Mortgage Portfolio Models: The Competing Risks of Prepayment and Default

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Facts on mortgage credit risk

- $700 B in junior liens outstanding end of 2004
- $1.01 T in whole loans held by 50 largest banks and thrifts as of 2005 Q1
- $184 B in non-prime mortgages originated 2005 Q1, comprising 28.5% of all new loans
- Fannie/Freddie bought $212 B in non-prime MBS in 2004

➡ increasing amount and type of credit risk in the system, held by many institutions

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Tools for Managing Credit Risk

- Origination/Behavior Models
  - Goal: predict if a new/seasoned loan will default
  - Horizon: 1-24 months
  - Data: large numbers of static variables from origination data (application information, credit bureaus), servicing systems, etc.
- Portfolio Models
  - Goal: predict if <u>and</u> when a loan will default
  - Horizon: 24-360 months
  - Data: smaller number of both static <u>and</u> dynamic variables, drawn largely from post-origination servicing-type systems

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Hazard Models for Portfolios

- Heavily used in prepayment modeling
- A few credit risk-specific references:
  - Alexander et. al. (2002) - subprime mortgages
  - Calem/LaCour-Little - FRB/Wells Fargo (2002) Calhoun/Deng - OFEHO (2002) for mortgages
  - Heitfield/Sabarwal - FRB/UT (2003) for autos
- Increasing use of hazard models for competing risks of prepayment and default in mortgage portfolios

Why Competing Risks Hazard Models?

- Account for static predictive variables
  → "if" a loan defaults
- Address the timing of the default event
  → "when" a loan defaults
- Incorporate time-varying predictive variables
  (i.e., current loan-to-value or asset-to-liability ratios)
  → longer horizons
- Allow for prepayment and other options
  → competing risks

Competing Risks Hazards for Mortgages

- Two equations, simultaneously estimated, that predict both “if” and “when” a loan prepays/defaults
  - Prepayment ~ f(Age, Refinance Incentive, Payment Shock, etc.)
  - Default ~ g(Age, Borrower Strength, Distance to Default, etc.)
- Typical variables
  - Age
  - Distance to Default - current LTV, probability of negative equity, etc.
  - Refinance Incentive - spread/ratio between loan rate and current coupon
  - Borrower Strength - credit score, documentation, occupancy, etc.
  - Payment Shock - rate/payment change, prepayment penalty, etc.

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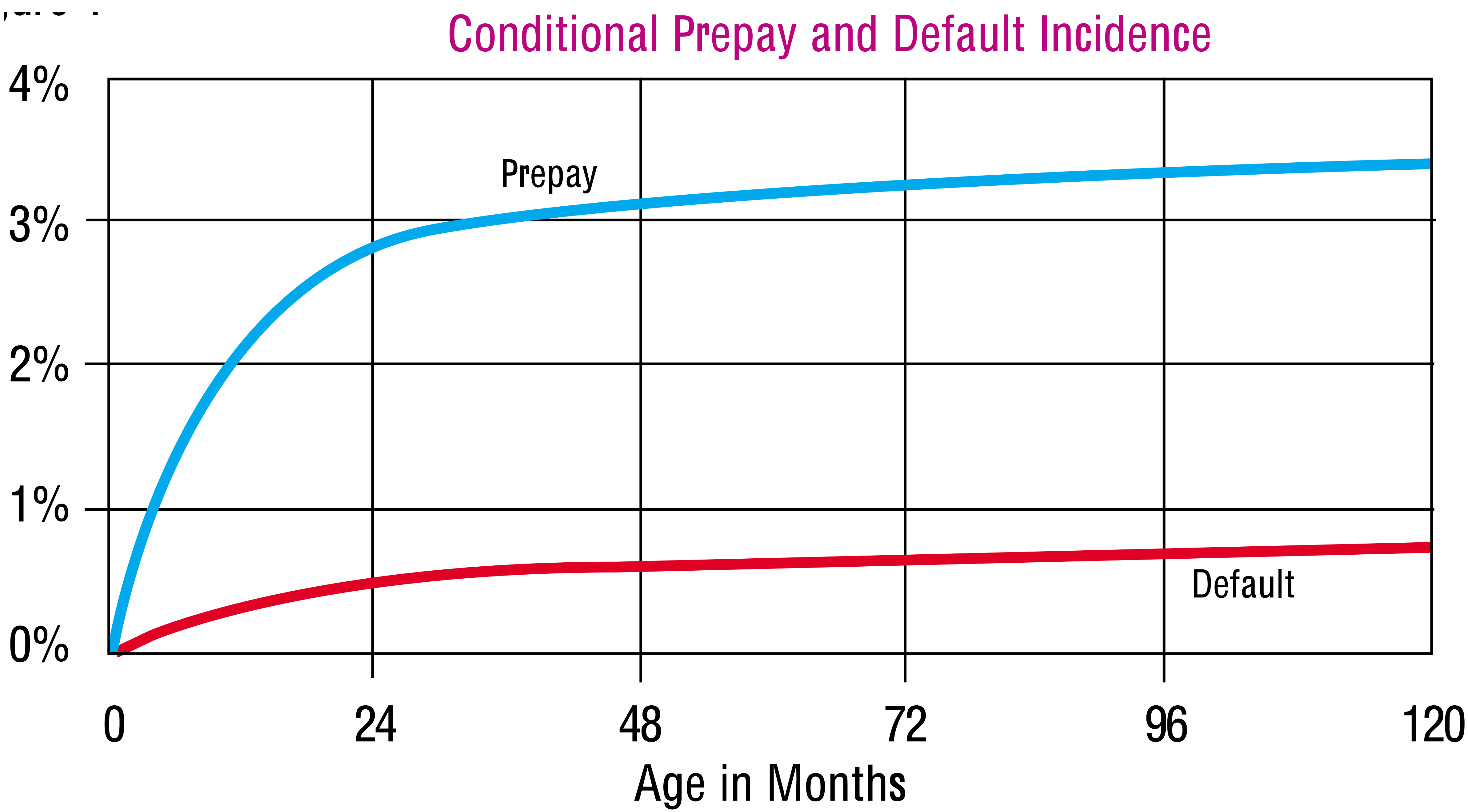
Hazard models provide results under alternative economic futures ("scenarios")

