

# Residential mortgage-backed securities and their pricing

Fekete Fanni

December 9, 2021

Supervisor: Molnár-Sáska Gábor

## 1 Introduction

Mortgage-backed securities (MBS) are debt-based securities, where the cashflows (CF) come from the payments of a "pool" of mortgages. Residential mortgage-backed securities (RMBS) are a type of MBS, backed by the interest paid on loans for residences. For investors there are a few risks, if someone no longer can pay for their mortgage, we call this default, and if the borrower pays back the mortgage early, therefore the flow of interest rates stop.

During this semester I studied this topic, it has many interesting aspects that can vary depending on the risk. First I would discuss the features of a bond, then the general idea of mortgage-backed securities and residential mortgage-backed securities. After these topics, I would present what happens when a borrower pays back the loan early, and what happens if they could not pay. Then I would talk about the idea of pricing bonds and MBSs, and ultimately in what direction I would like to continue in the future.

## 2 Theoretical background

### 2.1 Bonds and their characteristics

Today there are two ways for an entity to raise capital: issuing equity and issuing fixed-income securities. Fixed-income is a commonly used method for governments and companies to borrow money from investors.

Fixed-income securities differ from equities in several ways:

- a fixed-income investor has no ownership rights in the business.
- the money borrowed (principal) is repaid at maturity. In addition, interest on the borrowed money is paid periodically.
- fixed-income investors get paid before the common shareowners; hence the risk is lower.

A bond is a fixed-income instrument that represents a loan made by an investor to a borrower (typically corporate or governmental). A bond could be thought of as an I.O.U. (an informal document acknowledging debt) between the lender and borrower that includes the details of the loan and its payments. Bonds are used by companies, municipalities, states, and sovereign governments to finance projects and operations. Owners of bonds are debtholders, or creditors, of the issuer.

Bond details include the end date when the principal of the loan is due to be paid to the bond owner and usually include the terms for variable or fixed interest payments made by the borrower.

At first we should take a look on the basic features of a bond.

### **2.1.1 Issuer**

The issuer is the entity that has issued a bond or the one who borrowed money. It is responsible for servicing the debt, that is paying interest and principal payments.

Governments and corporations commonly use bonds in order to borrow money. Governments need to fund roads, schools, or other infrastructure. Corporations will often borrow to grow their business, to buy property, for research and development, for hiring employees. There lies the problem of needing much more money for reasons like above than the average bank can provide. For this reason they are using bonds, allowing many individual investors to assume the role of the lender. Indeed, public debt markets let thousands of investors each lend a portion of the capital needed. Moreover, markets allow lenders to sell their bonds to other investors or to buy bonds from other individuals—long after the original issuing organization raised capital.

All bonds are exposed to *credit risk* which is a risk that the interest and principal payments will not be made by the issuer as they come due. There are credit rating agencies which assign a rating to issuers based on this risk.

### 2.1.2 Maturity

We call the date on which the last payment is made for a bond the maturity date, in other words it is the date on which the bond issuer will pay the bondholder the *face value* of the bond. Once a bond is issued, the time remaining until maturity is called the *tenor* of the bond.

The *face value* ( or *par value/ maturity value/ redemption value*) is the money amount the bond will be worth at maturity, but it is also the reference amount the bond issuer uses when calculating interest payments.

We say that:

- if the market price is bigger than the par value, then the bond is trading at *premium*;
- if the market price is less than the par value, then the bond is trading at *discount* and
- if the market price is equal to the par value, then the bond is trading at *par*.

The *issue price* is the price at which the bond issuer originally sells the bonds.

The *coupon rate* is the rate of interest the bond issuer agrees to pay on the face value of the bond, expressed as a percentage. This can be a fixed-, or a floating rate.

For example, a 5% coupon rate means that bondholders will receive  $5\% \times \$1000$  face value = 50 every year.

*Coupon dates* are the dates on which the bond issuer will make interest payments. The payments can be made in any interval: annual, quarterly, monthly, but the standard is semiannual payments.

