Allen Frankel

+41 61 280 9457
allen.frankel@bis.org

Prime or not so prime? An exploration of US housing finance in the new century[1]

Significant US house price appreciation in the last few years has greatly helped to enlarge the size and scope of secondary markets for securities backed by non-prime mortgage loans. But while many households now have access to loans which otherwise might not have been available, were housing market conditions to worsen, investors would face new issues in the valuation of mortgage-backed securities and possibly unanticipated risks.

JEL classification: G180, G280, L890.

The system of US housing finance has changed profoundly in recent years. Despite the dominant role of the government-sponsored housing finance agencies, non-agency mortgage underwriters account for a steadily increasing share of US housing finance. While the agencies specialise in the underwriting of mortgage loans to prime households, growth in non-agency lending has been to non-prime borrowers. This implies lending not only to borrowers with somewhat blemished credit histories, but also to those unable or unwilling to either finance required down payments with own funds or document their sources of income.

The securitisation of non-prime housing loans represents a significant change for one of the biggest and most important financial markets in the world. Most US residential mortgages are packaged and resold in mortgage-backed securities (MBSs), and foreign investment in these securities has soared. As with the restructuring of mortgages and the secondary sale by the housing finance agencies of pass-through securities, non-prime loans have also come to be routinely incorporated into pass-through securities via a similarly structured process. However, in contrast to agency-backed securities, which are exposed to prepayment risk but protected against loan defaults by guarantees, investment in non-agency securities involves exposure to both prepayment *and* default risk. In this article, we argue that the significance of this additional risk has been disguised in recent years by housing price

---

[1]   The views expressed in this article are those of the author and do not necessarily reflect those of the BIS.
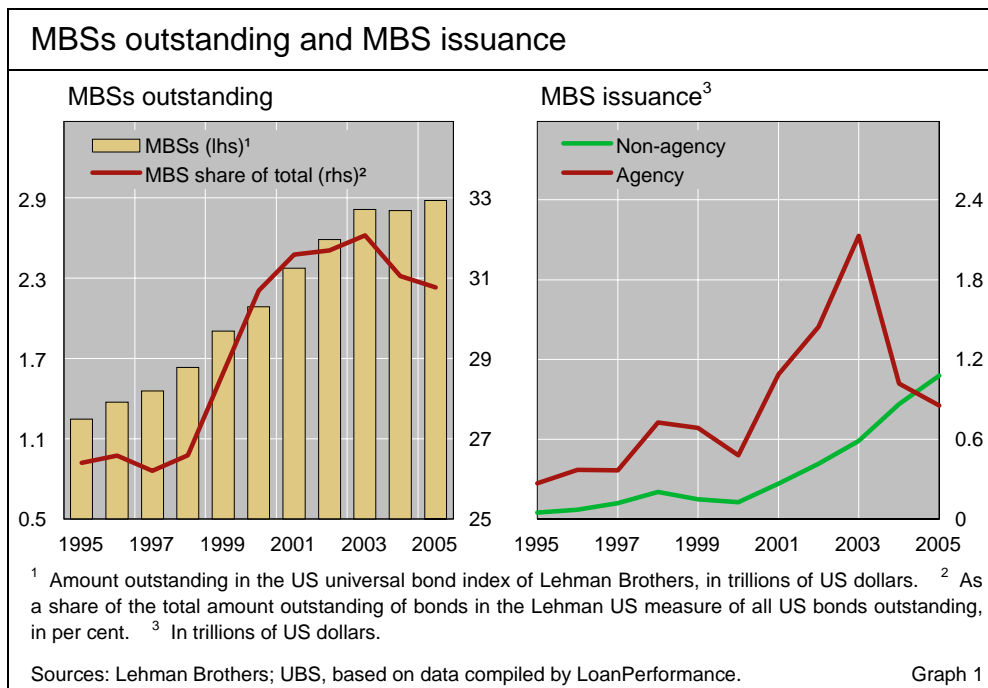
appreciation. In consequence, a turn in the housing market might remind holders of these securities of some of their downside risk characteristics.