- Account for changing explanatory variables over longer horizons
- Separate the effect of portfolio composition from the effect of risk factors ("macro" effects")
- Obtain projected defaults in a variety of "good" and "bad" scenarios which differ from history
- Account for historical data on risk factors which, unlikely equities, are not remotely lognormal
- Well-understood by investors on Wall Street, and in use for valuation & market risk measurement of MBS, ABS, CLO, CDO, etc.

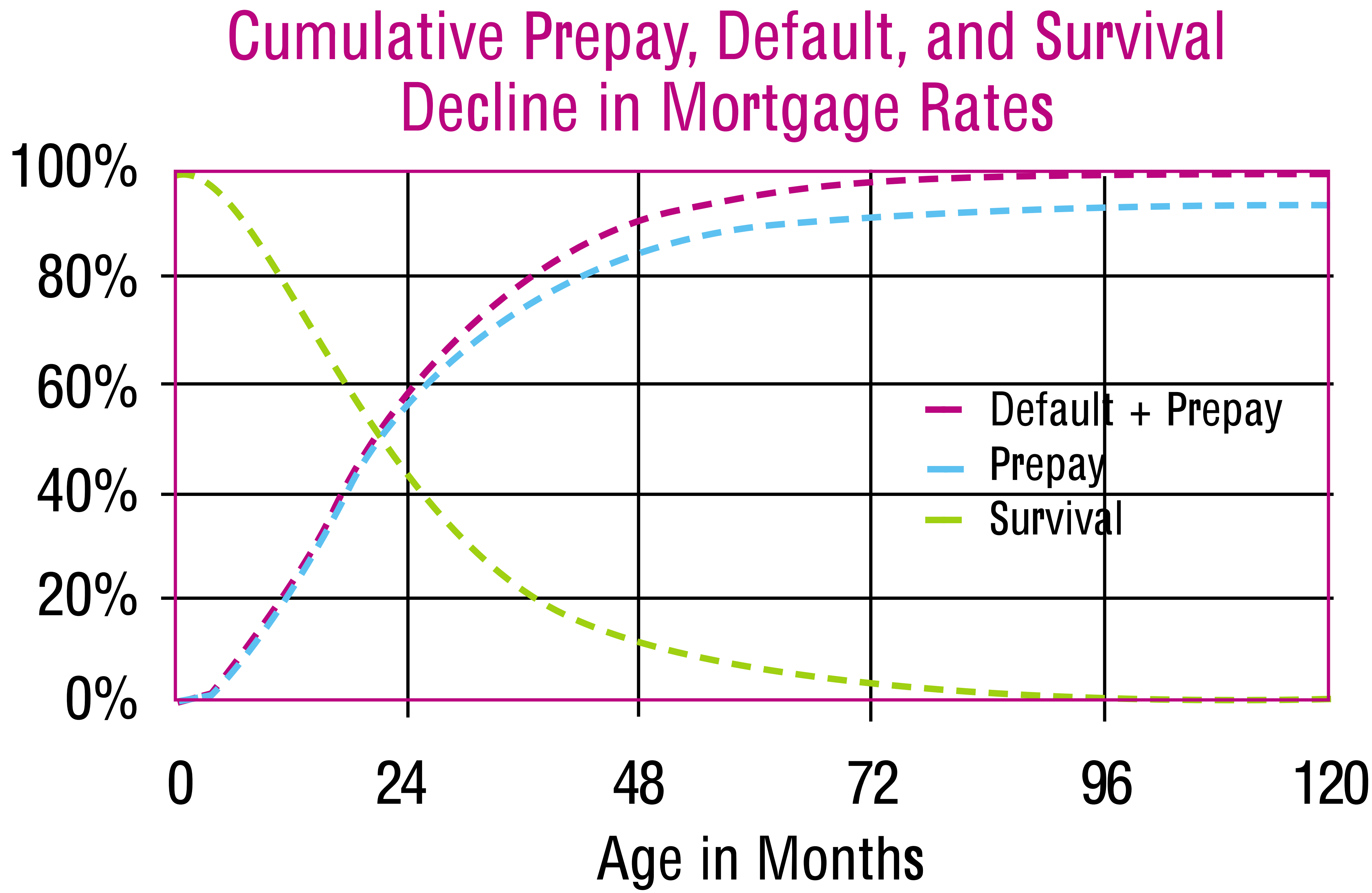
Example: conditional prepayment and default rates for home equity loans