## 2.2 Yield measures

There are two widely used yield measures to describe a bond: the current yield and the yield to maturity.

### 2.2.1 Current yield or running yield

The current yield is the annual coupon divided by the bond's price and expressed as a percentage.

For example we have a 3 year annual coupon bond with the face value of \$100, issued at \$95. The coupon rate is 10%, which means the coupon payments are \$10 every year. In this case the current yield is  $\frac{10}{95} = 10,5\%$ .

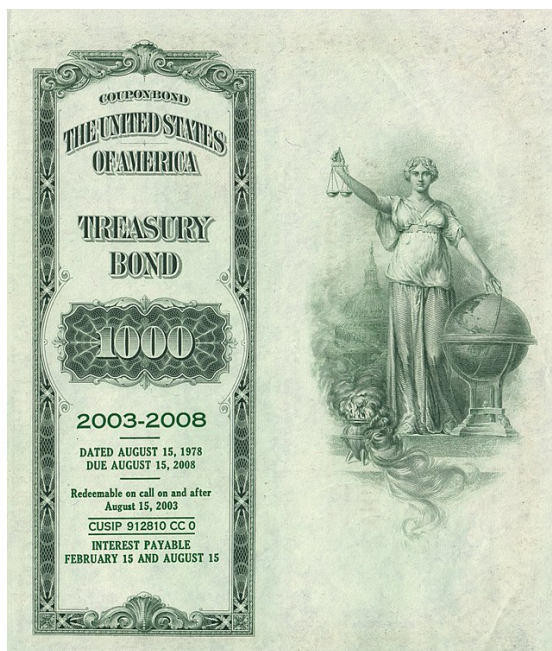


Figure 1: An example of a treasury bond.

## 2.3 Bond Pricing

There are a few ways to price a bond. For example we can use the market discount rate, the yield to maturity, spot rater, matrix pricing, yield spreads and so one. I would like to mention just two types below.

### 2.3.1 Yield to maturity

The yield to maturity (YTM) is a way to consider a bonds' price. Yield to maturity is considered a long-term bond yield but is expressed as an annual rate: is the internal rate of return on a bond's expected cash flows. In other words, it is the expected annual rate of return an investor will earn if the bond is held to maturity.

YTM is a complex calculation but is quite useful as a concept evaluating the attractiveness of one bond relative to other bonds of different coupons and maturity in the market.

$$YTM = \sqrt[n]{\frac{\text{Face value}}{\text{Present value}}} - 1. \quad (1)$$

## 2.4 Bond pricing with market discount rate

A bond's price is the present value of all the future cash flows at the market discount rate. The discount rate is the rate of return required by investors given the risk of investment in the bond.

$$PV \text{ of a bond} = \frac{PMT}{(1+r)^1} + \frac{PMT}{(1+r)^2} + \cdots + \frac{PMT + FV}{(1+r)^N}, \quad (2)$$

where  $PMT = \text{coupon payment per period}$ ,  $FV = \text{par value the bond paid at maturity}$ ,  $r = \text{market discount rate}$ ,  $N = \text{number of periods until maturity}$ .

## 2.5 Securitization

A mortgage-backed security represents an ownership interest in mortgage loans made by financial institutions to finance a borrower's purchase of a home or other real estate. Mortgage backed securities are created when mortgage loans are packaged, or "pooled", by issuers or servicers, and securities are issued for sale to investors. As the underlying mortgage loans are paid off by the borrowers, the investors in the securities receive payments of interest and principal.

Mortgage-backed securities play a crucial role in the availability and cost of housing in the United States. The ability to securitize mortgage loans enables mortgage lenders and mortgage bankers to access a larger reservoir of capital, which makes financing available to home buyers at lower costs and spreads the flow of funds to areas of the country where capital may be scarce.

