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Failure to learn from failure: The 2008 mortgage crisis as a déjà vu of the mortgage meltdown of 1994

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ABSTRACT

This article traces the developments in the market for residential mortgage-backed securities (MBS) during the period 1970–2008. Drawing on an analysis of trade publications, business press, and interviews with practitioners, it shows that an MBS market meltdown in 1994 provided clear signals of problems with MBS. The market participants did not re-evaluate their use of risk management tools or adjust security design in response to the 1994 crisis, suggesting a lack of understanding of the implications of the crisis. The 1994 meltdown showed that MBS were vulnerable to systematic risks and that these risks could precipitate an MBS market crash. Furthermore, the 1994 meltdown demonstrated that large-scale investment in MBS could affect the primary mortgage market, thereby rendering the MBS risks unpredictable. After 1994, MBS investment shifted to MBS backed by mortgages with default risk – a development that led to the crash of 2008. By drawing parallels between the 1994 and 2008 crises, this article shows how the MBS market failed to self-correct. The results suggest that financial market participants do not always incorporate relevant information in their decision-making and that market participants have difficulties in both foreseeing the effect of financial innovations on markets and interpreting these effects.

KEYWORDS

Financial crises; 2008 mortgage crisis; mortgage-backed securities; tranching; prepayment risk; default risk; collateralised mortgage obligation (CMO); 1994 mortgage meltdown; learning from failure

One striking weakness of our financial architecture, which helped bring on and perhaps deepen the Panic of 2008, is an inadequate appreciation of the past.¹

Financial crisis scholars attribute the recurrence of financial crises to the decision-makers' failure to learn from the past. For instance, Reinhart and Rogoff frame this failure to learn from the past as the 'this-time-is-different' syndrome:

The essence of the 'this time is different syndrome' is simple. It is rooted in the firmly-held belief that financial crises are something that happen to other people in other countries at other times; crises do not happen here and now to us. We are doing things better, we are smarter, we have learned from the past mistakes. The old rules of valuation no longer apply. The current boom, unlike the many booms that preceded catastrophic collapses in the past (even in our country), is built on sound fundamentals, structural reforms, technological innovation, and good policy. Or so the story goes.²

This quote, as well as *This Time Is Different*, Reinhart and Rogoff's influential recent book on the subject, implies that financial crises are similar enough to allow learning.³ Despite the interest in drawing lessons from financial crises – hundreds of academic articles offer lessons from them – no study to date has documented market participants' failure to learn from these crises.⁴

The lack of attention to financial market participants' failure to learn from financial crises is puzzling because understanding how and why learning in financial markets occurs or fails to occur is fundamental to whether the lessons distilled by the financial crisis scholars are learned. Answering the question of whether and how market participants learn from financial crises requires detailed analysis of market participants learning as well as failing to learn from them.

This article fills the gap in the literature by examining the financial market participants' failure to learn from a crisis that presaged the 2008 mortgage crisis in the US – namely, the 1994 mortgage-backed securities (MBS) meltdown. The comparison of the two crises is informative because they took place in the same market, within the memory of the same market participants, and involved the use of the same tools. This article analyses the similarities between the two crises by investigating (1) the emergence and evolution of the risk-management tools implicated in both crises, and (2) the market participants' understanding of the tools from 1970 when the first MBS were issued in the 2008 crisis.

My findings suggest that from the market's inception in the 1970s to the early 1990s, the major risk in MBS was prepayment, the risk of investors not receiving the interest on their investments due to mortgage borrowers repaying their loans before they were due. To protect investors from this risk, MBS issuers employed tranching, an approach to risk management that when applied to prepayment risk relies on the assumption that individual borrowers' probabilities of refinancing are independent of each other.⁵ Tranching entails assigning different investors different seniority levels with respect to repayment and following these levels in prioritising the distribution of cashflows. In the early 1990s, a series of Federal Reserve interest rate cuts provided borrowers with an incentive to refinance their loans. A contemporaneous infusion of liquidity into the primary mortgage market from MBS investors (who bought MBS with tranching prepayment risk) provided borrowers with opportunity to refinance.⁶ This combination of incentive (lower interest rates) and opportunity (expanded access to mortgage credit) enabled millions of Americans to refinance their mortgages at the same time. The resultant refinance boom was not anticipated by the MBS prepayment models and rendered tranching ineffective at managing prepayment risk. This ineffectiveness brought about the meltdown of 1994.

The early 1990s prepayment risk meltdown encouraged MBS investors to develop an appetite for MBS with default risk – the risk of not getting back the principal of the investment due to borrowers failing to repay their mortgages.⁷ This was because MBS with greater default risk were backed by mortgages that carried prepayment penalties, thus protecting investors from prepayment risk.⁸ The vast majority of MBS issued before the 1990s did not have default risk because the repayment of mortgages backing them was implicitly and/or explicitly insured by the US federal government. However, the burgeoning of investor interest in MBS that were backed by conventional (i.e. not-government insured) mortgages issued by private parties in the early 1990s introduced default risk into MBS.⁹ One reason investors underestimated the severity of default risk in MBS is that the securities with government repayment guarantees which dominated the MBS market until this point effectively turned

default risk into prepayment risk, by returning the principal of the defaulted mortgages to the investor.¹⁰

The limitations of prepayment risk tranching in part triggered investor interest in default risk. However, observing these limitations did not preclude MBS issuers from using tranching to manage the default risk in what the market participants termed ‘credit-sensitive’ MBS. The set of tranching tools used to manage *default risk* incorporated and built on the same tools used to protect investors from *prepayment risk* that led to the 1994 meltdown. Default risk tranching relied on the same assumption of independence of borrower decisions as prepayment risk tranching, i.e. that individual borrowers’ probabilities of default are independent of each other. The bottom line is that in both instances, MBS issuers deployed risk-management tools to provide a form of insurance for risks that were driven by economy-wide changes, which rendered the individual risks correlated and, consequently, not insurable.

Risk management tools and the 2008 crisis

Much of the existing literature on the 2008 crisis has focused on the role of securitisation – the process of turning previously illiquid bank assets such as mortgage loans into securities sold to investors – in bringing about the crisis. Specifically, scholars have argued that the developments in securitisation contributed to the events of 2008 by changing the incentives, and consequently, the behaviour of consumers,¹¹ lenders,¹² investment banks,¹³ and rating agencies.¹⁴ In exploring the roles of the investment banks and rating agencies in the lead-up to the crisis, researchers have scrutinised the financial models and risk-management tools used in structuring the default risk in MBS.¹⁵

Financial crisis scholars have argued that understanding the limits of the financial models lies at the core of learning from financial crises:

If crises have a silver lining, it is their ability to challenge assumptions about the operation of financial markets. *They lay bare the limits and flaws of the models used to analyze such markets* – including those used by major financial institutions and their regulators when, *inter alia*, gauging capital adequacy. They similarly point to the existence of flaws in how the markets are organized and regulated [emphasis added].¹⁶

In the case of the 2008 crisis, the models have attracted interest because of the mismatch in their predictions (that certain MBS tranches were safe from default risk) and the securities’ performance during the crisis (losses incurred by the safe MBS tranches).

Missing from the analysis of risk management tools that enabled securitisation has been an understanding of their history – where they came from, how they evolved over time, and what learning opportunities were missed during this evolution. Documenting these learning opportunities is important to understanding whether and when the market participants could have anticipated, and possibly prevented, the 2008 crisis by learning from the tools’ prior performance. Investigating the relationship between the tools used for managing default risk in MBS and their deeper roots, which lay in the tools used for managing prepayment risk in MBS in the 1970s and 1980s, is a particularly fruitful domain for documenting such learning opportunities.

One reason scholars have not engaged in a thorough analysis of the relationship between the tools used for managing default risk and those used for managing prepayment risk is because the history of the tools used for managing prepayment risk in MBS and the

emergence of prepayment risk tranching remains largely unexplored in the academic literature. This omission is particularly glaring given that tranching – the dominant approach to the management of default risk, which figured prominently in the 2008 crisis – was used to manage prepayment risk before the introduction of default risk into MBS. Only three articles to date have touched on the history of how the two sets of tranching tools evolved. While each of these articles made important contributions to the literature on the development of MBS, none focused explicitly on the history of tranching. This lack of focus accounts for the limitations in the articles accounts of the history of tranching. I will discuss these limitations in turn.

Donald MacKenzie's omits the role played by tools used for tranching prepayment risk in the development of tools for tranching default risk.¹⁷ McConnell and Buser's does not address the changes in how the market participants used tranching tools for managing prepayment and default risk.¹⁸ Fostel and Geanakoplos' asserts that the development of tools for tranching prepayment risk was a necessary precondition for the development of tools for tranching default risk.¹⁹ All three approaches are problematic when it comes to understanding the development of the MBS market because they fail to examine the co-evolution of the two types of tranching tools; thus, obscuring from view the opportunities for learning that were missed by the market participants. I review each approach in turn below.

In his thorough investigation of the role of the rating agencies' models in facilitating the events of 2008, MacKenzie acknowledges the important role played by prepayment risk in the MBS market development: 'Prepayment was, for example, the primary risk of these securities that Ranieri and the other Salomon Brothers' traders (described in Lewis's *Liar's Poker* 1990) were slicing, dicing, buying, and selling.'²⁰

However, he does not make the connection between the slicing and dicing of prepayment risk and the emergence of default risk tranching.²¹ Instead, MacKenzie assumes that the first issue of MBS that exposed investors to default risk in 1977 coincided with the first use of tranching in the MBS market, which is not the case. In MacKenzie's timing of the introduction of tranching, default risk tranching appears before prepayment risk tranching. This would preclude the MBS market participants' experience with prepayment risk tranching from informing their use of default risk tranching.

As the quote below indicates, McConnell and Buser accurately time the introduction of tranching in MBS to 1983, but assume away any changes between how market participants used tranching to manage prepayment risk and default risk:

Innovations have also occurred within the MBS market. These have taken one of two forms. The first is in the structure of MBS. The second is in the type of underlying collateral. As regards structure, collateralized mortgage obligations (CMOs), the first of which was issued in 1983, allocate the cash flows from the MBS into tranches that allow investors to choose among a wide array of payoff patterns.²²

The quotation reflects an implicit assumption that tranching tools used to manage prepayment risk and tranching tools used to manage default risk are identical. The two sets of tools relied on the same set of assumptions, i.e. that the borrowers' decisions were independent of each other. However, assuming that the tools were identical precludes the investigation of the sequence in which the tools were developed and what the market participants could have learned from this sequence. Taken literally, this quote traces the beginning of structured credit (as the slew of products which used tranching to manage default risk came to be

called) to CMOs without acknowledging that the risk structured in the CMOs in the early 1980s was not default risk, but rather prepayment risk.

While McConnell and Buser assume that the market participants used the same tranching tools for managing prepayment and default risk, Fostel and Geanakoplos assert a causal connection between the tranching tools used to manage the two types of risk. However, they treat the history of tranching tool development as exogenous to their argument and, consequently, do not investigate the implications of this connection, as evidenced by the following quote:

Our approach, like many papers in economics that take technological innovation as exogenous, is to take the financial innovations in the mortgage market between 1986 and 2010 as exogenous and investigate their consequences for asset pricing. Under this view, the tranching of subprime mortgages couldn't have begun earlier because it had to wait for the innovation of CMO tranching.²³

Translating this quote into the language of prepayment and default risk, what the authors term 'CMO tranching' and 'tranching of subprime mortgages' respectively, suggests that default risk tranching tools had to wait for the prepayment risk tranching tools to be developed. Tranching tools developed in the early 1980s focused on prepayment risk rather than default risk. The federal government's implicit and explicit guarantees of the default risk for most MBS issued prior to the late 1980s–early 1990s obviated the need for the development of risk management tools in early MBS. This account asserts that the developments in tranching prepayment risk were preconditions for tranching default risk.

Of the three articles that touch on the history of tranching, the third comes closest to accurately describing the sequence in which tranching tools for prepayment risk and default risk emerged. However, treating the development of tranching as exogenous prevents Fostel and Geanakoplos from examining the implications of the sequence in which the two sets of tools emerged. An important implication of this sequence is that market participants had an opportunity to learn from the early developments in the history of tranching but failed to do so.

This article fills the gap in the literature's understanding of the history of risk management tools in the MBS market by offering a detailed account of the history of tranching tools from the early beginnings of the MBS market in the 1970s to the 2008 crisis. The evidence that I have collected enables me to construct a nuanced account of how the two sets of tools evolved, documenting the parallels in their evolution. This account allows me to examine the validity of the three assumptions offered by the literature to date, thus filling the gaps in the literature's coverage of this history.

My analysis of the evidence suggests that the 1994 crisis is an important event in the history of tranching tools and the MBS market. However, in the voluminous academic literature on the 2008 crisis, I have come across only one mention of the 1994 crisis in an article that uses the events of 1994 in passing as an example of a crisis brought about by financial innovation.²⁴ Similarly, in the 2008 trade press accounts of the crisis, I have come across only one mention of the 1994 event.²⁵ While the two sources draw a number of parallels between the two crises, they do so without a detailed examination of the history of the tools that contributed to the crises.

In the article, I provide an in-depth analysis of the similarities between the two crises, explicitly considering the nature of the tools and the risks the tools addressed. In making

my case for the parallels between the two sets of tranching tools, I offer an analysis of the role played by tranching in bringing about the 1994 crisis. I then draw parallels between 1994 and 2008 in terms of their antecedents, underlying mechanisms, and explanations offered for the crises. This analysis allows me to examine the learning opportunities missed by the market participants in the aftermath of 1994. My findings suggest that taking advantage of these missed learning opportunities could have helped prevent the 2008 crisis.

Tracing the evolution of the MBS market

My research on the similarities between the MBS market events of 1994 and 2008 draws on nearly 400 printed primary and secondary source documents, collected between 2010 and 2016. The project began with semi-structured interviews of 21 current and former industry participants and regulators involved in the development of the MBS market. Conducted between 2008 and 2010, these interviews explored which organisations participated in the creation of MBS, what roles these organisations played and how they interacted with each other. The choice of individuals and the organisations they represented drew on theoretical sampling, with the set of interviewees expanding until the interviews covered the entire MBS value chain.²⁶

Following the interviews, I read all editions of *The Handbook of Mortgage-Backed Securities*, the industry trade manuals published between 1985 and 2006,²⁷ to understand changes in industry practices and link the timing of these changes to newspaper and trade publication accounts.²⁸ The discussions that accompanied the changes in industry practices in both the manuals and the trade press were an excellent source for tracing the evolution of the market participants' practices.

Ethnographies of financial markets,²⁹ transcripts of National Public Radio interviews with mortgage industry players and consumers, and published practitioner accounts,³⁰ provided important insights into practitioners' decision-making. WorldCat, an online bibliographic catalogue, proved useful for finding manuals, pamphlets, and white papers describing the activities of the securities' issuers, rating agencies, regulators, and industry trade associations.³¹ Searches of online databases ABI Inform/Global and ProQuest Historical Newspapers using as keywords the names of the securities,³² organisations,³³ and individuals³⁴ provided broad coverage of the development of the MBS market.³⁵ Published academic manuscripts dealing with either MBS directly or the history of mortgage lenders supplemented these online searches.³⁶

The combination of these efforts yielded a collection of 379 publications including 13 books and 366 industry documents and periodicals spanning the period from 1960 to 2008. The industry documents include prospectuses of individual securities, annual reports of the securities' issuers and the issuers' regulators, as well as listings of the individual securities in regulatory filings and rating agencies' publications. The periodicals section of the document collection includes stories from major newspapers,³⁷ general interest business journals,³⁸ journals focusing on investing,³⁹ as well as trade publications for the different industry groups involved in creating, buying, and selling MBS.⁴⁰ The resultant combination of printed primary and secondary sources provided the basis for tracing how the MBS market and the tools used by the market participants evolved from 1970 to 2008.

MBS market development and prepayment risk: 1970–1994

MBS before tranching: 1970–1983

The history of the development and use of tranching tools in structuring MBS is closely intertwined with the development of the MBS market in the US between 1970 and today. Both the market itself and the use of tranching in structuring MBS came about as a result of MBS issuers' efforts to attract bond investors' capital to the mortgage market. These efforts grew out of the attempts to sell mortgage loans to pension funds in the 1960s and continued with the issuance of the first 'modern' MBS in 1970.⁴¹ The first major success of these efforts was the issuance of 'collateralised mortgage obligations' (CMOs) by the Federal Home Loan Mortgage Corporation (FHLMC or 'Freddie Mac')⁴² in 1983. The issuance of CMOs became a watershed moment in the development of the MBS market because CMOs were the first type of MBS accepted by bond investors as bonds. This acceptance – manifested in the bond investors' willingness to invest in CMOs – helped grow the market from hundreds of millions of dollars to hundreds of billions of dollars in securities traded.⁴³

The issuance of CMOs is indicative of the connection between the evolution of the MBS market and that of the tranching tools used in structuring MBS. This is because CMOs were the first public issue of MBS that employed tranching – a method of dividing risk among the investors – to manage prepayment risk.⁴⁴ Before the issuance of CMOs, pass-through certificates – securities that represented partial ownership of a pool of mortgages – were the most commonly issued type of MBS. The name of these securities describes their function of passing through the principal and interest payments from the mortgage borrowers to the securities' investors. This structure meant that the pass-through certificates shared a number of attributes with the mortgages in the securities' collateral.

