

# Understanding Mortgage Prepayment Models

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U.S. agency residential mortgage-backed securities (RMBS) are the largest and most liquid securitized asset class in the world. Pooling thousands of individual mortgages into a standardized security lets investors easily gain exposure to this important asset class. RMBS provide an attractive yield

relative to U.S. Treasuries with comparable credit risk, but at the cost of assuming prepayment and extension risk. This article describes the drivers of mortgage prepayments and provides a high level overview of the prepayment modeling process.

Residential mortgages typically allow home owners to repay the mortgage balance, partially or in total, prior to the mortgage maturity date. This prepayment option makes it difficult for investors to price RMBS as the prepayment decision is driven by a wide variety of factors and borrower behaviors. Prepayment risk impacts mortgage investors as they are forced to reinvest at potentially lower rates than the yield on the existing RMBS.

Over the past 40 years, academic and industry researchers have developed a number of models for quantifying prepayment risk, which have become a mainstay of the institutional risk management toolbox. Asset managers rely on technology vendors to integrate prepayment models in their portfolio management and risk workflows and to recalibrate these models on a periodic basis as new market and prepayment data becomes available.

While prepayment models can be quite sophisticated, the components and inputs are easy to understand, and go a long way to making this class of models explainable. Understandability is important, because investors and regulators tend to unfairly blame complex buy-side models during times of market stress.

## Prepayment model overview

Top-down models are a popular and proven approach to estimating prepayment rates. In this model, prepayments are a function of aggregate, pool-level characteristics such as weighted average coupon and weighted average loan age. The model is based on the fact that two primary drivers cause mortgage owners to prepay their loans, and is central to understanding mortgage investments:

**Turnover** Barring significant economic shocks, housing generally changes ownership at a constant baseline rate. These sales are due to homeowners moving, upgrading, downsizing, or reducing debt burdens. This is called housing turnover and is the relatively stable, and predictable, component of mortgage prepayments.

**Refinancing** This is a more volatile driver, and can have a far greater impact on prepayment rates than turnover, depending on market conditions. As mortgage rates fall, homeowners have an increasing incentive to refinance, thereby reducing their monthly payments.

### Estimating the prepayment rate is the key element in helping asset managers:

- a) Accurately value RMBS in their portfolios
- b) Compare RMBS to other fixed income securities
- c) Manage portfolio risk under various interest rate scenarios
- d) Understand cash flows

A properly designed front-office technology solution makes this information readily available to portfolio managers, enhancing their ability to make timely, well-informed investment decisions.

## Understanding refinance incentives

**Refinance incentive** The pace of refinancing tends to increase rapidly when current mortgage rates fall below earlier mortgage rates, driven by homeowners looking to reduce their monthly payments. Termed the refinance incentive, this number quantifies the benefit of switching to a lower mortgage rate. One simple and effective proxy for the refinance incentive is the ratio of the current loan rate to the new rate. This value drives the refinance component and is also used in modeling the turnover component of the model.

**Spread at origination (SATO)** Credit quality plays a key role in determining whether or not a mortgage can be refinanced. A useful proxy for aggregate credit quality is the spread at origination: the difference between the coupon on the mortgage and the prevailing rate. A borrower who got a mortgage with a coupon of 5% when prevailing rates are 3% is likely to have much poorer credit than the one who qualified for a coupon of 5% when prevailing rates are 6%. At the time of refinancing, the borrower in the first case will likely pay above the prevailing rate, while the borrower in the second case will typically obtain a better rate. In order to capture this in the model, SATO is added to the current loan rate when calculating the refinance incentive.

Turnover and refinancing rates are typically modeled separately and the final prepayment rate is simply the sum of these two rates.

## Turnover model

The turnover model explains the majority of the prepayment rate during periods of rising interest rates when the refinance incentive is minimal. Data collected during these periods is used to build the turnover model. Three primary factors that describe borrower behaviour serve as model inputs:

**Seasonality** captures monthly and annual variation in prepayment rates. For example, typically more homes sell in the summer than winter.

**Seasoning** describes the dependence of turnover rates on the age of the loan. Newer buyers are far less likely to sell than owners who have been in a property for several years.

**Lock-in** arises when a borrower who wants to sell doesn't do so, as mortgage rates are noticeably higher than the current rate on the loan. The higher rates mean, for example, that the property may have decreased in value or that monthly payments on a new property may be too high.

## Refinance model

This model uses the refinance incentive and seasoning as predictors, in addition to a third factor termed "burnout". As the incentive to refinance increases, prepayments rise quickly before leveling off. Once the incentive has been at a high level long enough, all homeowners who want to refinance will have done so. Prepayment rates then start to decline, despite the refinance incentive remaining attractive.

This is called burnout, and is due to the heterogeneity of the borrowers in any given pool: some are quick to refinance when the opportunity arises while others are less responsive to these incentives, whether voluntarily or due to their changed financial circumstances. Essentially, burnout is when mortgage holders do not refinance despite repeated opportunities to do so.

## Applying prepayment models to value RMBS

For securities with optionality, such as RMBS, an interest rate model is needed for valuation, as the decision to exercise the option depends on interest rate levels. A number of interest rate models have been developed for valuing interest rate derivatives, and short-rate models such as the two-factor Hull-White model are a good choice for valuing RMBS.

**While mathematically sophisticated, valuing an RMBS is conceptually simple:**

- a) Simulate mortgage paths using the 10 year swap rate (a close interest rate proxy for mortgage rates)
- b) Calculate the cash flows along each path using the prepayment model
- c) Generate the discount factors along each path.
- d) The RMBS price is then simply the average of the discounted cash flows over all mortgage rate paths.

## The importance of accurate prepayment models

Given their liquidity and low credit risk, RMBS are a widely held asset class in institutional portfolios. A good prepayment model allows asset managers to make better informed trading and portfolio allocation decisions across all phases of the interest rate cycle and plays a key role in managing these investments properly. While prepayment modeling is a well-established discipline, both technology vendors and academics continue to work to improve model accuracy and responsiveness.

It is incumbent on buy-side technology vendors to make prepayment models an integral component of their portfolio and risk analytics platforms. This provides portfolio managers with accurate RMBS valuations and cash flow projections, and allows them to effectively manage prepayment risk during times of falling interest rates.

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