Asset securitization began when the first mortgage pass-through security was issued in 1970, with a guarantee by the Government National Mortgage Association ("GNMA" or Ginnie Mae). The most basic mortgage-backed securities, known as pass-throughs or participation certificates ("PC"s), represent a direct ownership in a pool of mortgage loans. Shortly after this issuance, both the Federal Home Loan Mortgage Corporation ("FHMLC" or Freddie Mac) and Federal National Mortgage Association ("FNMA" or Fannie Mae) began issuing mortgage-backed securities.

Although mortgage-backed securities are fixed-income securities that entitle investors to payment of principal and interest, they differ from corporate and Treasury securities in significant ways. With a mortgage-backed security, the ultimate borrower is the homeowner who takes on a mortgage loan. Because the homeowner's monthly payments include both interest and principal, the mortgage-backed security investor's principal is returned over the life of the security,

or amortized, rather than repaid in a single lump sum at maturity.

Mortgage-backed securities provide payments to investors that include varying amounts of both principal and interest, due to the flexibility that the homeowner has in being able to pay more than the minimum payment required by the loan agreement. As the principal is repaid, or prepaid, the interest payments become smaller because the payments are based on a lower amount of outstanding principal. In addition, while most bonds pay interest semiannually, mortgage-backed securities may pay interest and principal monthly, quarterly or semiannually, depending on the structure and terms of the issue. Most mortgage pass-through securities are based on fixed-rate mortgage loans with an original maturity of 30 years, but typically most of these loans will be paid off much earlier.

## **2.6 The trading of agency pass-throughs**

Mortgage-backed securities are traded in the over-the-counter (OTC) market, and much of the volume in the agency mortgage-backed security market today is in the form of to-be-announced (TBA) trading. A TBA is a contract for the purchase or sale of mortgages to be delivered at a future agreed-upon-date; however, the actual pool identities or the number of pools that will be delivered to fulfill the trade obligation or terms of the contract are unknown at the time of the trade. The TBA market is based on one fundamental assumption: homogeneity. The TBA market is based on the assumption that the specific mortgage pools which will be delivered are fungible, and thus do not need to be explicitly known at the time a trade is initiated. At a high level, one pool is considered to be interchangeable with another pool.

Actual mortgage pools guaranteed by Ginnie Mae, Fannie Mae, Freddie Mac are subsequently assigned or "allocated" to the TBA transactions to be delivered upon settlement. Settlement dates are standardized by product type (e.g. 30-year Fannie Mae/Freddie Mac pools, 30-year Ginnie Mae pools). Monthly settlement date calendars for the TBA market are published one year in advance by a Securities Industry and Financial Markets Association ("SIFMA") committee on a rolling 12-month basis. This is done to increase the efficiency of the settlement infrastructure. Pools may, however, be settled on days other than the established settlement date if the parties to the trade desire.

For example, in a typical trade, a buyer may ask to purchase a \$100 million of 30 year Fannie Mae Mortgages with a 6% coupon for delivery next month. The buyer does not know the exact

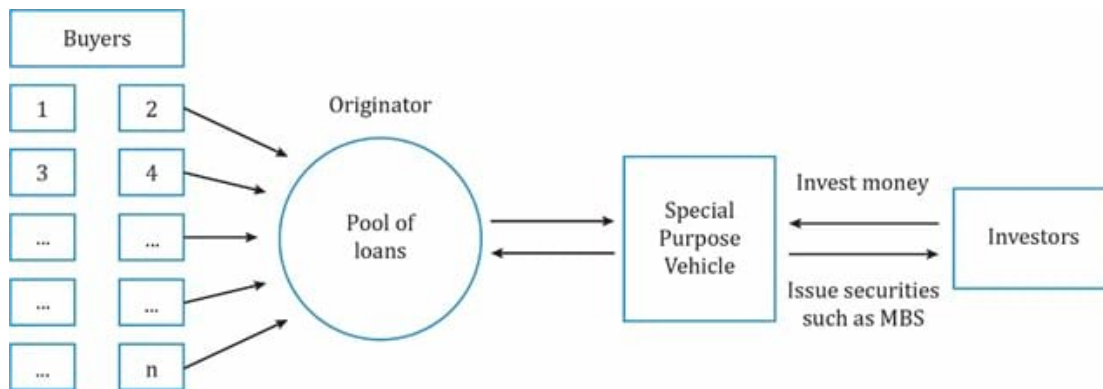


Figure 2: How securitization works.

bonds that will be delivered. According to industry practice, two days before the contractual settlement date of the trade (known as 48-hours day), the seller will communicate to the buyer the exact details of the mortgage-backed security pools that will be delivered.