Two of these shared attributes had to do with the maturities of pass-through securities – the term during which the securities would remain outstanding.⁴⁵ The first attribute was the long stated maturity of the securities. Most mortgages at the time were fixed-rate 30-year mortgages, which meant that most pass-through certificates had a stated maturity of 30 years.⁴⁶ The second attribute was the unpredictability of the actual maturity of the securities. Mortgage borrowers had the right to repay (or prepay) a mortgage at any time without incurring a penalty, a contractual provision that rendered the actual maturity of both mortgages and pass-through securities unpredictable. Thus, what was in theory a 30-year security could turn into a one-, two-, or ten-year security depending on the decisions of borrowers whose loans served as the security's collateral. A borrower's decision to repay the mortgage before the end of the loan's term curtailed the stream of interest payments to the investors, thus subjecting the investors to prepayment risk – the risk of receiving less interest than they anticipated when purchasing a pass-through security.⁴⁷

These two shared attributes of mortgages and pass-throughs (long stated maturity and unpredictability in actual maturity) translated into two problems for the bond investors whose capital MBS issuers tried to attract to the mortgage market. One problem was that most bond investors did not want to buy securities with the stated maturity of 30 years.⁴⁸ This was because they were concerned about how interest rate fluctuations over this long period of time would affect the value of their investments. The other problem was that the long stated maturity of the securities did not reflect the securities' actual maturity because of the mortgage borrowers' right to repay the mortgage loans early. An early industry

convention estimated the actual maturity of the securities, backed by 30-year mortgage loans, to be 12 years.⁴⁹ Conventions that emerged later offered estimates as low as seven years.⁵⁰

The combination of the long stated maturity and the likely discrepancy between the stated and the actual maturity made pass-through certificates a bad fit for investors with both short and long investment horizons. Investors with short investment horizons were concerned about the long stated maturity of the securities; investors with long investment horizons were concerned about the prepayment patterns of mortgages backing the pass-through securities. The growth of the MBS market, therefore, depended on the MBS issuers' ability to provide investors with securities that offered shorter maturities and a greater degree of predictability in prepayment patterns than those of pass-through securities.

Tranching prepayment risk: 1983–1994

As early as 1971, the year after the first pass-throughs were issued, market participants discussed the possibility of creating serialised pass-throughs to address the investors' concerns. These 'serialised' securities would be backed by a single pool of collateral, but offer a range of different maturities shorter than 30 years. By offering this range of maturities, MBS issuers sought to attract investors with investment horizons shorter than 30 years.⁵¹ This serialisation, later referred to as tranching of prepayment risk, implemented 12 years later in the CMOs, was supposed to help MBS issuers address two interrelated bond investors' concerns, described in the previous section. Specifically, MBS issuers sought (1) to offer MBS with a shorter maturity than that of the mortgages in the securities' collateral and (2) to provide more predictability in the maturity of MBS. Tranching was supposed to meet these goals by protecting the bond investors from prepayment risk, a risk present in MBS but not in conventional bonds.

Tranching worked by changing the distribution of prepayment risk among the MBS investors. Prior to 1983, prepayment risk – in the form of prepayments received from borrowers – was distributed proportionally to the share of the investors' ownership in the pool of mortgages or pro rata. Figure 1 provides a graphical illustration of the differences between the pro rata method used to distribute prepayments in MBS, such as pass-through certificates, prior to 1983 (top half of the figure) and tranching, the method used to distribute prepayment risk in CMOs (bottom half).

The simplified example in the figure starts with investors A and B, each of whom owns 50% of a pool of mortgages, the outstanding principal of which is worth \$100 million at the outset. This example assumes that \$2 million of the mortgages in the pool prepay every year. After five years, A and B could expect \$90 million worth of mortgages to remain in the pool, with \$10 million of prepayments returned to the investors. The top half of the figure shows the prepayments distributed pro rata between the two investors, thus shrinking the principal of each investor's portfolio to \$45 million.

The bottom half of the figure shows how tranching changes the distribution of prepayment risk among the investors. In the tranching structure, investors in the shorter-maturity tranche of the MBS issue (in this case, investor B) would receive all the prepayments made by the borrowers until B is paid back the principal in full and then investors in the longer-maturity tranche (in this case investor A) would receive the remaining prepayments. In the simplified example in Figure 1, if B held the shorter-maturity tranche of the new MBS and A

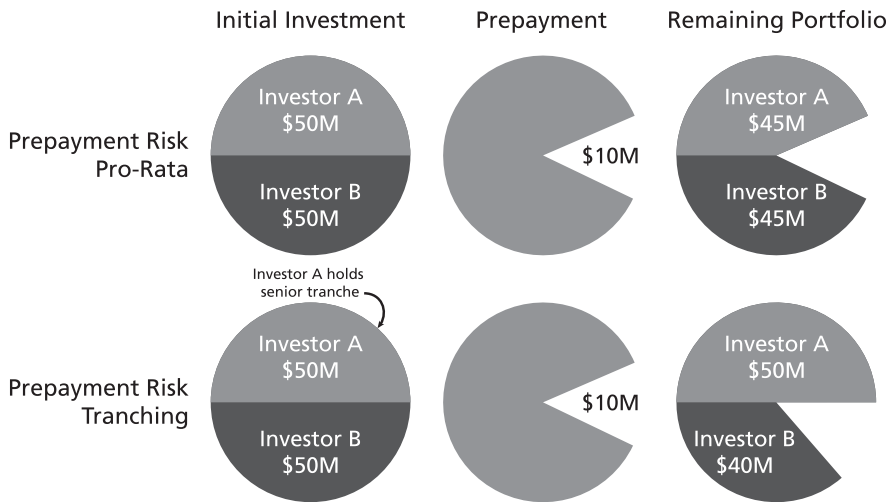


Figure 1. Two approaches to distributing prepayment risk: pro rata and tranching.

held the longer-maturity tranche, then after five years of prepayments the principal of A's investment would remain unchanged at \$50 million, while the principal of B's investment would shrink to \$40 million.

Here, tranching addresses the prepayment risk concerns of investors in the longer-term tranches (investor A) by having the investors in the shorter-term tranches (investor B) receive the early prepayments and thus bear the brunt of the prepayment risk burden. Effectively, tranching here plays the role of insurance from prepayment risk for senior investors. In this structure, MBS issuers buy prepayment risk protection from investors in the short-term or junior tranches by paying them a higher rate of return and sell this protection to the investors in the long-term or senior tranches. The investors in the senior tranches pay for this prepayment risk protection by accepting a lower rate of return.⁵²

As the quote below indicates, investors chose CMOs over pass-throughs because of the perception that tranching provided protection from prepayment risk:

The major advantage of CMOs over other mortgage-backed securities is predictability. Rather than researching to find a \$1 million pool of GNMA's [an industry term for the dominant type of pass-through certificates] which demonstrate historical experience fitting investors' parameters, only to find out that the pool is a fluke, investor can choose a CMO, which allows him/her to purchase a specific tranche, designed to perform in a particular manner but backed by a pool of several hundred million dollars of mortgages to provide statistical consistency. This diversity gives the CMO a stable prepayment experience, allows the investor to predict cash flow and creates an investment which may be suitable for some corporate cash portfolios.⁵³

One source of evidence that the bond investors viewed the CMO structures as effective at managing prepayment risk was that CMOs commanded a premium over regular pass-throughs.⁵⁴ The acceptance of tranching as a risk management tool for prepayment risk, and the idea that CMOs 'offer a more predictable principal repayment schedule',⁵⁵ was questioned by some market observers including Federal Reserve economists, who argued that tranching could not reduce the uncertainty associated with prepayment risk in MBS and only redistribute this uncertainty.⁵⁶

Developing prepayment benchmarks

The 1983 first public issue of MBS that deployed tranching to manage prepayment risk took 12 years from the first trade press mention of the idea. This 12-year period between the first mention of the idea and the first security issue was a time when recognition of prepayment patterns in the MBS collateral – and their significance – slowly emerged.⁵⁷ Understanding prepayment patterns was required in order to use tranching to manage prepayment risk. Specifically, MBS issuers needed to know how many tranches an issue of securities could have and what percentage of the total issue could go into each tranche.

The early efforts to gain such an understanding grew out of the issuers' attempts to calculate yield for the pass-through securities.⁵⁸ The yield is an important metric in trading bonds because it allows the traders to compare the price of a security to the cash flows the security would generate over the period it remained outstanding. The discrepancy between the stated and actual maturity in MBS made stated maturity an unreliable indicator of the cash flows MBS would generate, rendering stated maturity unsuitable for yield calculations.

Consequently, instead of using the securities' stated maturity, the traders arrived at a convention that assumed that all 30-year mortgages in the MBS collateral would be repaid 12 years after the securities were issued. This convention, described as 'the oldest and the simplest' by the market participants, was based on the analysis of the repayment behaviour of 30-year loans insured by the Federal Housing Administration.⁵⁹ The endorsement of this convention by the GNMA led some market participants to refer to it as the 'Ginnie Mae Formula'.⁶⁰ While this convention dominated MBS trading for much of the early 1970s, it was not sufficiently flexible to address the traders' needs. One problem with this convention was that it was too rigid to describe the differences between different mortgage pools. The other problem was that it was hard to modify in response to changing market conditions.⁶¹

In response to these shortcomings, the MBS traders started using the FHA experience as a more flexible benchmark for describing prepayments in a given pool of mortgages. Instead of a single fixed number to indicate the expected maturity of the securities, the MBS traders used the FHA experience with mortgages issued in different years to describe the prepayment behaviour of mortgage loans in different pools. The advantage of the FHA experience benchmark over the 12-year convention was that it allowed the traders to quantify the similarities and differences between the prepayment behaviour of a benchmark pool of FHA mortgages and the mortgages in a pool they were interested in describing. Mortgages repaying at the same rate as the FHA loans prepaid at 100% of the FHA experience. Mortgages repaying twice as fast as the FHA benchmark prepaid at 200% of the FHA experience. Mortgages repaying at half the rate prepaid at 50% of the FHA experience and so on.

In addition to enabling MBS trading in the 1970s, these conventions also established the analysis of past trends and extrapolation from these trends as an acceptable approach to understanding the mortgage prepayment patterns. This approach was further refined in the late 1970s and early 1980s when the analysis of more data enabled by access to computing power convinced the MBS market participants that they understood mortgage prepayment patterns.⁶² The prepayment benchmarks, once developed, were used by the market participants to undergird tranching of prepayment risk in MBS. The development of prepayment benchmarks continued after the issuance of CMOs.

The emergence of the Standard Prepayment Model benchmark

In 1985, the Public Securities Association, a trade group of MBS dealers, developed a benchmark for assessing prepayment risk in CMOs. The trade group launched the benchmark to standardise the different prepayment assumptions used by the market participants to model the prepayments that the securities would be likely to incur.⁶³ The benchmark was labelled the Standard Prepayment Model, but commonly known as PSA, after the acronym for the group that developed it. Prior to the launch of the PSA, industry participants relied on a range of FHA benchmarks. According to the *New York Times* account for why the PSA was launched, in estimating the future prepayments from the securities, some used 'the prepayment experience for Federal Housing Administration-insured mortgages during 1957–81, others used F.H.A. mortgage experience during 1980–83, and still others used the F.H.A. experience in 1970–84'.⁶⁴

The PSA was intended to bring the market participants to a common standard that would allow MBS traders and investors to more easily compare and trade the different securities being issued. The consistency offered by the PSA came at the price of accuracy. As Figure 2 shows, the PSA overestimated the observed prepayment speeds about 270 months or 75% of the 30-year mortgages' stated maturity.⁶⁵

These inaccuracies notwithstanding, PSA displaced the variety of FHA benchmarks, becoming the new anchor for describing mortgage prepayment rates. A pool of mortgages now prepaid at 100% PSA, 200% PSA, etc., where 200% referred to a pool prepaying twice as fast as the (once FHA, now PSA) benchmark. The PSA assumed that 0.2% of the mortgages would be prepaid every month for the first 30 months after the loan is originated, and after the first 30 months 6% of the mortgages in the pool would be prepaid every year.⁶⁶ Models designed to predict prepayment used the resultant PSA curve to estimate future prepayments and structure MBS.

PSA Versus FHA CPR Series

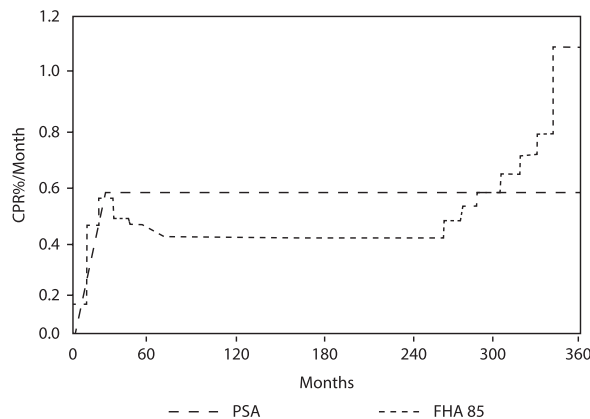


Figure 2. The discrepancy between PSA and the 1985 FHA experience. Source: Reproduction of Exhibit 2–5 from Lowell, "Mortgage Pass-Through Securities," 40; reproduced with permission from McGraw-Hill. Notes: CPR refers to the conditional prepayment rate – an empirical measure of prepayments incurred by a given pool of mortgages. Source: Reproduction of Exhibit 2–5 from Lowell, "Mortgage Pass-Through Securities," 40; reproduced with permission from McGraw-Hill.

The making of the 1994 crisis

The success of the CMOs led to a flourishing of the MBS market that grew from being the purview of a few specialist firms to attracting broad swathes of institutional investors. MBS issuers responded to the influx of new capital by designing sophisticated securities, custom-tailored to the needs of the investors entering the market. The design of these securities relied on tranching. This period yielded a proliferation of complex structures with as many as 69 tranches,⁶⁷ a development that represented a more than twentyfold increase in the number of tranches from the inaugural three-tranche CMO issued by Freddie Mac in 1983. The development of sophisticated forecasting models enabled this proliferation. The models relied on complicated statistics, resulting in the invention of securities with exotic names, including 'sticky jump Z' tranches, inverse interest rate floaters, turbo bullets, soft bullets, and so on,⁶⁸ a proliferation would be mirrored by the securities with tranching default risk in the lead-up to the 2008 crisis. Arguably, the structures' complexity and the sophistication of the underlying models created an impression that MBS structures responded comprehensively to different levels of risk.

Early in the industry use of the PSA benchmark, market participants warned each other not to take 100% PSA as reflecting an empirically derived average of prepayment expectations.⁶⁹ The reason for this warning was that the prepayment benchmarks, first the FHA experience and then the PSA, became important inputs into decisions for how tranching securities were structured. The estimate of the prepayment speed of the mortgages in the collateral drove the decisions about the size and the estimated maturities of the different tranches. The benchmark also helped facilitate communication with investors. For instance, some of the super-senior prepayment risk tranches known as planned amortisation classes (PACs) were designed to protect investors from prepayment risk as long as the collateral prepayment speeds stayed within an 85–300% range of the PSA benchmark.⁷⁰ The acceptance of PSA as a model input along with its use in investor communication reinforced the temptation to view 100% PSA as an empirically derived expectation of prepayment rates.

