Mortgage-Backed Securities *

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Abstract

This paper reviews the mortgage-backed securities (MBS) market, with a particular emphasis on agency residential MBS in the United States. We discuss the institutional environment, security design, MBS risks and asset pricing, and the economic effects of mortgage securitization. We also assemble descriptive statistics about market size, growth, security characteristics, prepayment, and trading activity. Throughout, we highlight insights from the expanding body of academic research on the MBS market and mortgage securitization.

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1 Introduction

The mortgage backed securities (MBS) market emerged as a way to decouple mortgage lending from mortgage *investing*. Until the 1980s, nearly all US mortgages were held on balance sheet by financial intermediaries, predominately savings and loans. Securitization today allows these mortgages to be held and traded by investors all over the world, and the US MBS market is one of the largest and most liquid global fixed-income markets, with more than $11 trillion of securities outstanding and nearly $300 billion in average daily trading volume.[1] MBS and a related instrument, covered bonds, are also used for funding mortgages in many European countries as well as some other parts of the world.

This chapter presents an overview of the MBS market, including the institutional environment, security design, MBS risks and asset pricing, and the economic effects of mortgage securitization. It also assembles descriptive statistics about the MBS market, including market size, growth, security characteristics, prepayment, trading activity and yield spreads. We particularly focus on the large agency residential MBS market in the United States, but also discuss other types of MBS both in the US and around the world. We also consider the role of the Federal Reserve through its quantitative easing program.

Throughout, we highlight insights from the growing literature on MBS and mortgage securitization, a body of research catalyzed by the role of MBS markets in the 2008 financial crisis. We also highlight topics for future research. This chapter can only scratch the surface of such a complex topic, however, and for other surveys and further information, we refer the reader to McConnell and Buser (2011), Fabozzi (2016), Green (2013) and Davidson and Levin (2014).

2 The MBS universe

2.1 MBS market segments and their evolution over time

Mortgage-backed securities are bonds with cash flows tied to the principal and interest payments on a pool of underlying mortgages. Mortgage securitization has a long history

[1] Source: SIFMA. Includes commercial and residential MBS pools and collateralized mortgage obligations.

(e.g., see Goetzmann and Newman, 2010), but the birth of the modern US MBS market is typically dated to the issuance of the first agency MBS pool by Ginnie Mae in 1970.

Figure 1 documents the enormous growth in the MBS market over the past half-century. The figure breaks down the market along two key dimensions:

- **Agency vs nonagency.** Agency MBS carry a government-backed credit guarantee from one of three housing agencies: Fannie Mae, Freddie Mac or Ginnie Mae.[2] Non-agency MBS, on the other hand, are issued by private financial institutions and are not guaranteed. Instead, securities are tranched in terms of seniority to cater to investors with different credit risk appetites.

- **Residential vs commercial.** The bulk of MBS are backed by mortgages on individual residential properties (RMBS). But there is also an active commercial MBS (CMBS) market secured by a diverse range of commercial real estate (e.g., office, multifamily, industrial, hotel, and warehouse properties). Commercial mortgages are larger, less homogenous and more complex than residential mortgage, and these features are reflected in the design of CMBS, as we discuss in section 3.

The top panel of Figure 1 plots the evolution of the volume of residential MBS. The market began to expand significantly in the early 1980s, driven at the time by high and volatile interest rates and the need to alleviate the maturity and liquidity mismatch faced by savings and loans. Regulatory and tax incentives also played an important role.[3] The RMBS market continued to expand rapidly over the following two decades, with the volume of securities outstanding reaching almost 50% of GDP by the time of the Great Recession. Particularly notable is the rapid growth in nonagency MBS during the 2000s

[2]Fannie Mae and Freddie Mac purchase and securitize "conforming" mortgages, which are typically prime-quality loans. They are not permitted to purchase large jumbo mortgages above the conforming loan limits or mortgages with a loan-to-value (LTV) ratio exceeding 80 percent unless the loan carries mortgage insurance. Fannie Mae and Freddie Mac are "government-sponsored enterprises" or GSEs. Although not explicitly government-owned, their debt is perceived to carry an implicit public guarantee, and the two GSEs have been in public conservatorship since 2008 (Frame et al., 2015). Ginnie Mae guarantees MBS assembled from mortgages explicitly insured by Federal government agencies, primarily the Federal Housing Administration (FHA) and Veterans Affairs (VA). See Burgess et al. (2021) in this volume for more details on these agencies.

[3]See the finance classic *Liar's Poker* (Lewis, 2010) for a lively account of the MBS market during this period.

due to the issuance of subprime and "alt-A" MBS backed by mortgages with high levels of credit risk.[4]

The home price crash and wave of mortgage defaults that precipitated the Great Recession also caused a freeze in the issuance of nonagency MBS in mid-2007 (Calem et al., 2013; Vickery and Wright, 2013; Fuster and Vickery, 2015; Kruger, 2018). The market has partially recovered but nonagency MBS issuance remains far below pre-crisis levels even to the present day. The MBS market as a whole remains very active, however — as of 2021, 65% of total home mortgage debt is securitized into MBS, up from 60% a decade ago, nearly all of it in the form of agency MBS. The stock of MBS as a share of GDP is smaller than prior to the Great Recession though, reflecting the post-crisis normalization of household leverage.

The bottom panel of Figure 1 focuses on CMBS. The CMBS market is smaller than the residential market, and did not grow in earnest until the 1990s, fueled by the Resolution Trust Corporation which issued securities backed by distressed commercial real estate in the wake of the savings and loan crisis (An et al., 2009; Chandan, 2012). Like its residential cousin, the nonagency CMBS market experienced an extraordinary boom during the 2000s — almost tripling in size as a share of GDP — before CMBS issuance ground to a halt at the start of the Great Recession. The market has returned to health in the post-crisis period, but normalized by GDP, the volume of nonagency CMBS today is only at the level of the early 2000s.

In contrast, the *agency* CMBS market has grown rapidly since the Great Recession. These securities have an explicit or implicit government credit guarantee, like agency RMBS, and are typically backed by mortgages on apartment buildings or other form of multifamily housing (e.g., senior housing, student housing).[5]

Competition and substitution between government-backed and private securitization is a central feature of both the commercial and residential market. For instance, Adelino

[4]This included mortgages to borrowers with low credit scores, and loans with incomplete documentation of borrower income and assets. The growth and collapse of the nonagency mortgage market during the 2000s is of course the subject of a very large literature. See Gerardi et al. (2008), Ashcraft and Schuermann (2008), Mian and Sufi (2015), Adelino et al. (2016), Foote et al. (2020), Adelino et al. (2020), Calem et al. (2013), Kruger (2018), Vickery and Wright (2013) and references cited therein.

[5]See Credit Suisse (2011) for a primer on the agency CMBS market.

et al. (2020) show that high-LTV lending migrated almost entirely from the FHA and VA to the private subprime market during the 2000s boom, before shifting back during and after the Great Recession. The market price of credit risk is a key driver of these substitution effects, because credit guarantee fees on agency MBS are set administratively and do not reflect market prices. Regulatory policies also shape the relative size of the agency and nonagency market, and may have contributed to the slow post-crisis recovery of nonagency RMBS, for example: (i) the introduction of higher conforming loan limits in counties with high home prices, expanding the footprint of the GSEs (Vickery and Wright, 2013); (ii) new risk retention requirements, as well as Dodd-Frank constraints on household leverage through the "Ability-to-Repay" rule which until recently exempted Fannie Mae and Freddie Mac (DeFusco et al., 2019); and (iii) bank liquidity regulations that favor agency securities (Roberts et al., 2018).