The TBA market is the most liquid, and consequently the most important secondary market for mortgage loans in the world. Market participants that benefit from TBA trading are the mortgage bankers, commercial banks, and thrifts that originate residential mortgages and sell them into the secondary mortgage market in securitized form.

During most mortgage application processes, a borrower may lock in a mortgage rate at some point prior to the closing of the loan. After this rate lock, the mortgage originator is exposed to interest rate risk: the risk that the value of the mortgage may change as market rates change before the mortgage is sold. Actual mortgage-backed security pools can only be formed after the mortgages close; while the mortgages are awaiting closing, pool characteristics may shift if applicants withdraw their applications, postpone closing, fail to meet underwriting standards or change loan amounts.

## 2.7 Tranches

A portfolio of income-producing assets such as mortgage loans in this case is sold by the originating banks to a Special Purpose Vehicle (SPV) and the cashflows from the assets are then allocated to tranches. These loans are divided up by risk, time to maturity, or other characteristics in order to be marketable to different investors. Each portion or tranche of a securitized or structured product is one of several related securities offered at the same time, but with varying risks, rewards and maturities to appeal to a diverse range of investors.

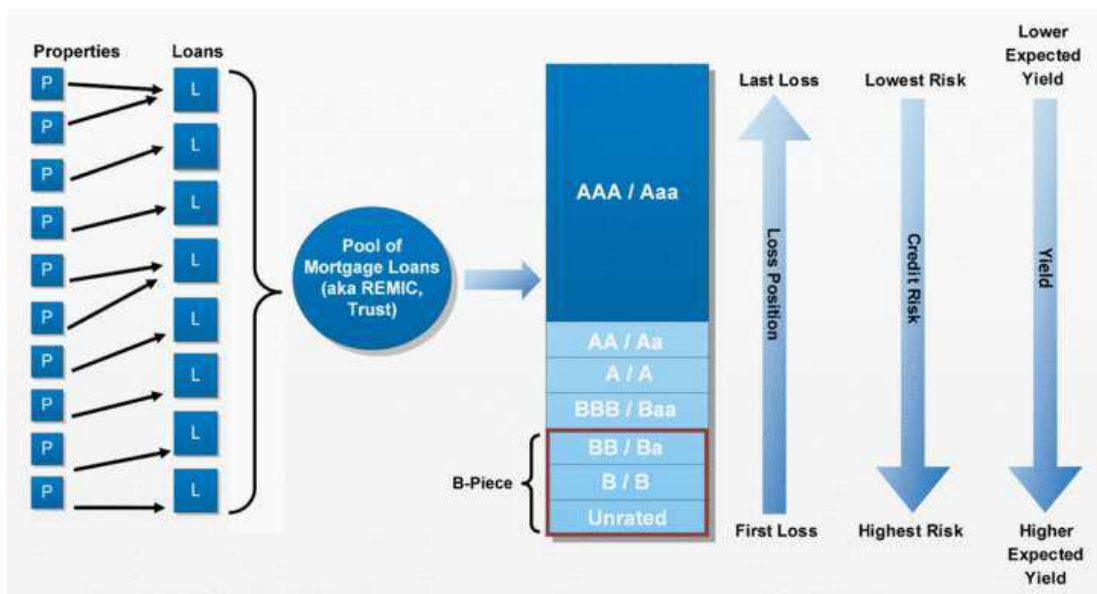


Figure 3: How tranches look like.

