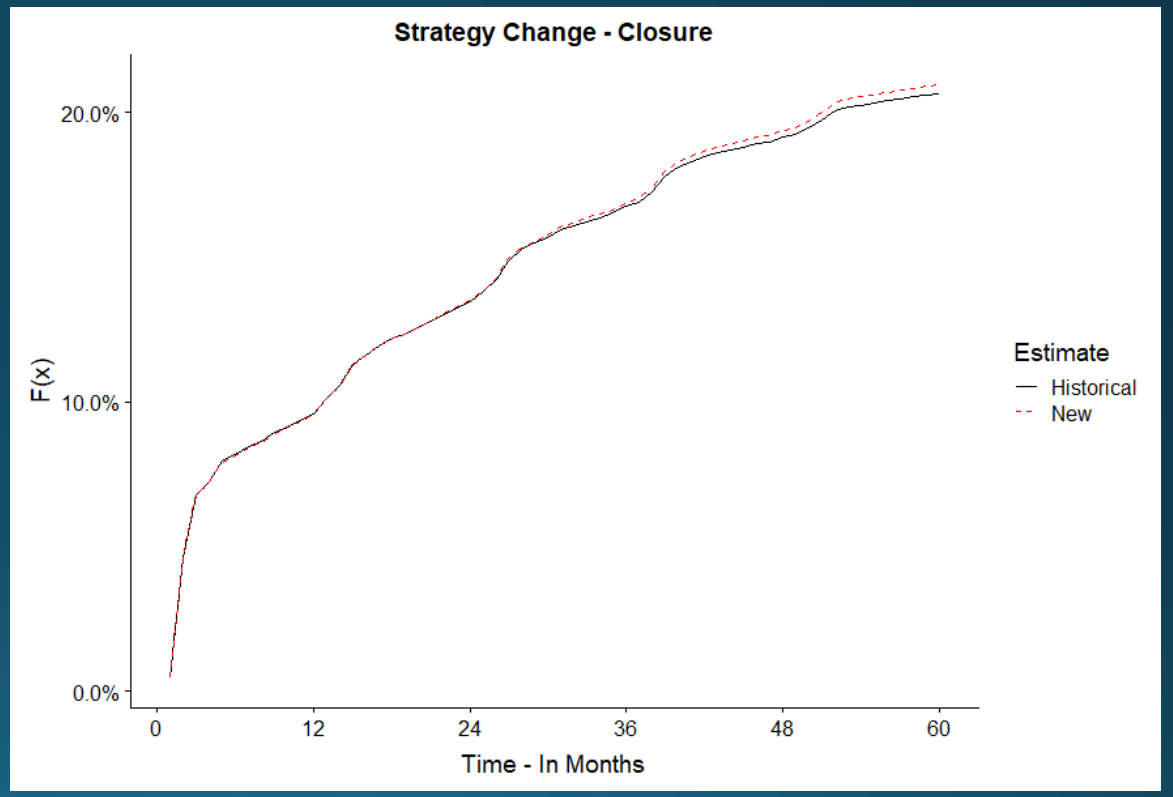
- Risk underwriting determines what accounts are given a credit card solicitation
- According to stakeholder's risk appetite, we can set cutoffs accordingly





Predicted Curves





Questions?