2.2 Investors

Who invests in MBS? The Financial Accounts of the United States provides a partial answer by tabulating investors in agency and GSE-issued securities, a category which mainly comprises agency MBS. As of mid-2021, depository institutions are the largest class of investors (32% of the total), followed by the Federal Reserve (23%), international investors (11%), mutual funds (7%) and money market funds (5%). A full tabulation is provided in the Appendix.

More detailed information on bank MBS holdings is presented in Federal Reserve Bank of New York (2021). Agency MBS account for about half of banks' total investment security holdings. Banks are also significant investors in agency collateralized mortgage obligations (CMOs), and to a lesser extent, nonagency MBS.

The Federal Reserve is the single largest agency MBS investor through its large-scale asset purchase program, with total holdings of $2.5 trillion as of October 2021. Research has found that Fed MBS purchases significantly reduce MBS yields and have a range of other effects on financial markets and the macroeconomy (see section 4).

2.3 Agency RMBS in the cross-section

Table 1 presents a cross-sectional snapshot of the population of agency residential MBS pools, based on security-level data from eMBS as of March 2021. We divide the universe by agency – Fannie Mae, Freddie Mac or Ginnie Mae — and within the Ginnie Mae population, we separately break out multi-issuer pools, which are large, diversified pools from multiple lenders and comprise the bulk of new Ginnie issuance.[6] Averages and distributional statistics reported in the table are weighted by outstanding pool balance.

The population consists of just over a million individual MBS pools, which together comprise $7.7 trillion of home mortgage debt. Almost all of this debt consists of fixed-rate mortgages (FRMs), mainly in the form of 30-year FRMs ($6.5 trillion of the total). For Fannie, Freddie and Ginnie multi-issuer pools, around 95% of the pool balances are deliverable in the TBA market, which is the primary venue for agency MBS trading (see section 5).

Strikingly, 42% of the outstanding balance reflects pools with an age of one year or less.[7] This is an unusually high percentage, due to a record refinancing wave and home price boom in 2020 that resulted in more than $4 trillion of mortgage originations (Fuster et al., 2021). Even so, nearly a quarter of the total unpaid balance represents pools with an age exceeding 5 years. This diversity of vintages is also evident in the distribution of coupons (the rate of interest paid to investors). About 45% of the universe consists of MBS pools with a coupon of 2.5% or less – these are the typical coupons into which new mortgages would be securitized reflecting recent record-low mortgage rates. But there is still a substantial population of much higher coupons, with 18% of the total unpaid balance reflecting coupons of 4% or higher. Borrowers represented in these pools would almost surely benefit substantially from refinancing, but for one reason or another have failed to do so (see e.g., Keys et al., 2016 for discussion.)

Pool size also varies widely. The bottom 10 percent of the universe consists of pools with an outstanding balance of $5 million or below, while the top 10 percent has a balance

[6] See Tozer (2019) for further discussion. Tozer estimates that multi-issuer pools comprise 85-90% of new Ginnie Mae security issues.

[7] The pool age closely corresponds to the age of the underlying loans, since agency mortgages are typically securitized shortly after origination. See section 3 for more detail on the securitization process.

exceeding $20 billion. This dispersion reflects differences in original issue amount as well as the fact that many older pools have partially or almost completely paid down. Pool size is much larger for Ginnie Mae multi-issuer pools than for the other categories. Prepayment speed – the primary driver of security value – is also very heterogeneous across pools. The median three-month prepayment speed, measured by the conditional prepayment rate (CPR), is 27.8%, but the 5th and 95th percentiles are 2.6% and 52.6% respectively. Section 4.2 discusses the drivers of prepayments.

To sum up, Table 1 documents the heterogeneity and fragmentation of the agency MBS universe across more than a million unique individual pools. Even so, trading arrangements have evolved to facilitate a liquid, well-functioning secondary market, with trading concentrated in a small number of forward contracts, as we discuss in section 5.

2.4 International MBS markets

Outside the US, securitization is also used as a form of secondary market mortgage finance around the world, including China, continental Europe, Canada, the United Kingdom, and Australia.

Some countries share features of the US mortgage finance system. For example, the Danish model is similar in many respects to agency securitization, as discussed by Berg et al. (2018). Mortgages in Denmark are originated by a small number of specialist mortgage banks, which issue bonds with cash flows matching the borrower's payments. The mortgage bank retains the loan on balance sheet, however, and bears the credit risk if the borrower defaults. In this sense, Danish mortgage banks play a role similar to Fannie Mae and Freddie Mac. Another example is the Canadian model, which features a significant role for government guarantees, with the public sector insuring all mortgages with a downpayment of less than 20%. There is an active market for securitizing these government-insured loans, with payments to investors guaranteed by the Canada Mortgage and Housing Corporation, a government agency also similar in some ways to Fannie Mae and Freddie Mac (Mordel and Stephens, 2015).

In most other countries, however, securitizations more closely resemble nonagency

MBS, with credit risk being borne by capital market investors.[8] Standard and Poor's (2021) provides an overview of market conditions for credit-sensitive MBS around the globe.

Covered bonds are a distinct but related form of capital market mortgage financing, and are popular in many European countries.[9] Covered bonds are debt instruments that finance a "cover pool" of ring-fenced assets. The bond investor has exclusive recourse to the asset pool in case of default, with further recourse to the issuer's other assets if needed (see Berg et al. 2018 for more details). Unlike securitization, the cover pool is pledged as *collateral* for the bonds but remains on the issuer's balance sheet, and mortgage prepayment and default therefore do not typically affect the payments to investors. The US does not have an active covered bond market, but banks have access to funding collateralized by mortgages through the Federal Home Loan Bank system (Bernanke, 2009).

3 Security design

Aside from the underlying mortgage type (residential or commercial) and whether they carry a government-backed credit guarantee, MBS also differ in terms of how cash flows from the mortgages are allocated to investors.

The most straightforward MBS design is provided by so-called "pass-through" securities. All cash flows – including scheduled principal and interest, as well as prepayments – are paid to investors on a pro-rata basis, after first subtracting from the interest payments a fee to the loan servicer, and (in case of loans with a credit guarantee) the guarantee fee ("g-fee"). This is how residential agency MBS pools are structured.[10]

[8] E.g., Standard and Poor's (2020) is a primer on the China RMBS market, which finances only a small share of Chinese mortgage debt but has grown rapidly in recent years.

[9] E.g., see Prokopczuk et al. (2013) for a discussion and analysis of the German "Pfandbrief" covered bond market and Meuli et al. (2021) for an analysis of the Swiss covered bond market, which shares features of the Federal Home Loan Bank system. Berg et al. (2018) reports that the five largest covered bond markets are Denmark, Germany, France, Spain and Sweden. As we have discussed above, however, Danish covered bonds have the distinctive feature that market risk and prepayment risk are passed through to investors, making these bonds more similar to agency MBS than to other covered bonds.

[10] For GSE pools, the servicer fee is 25 basis points (bp), while the periodic g-fee is around 40-50bp. (Fannie Mae and Freddie Mac only disclose average effective g-fees, which include flow equivalents of required upfront payments, so-called loan-level price adjustments. These average effective g-fees have hovered between 50 and 60bp in recent years — see Urban Institute (2021), p. 26.) For Ginnie Mae-backed loans,

However, there are economic reasons to depart from the simple pass-through structure to appeal to investors with different needs and risk appetites. In the agency MBS segment, pools are resecuritized into collateralized mortgage obligations (or CMOs) to create tranches with different prepayment risk and duration. In a "sequential pay" structure, principal prepayments are first only disbursed to class A bondholders until these bonds are completely paid off; then to class B, and so on. This structure caters to investors with different maturity habitats – for example life insurers favor long-duration assets to match their policy liabilities. Also popular, "stripped" CMOs separate cash flows into interest-only (or IO) and principal-only (or PO) tranches. The universe also includes many other security types; see Arcidiacono et al. (2013) for a review. As of 2021 there is $1.3 trillion in agency CMOs outstanding (source: SIFMA).