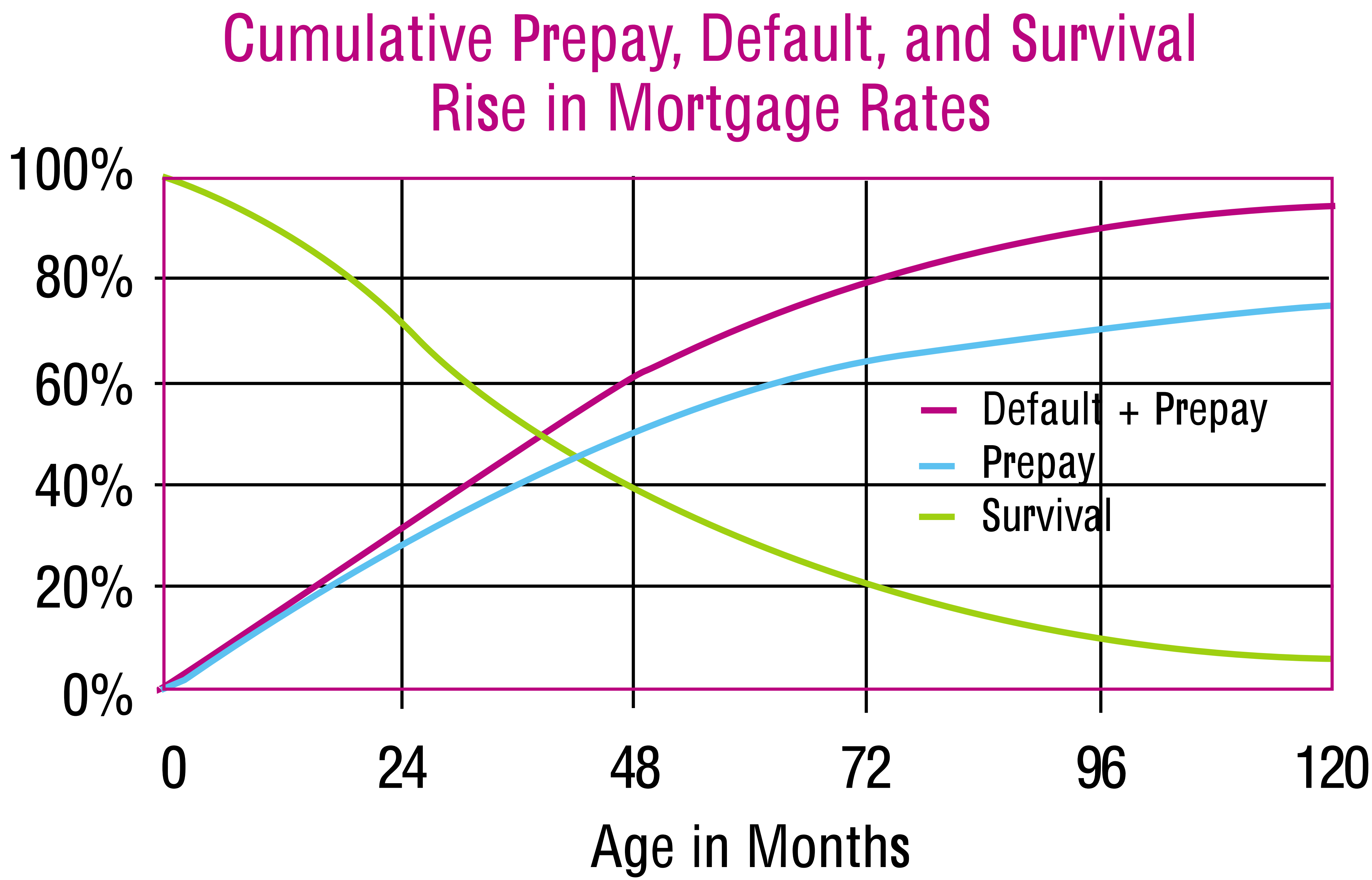
Why are Default and Prepayment Interdependent?