The CMOs and other tranching MBS worked as advertised between 1983 and 1991. The flourishing of the MBS market was brought to a halt by changes in the interest rate environment. Between 1990 and 1993, the Federal Reserve took the effective federal funds rate from 8.29% in June 1990 to the low of 2.96% in December 1993 (over a series of interest rate cuts). These cuts in the federal funds rate translated into cuts in mortgage interest rates. The cuts in mortgage interest rates, in combination with the availability of mortgage credit facilitated by the presence of the bond investor capital in the MBS market, created the ideal conditions for many borrowers to refinance their mortgages. The trade press described the homeowners' response to the changes in interest rates as follows:

Homeowners are responding to the dramatic drop in interest rates by stampeding to refinance their older, high-cost mortgages. Replacing a \$200,000, 10½%, 30-year home loan with one costing 8¼% slashes the monthly (principal and interest) payment from \$1,829.48 to \$1,502.53.⁷¹

Figure 3 plots the changes in interest rates and the dollar volume of MBS securities repaid as a result of borrowers refinancing, i.e. prepaying their loans, between 1984 and 1993. As Figure 3 indicates, a large number of borrowers responded to the interest rate changes of the early 1990s by refinancing their loans.⁷²

The large numbers of borrowers refinancing their loans, variously labelled deluges, avalanches, or 'waves of refinancing' in the trade press, rendered tranching ineffective in

Mortgage Interest Rate and Refinancing Activity

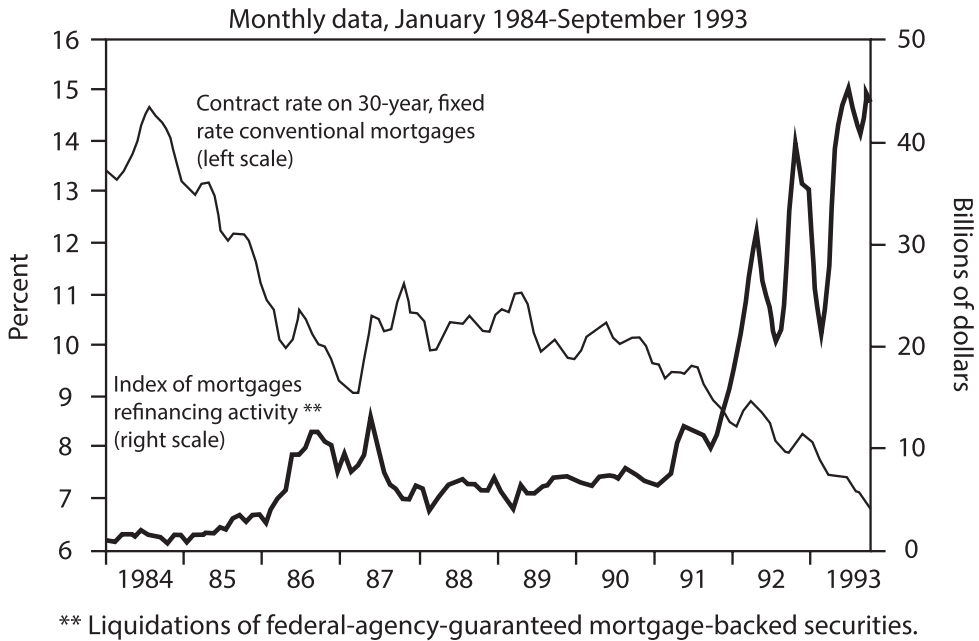


Figure 3. Refinancing in response to interest rate changes. Source: Reproduction of Figure 1 from Anderson, "The Effect of Mortgage Refinancing," 51; reproduced with permission from the Federal Reserve Bank of St. Louis.

managing prepayment risk.⁷³ This was because the number of borrowers refinancing their loans exceeded the thresholds of the shorter-maturity MBS tranches, thus rendering the longer-maturity tranches vulnerable to prepayment. The high levels of refinancing led to as many as 70% of mortgages in MBS pools prepaying in a year. This rate was nearly 12 times the baseline scenario of the 6% per year prepayments of the 100% PSA benchmark or, in industry terms, 1200% PSA. Such high levels of refinancing meant that the prepayments effectively wiped out the interest component of existing MBS holdings.⁷⁴

In so doing, these levels of refinancing, not anticipated by the prepayment models used to structure the securities, surprised the senior tranche holders of MBS, who thought they were protected from prepayment risk. Jamie Newell, a senior advisor for capital markets for the Office of the Comptroller of the Currency (OCC), a major bank regulator, reflected on the developments as follows:

A lot of instruments that people bought last year, like PAC bonds, were deemed to be safe, [b]ut with the prepayments we had in 1992, all the companions got eaten away, and it wasn't a PAC, it was a straight sequential bond.⁷⁵

As this quote suggests, the market participants did not anticipate the extent of the senior tranche vulnerability to prepayment risk.

The market participants did not anticipate the events of 1994. One piece of evidence for such lack of anticipation is that in addition to causing losses for the novice investors, the 1994 meltdown also wreaked havoc on the portfolios of MBS market pioneers such as David

Askin and Lewis Ranieri. For a number of years prior to the crisis, Askin headed the Fixed Income Research department at Drexel Lambert, an investment bank that was one of the early movers in the MBS market. Askin was a well-regarded expert on prepayment risk. While at Drexel Lambert, he authored and co-authored the chapters on forecasting prepayments for the first two editions of *The Handbook of Mortgage-Backed Securities*, the trade manual used by MBS market firms to train their staff, as well as proprietary publications with titles like: 'Unsafe at Any Speed? Derivative Mortgage-Backed Securities and the PSA Prepayment Model'.⁷⁶ *Institutional Investor* reporters described the performance of Askin's firm in 1994 as losing 'a massive chunk of the \$600 million' invested by his clients.⁷⁷ Market observers listed the juxtaposition of Askin's reputation and the scale of his fund's losses as one of the two events, along with the Orange County, CA interest rate derivatives speculation failure, that shook the investors' confidence in the derivatives market.⁷⁸

Market observers were also quick to point out the mismatch between the reputation of Lewis Ranieri, another MBS market pioneer, and his firm's performance. A 1993 *Euromoney* article described the performance of Ranieri's firm as follows:

At the time of going to press a lawsuit had just been launched against Lewis Ranieri (the former Salomon Brothers trader and a central figure in the book *Liar's Poker* by former Salomon bond salesman Michael Lewis) and his Hyperion Capital Management company. The suit alleges that investors in one Hyperion Trust were led to believe that they were buying high-yielding but stable investments, whereas one third of the \$630 million fund was in fact invested in IOs [interest-only securities that entitled investors to only the interest portion of the MBS cash flows].⁷⁹

Because of these losses by experienced investors, CMO issuance virtually ground to a halt. Industry sources suggest that it took several years for the investors to buy CMOs again:

As of the third quarter of 1996, CMO production represented about 21% of total MBS production for the period. This is up from the single-digit percentages of 1994–1995, but still a far cry from the early 1990s when the CMO market consumed as much as 70% of new securities issuance.⁸⁰

As Figure 4 demonstrates, the contraction in the CMO issuance between 1993 and 1995 is the largest such contraction in the history of CMO issuance in either percentage or dollar terms. It took the CMO issuers eight years to return to the 1993 issuance levels.

The models that MBS market participants used to predict prepayments and structure securities did not anticipate the possibility of this meltdown, as the following quote from *Institutional Investor* describing the refinancing patterns between 1991 and 1993 suggests: 'Homeowners refinanced at unheard-of rates. Wall Street's prepayment models, based on the 1985–'87 experience (when interest rates actually fell more steeply), failed to predict the onslaught of prepayments.'⁸¹ The differences between the changes in prepayment rates and in interest rates in 1985–1987 and 1991–1993 alluded to in the quote are shown in Figure 3. The period from 1985 to 1987 saw a steep drop in mortgage interest rates and a correspondingly smaller uptick in refinances. By comparison, the period from 1991 to 1993 saw a slight decline in mortgage interest rates and a steep increase in refinances. What enabled the homeowners to refinance at rates that were previously 'unheard of'?

The role of MBS market growth in bringing about 1994

According to the logic for the existence of the MBS market, MBS were created to inject liquidity into the previously constrained home-lending market by attracting bond investor capital to the primary mortgage market.⁸² The presence of this liquidity in the early 1990s provided homeowners with opportunities for refinancing that were not previously available

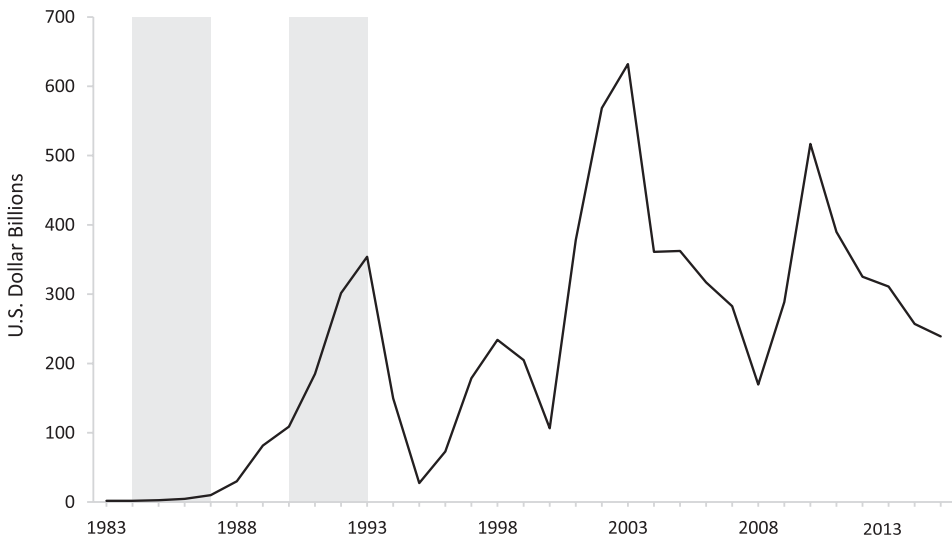


Figure 4. Collateralised Mortgage Obligation (CMO) issuance between 1983 and 2015. Sources: Securities Industry and Financial Markets Association, “U.S. Agency Mortgage Securities Issuance,” US Mortgage-Related Issuance and Outstanding; <https://www.sifma.org/wp-content/uploads/2017/06/sf-us-mortgage-related-sifma.xls>; accessed on March 9, 2018.

Notes: Periods associated with refinancing peaks are shaded in grey.

to them and, in turn, rendered prepayment risk models based on past trends unreliable. What made 1991–1993 different from 1985–1987 was the extent of the development of the MBS market. Figures 5 and 6 map the refinancing activity between 1983 and 1996 against the growth in the MBS market and CMO issuance respectively.

Figure 5 shows that mortgage interest rates and federal funds rates were correlated with the refinancing activity. However, the changes in these variables are mild compared to the changes in the refinancing activity levels. These data suggest that the MBS market played the role of an amplification mechanism enabling borrowers to react to the changes in the interest rate. Consistent with the argument that the liquidity coming from the MBS market played an important role in shaping the refinancing activity levels, the size of the MBS investor holdings maps exactly to the two refinancing peaks. Such mapping suggests that the liquidity channelled into the primary mortgage market by the MBS market enabled both the 1980s and 1990s refinancing peaks. The growth of the MBS market between the 1980s and 1990s explains the difference in the refinancing activity levels between the 1980s and 1990s.

This article suggests that tranching played an important role in enabling the development of the MBS market. Specifically, I argue that the difference in the heights of the two MBS market peaks, which correspond to the two refinancing activity peaks, is the degree of acceptance of CMOs – MBS that used tranching to manage prepayment risk – by the MBS investors.

Figure 6 shows the growth in the volume of CMO securities issued between 1983 and 1996. The CMO issuance volume lines up perfectly with the 1990s refinancing peak, suggesting that the growth in CMO issuance was an important contributing factor to the growth in the MBS market, thus enabling the spike in the refinancing activity in response to the interest rate cuts.

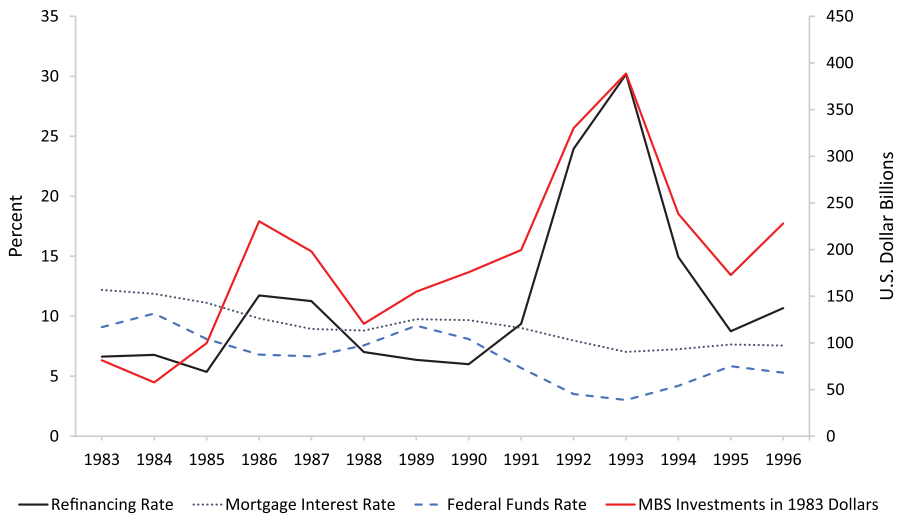


Figure 5. Refinancing rate, mortgage interest rate, federal funds rate, and MBS investments. Sources: refinancing rate – the average monthly conditional prepayment rate for MBS issued by FNMA, GNMA, FHLMC, weighed by coupon, and maximum amount remaining for coupons 5–11.5%, Bloomberg; mortgage interest rate – *Federal Reserve Bulletin* for 1998, 1995, 1992, 1989, 1986, 1981, 1978, 1975, 1972; federal funds rate – Federal Reserve Economic Data, <https://fred.stlouisfed.org>; MBS investments (defined as mortgages acquired by mortgage pools) – US Department of Housing and Urban Development, Office of Policy Development and Research, 4th Quarter 1994 US Housing Market Conditions, February 1995, <https://www.huduser.gov/periodicals/ushmc/hsgmkt4.pdf> ; US Department of Housing and Urban Development, Office of Policy Development and Research, 4th Quarter 1997 US Housing Market Conditions, February 1998, <https://www.huduser.gov/periodicals/ushmc/winter97/>; mortgage interest rate – *Federal Reserve Bulletin* for 1981, 1986, 1989, 1992, 1995, 1998. Note: All rates expressed in percentages.

MBS market participants were surprised by the borrower response to changes in the mortgage interest rates in the early 1990s. I argue that the growth in CMO issuance and the concomitant injection of liquidity into the primary mortgage market drove this response. Figure 7 shows the growth of residential mortgage loan originations, MBS investments, and CMO issuance between 1983 and 1995.

The \$107 billion growth in CMO issuance between 1984 and 1990 shown in Figure 7 accounted for 63% of the \$169.8 billion increase in MBS holdings and 42% of the \$254 billion growth in the primary mortgage market.⁸³ The growth in CMO issuance between the two refinancing peaks led to an injection of more than \$100 billion into the primary mortgage market. This injection translated into greater availability of mortgage credit for the borrowers. In 1985–1987, the borrowers had the incentive to refinance their mortgages, but they may not have had the opportunity to refinance. By the early 1990s, the borrowers had both the incentive and the opportunity to refinance.

The original rationale for the MBS market existence was that it would provide greater liquidity for consumers. However, as the market grew, MBS issuers, traders, and investors did not incorporate this rationale into their prepayment forecasting models. The market participants' prepayment risk models did not take into account how the growth of the MBS

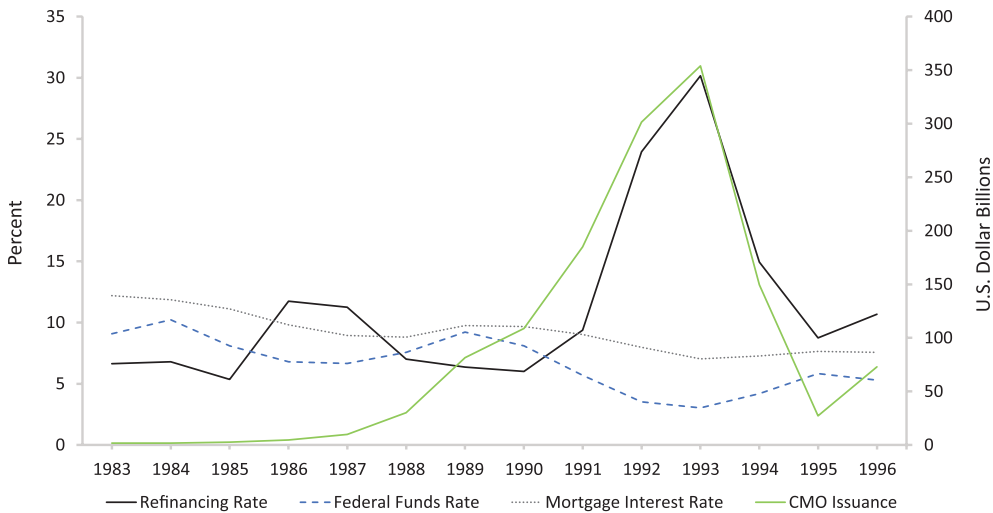


Figure 6. Refinancing rate, mortgage interest rate, federal funds rate, and CMO issuance. Sources: refinancing rate – the average monthly conditional prepayment rate for MBS issued by FNMA, GNMA, FHLMC, weighed by coupon, and maximum amount remaining for coupons 5–11.5%, Bloomberg; mortgage interest rate – *Federal Reserve Bulletin* for 1998, 1995, 1992, 1989, 1986, 1981, 1978, 1975, 1972; federal funds rate – Federal Reserve Economic Data, <https://fred.stlouisfed.org>; CMO Issuance – Securities Industry and Financial Markets Association, “U.S. Agency Mortgage Securities Issuance,” US Mortgage-Related Issuance and Outstanding, <https://www.sifma.org/wp-content/uploads/2017/06/sf-us-mortgage-related-sifma.xls>; accessed on March 9, 2018.