In the non-agency market, similar structures are used to allocate credit risk across investors. Typically, nonagency CMOs follow a "senior-subordinated" structure, where principal payments are directed first to the senior tranches, at least during an initial "lock-out" period, while lower-ranked "mezzanine" tranches initially receive only coupon payments.[11] The lowest-ranked "equity" tranche is the first to absorb credit losses and therefore has the highest risk. In the CMBS market, the most junior tranches are typically retained by the "special servicer" (or "B-piece buyer") who is also responsible for negotiating work-outs for delinquent loans. B-piece buyers therefore have strong incentives to carefully assess the credit risk of the underlying loans before entering a deal, and are considered the gate-keepers in the CMBS market (Ashcraft et al., 2019).

3.1 Process of securitization

How are MBS actually produced? We here provide a brief overview for standard residential agency MBS, following Fuster et al. (2013). See Bhattacharya et al. (2008) for a broader discussion that also covers nonagency securities.

The building blocks for any MBS are individual loans. These do not need to be newly-

the servicer fee is 44bp, while the guarantee fee is 6bp.

[11] During the housing and non-agency MBS boom that ended in 2007, these mezzanine tranches were then pooled and re-securitized as collateralized debt obligations (CDOs). These CDOs suffered very high credit losses during the subsequent bust, including the AAA rated tranches (Cordell et al., 2019).

originated mortgages, but typically are. The loan origination process begins with the borrower and loan originator agreeing on the terms (interest rate and upfront payments, including "points"). The loan originator could be a bank or a nonbank mortgage company, with nonbanks accounting for about two-thirds of originations in recent years. The terms are guaranteed by the originator for a "lock-in period" of typically 30 to 90 days, during which time the borrower's application is evaluated and processed—in particular, to ensure that they fulfill agency guidelines. Assuming the originator decides to fund the loan through an agency securitization (rather than keeping the loan in portfolio), they may at this point already forward-sell the loan in the TBA market, as discussed in Section 5. This allows the originator to effectively hedge against changes in the value of the loan during the lock-in period.

There are then two ways for the securitization to take place. In a "lender swap" transaction, the originator directly pools loans and delivers the pool to the securitizing agency (e.g. Fannie Mae) in exchange for an MBS certificate, which can be subsequently sold to investors in the secondary market (or delivered to them, in case it had already been forward-sold previously). In addition, Fannie Mae and Freddie Mac also conduct "whole loan conduit" or "cash window" transactions, where the agencies purchase loans directly from originators (typically smaller ones), pool these loans themselves, and sell the issued MBS in the secondary market. The tradeoff for originators is that the pricing they obtain at the cash window is typically worse, but they obtain liquidity immediately and do not face the risk of not assembling enough loans for a pool.[12]

4 Risks to MBS investing, prepayments and the OAS

MBS yields significantly exceed the risk-free rate, reflecting risks to investing in MBS. We review these risks and then discuss prepayments, both their measurement and their modeling. Finally, we delve more deeply into the valuation of agency MBS through option adjusted spread (OAS).

[12]There is no cash window for Ginnie Mae MBS. According to https://www.machinesp.com/post/a-close-look-at-the-gse-cash-window, for Freddie Mac-issued pools, the share of cash window transactions has been 50% or more in recent years.

4.1 Risks to MBS investing

The main four risks associated with MBS investing are: duration, prepayment, credit and liquidity.

Duration risk: The duration of an MBS measures two closely related concepts. It is the weighted average time until cash flows, which include both principal and interest payments, are paid out to investors. But duration is also the sensitivity of the price of the MBS to a change in the general level of interest rates. Because MBS pay fixed coupons to investors and typically have 30 year maturities, duration risk is very important in MBS pricing. A key distinguishing feature of MBS is that the duration of the security is not fixed but rather uncertain because borrowers can prepay their loans at any time.

Prepayment risk: MBS prepayments include both voluntary and involuntary prepayments. Voluntary prepayments is largely determined by borrowers' refinancing and relocation decisions. Refinancing is the most important source of prepayment. For typical residential mortgages securitized in agency MBS, the borrower can pay off the remaining principal balance at any point in time and investors devote significant efforts to modeling prepayments. Because refinancing is valuable to borrowers when interest rates decline, prepayments rise and the duration of the MBS falls. In other words, MBS are callable securities, and price appreciation from interest rate declines is capped. Involuntary prepayments are, instead, associated with borrowers' defaults.

Credit risk: At any point in time, borrowers can fail to make payments on the mortgage underlying an MBS. Default occurs when the loan no longer pays principal and interest until liquidation. The economic drivers of mortgage default include a double trigger of "opportunity" and "necessity." The opportunity of default is given when the borrower's home equity becomes negative. But it is not typical for borrowers to walk away from their loans just when equity is negative (e.g., Bhutta et al., 2017). Instead, default is most often triggered by life events, such as unemployment, illness or divorce (e.g., Ganong and Noel, 2020). More generally, not all delinquencies turn into defaults as loans can cure without "rolling" into more severe credit buckets.

The implications of borrowers' defaults for investors depend on whether the MBS is an agency security or not. For agency securities, the GSEs and Ginnie Mae promise full

and timely payment of principal and interest, a guarantee that is either explicitly or implicitly backed by the US government. When a borrower defaults, the issuer repurchases the mortgage from the MBS pool at par, resulting in a prepayment event for the MBS investor (an involuntary prepayment). For nonagency MBS, borrowers' default is more significant as the principal balance is not repaid. Investors MBS model PDs and LGDs using reduced-form models that include loan characteristics (such as LTVs and FICO scores) and macroeconomic variables (e.g., Demyanyk and Van Hemert, 2011).

Trading and funding liquidity: MBS trading liquidity—the ease with which securities are traded—and funding liquidity—how easily MBS collateral is funded—are additional risks to investing in MBS and that influence returns (Brunnermeier and Pedersen, 2009; Song and Zhu, 2019). As discussed in the next section, trading liquidity of MBS varies quite significantly by type of MBS. Liquidity in private-label MBS is very limited. Instead, the so-called to-be-announced (TBA) market provides both trading and funding liquidity for agency MBS through the dollar-roll market.

4.2 Measuring and modeling prepayments

We now turn to a more detailed discussion of prepayment risk, which is the most salient of these four risks for agency MBS. From a borrower's perspective, prepayment often involves paying down the entire loan balance. An MBS consists of many individual loans, so prepayment of a single loan only results in a fraction of the pool balance being payed down. Prepayment is measured by the single monthly mortality (SMM), which is the fraction of an MBS balance prepaid in a month relative to the remaining principal balance outstanding, and by the conditional prepayment rate (CPR) which is simply the SMM expressed at an annual rate.