- Two hazards may not be statistically related, but outcomes will be related in other ways
- For each hazard, the probability of transition over longer time intervals will depend on transition probabilities of the other hazard – lifetime default probability will be lower if monthly prepayment probabilities are higher.
- Some observed predictive variables may affect both hazards (prepayment and default)

Competing risks: falling rates -> fast prepays -> little opportunity to default



Competing risks: rising rates -> increased duration -> more defaults



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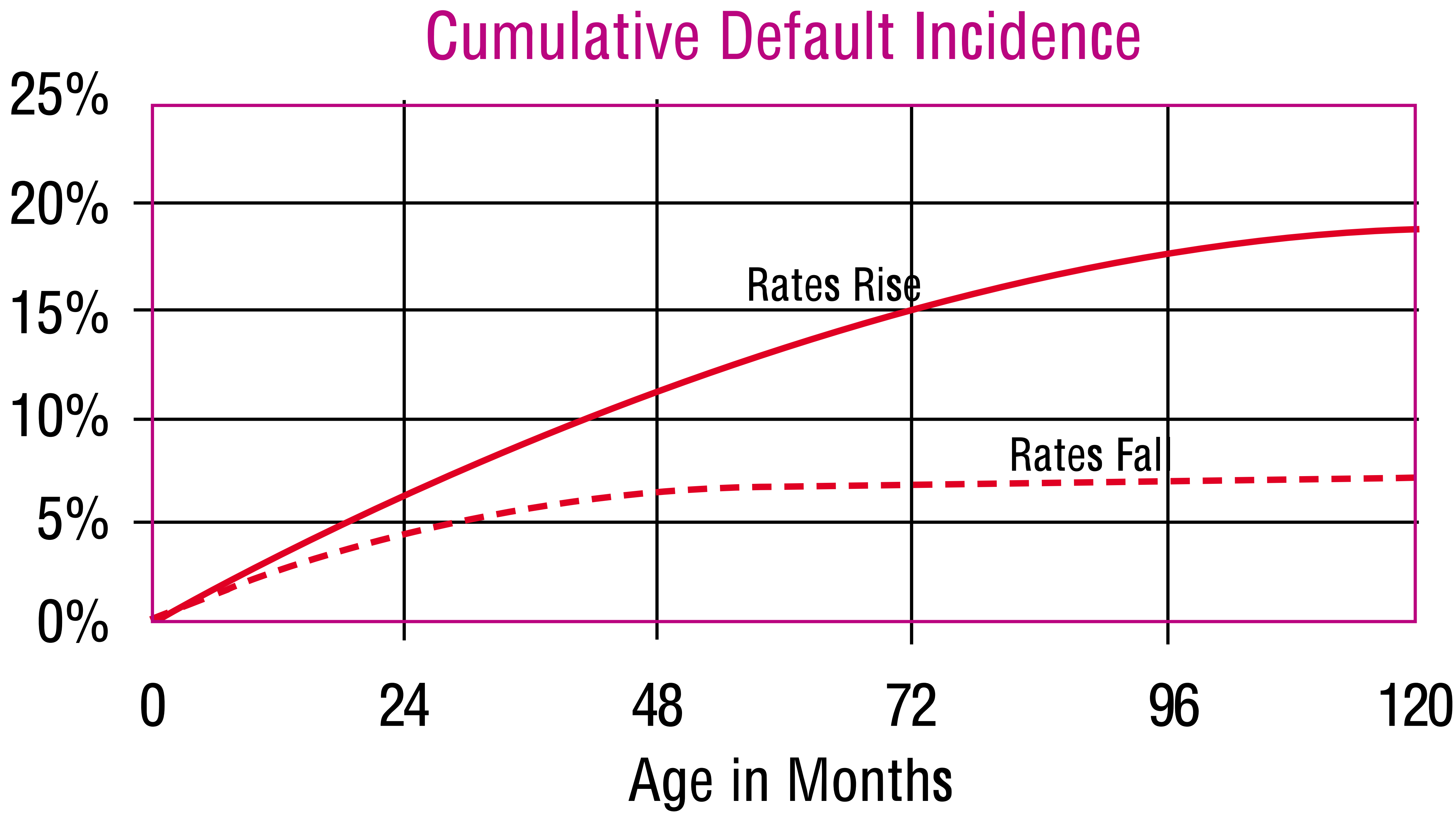
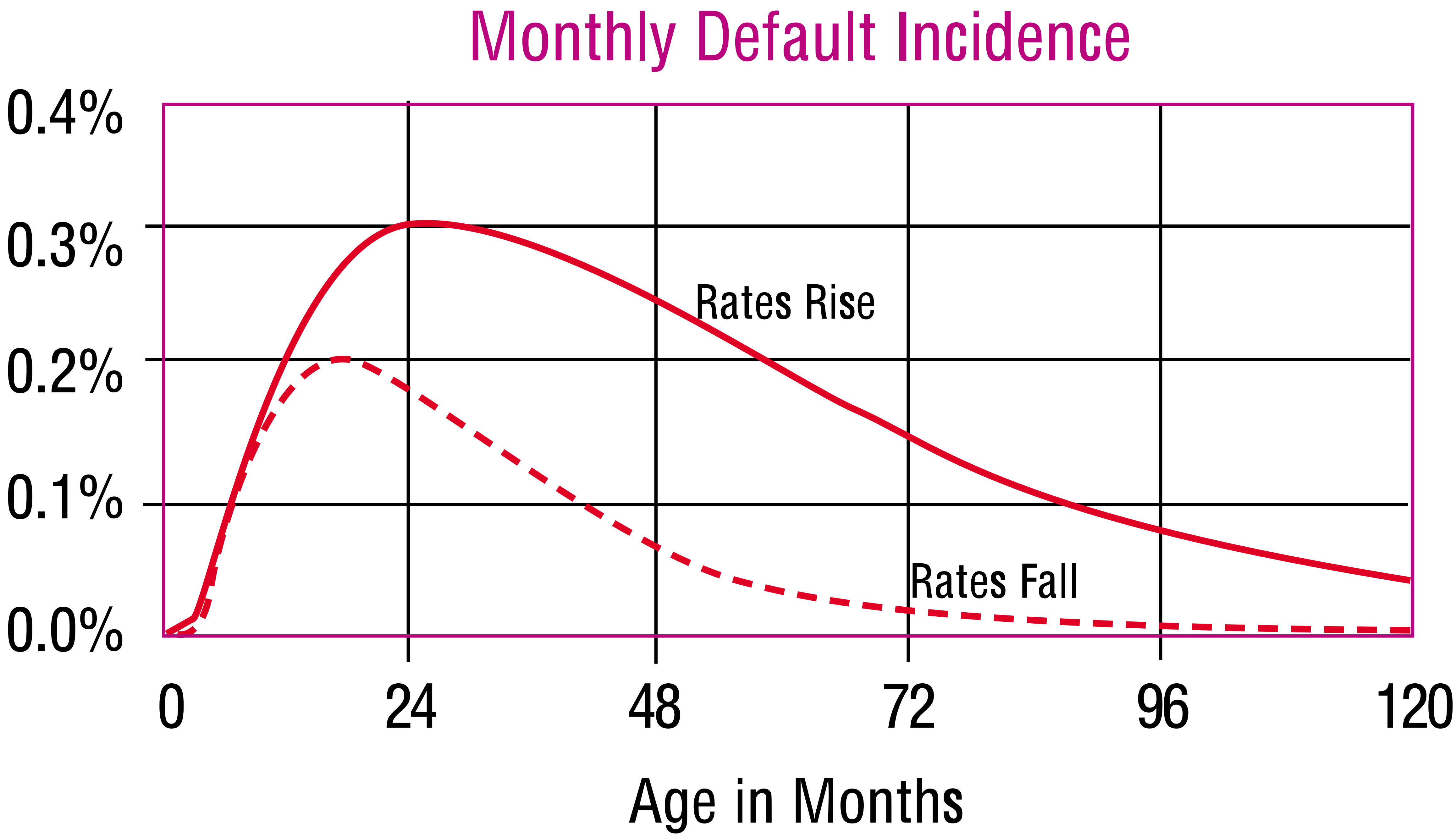
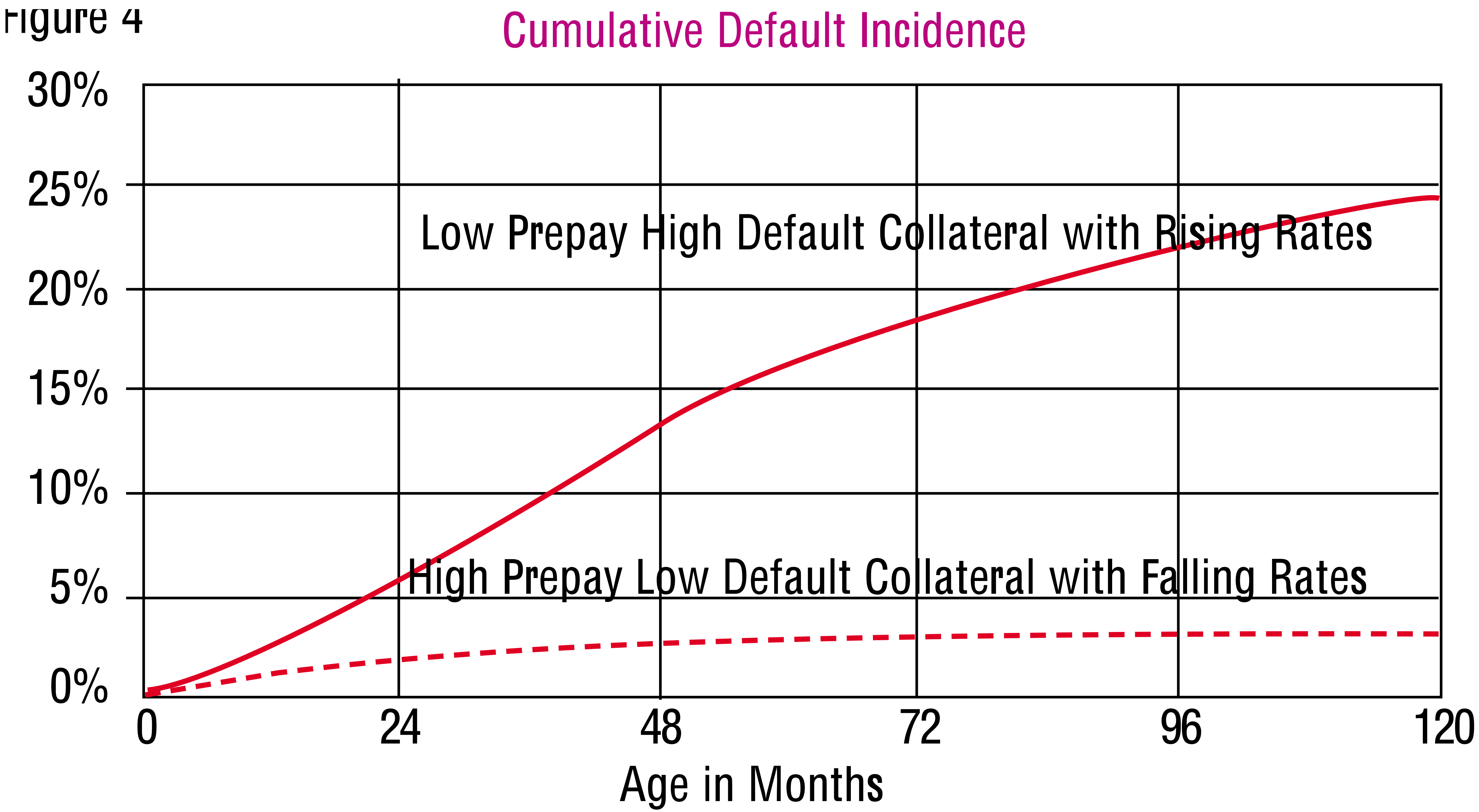
Prepayment affects not only the cumulative number of defaults, . . .