The remainder of this special feature is structured as follows. The next section presents a broad overview of recent developments in MBS markets. The section which follows focuses on innovations in mortgage contracts, the employment of credit scoring measures to calibrate default risk, and new challenges in forecasting prepayments. We finish with some brief concluding remarks.

Recent developments

Mortgage-backed securities are now well established as one of the largest and most significant financial markets in the world, as well as the most prevalent form of securitisation. More than half of all US residential mortgages are incorporated in MBSs.[2] Since the mid-1990s, the share of MBSs in US bond markets has surged to nearly one third of the total outstanding and has remained at a high level (Graph 1, left-hand panel). The market has also become more global: the stock of foreign investment in US mortgage securities has increased more than fourfold since 1990, to nearly $1 trillion. Although much of this foreign investment is accounted for by holdings of agency-issued straight debt securities, recent survey data suggest that foreign investors have assumed sizeable stakes in MBS investments as well.[3]

The MBS market has grown markedly …

MBSs outstanding and MBS issuance

MBSs outstanding

MBS issuance[3]

[1] Amount outstanding in the US universal bond index of Lehman Brothers, in trillions of US dollars. [2] As a share of the total amount outstanding of bonds in the Lehman US measure of all US bonds outstanding, in per cent. [3] In trillions of US dollars.

Sources: Lehman Brothers; UBS, based on data compiled by LoanPerformance. Graph 1
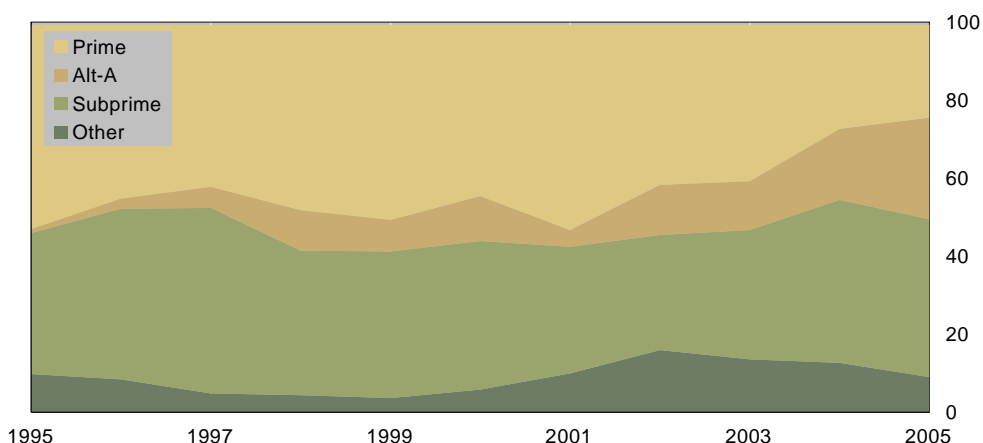
---

[2] This includes MBSs held in own portfolios by Fannie Mae and Freddie Mac; see Office of Federal Housing Enterprise Oversight (OFHEO) (2005).

[3] A recurring survey of central banks conducted by UBS found that 40% of central banks listed MBSs in 2005 as an approved class for their investments as compared to only 2% in 1998; see UBS (2006a). However, the absence of detail in existing data sources means that we

Non-agency MBS issuance by market segment

As a percentage of total[1]

Note: For the definition of the various market segments, see footnote 4 in the main text.

[1] First half of 2005.