The blue line in the top panel of Figure 2 plots the time series of CPR for the aggregated universe of 30-year fixed-rate agency MBS. Aggregating balances hides pool-specific prepayment variation, which is significant as shown earlier in Table 1. But even the aggregate prepayment rate exhibits very wide variation, ranging from CPRs of about 55 percent during the 2003 refinancing wave to a low of about 10 percent in 2008. The dashed red line is the "moneyness" of the mortgage universe, which is the difference between the average

interest on the universe of loans outstanding and the current mortgage rate. When the moneyness of the universe increases, refinancing becomes more attractive and prepayments therefore rise. Even so, similar levels of moneyness in 2003 and 2008 led to very different prepayment outcomes. A much greater degree of heterogeneity also exists at the level of specific pools. Prepayment modeling attempts to explain this variation and to predict prepayments.

The academic literature on mortgage prepayments considers structural and rational prepayment models (e.g., Stanton, 1995), but practitioners rely on reduced-form statistical prepayment models. The decision to refinance a mortgage is very complex, and, in fact, closed-form solutions only exist under very restrictive assumptions (Agarwal et al., 2013). Borrowers often fail to refinance when it is optimal to do so, or refinance when rate savings are insufficient. Reduced form prepayment models do not assume rational behavior but use information on observable borrower characteristics and macroeconomic factors to explain variation in the SMM.

Prepayment models can be very complex and include many variables. These variables are logically grouped into those related to refinancing, turnover as well as defaults and curtailments. The first two channels are the most important.[13] While most prepayment models share this general structure, models of leading investors often disagree about predicted prepayments (Carlin et al., 2014).

The turnover channel is associated with property sales, which is driven by changes in income, house price appreciation and idiosyncratic factors. Turnover is very seasonal, peaking during the summer, and is also subject to a "seasoning" effect because relocations are less likely during the first two to three years after a home purchase. The key variables included in the refinancing channel are a pool's moneyness, the so-called burnout effect, and the media effect. Pool moneyness captures the strength of the refinancing incentive. When moneyness is positive, a borrower can lower their monthly payment by refinancing the loan balance—in other words, the borrower's prepayment option is "in-the-money',' or ITM. Negative moneyness, instead, means that refinancing (or selling the home and

[13]Curtailments are partial—rather than full—principal payments that often occur late in the life of a mortgage. Defaults are quite rare in agency securities because borrowers are typically prime. In the rare occasions in which default occur, the agencies guaranteeing the payments buy out the loans for the pool, which from the investor's perspective represent a prepayment event.

buying another home with a new mortgage of equal size) would increase the monthly mortgage payment—the borrower's option is "out-of-the-money" (OTM).

The bottom panel of Figure 2 plots average prepayment rates as a function of moneyness in a panel of MBS indexed by prepayment date and MBS characteristic (coupon rate and year of origination). Given the shape of the relationship, this is known as an "S-curve." While prepayments rise with the moneyness incentive, on average, they never come close to reaching 100 percent.[14] In addition, the S-curve bends down as pools become deeply ITM, reflecting the so-called "burnout effect." As time passes, a mortgage pool becomes less responsive to interest rates because of within-pool heterogeneity in the borrowers' sensitivity to the refinancing incentive. More sensitive borrowers are the first to exit the pool when rates decline, so the pool's overall sensitivity to interest rates drops over time. Another key driver of the refinancing-driven prepayment is the media effect which captures "buzz" of multi-year lows in interest rates. This channel was prominent during the 2003 refinancing wave, which exhibited record-high levels of refinancing (Figure 2, top panel), and may also have contributed to rather high prepayments during the COVID-19 pandemic when interest rates reached record lows. Lastly, because refinancing requires a new round of mortgage underwriting, it also crucially depends on creditworthiness of the borrower, the riskiness of the loan as measured by the LTV and loan sizes because of the fixed costs involved in the refinancing process.

4.3 The OAS and risks to investing in agency MBS

We use the option-adjusted spread (OAS) to delve further into the risks associated with agency MBS. The OAS is the most popular metric to assess agency MBS valuations and risk premia. As shown by Boyarchenko et al. (2019), the OAS is equal to the average expected excess returns over the lifetime of the security.[15] Formally, the OAS is the constant spread to baseline rates that sets the expected discounted value of cash flows equal to the

[14] Note that in constructing this curve, we bin together a large number of securities. At shown in 1 the underlying variation at the level of single pools is much larger than what the S-curve would imply.

[15] In addition, period-by-period excess returns on an MBS can be expressed as the sum of carry income and capital gains. In terms of the OAS, these are equal to the OAS itself plus the (negative) change in the OAS with a weight equal to the MBS duration. One limitation of the OAS is that it is a model-derived measure and thus subject to various assumptions.

security's market price after accounting for prepayments:

$$P_M = \mathbb{E} \sum_{k=1}^{T} \frac{X_k(r_k)}{\prod_{j=1}^{k} (1 + \text{OAS} + r_j)}, \tag{1}$$

where P_M is the market price of an MBS, r_j is the riskless interest rate at time j and X_k is the cash flow from the security. The OAS increases the larger the value of discounted cash flows relative to the market price, meaning that when spreads are positive, MBS trade below the discounted price net of the OAS.[16] The calculation of the expectation term in the OAS uses Monte Carlo simulations and both a calibrated interest rate and an estimated prepayment model. The two are combined to simulate interest rate paths and corresponding prepayment flows to obtain model prices and spreads in (1).[17]

We turn to data on OAS from a major dealer (JP Morgan) to show stylized facts both in the time-series and cross section of agency MBS. The top panel of Figure 3 shows the evolution of Treasury OAS for so-called current-coupon securities, meaning the coupons trading closest to par, issued by Fannie Mae.

This OAS averaged about 50 basis points since 2000, but spiked to about 150 basis points in the fall of 2008, and turned negative at times during the periods of the QE3 and QE4 programs, when the Federal Reserve purchased large quantities of agency MBS.

The bottom panel of Figure 3 focuses on the cross section of OAS and reveals substantial variation across MBS with different moneyness levels.[18] In the cross section, a

[16] Another commonly used metric is known as the zero-volatility spread. The ZVS abstract from rate uncertainty and it is defined as:

$$P_M = \sum_{k=1}^{T} \frac{X_k(\mathbb{E}r_k)}{\prod_{j=1}^{k} (1 + \text{ZVS} + \mathbb{E}r_j)}. \tag{2}$$

The ZVS-OAS difference is known as the "option cost." In computing the ZVS both cash flows and discounts are evaluated along a single expected risk-neutral rate path, thus ignoring the effects of uncertainty about the timing of prepayments on the MBS valuation. This implies that the ZVS will be larger than the OAS.

[17] The interest rate model is calibrated to the term structure of interest rates and volatility surface implied by prices of interest rate derivatives. Once the paths for the interest rates are determined, the cash-flows are obtained from the prepayment model.

[18] Here we define moneyness as the difference between the MBS coupon rate and the current level of the 30-year fixed mortgage rate after adding a constant adjustment of 50 basis points. We make this adjustment because the mortgage note rates are typically around 50 basis points higher than the MBS coupon due to the agency guarantee fee as well as servicing fees.

smile-like pattern emerges: spreads are lowest for securities for which the prepayment option is at-the-money, and increase if the option moves out-of-the-money and especially when it is in-the-money. Aside from determining the refinancing propensity of a loan, moneyness also measures an investor's gains or losses (in terms of coupon payments) if a mortgage underlying the security prepays (at par) and they reinvest the proceeds in a "typical" newly originated MBS. The OAS smile-pattern in was first shown by Boyarchenko et al. (2019), who also find that OAS predicts realized excess returns. A similar smile-shaped pattern in MBS excess returns is documented by Diep et al. (2020).

The large positive spreads both in the time series and cross section suggest that MBS investors require risk compensation to invest in these securities as compared to holding Treasuries.