. . . but also the time pattern of defaults.



Combining rate & prepayment impacts results in large default differences



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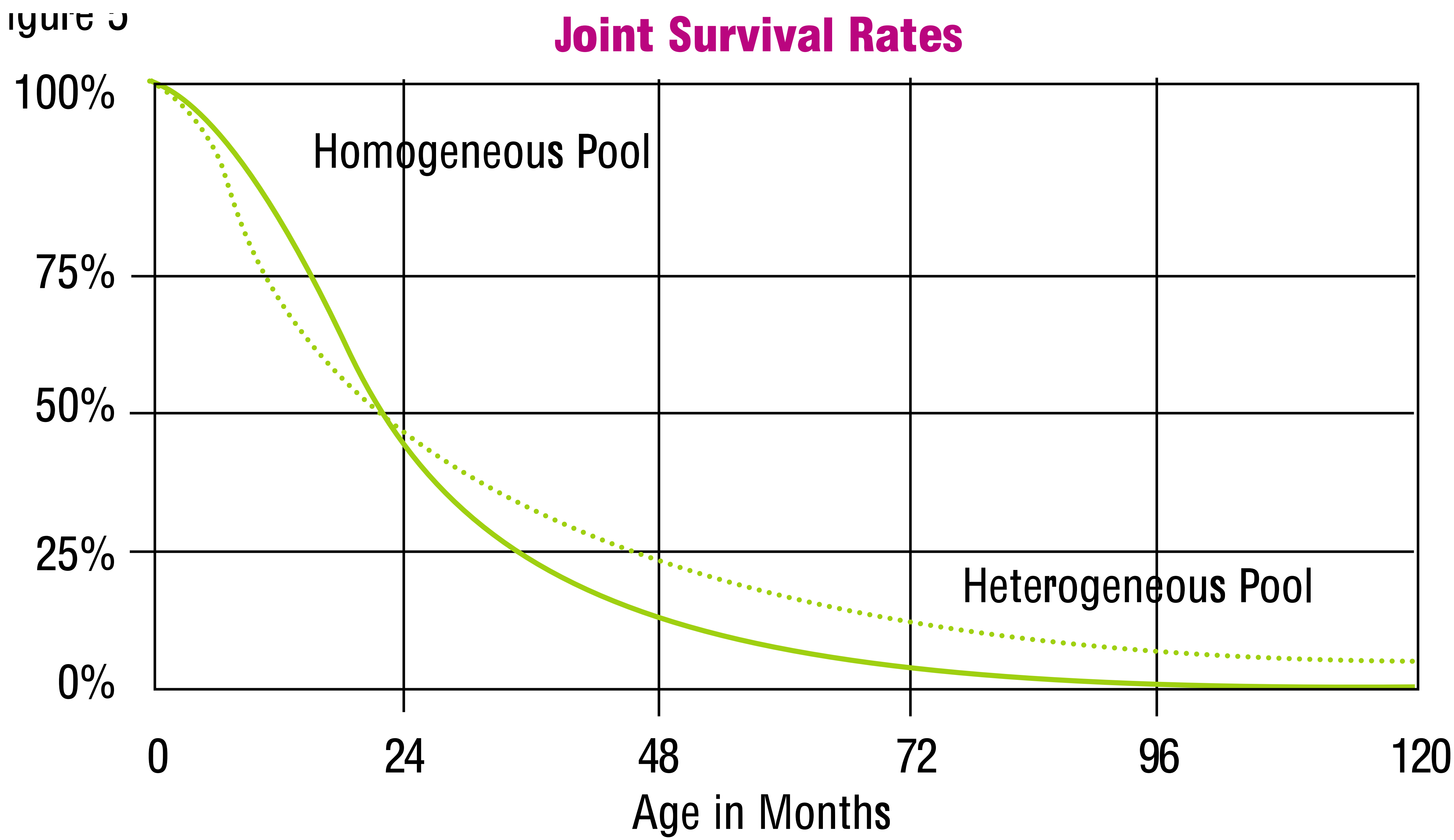
Heterogeneity -> less prepayment -> longer life for the pool