Note: All rates expressed in percentages.

market might affect consumer behaviour and, with it, the efficacy of tranching at managing prepayment risk and the performance of MBS.

The underlying dynamic of the 1994 crisis was that the investors’ acceptance of the prepayment risk tranching tools attracted capital to the MBS market. These tranching tools were grounded in historical benchmarks, i.e. an understanding of consumer behaviour in the mortgage market as it was before the MBS market developed. The injection of capital into the MBS market enabled consumers to refinance their loans at new, higher levels, well above the historical benchmarks, thus rendering tranching tools ineffective in managing prepayment risk. The acceptance of tranching tools both helped develop the MBS market and sowed the seeds for the market’s crisis.

MBS market participants’ explanation of 1994

My explanation of the underlying causes of the 1994 crisis differs from the one arrived at by the market participants. By 1996–1997, the conventional wisdom about the crisis coalesced around the idea that the proximate cause of the 1991–1993 refinancing activity was the change in the mortgage origination fees charged by the mortgage lenders and the failure of prepayment models used to structure MBS to account for this change.⁸⁴ While the industry participants acknowledged that the experience of 1991–1993 differed from the experience of 1985–1987, they saw the reduction in the mortgage origination fees charged by the

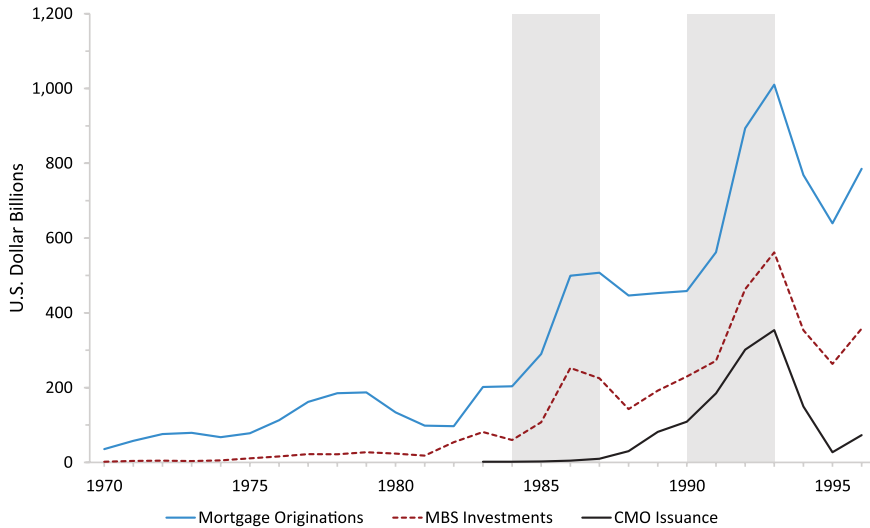


Figure 7. Residential mortgage originations, MBS investments, and CMO issuance in billions of US dollars. Sources: mortgage originations – Table 18, and MBS investments – Table 19, US Department of Housing and Urban Development, Office of Policy Development and Research, 4th Quarter 1994 US Housing Market Conditions, February 1995, <https://www.huduser.gov/periodicals/ushmc/hsgmkt4.pdf>; US Department of Housing and Urban Development, Office of Policy Development and Research, 4th Quarter 1997 US Housing Market Conditions, February 1998, <https://www.huduser.gov/periodicals/ushmc/winter97/>; CMO Issuance – Securities Industry and Financial Markets Association, “U.S. Agency Mortgage Securities Issuance,” US Mortgage-Related Issuance and Outstanding, <https://www.sifma.org/wp-content/uploads/2017/06/sf-us-mortgage-related-sifma.xls>; accessed on March 9, 2018; 1980s and 1990s refinancing peaks shaded in grey.

Note: All numbers – in billions of US dollars; periods associated with refinancing peaks are shaded in grey.

lenders as the reason for the difference between the two periods. By contrast, I argue that the development of the MBS market contributed to the spike in the refinancing activity.

The market participants’ origination-fees hypothesis is an incomplete explanation of the 1990s refinancing peak because it does not account for the availability of credit necessary for refinancing to take place. By contrast, the explanation of the crisis in terms of the growth of the MBS market can account for the role played by the MBS market in providing such access to credit and the cuts in mortgage origination fees. Specifically, I suggest that the easy availability of credit enabled the lenders to lower the fees because they could underwrite more loans to make up for the lost fee income.⁸⁵

One factor that may explain the MBS traders’ willingness to accept this incomplete explanation is that it allowed them to attribute the crisis to a single idiosyncratic event rather than to the limitations of tranching. Not accepting this explanation would have forced the market participants to consider alternative approaches to managing prepayment risk such as lobbying for government-provided interest rate risk insurance in managing prepayment risk.⁸⁶

The market resurgence (possibly due to the acceptability of this explanation) may be the reason why MBS market participants not only failed to learn more from 1994, but also failed to act on what they did learn, i.e. that refinancing could undermine the efficacy of tranching.

After the 1994 meltdown, Lewis Ranieri commented: ‘We did not build this system to finance refinancing. We built this system to finance housing ... It is time to go back and fix the system.’⁸⁷ Despite this rhetoric, market participants did not fix the system. Refinancing reprised its role in blinding the MBS market participants to the role played by the increased liquidity pouring into the MBS market in changing the dynamics of the primary market in the 2008 crisis.

Lessons learned from 1994

What did the market participants learn from 1994? Of the five different types of actors involved in or affected by the MBS market – consumers, lenders, rating agencies, investors, and MBS traders – the 1990s refinancing peak constituted a problem for only two. These two groups were MBS traders, who found it difficult to sell CMOs in the aftermath of the crisis, and investors, who lost money.⁸⁸ By contrast, the refinancing peak was a positive development for consumers, who obtained lower rates on their mortgages, and lenders, who received fees from originating and servicing new loans.⁸⁹ Below, I consider what the MBS traders and investors learned from the crisis.

The MBS traders channelled what they learned from the 1994 crisis in three directions: (1) confirming the importance of focusing on prepayment risk, (2) confirming the danger of misunderstanding the models, and (3) suggesting a possible need to tweak the models. The first two directions treated the crisis as confirming (rather than disconfirming) the existing understanding of the models. The third direction framed the crisis as an opportunity to collect more data to improve the existing models rather than to engage in a wholesale reconsideration of the efficacy of tranching.

The 1994 crisis confirmed the market participants’ understanding that managing prepayment risk was essential to the acceptance of MBS as bonds. Compare the opening quote from the 1992 *Handbook of Mortgage-Backed Securities* chapter on prepayment risk with the post-crisis version in the 1995 *Handbook* (differences italicised):

[1992] Prepayments are fundamental to mortgage-backed securities (MBS). Were it not for the right of mortgagors to prepay their mortgages without a penalty, a mortgage security would be similar to an ordinary bond; but from the right of mortgagors to prepay, the risk characteristics of mortgage-backed securities are derived, and they differ dramatically from those of ordinary bonds.⁹⁰

[1995] Prepayments are fundamental to mortgage-backed securities (MBS). Were it not for the right of mortgagors to prepay their mortgages without a penalty, a mortgage security would be similar to an ordinary, *non-callable corporate or Treasury* bond; but from the right of mortgagors to prepay *and their inefficient exercise of this option*, the risk characteristics of mortgage-backed securities are derived, and they differ dramatically from those of ordinary bonds [emphasis added].⁹¹

The comparison suggests that even before the crisis MBS market participants saw prepayment risk as a fundamental difference between MBS and bonds. The only passing acknowledgement of the crisis in the post-crisis chapter on prepayment risk is the authors’ remark on the borrowers’ ‘inefficient exercise’ of the prepayment option (presumably ‘inefficient’ for the MBS investors). The only other change in the text content is the more precise specification of what type of bond MBS were compared to as ‘non-callable, corporate or Treasury’.

The crisis also reminded market participants of the dangers inherent in misunderstanding the models, a known problem before the crisis:

Some investors have assumed that 100% PSA was designed to represent housing turnover on current coupon conventional agency mortgages. This is not the case. The long-term prepayment rate of 6% CPR [conditional prepayment rate – an empirical measure of prepayments incurred by a given pool of mortgages] implied by 100% PSA was chosen as a reference point only.⁹²

This 1995 quote indicates that rather than attempting to search for deeper sources of the crisis, some MBS system participants attributed the models' performance problems to the investors' interpretation of the models. In so doing, these market participants implicitly argued that the crisis stemmed from a misinterpretation of prepayment risk benchmarks by investors. This argument obscures the idea that the infusion of MBS capital into the primary market is what rendered the historical benchmarks irrelevant.

These 1995 warnings echo the ones issued by David Askin and his co-authors in the 1988 chapter on forecasting prepayment rates in *The Handbook of Mortgage-Backed Securities*:

The large variation possible between a security's actual prepayment behavior and a PSA measure can have disastrous consequences not only for pass-throughs but even more so for highly leveraged derivative products such as Strips [MBS that entitled investors to either interest-only (IO) or principal-only (PO) components of mortgage cashflows] and CMO residuals. Finally, and most pertinent to this discussion, the PSA standard is not a forecast model and cannot be used in place of a formal forecast model.⁹³

A comparison of the 1995 and the 1988 quotes suggests that market participants saw the crisis as a confirmation of the idea that misunderstanding the models was dangerous, rather than a signal of the need to re-evaluate the existing models.⁹⁴

Finally, the market participants who did think that the models' performance was problematic during the crisis saw the crisis as an opportunity to improve the prepayment models, as the following quote from a post-crisis chapter on prepayment modelling indicates:

Over the last several years, the U.S. mortgage securities market has endured a dramatic range of prepayment experiences, frustratingly few of which were adequately predicted by existing prepayment models. Today, the market has both the motive and, for the first time, the opportunity to seek a superior approach to prepayment predictions.⁹⁵

The market participants who acknowledged model failure framed the crisis as an opportunity to tweak the existing tools. One example of such tweaking was the suggestion to incorporate the data from the crisis in predicting the behaviour of the mortgage loans of most recent vintage:

The rampant refinancing in 1992 and 1993 replaced voluminous higher-coupon pass-throughs with newly issued ones that carry a 6.5% to 8% coupon rate. On average at least 50% of the mortgage pools backing these new pass-throughs are 'refinancing mortgages' – those that are originated to facilitate refinancing. This phenomenon raises the need to modify the ramp of the PSA curve as a yardstick for measuring prepayment rates of new pass-throughs.⁹⁶

Thus, instead of recognising the challenges of forecasting and controlling prepayment risk in a changing environment, system participants saw the way forward in modifying 'the ramp of the PSA curve'. If the crisis promoted a change in MBS traders' attitudes towards their models, this change was confined to updating the data in the existing models rather than rethinking their approach to managing and modelling risk.

Stemming investor flight

The failure of tranching at managing prepayment risk could have (and, arguably, should have) triggered a flight of bond investors from the MBS market. Indeed some business press

observers argued that the performance of tranching tools in the 1994 crisis meant that CMOs were not bonds. These writers used terms like ‘mortgage-backed mutants’ to describe the securities.⁹⁷ In the aftermath of 1994, investors switched from buying CMOs to pass-throughs — a development that suggests a degree of understanding the limitations of tranching in managing prepayment risk. However, this understanding proved to be short-lived. By 1996, the issuance of CMOs resurged and the market participants proceeded to transfer the tranching tools from prepayment risk to default risk.⁹⁸

One of the issues raised by the MBS investors in the aftermath of 1994 was the concern that the credit rating agencies’ ratings of MBS did not consider prepayment risk. The agencies’ ratings focused solely on default risk — the risk of investors not getting back the principal of their investments. Since default risk at the time was largely absent from the MBS securities, most of the securities on which the investors lost money during the 1990s refinancing peak received the highest possible rating from the rating agencies. Standard & Poor’s responded to investors’ prepayment risk concerns by briefly entertaining the notion of adding the symbol ‘r’ for risk to its ratings to denote the presence of risk other than default risk in the securities.⁹⁹

Instead of seeking to develop a deeper understanding of the mechanisms behind the crisis, MBS market participants worked harder to dispel the notion that MBS were not sufficiently bond-like. The 2001 edition of *The Handbook of Mortgage-Backed Securities*, for instance, lists the following as the most significant event in the MBS market in the 1990s:

In the mid-1990s several developments encouraged a dramatic shift in focus from CMOs back to pass-throughs on the part of many fixed income investors. Perhaps the most sweeping and enduring of these was the growing practice of evaluating [MBS] portfolio managers’ performance against a bond market index.¹⁰⁰

Here, the flight of investors from CMOs to pass-throughs, triggered by the high prepayment rates, is the only indirect acknowledgement of the 1994 crisis. In the aftermath of the crisis, MBS traders focused on managing the risk that bond investors would flee the MBS market. They managed this risk by making MBS market practices more similar to those of the bond markets. One example of these changes is the use of bond market indices to evaluate the MBS portfolio managers’ performance alluded to by the quote above. In another example of furthering the similarity with bond market practices, the MBS dealers’ trade group, Public Securities Association, changed its name to Bond Market Association in 1997.¹⁰¹

After a brief halt, CMO issuance rebounded in 1996. The rebound in issuance put an end to a need for making sense of and learning from the 1994 events. By 1996, CMOs featuring as many as 128 tranches emerged.¹⁰² The re-emergence of complex tranching securities suggests that market participants did not see the connection between the 1990s refinancing peak and the growth in secondary markets triggered by the acceptance of tranching as a risk management tool.

The 1994 crisis made market participants prioritise their concerns about prepayment risk over other risks. The following quote from a 1996 securitisation primer suggests that the 1994 crisis taught MBS investors to focus on prepayment rather than default risk: ‘The dramatic decline of interest rates since 1991, followed by the sharp reversal of rates during 1994, has shown that prepayment risk is significantly more onerous than credit risk.’¹⁰³ This lesson, embedded in industry practices, survived well into the 2000s. In MacKenzie’s analysis of the lead-up to 2008, he finds that ‘the evaluation practices ... surrounding mortgage-backed securities were concerned primarily with prepayment [as opposed to default risk].’¹⁰⁴ The

concerns about prepayment risk, enhanced by the events of 1994, made investing in mortgages that were likelier to default more attractive. The attraction was due to some of these mortgages carrying prepayment penalties, which rendered the prepayment risk more predictable.

Tranching default risk: 1986–2008

As early as 1979, MBS market participants were working on developing tranching tools to protect investors from default risk.¹⁰⁵ The development of tranching tools for the management of default risk was driven by the desire to limit the role of government in the mortgage markets – a commitment shared by both private market participants and government officials.¹⁰⁶ Prior to the development of default risk tranching, most MBS carried implicit and/or explicit government repayment guarantees because they were issued by quasi-government agencies and/or backed by government-insured mortgage loans. The early developments in securitisation met the capital needs of the mortgage lenders, originating government-backed mortgages, but not the needs of lenders originating conventional (i.e. non-government-insured) mortgages. Private issuers of MBS backed by conventional mortgages needed a way to convince investors that the securities they issued were creditworthy. Tranching of default risk grew out of the desire to enable securitisation of conventional mortgages by private companies, thus limiting government involvement in the mortgage markets.

The first public issue of private-label (i.e. non-government-insured) MBS backed by conventional mortgages was the 1977 Bank of America issue of conventional pass-through certificates. The issue relied on private third-party insurance of default risk for providing investors with assurances of mortgage repayment. In its capacity as the securities' issuer, Bank of America contracted with Mortgage Guarantee Insurance Corporation (MGIC), a private company specialising in mortgage insurance, to insure the repayment of 5% of the mortgages in the securities' collateral.¹⁰⁷ Despite the issue's success, the investment bankers who worked on the Bank of America deal found insurance offered by companies specialising in mortgage insurance to be too costly a credit enhancement mechanism for issuing MBS.