To understand why, first note that the embedded prepayment option means that even if payments are guaranteed, the timing of cash flows accruals is uncertain. Because prepayments respond to interest rates, MBS investors face reinvestment risk and have limited upside as rates decline, or more formally, they are short an American option. Equation (1) explicitly denotes that cash flows depend on interest rates through prepayments. In fact, only interest rate uncertainty is explicitly considered in the OAS, thus abstracting from uncertainty related to other non-interest rate factors that affect prepayments, such as house prices and lending standards. Using matched pairs of IO and PO strips, Boyarchenko et al. (2019) show that MBS investors earn risk compensation for these non-interest-rate prepayment factors and that these factors underlie the cross-sectional smile pattern in the OAS. In the time series, risk factors unrelated to prepayment, such as liquidity or changes in the perceived strength of the government guarantee on the agencies, are important drivers of the OAS. For example, the non-prepayment component in the OAS co-moves with spreads on other agency debt and corporate securities, reflecting shared risk factors.

4.4 Supply Effects and Fed Quantitative Easing

The *supply* of MBS — which is affected by the net volume of new issuance as well as Fed MBS purchases that reduce the net supply available to private investors — is also posi-

tively related to the non-prepayment component of OAS. As an indication of these effects, the OAS turned negative during the large purchases of agency MBS by the Fed during QE3 and QE4 (grey bars in Figure 3, left panel). Consistent with this fact, event studies using high-frequency data find that announcements of new Fed MBS purchases are associated with significant declines in MBS yields (Gagnon et al., 2011; Hancock and Passmore, 2011; Krishnamurthy and Vissing-Jorgensen, 2011). Chernov et al. (2016) similarly find evidence that risk premiums on MBS are affected by the Federal Reserve's quantitative easing programs, using a more model-based approach. Krishnamurthy and Vissing-Jorgensen (2011) and Di Maggio et al. (2020) furthermore show that MBS purchases have larger effects on MBS yields than a comparable volume of Treasury purchases, consistent with the presence of some degree of market segmentation.

Other research investigates the broader financial and macroeconomic effects of the Federal Reserve's MBS purchases. For example, Di Maggio et al. (2020) finds that Fed QE significantly boosted refinancing activity and as a result, led to higher aggregate consumption. Beraja et al. (2019) shows that the effectiveness of QE and monetary policy more generally depends on the distribution of home equity, because insufficient equity reduces the ability of borrowers to refinance.

5 Trading

Most agency RMBS trading occurs through the to-be-announced or "TBA" forward market. The key feature of a TBA trade is that the seller does not specify exactly which pools will be delivered at settlement. Instead, the buyer and seller agree on six trade parameters: the agency, coupon, maturity, price, face value, and settlement month. Any combination of pools satisfying the parameters and SIFMA good delivery guidelines can be delivered to settle the TBA trade.[19,20]

The TBA market effectively concentrates the fragmented universe of individual agency

[19] For details of the good delivery guidelines for TBA settlement, see Chapter 8 of SIFMA (2021).

[20] The exact CUSIPs to be delivered are specified two days prior to settlement. Settlement occurs once per month (e.g., for 30-year Uniform MBS, settlement day is typically between the 10th and 14th of the month). The TBA settlement schedule is available at https://www.sifma.org/resources/general/mbs-notification-and-settlement-dates/

MBS pools into a small number of liquid contracts for trading purposes, thereby improving fungibility and liquidity.[21] Investors use the TBA market to express views or hedging. TBAs are also utilized by mortgage lenders to hedge their origination pipeline; this in turn enables lenders to offer interest rate locks to borrowers, protecting the borrower from market fluctuations while they close on a home purchase.

The TBA market can also be used as a funding vehicle, through the execution of "dollar roll" transactions: the roll seller sells TBAs for a coming delivery month (the "front" month) and simultaneously purchases TBAs for a later "back" month. This provides short-term funding to the roll seller by postponing the date when she is due to pay cash to settle her long TBA position. The substance of a dollar roll is similar to a repurchase agreement, but there are some important differences; see Song and Zhu (2019) for further discussion and empirical analysis of the dollar roll market. The Federal Reserve has also used dollar rolls to support market functioning, and actively employed this tool during the COVID-19 pandemic (Frame et al., 2021).

Since mid-2019, Fannie Mae and Freddie Mac pools have traded through a single set of "Uniform MBS" (UMBS) TBA contracts, in which pools issued by either agency can be delivered at settlement. Previously, the two GSEs traded separately in the TBA market. The reason for this change in market structure is that TBA trading had historically been highly concentrated in Fannie Mae contracts, leading to an illiquidity discount for Freddie Mac pools which put them at a competitive disadvantage. Liu et al. (2021) find that UMBS implementation successfully improved Freddie Mac TBA liquidity without any obvious adverse effects on overall market functioning.

The agency market also features significant trading of individual pools (known as "spec pool" trading). One reason why is that the TBA market trades on a cheapest-to-deliver basis — sellers will deliver the least valuable eligible pools. Therefore, the market features a semi-separating equilibrium in which more valuable "pay-up" MBS pools trade on an individual basis while less valuable MBS trade on a pooled basis in the TBA market. See Li and Song (2020) for a theoretical model of this structure. Specified pool trades often

[21] E.g., Gao et al. (2017) find that over a sample period of several years, 12 maturity-coupon combinations accounted for 96% of TBA trades.

settle on TBA settlement dates, but can be executed to settle at any point in the month.[22]

Specified pool trading also includes agency MBS pools that for various reasons are not TBA-eligible.[23] Other mortgage securities, such as CMBS, agency CMOs, and nonagency RMBS, also trade on an individual basis.

5.1 Evidence on trading activity and liquidity

Table 2 presents trading volume statistics based on TRACE data aggregated by SIFMA. Agency residential MBS trading activity dwarfs the other segments of the market, with $288bn of daily trading volume, compared to $2.7bn for CMBS and only $0.5bn for nonagency RMBS. This reflects $261bn of TBA trading (about 90% of the agency RMBS total), followed by a smaller but still very significant $25.4bn of specified pool trades and $1.4bn of agency CMOs.

Estimated trading costs are also significantly lower in the TBA market. Bessembinder et al. (2013) estimate one-way trading costs of only 1 basis point (bp) for TBAs, compared to 40bp for specified pools, and 39bp for nonagency MBS. Gao et al. (2017) find that TBA liquidity also has positive spillover effects on the specified pool market — trading costs are lower for specified pools that are TBA eligible and for spec pool trades close to TBA settlement dates. Huh and Kim (2020) traces out the broader effects of TBA liquidity using a TBA-eligibility cutoff at the national conforming loan limit. TBA eligibility is estimated to reduce mortgage rates by 7-28bp, and to spur refinancing activity.

Table 2 also compares MBS trading volume to other US fixed income markets. TBA activity is lower than the Treasury market, but trading volume is more than six times higher than the corporate bond market, despite the larger stock of corporate bonds outstanding. Trading activity is even lower for municipal bonds, agency debt and asset backed securities, and Bessembinder et al. (2020) further shows that TBA trading costs are much lower

[22] Chen et al. (2020) show that during the market turmoil of March 2020, stressed market participants scrambled to raise cash by selling MBS in the specified pool market, temporarily driving spec pool prices below TBA prices. To meet the demand for liquidity and stabilize the market, the Federal Reserve responded by executing unconventional MBS purchases on a T+3 settlement basis.