For example we can divide these tranches into three categories: senior tranches, mezzanine tranches (the middle tranches) and junior tranches. Senior tranches typically contain assets with higher credit ratings than junior tranches. The senior tranches have first lien on the assets—they're in line to be repaid first, in case of default. Junior tranches have a second lien or no lien at all.

In the case of Figure 3 the tranches are divided by credit rating: AAA/Aaa is the best, therefore the senior tranche; the mezzanine tranche contains the ratings AA/Aa, A/A and BBB/Baa and the remaining is included in the junior tranche.

Investors receive monthly cash flow based on the MBS tranche in which they invested. They can either try to sell it and make a quick profit or hold onto it and realize small but long-term gains in the form of interest payments. These monthly payments are bits and pieces of all the interest payments made by homeowners whose mortgage is included in a specific MBS.

## 2.8 The constant default rate

The constant default rate (CDR) is the percentage of mortgages within a pool of loans in which the borrowers have fallen more than 90 days behind in making payments to their lenders.

The CDR evaluates losses within mortgage-backed securities. The CDR is calculated on a monthly basis and is one of several measures that those investors look at in order to place



a market value on an MBS. The method of analysis emphasizing the CDR can be used for adjustable-rate mortgages as well as fixed-rate mortgages.

The CDR can be expressed as a formula:

$$CDR = 1 - \left(1 - \frac{D}{NDP}\right)^N, \quad (3)$$

where  $D =$  Amount of new default during the period,

$NDP =$  Non – defaulted pool balance at the beginning of the period,

$N =$  Number of periods per year.

To protect investors from losing money on default, the security usually contains a *recovery rate*. Recovery rate is the extent to which principal and accrued interest on defaulted debt can be recovered, expressed as a percentage of face value.

The recovery rate enables an estimate to be made of the loss that would arise in the event of default, which is calculated as  $(1 - \text{Recovery Rate})$ . Thus, if the recovery rate is 60%, the loss given default or LGD is 40%.

The type of instrument and its seniority within the tranches are among the most important determinants of the recovery rate. The recovery rate is directly proportional to the instrument's seniority, which means that an instrument that is more senior in the tranches will usually have a higher recovery rate than one that is lower down in the tranches.

## 2.9 The conditional prepayment rate

A conditional prepayment rate (CPR) is an estimate of the percentage of a loan pool's principal that is likely to be paid off prematurely. The estimate is calculated based on a number of factors, such as historical prepayment rates for previous loans similar to the ones in the pool and future economic outlooks.

The CPR can help investors gauge the likely return on an investment and their prepayment risk, especially in changing economic conditions.

For example, in a time of declining interest rates, homeowners often prepay their mortgages to refinance them at a lower rate. When that occurs, the mortgage-backed security that their mortgage is packaged into may be paid back sooner than expected, with the proceeds released

back to the investor. The investor then needs to choose a new security to invest in, which is likely to have a lower rate of return since interest rates overall have dropped since their original investment.

The CPR can be expressed as a formula:

$$CPR = 1 - (1 - SMM)^{12}, \quad (4)$$

where  $SMM =$  *In effect, the amount of principal on mortgage-backed securities that is prepaid in a given month.*

In case of a prepayment, the borrower has to pay additional fees in addition the the principal, like a punishment for paying back the loan early. Therefore the investors gain a little compensation for their loss.

### 3 Aims and future plans

Since during the majority of the semester I was working on the better understanding of the topic by literature research, in the future I would like to analyze the risk and price connection furthermore. In addition, my main goal is to explore how different MBS bonds react to smaller and larger CDR and CPR changes. Also, I would like to prepare R-codes for analyzing these scenarios by using available market data. This is an interesting, complex and big topic, that needs further exploration.

## References

- [1] *Hull J. C.: Options, Futures, and other derivatives, ed. Pearson Education, 2012.*
- [2] *2022 CFA Program Curriculum Level I-III, ed. CFA Institute, vol. 1-6, 2021.*