Consequently, Salomon Brothers attempted to attract other insurance companies into the mortgage market to undercut the rates charged by the mortgage insurance companies. These efforts failed because non-mortgage insurers were not interested in underwriting insurance policies that would remain outstanding for 30 years.¹⁰⁸ Salomon Brothers' approach to being rebuffed by the traditional insurers was summarised by John McDonogh, the firm's assistant director for accounting services, as continuing the process of 'moving away from the mortgage insurance companies toward those that offer concessions and more competitive prices.'¹⁰⁹ This process reflected the approach taken by other MBS issuers. They too sought to minimise the cost of protecting investors from default risk, subject to getting a high enough rating from the credit rating agencies.¹¹⁰

Traditional insurers' reluctance to enter the MBS insurance space was representative of the lack of appetite of other financial market participants for providing cheap credit-enhancement tools to the MBS market. Faced with the lack of third parties interested in and capable of providing credit enhancement (i.e. default risk insurance) for the securities, MBS market participants turned to tranching to create 'stand-alone' securities, i.e. securities that did not depend on a third party for creditworthiness.¹¹¹

In 1986, the Home Savings of America issue of conventional pass-through certificates became the first public issue of MBS that used subordination (an early form of default risk tranching) to protect investors from default risk. Subordination was different from the third-party insurance, which guaranteed the repayment of a portion of the collateral in exchange for a premium paid by the securities issuer, used in previous deals. Instead of paying a premium to a third party, tranching or self-insurance entailed retaining a 5–10% share of the securities' collateral on the issuer's books.¹¹² This meant that the securities' issuer would absorb the first 5–10% of the losses incurred due to the borrowers' failure to pay back their loans. This form of protection was cheaper and market participants saw it as just as effective as credit enhancement provided by third parties. A 1986 change in tax law allowed MBS issuers to sell the retained share or the 'self-insurance' tranche to investors.¹¹³

The principles of tranching default risk were similar to the principles of tranching prepayment risk explained in the bottom half of Figure 1. Any mortgage defaults were first applied to the most junior tranche until the principal of that tranche was exhausted and then applied to the next most junior tranche until it was exhausted, and so on. In tranching default risk, the holders of the junior tranches were not paid the principal or interest on their securities until the holders of the more senior securities received theirs.

As with prepayment risk tranching, MBS issuers bought default risk insurance from investors in junior tranches by paying them a higher rate of return and sold this insurance to investors in senior tranches. The investors in the senior tranches paid for this default risk insurance by accepting a lower rate of return.

MBS issuers used the term tranching to refer to tranching of both prepayment and default risk, suggesting that they saw the two types of tranching as similar. In securities that employed tranching for managing both prepayment and default risk, market participants referred to tranching of prepayment risk as horizontal tranching and to tranching of default risk as vertical tranching.¹¹⁴

Transferring tools from prepayment risk to default risk tranching

The growing popularity of tranching default risk MBS with investors, described in the quote, drove the need to create new tools. The authors of the chapter on tranching default risk MBS described the investors' growing tolerance for default risk as moving 'down the rating curve':

Since 1993, investors have shown an increased willingness to extend further down the rating curve. While the single-A and triple-B subordinated classes have always enjoyed sound sponsorship, it was just recently that new players began to focus on the double- and single-B classes.¹¹⁵

As with the acceptance of CMOs in the 1980s, the growth in popularity of 'credit-sensitive' securities also triggered a round of tool creation, or more precisely tool transfer from the prepayment risk toolbox. Even as the 1994 crisis highlighted the limitations of tranching tools in managing prepayment risk, MBS issuers used these tools as templates for creating new tools for tranching default risk.

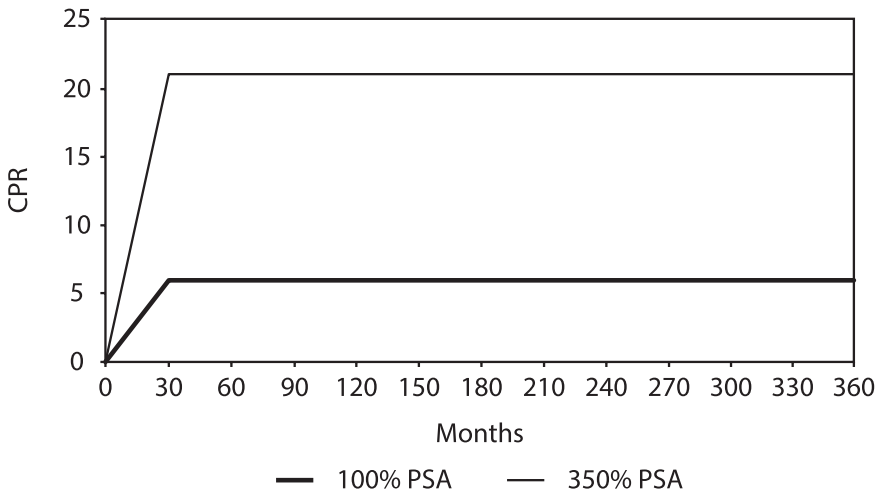
The emergence of the Standard Default Assumption benchmark

In one example of such tool transfer, in July of 1993 the Public Securities Association launched the Standard Default Assumption (SDA), a default risk benchmark modelled on the Standard Prepayment Model launched eight years earlier. Salomon Brothers researchers described the new default risk benchmark by comparison to PSA. For instance, like PSA (and FHA before it),

100% SDA, 200% SDA, 50% SDA, and so on, served as an anchor for quantifying the difference between the benchmark and the performance (in this case incurred losses) of a given pool.¹¹⁶

While neither PSA nor SDA were supposed to function as forecasting tools, both benchmarks assume that the borrowers' behaviour changes as the loans age. Figure 8(a) and (b) show graphical representations of the PSA and the SDA in the industry trade manuals.

(a) PSA CMO Structuring Prepayment Assumption



(b) Exhibit 25. Standard Default Assumption (SDA)

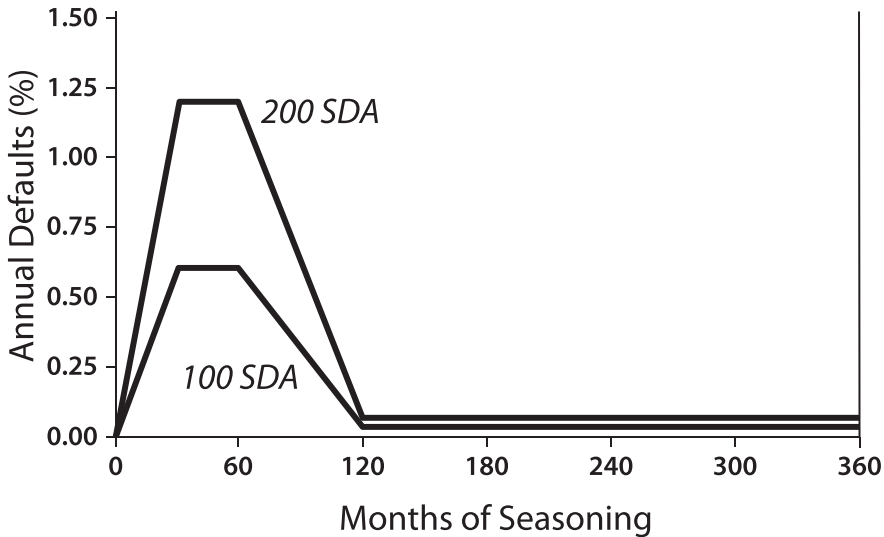


Figure 8. Comparison of PSA and SDA curve shapes. (a) Graphical depiction of PSA. (b) Graphical depiction of the SDA curve. Source: Figure 8(a) is a reproduction from Exhibit 3–5, Lowell and Corsi, “Mortgage Pass-Through Securities,” 57; horizontal axis label added by the author; Figure 8(b) is a reproduction of Exhibit 25, DiLiban and Lancaster, “Understanding and Valuing Mortgage Security Credit,” 479; both figures reproduced with permission from McGraw-Hill.

Note: CPR refers to the conditional prepayment rate – an empirical measure of prepayments incurred by a given pool of mortgages.

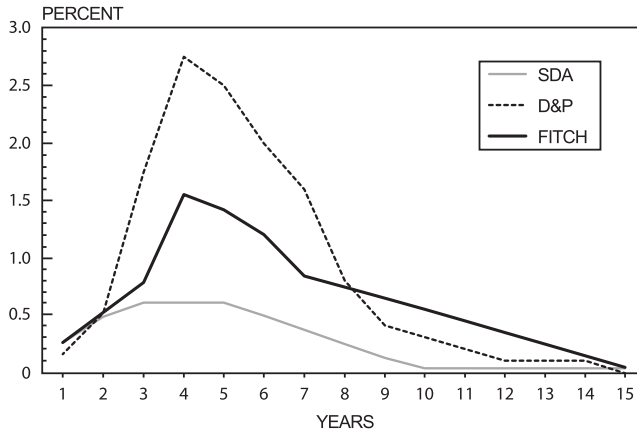
Exhibit I: Assumed Default Frequencies

Figure 9. The discrepancy between SDA and credit rating agency default assumptions. Source: Reproduction of Exhibit 1 from Bendt, Ramsey, and Fabozzi, “Rating Agencies’ Approach,” 192; reproduced with permission from John Wiley & Sons.

Note: D&P and Fitch refer to Duff and Phelps and Fitch rating agencies respectively.

Unlike PSA, which assumes prepayments to hold steady after reaching their peak at 30 months, SDA assumes that defaults go down as loans age. Specifically, SDA describes a pattern of defaults, which grow by 0.02% every month for the first 30 months, then peak at 0.6% for 30 months, and then decline by 0.0095% for 60 months before reaching the value of 0.03% per month. Both benchmarks assume that the respective risks they track peak at month 30 – a coincidence suggesting that PSA served as a basis for the design of SDA.

In another similarity between the two benchmarks, like the PSA, SDA deviated sharply from the rates observed empirically. However, while PSA mostly overestimated the observed prepayment rates (see Figure 2), SDA mostly underestimated the observed default rates. Figure 9 shows the differences between the SDA benchmark and the default rates anticipated by the credit rating agencies.

Despite these discrepancies between SDA and more empirically grounded estimates of mortgage defaults, documented in the trade manuals, the market participants used SDA to tranche default risk, just as they continued to use PSA to tranche prepayment risk.

The making of the 2008 crisis

Like the development of the MBS market following the introduction of prepayment risk tranching, the introduction of default risk tranching led to changes in the primary mortgage market that rendered obsolete the historical benchmarks undergirding tranching. These changes affected both mortgage lender and end-borrower behaviour. Specifically, the development of the tranching default risk MBS market set off cycles of house price inflation and riskier mortgage underwriting in the primary market.¹¹⁷ As investor demand for higher-risk MBS grew, mortgage lenders offered mortgages to borrowers even less likely to pay back their loans.¹¹⁸

First, the growth in the tranching default risk MBS market triggered house price inflation.¹¹⁹ The MBS market growth translated into access to credit for the borrowers who previously did not have such access, allowing them to buy houses. The influx of new buyers, financed by the riskier loans, drove up house prices.¹²⁰ The increase in house prices in turn left other consumers with the options of either being priced out of the housing market or buying now less affordable houses with the help of mortgages that they were less likely to pay back. The house prices rose further as more consumers took out loans they could not afford to pay back.¹²¹ As the prices for single-family homes increased, such increases reduced availability of rental housing, forcing even more consumers into mortgages they could not afford.¹²²

House price inflation, driven by the tranching-default risk MBS market growth, had two effects that obscured the risks of the underlying mortgages from the MBS investors. The first effect was at the secondary market level. Instead of seeing the rising house prices as a symptom of riskier underwriting, MBS investors interpreted the change in house prices as a sign that houses constituted higher-value collateral.¹²³ The view that house price inflation produced higher-value collateral made the investors more comfortable with investing in MBS backed by higher-risk loans. This comfort translated into increased investor demand for higher-risk MBS, thus, fuelling even riskier underwriting.¹²⁴

The second effect was at the primary market level. The growing popularity of higher-risk MBS with investors in combination with rising house prices enabled the consumers who could not afford to pay back their loans to refinance their mortgages instead of defaulting on their loans. Borrowers' ability to refinance their loans due to rising property values became a variable that entered lending decisions, thus leading to even riskier underwriting. The following quote from a court ruling on practices of Fremont Investment & Loan, a mortgage lending company, is representative of this lend-to-refinance rationale:

loans were made in the understanding that they would have to be refinanced before the end of the introductory period. Fremont suggested in oral argument that the loans were underwritten in the expectation, reasonable at the time, that housing prices would improve during the introductory loan term, and thus could be refinanced before the higher payments began.¹²⁵

Thus, by providing more borrowers with access to mortgage credit, MBS investors' capital served to inflate house prices and hide the risk of the loans that fed the housing inflation by enabling refinancing. In 2006, mortgage delinquencies showed downward trends as consumers used the MBS-fuelled supply of credit to refinance their mortgages instead of defaulting on the loans.¹²⁶

The combination of rising house prices and falling delinquencies (due to the availability of refinancing) lulled the tranching default risk MBS market participants into a false sense of security.¹²⁷

The new delinquency numbers were entered into historical default models, which predicted further improvements in the performance of mortgages and, in turn, MBS. Like the prepayment risk models in the early 1990s, the default risk models in the mid-2000s did not take into account the impact that liquidity provided by the MBS market would have on mortgage lender and end-consumer behaviour and, consequently, the performance of MBS. As in the lead-up to 1994, the investors' acceptance of tranching attracted capital to the MBS market, with the resultant liquidity changing the behaviour of the primary market participants in a way that rendered tranching ineffective.

As investor demand for new MBS slackened, the market unravelled. The lenders reduced the availability of mortgage credit, leaving consumers unable to refinance their mortgages.

This inability to refinance in turn gave rise to a wave of delinquencies and defaults, with a decrease in house prices as a result.¹²⁸ The resultant losses exceeded investors' expectations, rendering the senior tranches of the securities vulnerable to default risk. Like the refinancing waves of 1992 and 1993, the waves of defaults from 2007 onwards reduced the value of MBS portfolios, with tranching failing to protect investors from default risk in much the same way it failed to protect them from prepayment risk in the early 1990s.

As in the period between 1983 and 1994 that saw the growing acceptance of prepayment risk tranching and with it the growth of the MBS market, the acceptance of tranching tools that helped develop the market for tranching default risk MBS between 1993 and 2008 also contributed to the market's demise. As in the aftermath of 1994, in making sense of 2008 both practitioners and academic writers have charged the rating agencies with their ratings' failure to capture a dimension of risk that they argue led to the crisis. In 1994, this risk was prepayment risk. In 2008, the risk not captured by the default risk ratings issued by the agencies, was the systemic or catastrophic risk.^{129,130}

A big difference between 1994 and 2008 is that the refinances of the early 1990s did not endanger the principal holdings of MBS investors. By contrast, the defaults of 2008 put at risk both the interest and the principal components of MBS portfolios. Another big difference between 1994 and 2008 is the effect on the final consumers. In the early 1990s, consumers

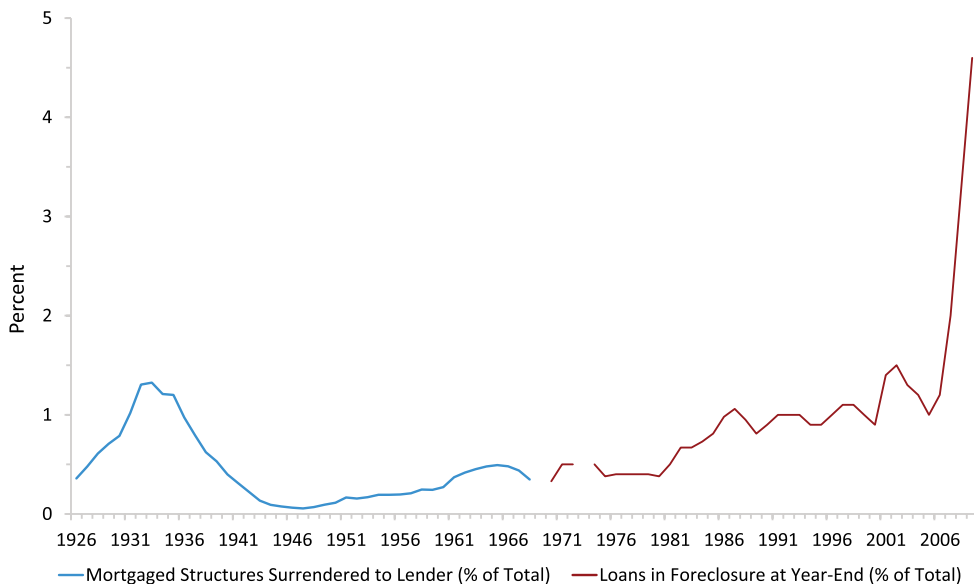


Figure 10. Foreclosures on non-farm residential properties in the US between 1926 and 2009. Sources: 1926–1968 data series is houses surrendered to the lender as percentage of mortgaged structures, using data from the Federal Home Loan Bank Board (FHLBB) (Snowden, “Table Dc1255–1270 Mortgage Foreclosures and Delinquencies: 1926–1979,” 4–569–4–570), <http://hsus.cambridge.org/HSUSWeb/table/expandtable.do?id=Dc1255-1270>; 1969–2009 data series is loans in the foreclosure inventory at year-end as percentage of loans serviced by the participating companies, using data from the National Delinquency Survey of the Mortgage Bankers Association of America (MBAA) (*Statistical Abstract of the United States* for 1987, 1988, 1991, 1995, 1998, 2001, 2004–2005, 2011); 1970 and 1974 data points were not available. For a more technical description of the survey, see: <https://www.mba.org/Documents/mba.org/files/Research/Flyers/NDSFAQ.pdf>, accessed on March 14, 2018.