[23] TBA-ineligible pools include MBS with more than 10 percent of superconforming loans exceeding the national conforming limit, and pools with LTVs exceeding 105 percent (Huh and Kim, 2020; Vickery and Wright, 2013). TBA eligibility rules are designed to limit heterogeneity within each cohort.

than for these other markets.[24]

6 Economic effects of MBS and mortgage securitization

What are the broader economic effects of MBS markets and mortgage securitization? A sizeable academic literature has studied different aspects of this question, in many cases also shedding light on potential downsides of securitization, especially in the wake of the Great Recession. In this section, we provide a brief overview of some of the main themes.

A key aspect of securitization is that it makes mortgages more liquid, thereby to an important extent de-coupling loan originators' ability to produce loans from their own financial conditions (e.g. funding, risk exposure). Loutskina and Strahan (2009) show that for conforming mortgages that can easily be securitized, bank holdings of liquid assets and their deposit costs play much less of a role than for the origination of jumbo mortgages which can less easily be securitized. Securitization is also fundamental to the rise of nonbank lenders (financed through wholesale funding) as the dominant origination channel in the US (Buchak et al., 2020; Gete and Reher, 2020).[25]

As securitization increases the ability of different types of lenders to originate mortgages, one would naturally expect an outward shift in credit supply, plausibly increasing credit access for otherwise "marginal" borrowers. However, a sizeable literature has argued that in addition, credit quality in securitization is lower through an additional "moral hazard" channel: as originators offload the credit risk, they may have less of an incentive to screen borrowers, leading to less acquisition of soft information and worse ex-post outcomes (e.g., Keys et al., 2010; Nadauld and Sherlund, 2013; Rajan et al., 2015; Choi and Kim, 2020). However, the strength of the evidence, and whether securitization is a plausible cause of the US mortgage boom of the 2000s, remains debated in the literature (e.g., Bubb and Kaufman, 2014; Foote et al., 2012).

[24] Bessembinder et al. (2020) and Gao et al. (2017) furthermore speculate that introducing a TBA-like forward market for corporate bonds could improve liquidity in that market. Corporate bonds are more heterogeneous than agency MBS, however, and the number of issuers is much higher, factors which would likely be hurdles to implementing such an idea.

[25] Without securitization, nonbank lenders could potentially sell whole loans to banks or other financial institutions, but such a market would be far less liquid. Indeed, in the jumbo market, where securitization is dormant since the Great Recession, nonbanks play a much smaller role than in the agency market .

A related literature has focused on the effects of securitization on the monitoring of loans after origination—in particular, whether the mortgage servicer may have insufficient incentives to work out solutions (such as modifications) for delinquent loans. Again, there is a debate in the literature about how important these incentive effects were in explaining (non-)modifications during the Great Recession (e.g., Agarwal et al., 2011; Piskorski et al., 2010; Adelino et al., 2013).

Securitization may also affect mortgage contract design. Fuster and Vickery (2015) show that lenders reduce the supply of long-term prepayable fixed-rate mortgages (rather than adjustable-rate mortgages) when securitization markets become illiquid. They argue that this is due to lenders' limited ability to absorb the interest rate and prepayment risk embedded in FRMs.[26] Thus, it appears unlikely that the 30-year prepayable FRM, which is by far the dominant mortgage type in the US, could be offered at similarly competitive rates without liquid securitization markets.

In turn, the prevalence of prepayable FRMs has consequences for overall market interest rates, and for the transmission of monetary policy. In particular, a number of studies have argued that "convexity hedging" flows lead to important interactions between the MBS market and the Treasury yield curve (Hanson, 2014; Malkhozov et al., 2016; Hanson et al., 2021). Furthermore, the fact that in the US, borrowers need to refinance their mortgages in order to benefit from a drop in market interest rates leads to a much less direct transmission of monetary policy to mortgage borrowers' finances than in a system with adjustable-rate mortgages (e.g. Campbell, 2013). Transmission is further blunted by the limited ability of mortgage originators to increase origination capacity during periods of peak demand; instead, originators tend to earn high markups during such periods (Fuster et al., 2013, 2017, 2021).

7 Directions for future research

The MBS market was a relatively neglected research topic prior to the 2008 financial crisis, but the literature has grown rapidly in the years since. Rich loan- and security-level

[26] Recent work by Xiao (2021) shows that this ability varies in the cross section of banks depending on their funding structure, which in turn affects their propensity to securitize mortgages.

datasets are now available to researchers, and the introduction of TRACE data for structured products in 2011 provides new opportunities to study MBS microstructure and liquidity. Below, we highlight some topics that we believe present opportunities for future research.

1. **Securitization and alternative mortgage designs.** Various alternative mortgage designs have been proposed to improve macroeconomic stability, reduce transaction costs, or produce other benefits for borrowers (e.g., the automatic stabilizer mortgage of Eberly and Krishnamurthy, 2014). An open question is how such alternative products would be funded and what role securitization markets would play. Securitization may in fact hinder innovation, in the sense that the existence of a thick, liquid secondary market for a particular contract type—30 year FRMs—may present a barrier for alternative designs.

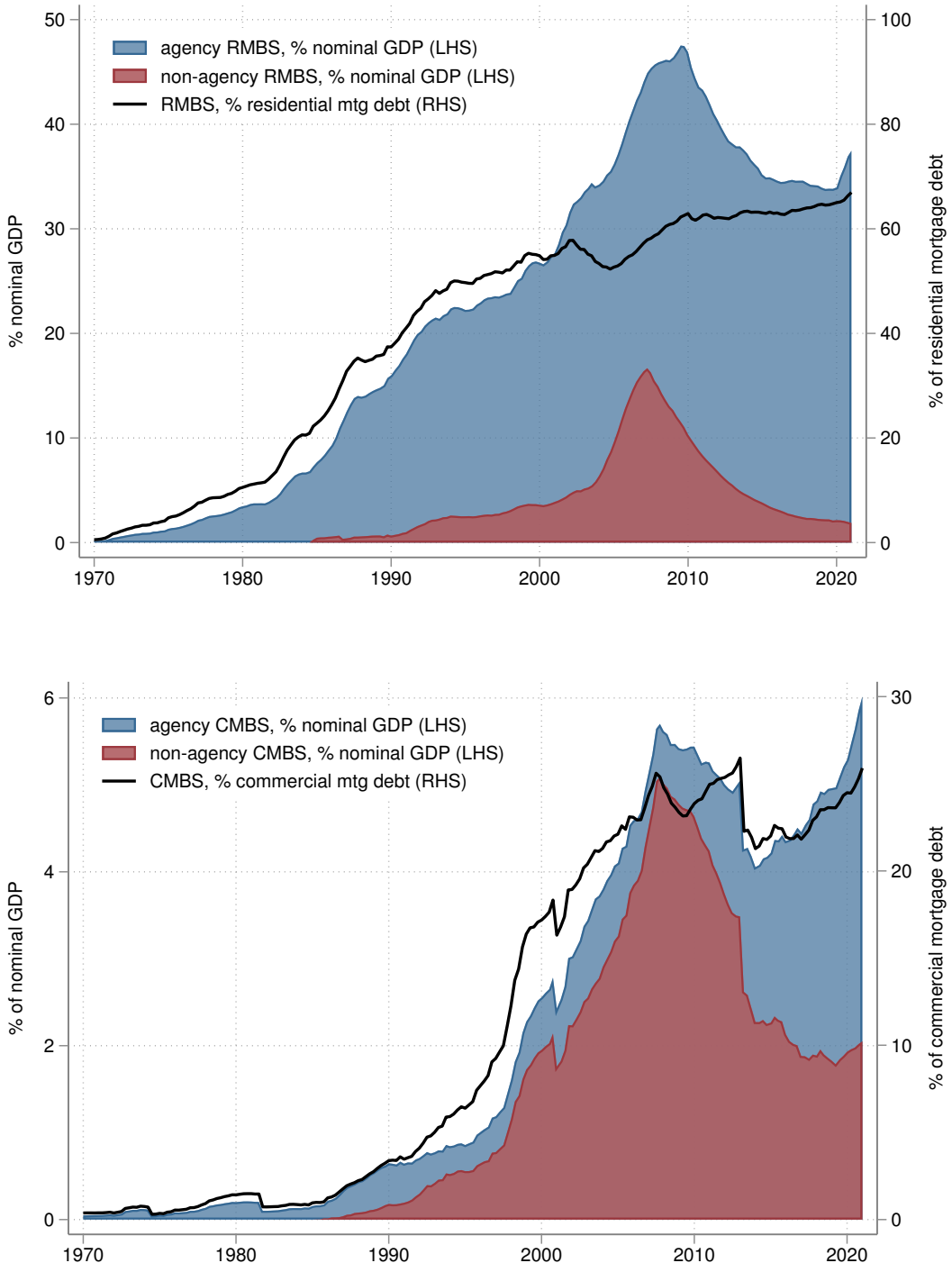
2. **What's holding back nonagency securitization?** Nonagency securitization remains far lower than prior to the financial crisis, despite the much higher credit guarantee fees now charged by the GSEs. Stricter post-crisis regulation is one candidate explanation why, as discussed in section 2.1. But research has not clearly disentangled the role of regulation from other factors.