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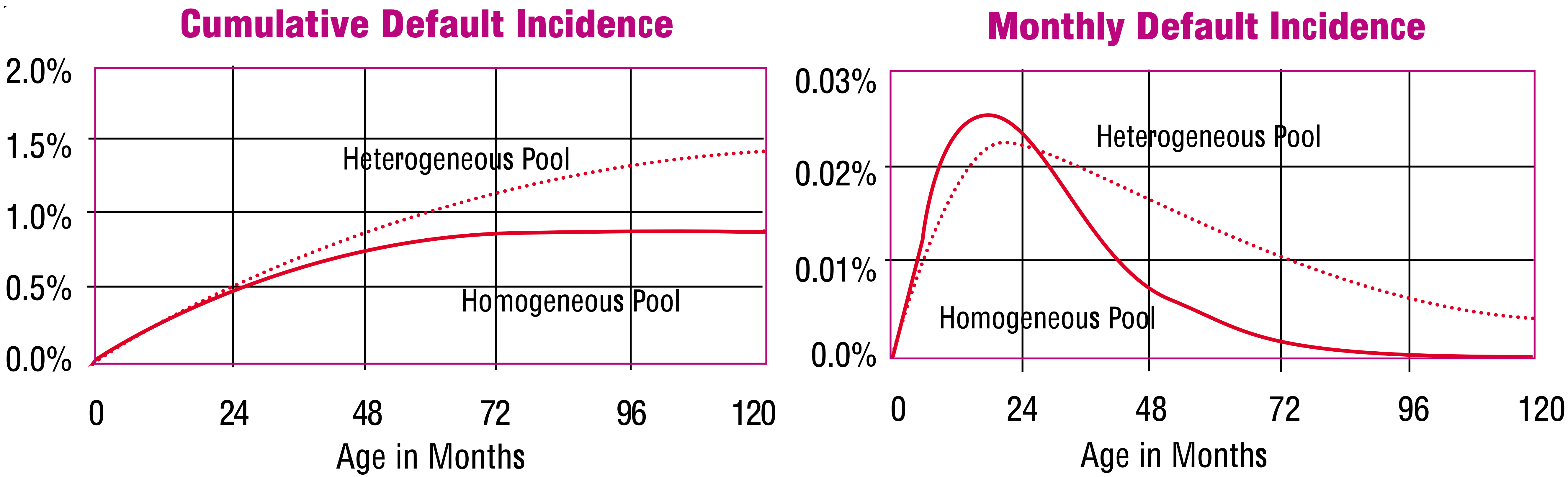
Heterogeneity thus leads to more default



Implications: Loan Loss Reserves

- cumulative defaults, and thus loss (life of loan loss), depend heavily on prepayment speeds
- traditional approaches ignore prepayment, or assume away prepayment variability - an increasingly serious error as horizon increases
- competing risks account for prepayment, and explicitly estimate timing of losses
- competing risks also allow for alternative estimates based on stress tests or scenario distributions of interest rates, house prices, etc.

Implications: Capital Allocation

- Basel II regulatory capital: simple Merton model using single “distance to default”-type variable
- Basel ignores prepayment, limits impact of other explantory variables, chooses arbitrary horizon, etc.
- Economic capital estimates, on the other hand, may be based on internal models without these issues → should be based on competing risks
- Management incentives based solely on Basel-type models potentially lead to sub-optimal behavior

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Implications: Market Risk Hedging

- credit risk typically managed via capital allocation, while prepayment risk considered part of market risk and hedged at the “overall institution” level
- competing risks for mortgages reveals <u>negative</u> correlation between prepayment and default
- consider credit risk as having a negatively correlated component and an uncorrelated component
  → combine the correlated component w/market risk
  - correlated component should not be counted as <u>both</u> market and credit risk
  - remaining uncorrelated component of credit risk is smaller → less capital
  - remaining market risk is smaller (negative correlation) → less market risk