Note: I am indebted to Larry White, Ken Snowden, and Chris Foote for their help in putting together this data series.

benefited from the influx of liquidity into the mortgage market by taking advantage of lower interest rates to refinance their mortgages. By contrast, in 2008, more than 3 million households in the US faced foreclosure.¹³¹ Figure 10 shows foreclosure rates from 1926 to 2009, casting the events of 2008 into historical perspective.

The 2008 foreclosures make the non-farm foreclosure numbers from the Great Depression in Figure 10 pale in comparison. The aftermath of the tranching default risk MBS market suggests that the introduction of default risk tranching into MBS set off a vicious cycle with dire consequences for consumers.¹³²

Despite the similarities between tranching prepayment risk and tranching default risk, MBS market participants were not able to learn enough from the failure of tranching tools in 1994 to avoid the mortgage crisis of 2008. Moreover, as Figure 4 shows, the issuance of CMOs rebounded following the 2008 crisis, suggesting that the acceptance of tranching outlived the events of 2008. In 2016, J.P. Morgan announced the issuance of new securities with tranching default risk.¹³³ The deployment of tranching in these securities is consistent with the possibility that the market participants may not have fully internalised the lessons about the limitations of tranching offered by the events of 1994 and 2008.

Learning from the two crises

This article contributes to the understanding of financial crises by offering a detailed account of the development of the MBS market and the evolution of tranching tools that enabled its development. In so doing, it enriches the understanding of the processes that brought about the 2008 crisis, with a particular focus on the role of market participants' learning and failure to learn from the 1994 crisis.

Specifically, this article shows that the MBS market participants could have learned three lessons from the 1994 crisis that might have helped prevent the events of 2008. One, the MBS market is susceptible to systematic risks that render all MBS – not just the junior tranches – vulnerable to fluctuations in economic circumstances and could lead to a MBS market crash. Two, investment in MBS can affect the primary mortgage market by channelling capital into the market. Three, the misinterpretation of benchmarks used in constructing MBS might lead to mispricing risks in MBS.

My research suggests that the market participants' failure to learn from the events of 1994 has to do with construction of particularistic explanations for the high levels of prepayments that stopped short of understanding the systemic causes of the events. In the case of 1994, these particularistic explanations focused on the changes in behaviour of the mortgage lenders who lowered the mortgage origination fees. This explanation stopped short of considering the role played by the influx of capital into the MBS market in bringing about this change. Stopping at this level of explanation precluded the market participants from seeing the connection between influx of capital in the secondary markets and changes in the primary markets – a dynamic that would be repeated in the lead-up to the 2008 crisis.

By drawing on detailed information about the development of MBS risk management tools in industry manuals and the trade press, this article fills the gaps left open by the existing literature's three approaches to understanding the relationship between the tranching tools used to manage prepayment risk and those used to manage default risk. My account suggests that MacKenzie's 2011 article mistimes the introduction of default risk tranching. While MacKenzie times the introduction of default risk as occurring before prepayment risk tranching, I find that

default risk tranching came after the tranching of prepayment risk. This difference in timing is important because it means that market participants had the opportunity to learn from the experience of tranching prepayment risk before developing tools for tranching default risk.

My findings also problematise the implications of McConnell and Buser's 2011 article that suggests that market participants used the same tools in tranching prepayment and default risks. While I document the similarity between the two sets of tools, the assumption that they are identical precludes an understanding of how a lack of understanding of the limitations of tranching tools in managing prepayment risk influenced subsequent developments in the MBS market. My findings suggest that the events of 1994 had two implications for the future of the MBS market. One, the crisis made MBS with default risk more attractive to MBS investors because these securities were backed by mortgages with prepayment penalties and thus exposed investors to less prepayment risk. Two, observing the limitations of tranching in managing prepayment risk did not deter market participants from using tranching in managing default risk because the market participants did not interpret the events of 1994 as information about the (in)efficacy of tranching.

The chronology of the events in my account is most consistent with the one postulated by Fostel and Geanakoplos.¹³⁴ However, my findings draw a different connection between the two sets of tools than what could be inferred from their work. Namely, without the evidence I present in this article, the causal connection between the development of tranching tools for managing prepayment and default risk could be interpreted as the success of one set of tools leading to the development of the other set. My account suggests a different, more interesting connection between the two sets of tools. I find that the limitations of tranching tools at managing prepayment risk were in part responsible for the development of investor interest in 'credit-sensitive' MBS.

For scholars interested in the 2008 crisis, my analysis has two implications. The first is to suggest that the events of 2008 could have been anticipated in 1994, if not before. This means that the accounts proposing that the foundations for the 2008 crisis were laid in the early 2000s are mistimed,¹³⁵ and while there are many starting points for the crisis, the early 1980s or even 1970s make for a more informed starting point of the chain of events that led up to the crisis. The second implication is that understanding the relationship between the events of 1994 and the events of 2008 helps diagnose which aspects of the MBS market decision-makers failed to learn from. It also provides us with an opportunity, and perhaps a warning, to examine how the acceptance of tools persists despite evidence that they do not reduce risk in the given setting.

For scholars interested in the factors enabling practitioner learning from the past, this account suggests that even in the presence of conditions that enable learning – the recency of the events of 1994, the usage of the same tools, applied to the same securities – learning from financial crises can be limited. Tranching tools emerged nearly simultaneously in the management of prepayment and default risk. The near-simultaneity could have helped market participants draw a connection between the two sets of tools – for example, appreciating that the two types of tranching relied on the same set of statistical principles and were subject to the same limitations. However, witnessing the limitations of tranching at managing prepayment risk did not translate into understanding these limitations and, consequently, did not influence the understanding of the limitations of tranching in managing default risk.

One worrisome similarity between the two crises is a disconnect between the lessons from financial crises drawn by academics and those drawn by practitioners. The academic

writing pointing to limitations of tranching appeared as early as 1984. However, market participants did not incorporate the insights of these accounts either before or in the aftermath of the 1994 meltdown. Similarly, market participants' persistence in using tranching suggests that the academic analyses of the 2008 crisis have not changed the market participants' behaviour, perhaps setting the stage for the next crisis involving tranching. This disconnect is yet to attract the scholarly attention it deserves, thus pointing to an important new research direction.

Conclusion

This article makes the case for the need to understand the challenges faced by decision-makers in learning from history. Specifically, it highlights decision-makers' tendency to construct particularistic explanations of past events rather than attempting to draw broader lessons from them. My analysis suggests that neither 1994 nor 2008 taught decision-makers about the limitations of tranching in the presence of systematic risks. The studies of how decision-makers learn and fail to learn from history are important because without developing a detailed understanding of how decision-makers use history, historians stand little chance of helping to inform public policy or avert future crises.

Despite a wealth of theoretical papers on financial crises, we do not have a clear model of what form learning from financial crises can take. A logical implication of the existing literature is that the absence of future crises could be one manifestation of learning from past crises. However, the mechanisms by which such learning could occur remain underexplored. To date, much of the literature has focused on regulatory responses as a mechanism through which crises stop recurring – these responses included the government acting as a lender of last resort¹³⁶ or broader financial regulation constraining the actions of market participants.¹³⁷ Missing from this literature is an articulation of the lessons market participants can draw from financial crises.

This paper suggests that carefully documenting and understanding failure to learn from history is necessary if we are to have any hope to break the cycle of failure to learn from failure. This article also puts forward one approach to uncovering and documenting such failure – namely, carefully documenting the evolution of financial instruments with particular focus on the instruments' strengths, foibles, and opportunities for learning missed in the instruments' evolution. We have an abundance of biographies of the individuals and organisations that shaped and continue to shape the world of finance. What we lack are biographies of the financial instruments – objects that persist as individuals and organisations come and go.

Notes

1. Kobrak and Wilkins, *History and Financial Crisis*, i.
2. Reinhart and Rogoff, "The Causes of Financial Crises," 119.
3. For an excellent overview of the disagreement about this assertion, see Lönnborg, Ögren, and Rafferty, "Banks and Swedish Financial Crises."
4. One attempt to document learning from financial crises has considered the process by which the Bank of England changed its policy to become the lender of last resort in the aftermath of the 1866 Overend and Gurney crisis. Wood argues that this policy change prevented the escalation of the failures of the City Bank of Glasgow in 1878 and of Barings in 1890 into

crises (Wood, "Great Crashes in History"). In *Manias, Panics and Crashes*, Kindleberger makes the case that the adoption of the lender-of-last-resort policy in question is a universal lesson from financial crises.

5. Insurance companies also employ the assumption that the risks are uncorrelated or spread out in the insured population in offering insurance.
6. The primary mortgage market is the market in which borrowers enter into contracts with lenders. The market into which the resultant mortgages are sold, of which the MBS market is a subset, is also known as the secondary market.
7. As kindly pointed out by Jack Guttentag, this appetite was distinct from a search for higher returns. Investors could have obtained higher returns in the MBS market by taking on more prepayment risk instead of default risk.
8. Mortgage prepayment penalties were common in the US in the lead-up to the Panic of 1893 and the Great Depression. In the 1890s, borrowers in Western states successfully advocated for prepayment penalty bans – a condition a 1907 *Bond Buyer's Dictionary* describes as: 'Western farmers have grown rather particular about their indebtedness. One of the common requirements of the modern mortgage is that the mortgagee shall accept any portion of the principal at the time of any interest payment' (Nelson, *Bond Buyer's Dictionary*, 130). Federal mortgage assistance programmes from the 1930s onwards including the Home Owners' Loan Corporation (HOLC), Federal Housing Administration (FHA) and Veterans Affairs (VA) offered mortgages with no prepayment penalties.
9. The MBS issued by private entities lacked the federal government mortgage-repayment guarantees implicit in the MBS issued by (quasi-)government agencies, which dominated the market prior to the private entities' entry.
10. MacKenzie (in "Credit Crisis as a Problem") points out that this guarantee meant that instead of worrying *whether* they would get the principal of their investment back, investors only had to worry about *when* they would get the principal back.
11. Ashcraft and Schuermann, "Understanding the Securitization."
12. Keys et al., "Did Securitization Lead to Lax Screening?"
13. Gartenberg and Pierce, "Subprime Governance."
14. Fligstein and Goldstein, "Anatomy of the Mortgage Securitization Crisis."
15. Coval, Jurek, and Stafford, "Economics of Structured Finance"; MacKenzie, "Credit Crisis as a Problem."
16. Eichengreen, "Thoughts about the Subprime Crisis," 265.
17. Donald MacKenzie, "The Credit Crisis as a Problem in the Sociology of Knowledge."
18. McConnell and Buser, "The Origins and Evolution of the Market for Mortgage-Backed Securities."
19. Fostel and Geanakoplos, "Tranching, CDS, and Asset Prices: How Financial Innovation Can Cause Bubbles and Crashes"
20. MacKenzie, "Credit Crisis as a Problem," 1792.
21. MacKenzie, "Credit Crisis as a Problem," 1792–3.
22. McConnell and Buser, "Origins and Evolution of the Market," 174. As the quote alludes to, after tranching enabled securitising mortgages, the tranching tools were applied to the securitisation of other types of assets. Structured credit as a term applied to securities that were backed by loans and employed tranching. With the development of tranching securities backed by different types of collateral, structured credit became an umbrella term for securities, which relied on tranching for managing default risk.
23. Fostel and Geanakoplos, "Tranching, CDS, and Asset Prices," 191.
24. Gennaioli, Shleifer, and Vishny dedicate a paragraph to the crisis in "Neglected Risks, Financial Innovation," 1453.
25. "Did It Say That?" These two sources draw the following parallels between the 1994 and 2008 crises: that financial innovation brought about both crises, that the investors neither understood the complex nature of the securities they were buying nor anticipated either crisis.
26. Glaser and Strauss developed theoretical sampling in *Discovery of Grounded Theory*. In contrast to statistical sampling which seeks to select a sample representative of a population as a whole,

theoretical sampling is driven by a question, in this case the desire to understand how different parts of the MBS value chain came together.

27. For every new edition of the manuals, *The Handbook's* editors recruit the leading experts on the MBS market to write different chapters. Consequently, the manuals reflect the state-of-the-art knowledge of the MBS market participants at the point of publication. I selected this particular set of trade manuals because the industry participants I interviewed used the latest edition of the manual to train new hires. To avoid single-source bias, I have supplemented my reading of these handbooks with the reading of other industry trade manuals, including the 1997 and 1999 editions of the *Handbook of Nonagency Mortgage-Backed Securities* and the 1993, 1994, and 1997 editions of *Collateralized Mortgage Obligations: Structures and Analysis*.
28. Prior work has shown industry trade manuals to be an important source of information on the evolution of industry practices. For instance, Rötheli uses bank trade manuals to study changes in bank practices in "Innovations in Banking Practices."
29. Abolafia, *Making Markets*; Zaloom, *Out of the Pits*; Ho, *Liquidated*.
30. Lewis, *Liar's Poker*; Einhorn, *Fooling Some of the People*; Tett, *Fool's Gold*.
31. When specific publications were not available from public sources, I requested copies of these publications directly from their authors.
32. For example: 'mortgage-backed securities (MBS)', 'mortgage-backed bonds (MBBs)', 'pass-through certificates', 'pay-through certificates', 'guaranteed mortgage certificate (GMC)', 'pay-through bonds', 'collateralised mortgage obligation (CMO)', 'real estate mortgage investment conduit (REMIC)'.
33. These included 'Federal National Mortgage Association (FNMA or Fannie Mae)', 'Government National Mortgage Association (GNMA or Ginnie Mae)', 'Federal Home Loan Mortgage Corporation (FHLMC or Freddie Mac)', 'Salomon Brothers', 'First Boston', 'Merrill Lynch', etc.
34. Such as Lewis Ranieri and Frank Fabozzi.
35. I compiled this list from the interview transcripts, trade manuals, and other printed sources.
36. Specifically, I read Haveman's "Between a Rock and a Hard Place" for the evolution of thrifts and Jacobides' "Industry Change" for developments in mortgage banking. I followed the reading by crosschecking the references of these articles against the sources in my document collection and adding the relevant sources.
37. The major newspapers included *Wall Street Journal*, *New York Times*, *Washington Post*, *Los Angeles Times*, and *Chicago Tribune*.
38. For example *Business Week*, *Forbes*, and *Fortune*.
39. For example: *Barron's*, *Crain's*, *Kiplinger's*, and *Money*.
40. I focused on publications targeting mortgage lenders, such as *American Banker*, *Bottomline*, *Mortgage Banking*, *Savings Bank Journal*, *Savings and Loan News*, *Real Estate Review*; bond investors: *Bond Buyer*, *Fixed Income Investor*, *Institutional Investor*, *Pensions and Investments*, *Pension World*; and their regulators: *Federal Reserve Bank of New York Quarterly Review*, *Review – Federal Reserve Bank of St. Louis*, *Federal Home Loan Bank Board Journal*, etc.
41. Quinn (*Government Policy, Housing*, 127) uses the term 'modern MBS' to refer to the first issue of pass-through certificates to distinguish them from earlier government experiments with securitisation.
42. Freddie Mac was a nickname given to the company by Wall Street traders to mirror the nicknames of the other quasi-government agencies active in the MBS market. Federal National Mortgage Association (FNMA) was Fannie Mae and the Government National Mortgage Association (GNMA) – Ginnie Mae. These nicknames covered not just the agency, but also the securities issued or guaranteed by the agency in question. For instance, Ginnie Mae was a common term for the pass-through certificates guaranteed by the GNMA.
43. Vinokurova ("How Mortgage-Backed Securities") argues that managing prepayment risk was critical to the acceptance of MBS as bonds.
44. The trade press explanations of the term's origin typically mention that tranche is the French word for slice. See for example Maier, "CMO Constructs," 560–61. The industry participants use the word to refer to a subset of a securities' issue, with each tranche having a different exposure to prepayment and, from 1990s onward, default risk.