3. **Investor behavior.** Research is limited on the determinants of investor behavior in the MBS market (e.g., the striking fact that MBS now make up *half* of bank security portfolios) and how investors affect pricing and liquidity.[27]

4. **Securitization and climate change.** An emerging literature studies the interaction between climate change and mortgage and MBS markets (e.g., Ouazad and Kahn, 2019). This is likely to be a fruitful topic for future work. For instance, securitization prices can provide useful high-frequency information about the market's assessment of climate and natural disaster risk. Another application: Fannie Mae has developed a "green MBS" program for loans backed by buildings with green building certifications — to our knowledge, its effects have not been rigorously studied.

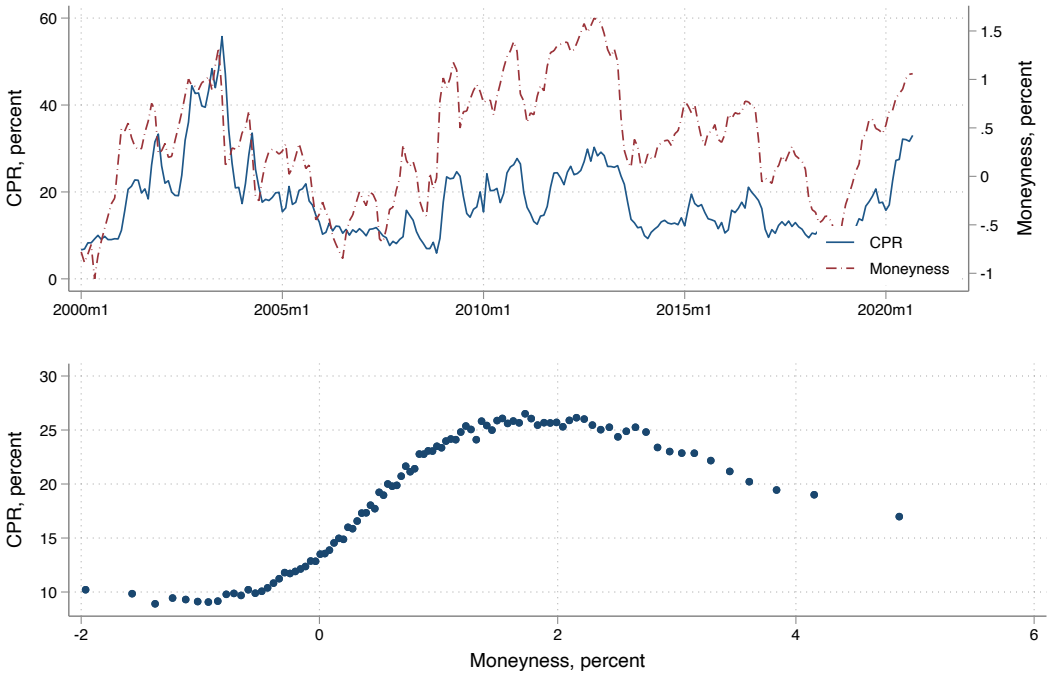
[27] One contribution along those lines is Erel et al. (2013) which studies the drivers of bank investments in nonagency MBS tranches.

Figure 1: **Mortgage-backed securities outstanding**



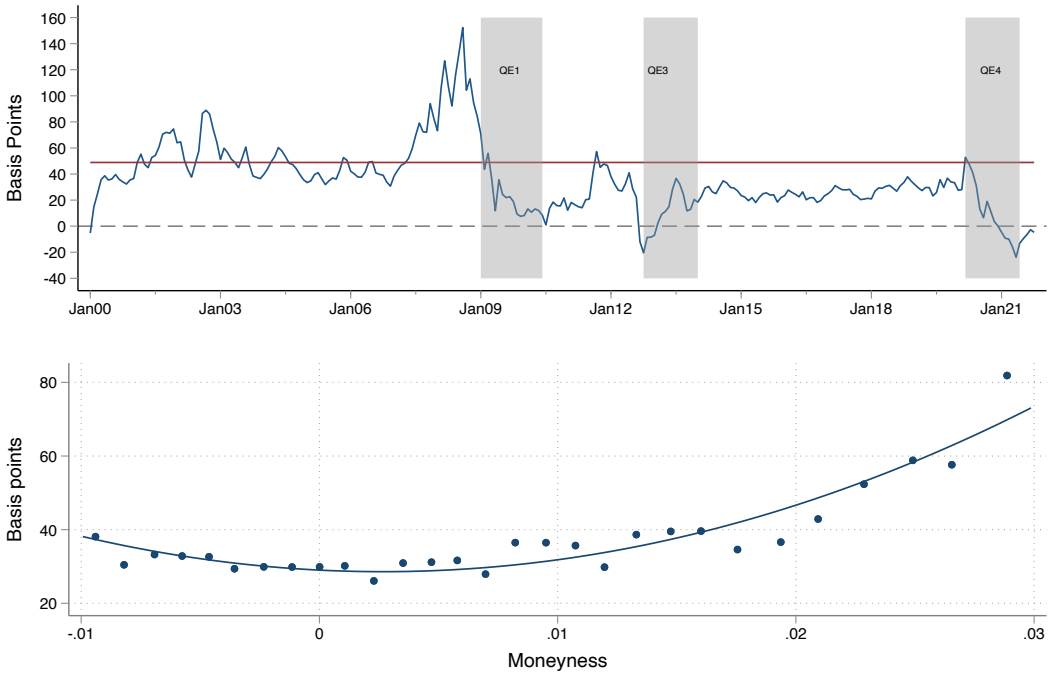
Shaded areas represent stock of agency and nonagency MBS as a percent of nominal GDP. Dashed line plots total MBS scaled by the relevant stock of mortgage debt. See section **??** for details of figure construction. Data sources: FAUS, BLS.

Figure 2: **CPR for agency MBS**



The top panel shows the time series of the monthly conditional prepayment rate (CPR) on the universe of 30-year fixed-rate agency MBS weighted by their remaining principal balance, against the moneyness of the mortgage universe. Moneyness is calculated as the weighted average coupon rate (WAC) minus the monthly average 30-year fixed-rate mortgage rate. The bottom panel shows a binned scatter plot (Cattaneo et al., 2019) of the cross-sectional variation in CPR as a function of their moneyness. All data is monthly and covers the period 2000-2021. Source: eMBS; Freddie Mac.

Figure 3: **Time-series and cross-sectional variation of the agency OAS.**



The top panel shorts the time series of the option-adjusted spread (to Treasuries and averaged each month) on the current-coupon agency MBS. The red line is the sample average and shaded areas represent periods in which the Federal Reserve purchased agency MBS in QE programs. The bottom panel shows a binned scatter plot (Cattaneo et al., 2019) of the cross-sectional variation in the OAS across MBS coupons as a function of their moneyness. Moneyness is calculated as the coupon rate plus 50 basis points (to account for servicing and the guarantee fee) minus the monthly average 30-year fixed-rate mortgage rate. The bottom panel only includes coupons with remaining principal balance of at least 100 million. All data is monthly average and covers the period 2000-2021. Source: JP Morgan; Freddie Mac.

Table 1: **The cross-section of agency MBS pools**

	Fannie Mae	Freddie Mac	Ginnie Mae		Total
			Multi	*Other*	
Number of Active Pools	474,062	274,588	8,547	246,025	1,003,222
Aggregate Outstanding Face Value (UPB, in billions)					
30yr FRM	2,590.139	1,902.786	1,575.783	386.343	6,455.051
15yr FRM	450.774	339.809	24.509	3.645	818.736
Other FRM	204.192	127.923	0.003	0.296	332.413
Other Mortgage Types	34.397	26.655	10.647	46.581	118.280
Total	3,279.503	2,397.173	1,610.941	436.864	7,724.480
TBA eligible (%, weighted by UPB)	94.1	94.1	96.2	21.3	90.5
Distribution of Pool UPB					
10th pctile	4.3	6.2	754.2	1.0	5.0
50th pctile	165.0	287.8	6,226.6	6.2	353.3
90th pctile	26,654.0	6,956.9	34,823.1	36.8	19,598.8
95th pctile	35,199.7	8,932.9	40,937.4	58.6	34,823.1
99th pctile	41,203.9	12,348.9	43,895.2	144.2	41,203.9
Distribution by Coupon (weighted by UPB)					
less than 2	0.05	0.09	0.01	0.03	0.05
2-2.5	0.24	0.27	0.16	0.07	0.22
2.5-3	0.18	0.17	0.20	0.18	0.18
3-3.5	0.20	0.18	0.25	0.14	0.20
3.5-4	0.15	0.13	0.22	0.19	0.16
4-4.5	0.11	0.09	0.10	0.17	0.10
greater than 4.5	0.07	0.07	0.06	0.22	0.08
Distribution of Pool Age (%, weighted by UPB)					
less than 1yr	41.92	47.44	38.52	27.44	42.11
1-5yr	32.69	30.81	40.84	41.71	34.32
5-10yr	20.38	17.43	17.87	18.52	18.84
greater than 10yr	5.01	4.32	2.77	12.32	4.74
Distribution of Prepayment Speed (weighted by UPB)					
1st pctile	0.05	0.10	7.52	0.00	0.04
5th pctile	1.87	3.60	9.83	0.01	2.64
25th pctile	13.90	13.24	27.86	3.84	14.82
50th pctile	24.88	23.91	40.34	23.22	27.80
75th pctile	36.26	35.63	47.23	38.81	40.03
95th pctile	50.88	48.93	55.88	66.92	52.57
99th pctile	66.09	61.90	59.98	87.32	66.10

Reflects the population of agency residential MBS pools measured as of March 2021. All averages and distributional statistics are weighted by outstanding pool unpaid balance. Source: Author calculations based on eMBS security-level data.

Table 2: **MBS trading volume**

	Avg. daily trading volume ($bn)
A. Residential: Agency MBS	
TBA	260.95
Specified Pool	25.34
CMO	1.37
Total	*287.67*
B. Residential: Non-agency MBS	
CMO (IO/PO)	0.05
CMO (P&I)	0.43
Total	*0.48*
C. Commercial MBS	
Agency CMBS	1.22
Non-Agency CMBS (IO/PO)	0.28
Non-Agency CMBS (P&I)	0.74
Total	*2.71*
Memo: other USD fixed income securities	
US Treasury	*603.2*
Corporate debt	*38.9*
Municipal bonds	*12.0*
Federal agency securities	*5.3*
Asset backed securities	*1.9*

Average daily trading volume is calculated over the period from January to September 2021. IO/POs are stripped passthrough pools that pay either interest only or principal only, whereas P&I CMOs are typically sequential pay bonds with cashflows derived from both principal and interest payments on the underlying mortgages. Source: SIFMA, aggregated from FINRA TRACE data.

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Internet Appendix for:

"Mortgage Backed Securities"

Andreas Fuster, David Lucca and James Vickery

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A Variable definitions for construction of Figure 1

All statistics are derived from the Financial Accounts of the United States, except for nominal GDP (source: BLS, via FRED). Commercial mortgages and MBS are inclusive of multifamily loans but exclude farm loans.

Total mortgage debt: residential:

- L. 217, FL893065105: One-to-four family residential mortgages

Total mortgage debt: commercial:

- L. 217, FL893065405: Multifamily residential +
  L. 217, FL893065505: Commercial

Total MBS: residential:

- L. 126, FL413065105: One-to-four-family residential mortgages (GNM) +
  L. 125, FL403065195: Mortgages, One-to-four-family residential, consolidated trusts (GSEs) +
  L. 127, FL673065105: One-to-four family residential (ABS)

Total MBS: commercial:

- L. 126, FL413065505: Commercial mortgages (GNM) +
  L. 126, FL413065405: Multifamily residential mortgages (GNM) +
  L. 125, FL403065495: Multifamily residential Consolidated trusts (GSEs) +
  L. 127, FL673065405: Multifamily residential (ABS) +
  L. 127, FL673065505: Commercial (ABS)

Total agency MBS: residential:

- L. 126, FL413065105: One-to-four-family residential mortgages (GNM) +
  L. 125, FL403065195: Mortgages, one-to-four-family residential, consolidated trusts (GSEs)

Total agency MBS: commercial:

- L. 126, FL413065505: Commercial mortgages (GNM) +
  L. 126, FL413065405: Multifamily residential mortgages (GNM) +
  L. 125, FL403065495: Multifamily residential, Consolidated trusts (GSEs)

Nominal GDP:

- Nominal GDP, Seasonally Adjusted Annual Rate https://fred.stlouisfed.org/series/GDP. Note: Statistics in figure normalized by four-quarter-ended GDP

Table A.2: **Investors in agency and GSE-backed securities**

	$bn	% of total
Depository institutions	3357	32%
Federal Reserve	2414	23%
Rest of the world	1145	11%
Mutual funds	713	7%
Money market funds	499	5%
State and local governments	428	4%
Life insurance companies	348	3%
Credit unions	297	3%
Pension funds	260	2%
Households and nonprofit organizations	247	2%
Government sponsored enterprises	219	2%
State and local government defined benefit pension funds	201	2%
Mortgage real estate investment trusts	188	2%
Property-casualty insurance companies	137	1%
Foreign banking offices	59	1%
Other	78	1%

Includes issues of federal budget agencies; issues of government sponsored enterprises such as Fannie Mae and FHLB; and agency- and GSE-backed mortgage pool securities issued by Ginnie Mae, Fannie Mae, Freddie Mac, and the Farmers Home Administration. Source: Financial Accounts of the United States, Table L.211, 2021:Q2.