45. The maturities of pass-through securities were determined by how long the mortgage loans in the securities' collateral would remain outstanding before being paid back by the borrowers.
46. These mortgages were so prevalent that Green and Wachter ("American Mortgage") refer to this type of loan as 'the American Mortgage'.
47. This risk was a problem for two reasons. One, because the borrowers were more likely to repay their mortgages when interest rates went down than when interest rates went up. This meant that the MBS investors who received back the principal had to look for reinvestment opportunities in a less favourable environment and thus were unlikely to realise the interest return they expected when investing in MBS. Two, the uncertainty introduced difficulties in pricing the securities, a problem in response to which the MBS issuers developed prepayment benchmarks discussed in the next section.
48. Ranieri, "Origins of Securitization," 34–5.
49. This convention was based on the analysis of 30-year loans insured by the Federal Housing Administration (FHA) (Sullivan, Collins, and Smilow, "Mortgage Pass-Through Securities," 113).
50. Sullivan and Lowell, "Mortgage Pass-Through Securities," 91.
51. Kidd, "One Year Old," p. 40.
52. One reason buying and selling this protection made sense for the issuers was because they made money on the difference between the returns they offered to junior and senior investors. Some MBS market participants cited this difference as evidence of inefficiency of the MBS market (Sega, "Mortgage-Backed Securities," 365).
53. Epstein, "Corporate Cash Investor's Guide," 43. The Government National Mortgage Association (also known as Ginnie Mae) guaranteed the repayment of mortgages in the collateral of the vast majority of pass-throughs issued at the time.
54. Hamecs, "CMOs and How They Grew," 10.
55. Boye, "Lack of Consensus," 9.
56. Estrella and Silver, "Collateralized Mortgage Obligations."
57. The MBS market participants developed the CMO in parallel with other alternatives to provide investors with call protection that did not require research into mortgage prepayment patterns. The CMOs emerged in response to the lack of success with other less research-heavy alternatives: 'Although the investment community and housing industry have long desired a mortgage instrument that offered "call-protection," attempts to design such an instrument proved futile in the past. A CMO successfully achieves this goal through a de facto breakdown of the underlying pool of mortgages according to how quickly the loans are repaid' (Hamecs, "CMOs and How They Grew," 9).
58. An important standard in evaluating the benchmarks was how easy they were to incorporate into yield calculation formulas. Industry participants described one such benchmark as 'The simple quantification is intuitive and easy to incorporate into pricing and yield formulas' (Sullivan and Lowell, "Mortgage Pass-Through Securities," 93).
59. Curley and Guttentag, "Yield on Insured Residential Mortgages," 139; Sullivan and Lowell, "Mortgage Pass-Through Securities," 91; Sullivan, Collins, and Smilow, "Mortgage Pass-Through Securities," 113.
60. Ranieri, "Origins of Securitization," 35. GNMA still used this 12-year convention in its marketing materials in 1994 (Government National Mortgage Association, *Ginnie Mae Investment Facts*, 6).
61. The convention also did not capture the relationship between the interest rate of the mortgages in the MBS collateral and the prevailing interest rate – a factor known to play an important role in the borrowers' refinancing decisions.
62. Laurence Fink of First Boston described this development as follows: 'In the early 1980s, several Wall Street firms invested in personal computers and the talent to run them. The availability of these technical tools enables us to take pools of mortgages and find ways to cut the cash flows up into new securities' (Fink, "Role of Pension Funds and Other Investors," 120).
63. The PSA 'was intended to simplify the comparison and analysis of CMO yield tables, but it was also occasionally used as a prepayment measure for pass-throughs' (Sullivan and Lowell, "Mortgage Pass-Through Securities," 95).

64. "Calculation Standard Set on C.M.O. Yields," *New York Times*, June 14, 1985: D13. In addition to the problems associated with using different vintages of FHA loans for comparison, the comparison was also problematic because the FHA numbers from the different periods relied on different assumptions and reporting conventions (Sullivan and Lowell, "Mortgage Pass-Through Securities," 91).
65. In addition to sacrificing accuracy, the consistency offered by the PSA also came at the price of flexibility. Historical benchmarks, by definition, do not account for future conditions. However, by offering a variety of historical reference points, the FHA benchmark allowed flexibility in using different environmental conditions as benchmarks, thus allowing for a more accurate historical analogy for the collateral of a given MBS. PSA gave up that flexibility in favour of consistency – allowing all traders to speak the same language.
66. Scowcroft, Davidson, and Bhattacharya, "Analyzing Fixed Rate," 653–4.
67. Carroll and Lappen, "Mortgage-Backed Mayhem," 82.
68. *Ibid.*
69. Askin, Curtin, and Lowell, "Forecasting Prepayment Rates," 611.
70. Marray, "Banks Innovate," 56.
71. Forsyth, "Mutual Bonds," 43.
72. A 1993 Federal National Mortgage Association survey, cited by Anderson ("Effect of Mortgage Refinancing," 50), indicated that 19% of all borrowers refinanced their loans between January 1992 and March 1993.
73. Marray, "Mortgage-Backed Securities."
74. MBS issuers offered securities that entitled investors to receiving only the principal or only the interest payments received from the borrowers. An investor holding interest-only (IO) MBS would lose the investment when the underlying mortgages refinanced. Carroll and Lappen, "Mortgage-Backed Mayhem," 85.
75. Newell quoted in Borowski "Banks Struggle to Control."
76. Askin "Forecasting Prepayment Rates"; Askin, Curtin, and Lowell, "Forecasting Prepayment Rates"; Askin, Hoffman, and Meyer "Evaluation of the Option Component."
77. Carroll and Lappen, "Mortgage-Backed Mayhem," 84.
78. Bruskin and Sykes, "Nonagency Mortgage Market," 13. While Askin Capital Management shut down following these losses in 1996, Askin continued to work in fixed-income long after the crisis (LinkedIn. Accessed January 26, 2017. <https://www.linkedin.com/in/davidjaskin>).
79. Marray, "Banks Innovate," 57.
80. Bruskin and Sykes, "Nonagency Mortgage Market," 13–14.
81. Carroll and Lappen, "Mortgage-Backed Mayhem," 91.
82. This logic was mentioned in major newspapers, trade publications, and referred to in the MBS trade manuals well after the crisis. See for example Bhattacharya et al., "Overview of the Mortgage Market," 4. For some data on the evolving nature of the relationship between the MBS market and the primary mortgage market, see Appendix A.
83. Sources: Mortgage originations and MBS investments – US Department of Housing and Urban Development, Office of Policy Development and Research, 4th Quarter 1994 US Housing Market Conditions, February 1995, <https://www.huduser.gov/periodicals/ushmc/hsgmkt4.pdf>; US Department of Housing and Urban Development, Office of Policy Development and Research. 4th Quarter 1997 US Housing Market Conditions, February 1998, <https://www.huduser.gov/periodicals/ushmc/winter97/>; CMO Issuance – Securities Industry and Financial Markets Association, "U.S. Agency Mortgage Securities Issuance," US Mortgage-Related Issuance and Outstanding, <https://www.sifma.org/wp-content/uploads/2017/06/sf-us-mortgage-related-sifma.xls>; accessed on March 9, 2018.
84. Bruskin and Sykes, "Nonagency Mortgage Market," 13.
85. For data relevant to this explanation, see Appendix B. My analysis suggests that the mortgage lenders lowered mortgage origination fees during both the 1980s and the 1990s refinancing peaks.
86. Such lobbying would have been at odds with the market participants' desire to limit the degree of government involvement in the MBS market. The members of the presidential commissions

- studying prepayment risk shared the commitment to private solutions. The Nixon commission's proposal for the establishment of a federal agency with a mandate to provide interest rate risk insurance never got much traction. In making the proposal, the commission itself asked the US Congress to study alternative approaches to tackling the issue (Commission on Financial Structure and Regulation, *The Report of the President's Commission*). A follow-on commission appointed by Ronald Reagan in 1981, two years before the first CMO was issued, also recognised the uninsurability of interest rate risk and the critical role of government in setting interest rates, but at the same time argued for private solutions to the problem of protecting market participants from interest rate risk (Seiders, "President's Commission on Housing," 340).
87. Ranieri, "Origins of Securitization," 43. According to Ranieri's 1996 account of the events, the mortgage origination fees the lenders charged borrowers who wanted to refinance their mortgages served as a form of 'embedded call protection' which was supposed to protect MBS investors from prepayment risk.
 88. In the aftermath of the 1994 crisis, mortgage lenders were able to sell mortgages, packaged as pass-through securities.
 89. Some MBS traders have gone so far as to claim that consumers profited at the investors' expense, effectively appropriating the surplus generated by securitisation. See for example Ranieri, "Origins of Securitization," 43.
 90. Schorin, "Modeling and Projecting MBS Prepayments," 221.
 91. Schorin and Gordon, "Mortgage Prepayment Modeling: I," 127.
 92. Wagner and Firestone, "Homeowner Mobility and Mortgage Prepayment," 177.
 93. Askin, Curtin, and Lowell, "Forecasting Prepayment Rates," 611.
 94. The authors of the 1995 chapter echoed the 1988 warnings without pausing to ask why David Askin, who co-authored the 1988 chapter, failed to heed his own advice.
 95. Patruno, "Mortgage Prepayment Modeling: II," 143.
 96. Hu, "Modifying the PSA Curve," 169.
 97. Shiebler ("CEO Finance," 69), for instance, categorises MBS as exotic investments; Osterland ("Mortgage-Backed Mutants," 116) uses the term 'mortgage-backed mutants' to describe CMOs.
 98. Bruskin and Sykes, "Nonagency Mortgage Market," 13–14.
 99. Vogel, Jr., "First Movies, Now Bonds," C1.
 100. Lowell, "Mortgage Pass-Through Securities," 25.
 101. SIFMA. Our History, <https://www.sifma.org/wp-content/uploads/2016/12/sifma-history-2017.pdf>, accessed on March 9, 2018.
 102. Clancy and Constantino, "Understanding Shifting Interest Subordination," 76.
 103. Kochen, "Securitization from the Investor View," 112.
 104. McKenzie, "Credit Crisis as a Problem," 1783.
 105. Perry, "Pass-Through Securities."
 106. For instance, a 1981 presidential commission acknowledged the uninsurability of default risk by private parties, but argued for a private insurance solution to this problem (Seiders, "President's Commission on Housing," 340).
 107. "Quest for New Funds," 17. MacKenzie implicitly assumes that this issue coincided with the first use of default risk tranching in MBS.
 108. Bergson, "Investment Guarantee Cover Fizzles," 56. The non-mortgage insurers lacked interest in the mortgage business because they had no experience in the mortgage market and managed the risk–return ratio of their portfolios by writing only short-term insurance policies and updating their rates every one to three years based on their experience with losses on the policies. Salomon's foray into the insurance market is what brought AIG, a company nearly bankrupted by the 2008 crisis, into this market.
 109. Ibid.
 110. Cantor and Packer, "Credit Rating Industry," 20.
 111. One factor that spurred the use of tranching for default risk was the absence of letter of credit and mortgage pool insurance providers sufficiently highly rated by the credit rating agencies (Bruskin and Sykes, "Nonagency Mortgage Market," 11–12).

112. The first public issue of pass-through certificates with tranching of default risk had an 8% share of subordinate interests that the issuer was supposed to retain as the insurance for the investors (Home Savings of America, *Prospectus*, 7). The 10% upper limit may have stemmed from the Federal Reserve Board's Regulation D, which excludes the retention of up to 10% of interest in a pool of conventional loans from being considered a liability of the bank. The lower limit may have stemmed from tradition – 5% was the amount of the issue insured in the Bank of America 1977 conventional pass-throughs issue.
113. 1986 Tax Reform Act, Section 860F(d), Public Law 99–514, October 22, 1986. http://www.ucop.edu/research-policy-analysis-coordination/_files/Public%20Law%2099-514.pdf
114. Industry observers drew parallels between tranching of prepayment risk and tranching of default risk before any tranching securities came about. For instance, a 1979 trade press article targeting pension funds discusses securities which rely on tranching to manage both default risk and prepayment risk: 'Split pools [another term for tranching securities] are also being developed with each portion of the pool having a different maturity based on the control of principal payment from the underlying mortgages' (Perry, "Pass-Through Securities," 53).
115. Bhattacharya et al., "Whole-Loan CMOs," 445.
116. Feigenberg and Lechner, *A New Default Benchmark*.
117. Demyanyk and Van Hemert, "Understanding the Subprime Mortgage."
118. The tranching of default risk MBS were riskier than the MBS backed by government-insured mortgages, the repayment of which was guaranteed by the full faith and credit of the US government. The government insurance of mortgage repayment was contingent on the mortgage borrowers meeting a set of underwriting standards. MBS issuers who opted for private default risk insurance, such as the kind provided by tranching, were no longer bound by these underwriting standards and could extend credit to a set of borrowers of lower credit quality.
119. Brunnermeier, "Deciphering the Liquidity."
120. Mian and Sufi, "House Prices, Home Equity."
121. Mian and Sufi, "Consequences of Mortgage Credit Expansion."
122. For an analysis of affordable rental housing shortages see US Department of Housing and Urban Development, Office of Policy Development and Research, *Rental Housing Assistance*; and Ehrenreich, *Nickel and Dimed in America*.
123. Goetzmann, Peng, and Yen, "The Subprime Crisis."
124. Justiniano, Primiceri, and Tambalotti, "Credit Supply and the Housing Boom."
125. *Commonwealth v. Fremont Inv. & Loan*, 897 N.E.2d 548, 558 (Mass. 2008).
126. Sanders, "Subprime Crisis."
127. This sense of security translated into major investment banks taking on leverage to invest in MBS. 'Specifically, the idea that the system was made less risky by the development of more derivatives may have led financial actors to take positions with extreme degrees of leverage' (Colander et al., "The Financial Crisis," 262).
128. Mayer, Pence, and Sherlund, "Rise in Mortgage Defaults."
129. Acharya et al., "Measuring Systemic Risk."
130. Coval, Jurek, and Stafford, "Economics of Structured Finance."
131. Armour, "2008 Mortgage Foreclosure."
132. Joseph Stiglitz summarised the consumer experience of 2008 as follows: 'There was no point of putting someone in a home for a few months and then tossing him out after having stripped him of his life savings' (*Freefall*, 11).
133. Glazer, "J.P. Morgan Readies Mortgage-Backed Deal," C2.
134. Fostel and Geanakoplos, "Tranching."
135. Fligstein and Goldstein ("Anatomy of the Mortgage Securitization Crisis," 32), for instance, see the seeds of the crisis as sown in 2003.
136. Wood, "Great Crashes in History"; Kindleberger, *Manias, Panics and Crashes*.
137. Allen and Gale, "Optimal Financial Crises."
138. The dotted lines represent linear trend lines for the data series.

140. See for example Keys, Pope, and Pope, "Failure to Refinance." Also, MacKenzie ("Credit Crisis as a Problem," 1792) argues that a reduction in mortgage origination fees makes the option to refinance without incurring prepayment fees more valuable for the borrowers.
141. Arguably, the role played by lenders in shaping borrower refinancing activity should not have come as a surprise to the investors in the aftermath of the 1990s refinancing peak. This is because the refinancing peak of 1985–1987 alerted the investors to the mortgage lenders' potential to affect refinancing activity. Specifically, in 1990 the Mortgage Bankers' Association (MBA) launched a weekly refinancing index to address the investor concern that mortgage lenders knew more about the borrowers' refinancing prospects than the investors did. Source: personal communication from Jay Brinkmann, former chief economist of the MBA, November 4, 2016.

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Appendix A. The relationship between MBS investments and the primary mortgage market

As I discuss in the article, both government and non-government actors advocating for the issuance of MBS have argued that MBS could help meet the demand for mortgage credit by attracting more capital to the primary mortgage market. The challenge of demonstrating the existence of such demand empirically is that unmet demand is hard to observe. In thinking about the channels through which the influx of capital into the MBS market could help meet demand in the mortgage market, I consider three possibilities: it could affect (a) the number of house sales (Figure A1), (b) the house prices (Figure A2), and (c) the mortgage interest rate (Figure A3).

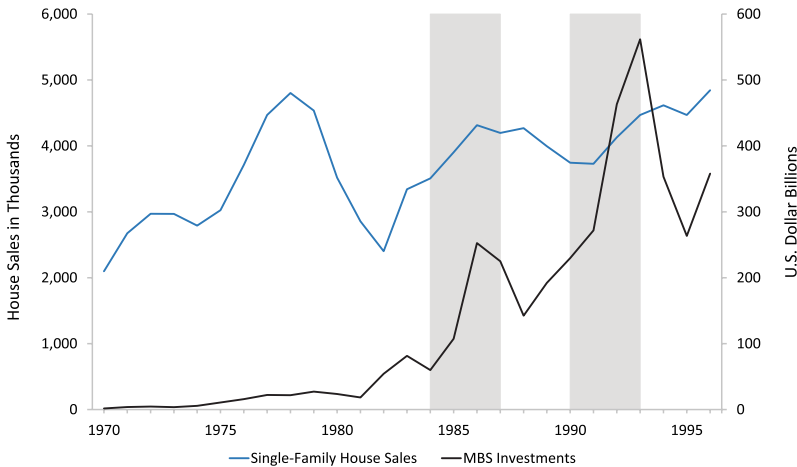


Figure A1. Single-family house sales and MBS investments. Sources: house sales – Tables 6 and 7; MBS investments – Table 19, Department of Housing and Urban Development, Office of Policy Development and Research. 4th Quarter 1994 US Housing Market Conditions, February 1995, <https://www.huduser.gov/periodicals/ushmc/hsgmkt4.pdf>; US Department of Housing and Urban Development, Office of Policy Development and Research. 4th Quarter 1997 US Housing Market Conditions, February 1998, <https://www.huduser.gov/periodicals/ushmc/winter97/>.

Notes: Axes for Figure A1: left axis – house sales in thousands; right axis – MBS investments in billions of US dollars. The periods around the two refinancing peaks (1984–1987) and (1990–1993) are shaded in grey.

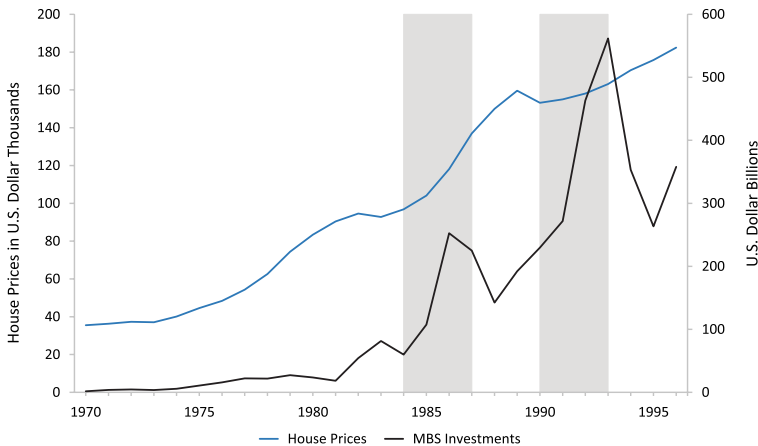


Figure A2. Average house purchase prices and MBS investments. Sources: house prices – *Federal Reserve Bulletin* for 1972, 1975, 1978, 1981, 1986, 1989, 1992, 1995, 1998; MBS Investments – same as in Figure A1. Notes: Axes for Figure A2: left axis – average house prices in thousands of US dollars; right axis – MBS investments in billions of US dollars; periods associated with refinancing peaks are shaded in grey.

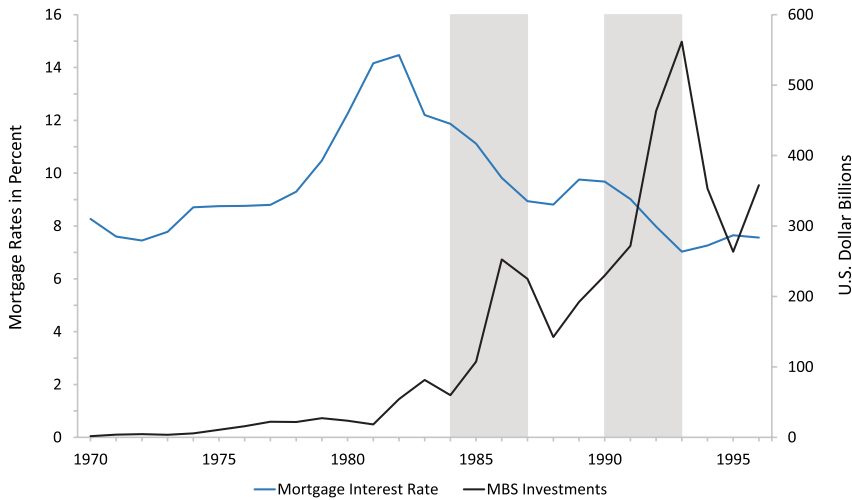


Figure A3. Mortgage interest rate and MBS investments. Sources: mortgage rates – *Federal Reserve Bulletin* for 1972, 1975, 1978, 1981, 1986, 1989, 1992, 1995, 1998; MBS investments – same as in Figure A1. Notes: Axes for Figure A3: left axis – mortgage rates in percentages; right axis – MBS investments in billions of US dollars; periods associated with refinancing peaks are shaded in grey.

Examining Figures A1, A2, and A3 suggests a change in the relationship between the MBS market size and the primary mortgage market occurring in the early 1980s. In the article, I argue that an influx of liquidity into the primary mortgage market from the MBS market drives this change. Consistent with the argument in the article, the change in these relationships seems to coincide with 1983, the year CMOs were first issued.

A correlation table is helpful in exploring changes in the relationships between the MBS market and the three primary mortgage market indicators. Table A1 presents these correlations.

Table A1. Correlation between the MBS market size and primary mortgage market indicators.

| Correlation between: | Before 1983 | After 1983 | Overall |
|------------------------|-------------|------------|---------|
| MBS and house sales | 0.16 | 0.63 | 0.58 |
| MBS and house prices | 0.80 | 0.68 | 0.86 |
| MBS and mortgage rates | 0.68 | (0.84) | (0.38) |

The data in Table A1 suggest that the influx of investor capital has changed the dynamics of the mortgage market in several ways. The stronger correlation between house sales and MBS market size after 1983 suggests that the influx of mortgage capital may have enabled transactions that would not have taken place without it. The somewhat weaker relationship between MBS investor holdings and house prices after 1983 suggests that the liquidity influx from the MBS market was channelled not just into house sales but also refinancing from 1983 to 1996.

The most noticeable change in the relationship between the two markets is the change in the correlation between MBS investments and the mortgage rates. The positive correlation between the two rates before 1983 suggests that before the early 1980s, MBS investors bought mortgages when they had higher interest rates than other available investments. After the early 1980s, the correlation turns negative, suggesting that the influx of investor capital helped lower the interest rates for mortgages in the primary mortgage market.

Together, the data presented in Figures A1, A2, A3, and Table A1 suggest that the development of the MBS market changed the relationship between the MBS market and the primary mortgage market starting in the early 1980s. Accordingly, these data lend support to the argument that the size of

the MBS market from the 1980s onward was sufficient to alter the dynamics of the mortgage market. While no data can provide conclusive evidence of unmet demand for mortgage finance, these data do suggest a change in the relationship between the MBS market and the primary mortgage market from 1980s onwards.

Appendix B. Changes in mortgage fees as an explanation for the refinancing events of the early 1990s

Mortgage origination fees

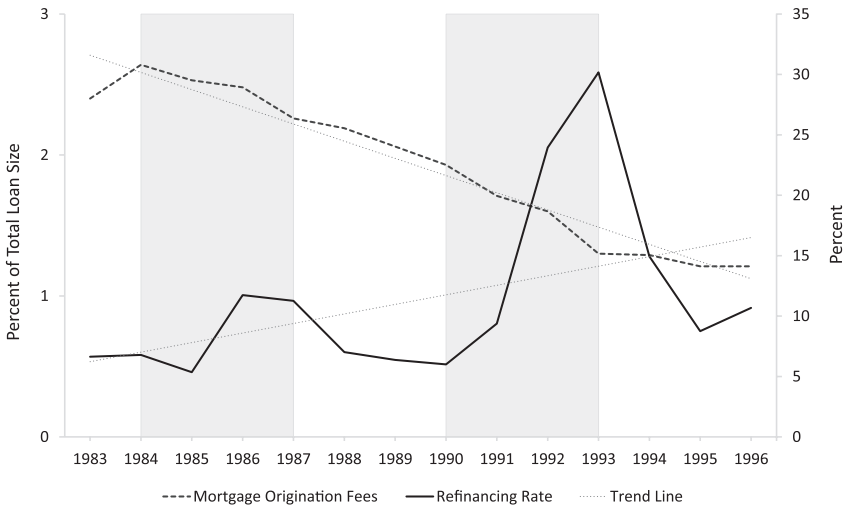


Figure B1. Mortgage origination fees and refinancing rate. Sources: refinancing rate – the average monthly conditional prepayment rate for MBS issued by FNMA, GNMA, FHLMC, weighed by coupon, and maximum amount remaining for coupons 5–11.5% from Bloomberg; mortgage origination fees – *Federal Reserve Bulletin* for 1986, 1989, 1992, 1995, 1998.

Notes: Refinancing rate expressed as percentage of MBS outstanding with mortgage fees reported as percentage of total loan size. Axes for Figure B1: left axis – mortgage origination fees; right axis – refinancing rate; periods associated with refinancing peaks are shaded in grey.

The data presented in Figure B1 suggest a negative relationship between the refinancing rate and the mortgage origination fees.¹³⁸ The correlation between the two data series between 1983 and 1996 is -0.53 . During 1984–1987 and 1990–1993, the periods of influx of MBS capital into the mortgage market, the correlation between the two data series is -0.67 and -0.93 respectively. The difference in the correlations between the 1980s and 1990s suggests that mortgage origination fee changes may have played a more important role in shaping the refinancing activity in the 1990s than in the 1980s. The change in correlations between the two refinancing peaks is consistent with the argument that the influx of liquidity into the primary mortgage market from the MBS market increased the availability of credit, thus enabling more borrowers to respond to lower fees.

Industry participants who explained the refinancing peak of the early 1990s by pointing to changes in lender behaviour made the case that mortgage lenders blindsided the investors by changing the fees unexpectedly. To examine the validity of this claim, I consider the longitudinal relationship between mortgage origination fees and mortgage interest rates, mapped in Figure B2.

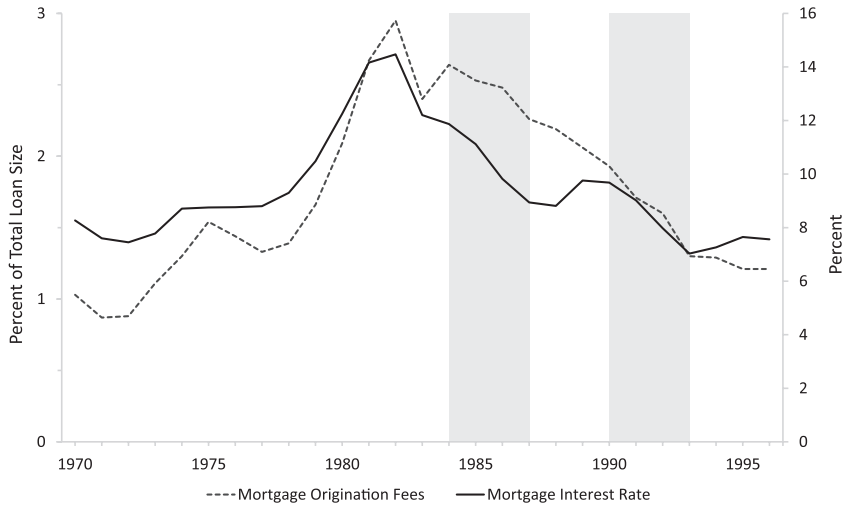


Figure B2. Mortgage origination fees and mortgage interest rate. Sources: *Federal Reserve Bulletin* for 1972, 1975, 1978, 1981, 1986, 1989, 1992, 1995, 1998.

Notes: Mortgage interest rate expressed in percentage with mortgage origination fees reported as percentage of total loan size. Axes for Figure B2: left axis – mortgage origination fees; right axis – mortgage interest rate; periods associated with refinancing peaks shaded in grey.

There is a 0.84 correlation between the interest rates and the fees charged by the lenders between 1970 and 1996. This means that when the interest rates are high the fees also tend to be higher.

During the two refinancing peaks, the correlation between fees and interest rates is even higher than during the rest of the time series: 0.95 and 0.98 respectively. The similarity of the correlations during the two refinancing peaks to the correlation observed longitudinally suggests little room for surprise in the degree of changes in mortgage origination fees in relation to the mortgage rates in the 1990s.

The fees charged by the lenders fell a bit more steeply in the 1990s than in the 1980s – a decrease of 0.68% compared to 0.34%. However, this larger reduction in mortgage origination fees was offset by a much smaller reduction in the mortgage interest rate in the 1990s, thus leaving the benefits from refinancing virtually unchanged for the individual borrowers.

Some scholars have argued that changes in mortgage origination fees play a disproportionate role in shaping refinancing activity.¹⁴⁰ This means that we might expect borrowers to respond more strongly to changes in mortgage origination fees than to changes in interest rates. However, this argument fails to explain the difference in the response to changes in mortgage origination fees we observe in Figure B2 between the 1980s and 1990s.¹⁴¹ The evidence presented in Figure B3 suggests that changes in mortgage origination fee levels were not likely to surprise the investors.

A change in the relationship between the mortgage interest rate and the federal funds rate could have been another potential source of surprise for the investors. If mortgage rates reacted more steeply to changes in the federal funds rate in the 1990s than in the past, one might expect a larger borrower reaction to steeper changes in mortgage interest rate that would surprise the investors.

Mortgage interest rates and federal funds rate

I examine this possibility in Figure B3, which maps the relationship between the mortgage interest rate and the federal funds rate between 1970 and 1996.

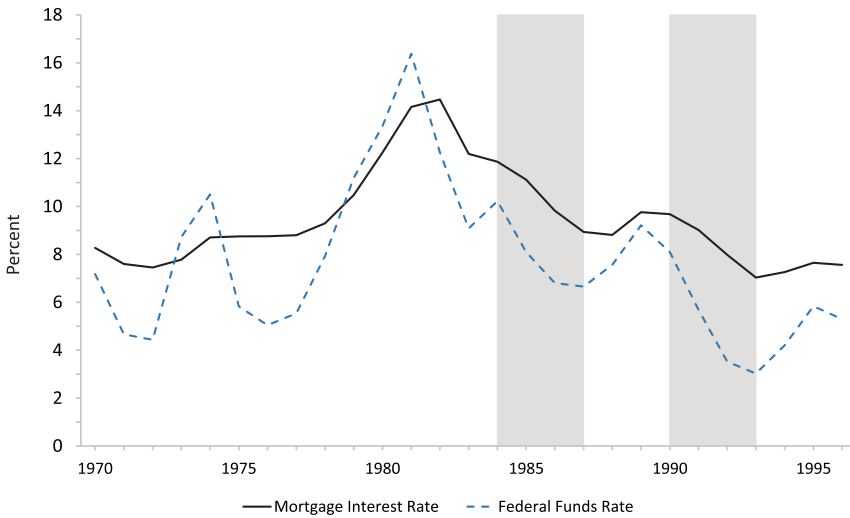


Figure B3. Mortgage interest rate and federal funds rate. Sources: mortgage interest rate – *Federal Reserve Bulletin* for 1972, 1975, 1978, 1981, 1986, 1989, 1992, 1995, 1998; federal funds rate – Federal Reserve Economic Data, <https://fred.stlouisfed.org>

Notes: Both rates expressed in percentages; periods associated with refinancing peaks are shaded in grey.

As shown in Figure B3, over the period from 1970 to 1996, mortgage rates closely followed the interest rates set by the Federal Reserve. The correlation between the federal funds rate and the mortgage interest rate is 0.84 over this period. For the two refinancing peaks, the correlation between the mortgage interest rate and the federal funds rate is even higher: 0.93 and 0.95 respectively. The similarity of the correlations during the refinance peaks to the correlation observed longitudinally suggests little room for surprise in the degree of the mortgage interest rate response to the changes in the federal funds rate.

In addition, looking at correlation alone hides the relatively weaker reaction of mortgage interest rates to cuts in federal funds rate in the 1990s. Note that the federal funds rate dropped by 5% between 1990 and 1993 which only translated into a 2.65% reduction in mortgage interest rates. Meanwhile, a smaller 3.5% drop in the federal funds rate between 1984 and 1987 translated into a 2.93% drop in mortgage interest rates. The mortgage interest rate change in the 1990s was smaller both in absolute terms and as a percentage of the federal funds rate change than the mortgage interest rate change in the 1980s. If the mortgage interest rate changes in the 1990s were proportionate to the change in the 1980s, the mortgage rate would have dropped by 4.17% rather than the observed 2.65%, potentially triggering an even larger refinancing peak.

This analysis shows that the relationship between the mortgage interest rate and the federal funds rate remained steady between 1970 and 1996. The comparison of mortgage rate response to federal funds rate changes in the 1980s and 1990s suggests that the refinancing rate in the 1990s could have been even higher than observed if the mortgage lenders had passed on the rate decrease more fully to the consumers.

Together the data presented in Figures B1, B2, and B3 indicate that the element of surprise associated with the refinancing activity in the 1990s was contained not in the magnitude of mortgage interest rate or mortgage origination fee changes, but rather in the magnitude of the borrower response to these changes. This locus of surprise is consistent with my argument that the expansion of the MBS market in the lead-up to the 1990s refinancing peak enabled mortgage borrowers to respond to changes in mortgage origination fees and interest rates.