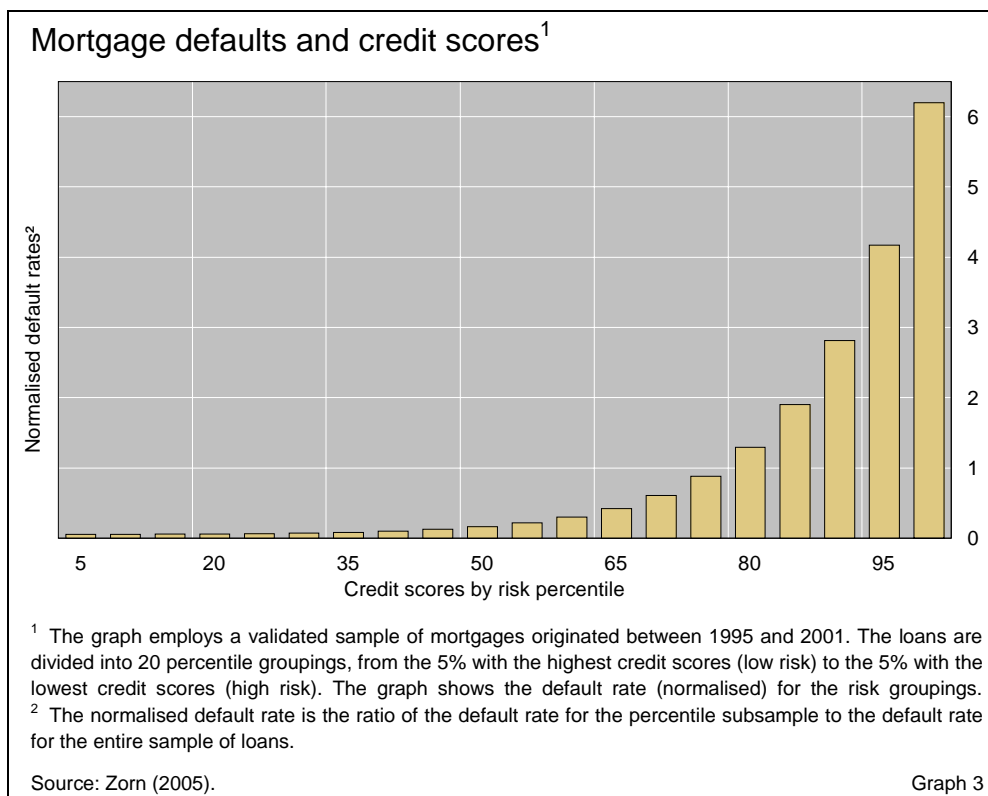Source: UBS, based on data compiled by LoanPerformance.   Graph 2

The MBS market has also undergone a major structural change. Annual non-agency MBS issuance has not only nearly doubled to more than $1 trillion in the past few years, but on a relative basis it has moved from less than a quarter to more than half of total MBS issuance (Graph 1, right-hand panel). This increase in non-agency issuance has coincided with an increase in mortgage loans to households not classified as prime; such loans accounted for less than 50% of all non-agency issuance in 2001, but for more than three quarters thereof in 2005 (Graph 2).[4] Of the categories below prime, the segment that has shown the greatest growth in recent years is the Alt-A segment, or loans to borrowers which have prime borrower-like credit histories but do not meet another agency classification for prime status, such as income documentation or property type. Thus the Alt-A market gives a number of households with good credit histories access to mortgages which otherwise would be unavailable. Expectations of rising house prices have probably played an important role in the increased share of this segment, and non-agency mortgage origination more generally, as will be explored in the next section.

Automation has facilitated the screening of mortgages

Technology has been an important factor in facilitating securitisation. Household mortgage loan applications are now much more likely to be assessed by an automated process that employs credit histories captured by

have no basis on which to assess the size of foreign investor exposure to credit risk through the purchase of non-agency MBSs.

[4]   Prime non-agency loans involve lending that would meet agency underwriting requirements except for the fact that the loan amounts exceed a government-set ceiling on individual agency-underwritten loans (currently $417,000 for single family homes in the continental United States). Alt-A loans are loans to borrowers which usually meet the agency requirements with regard to credit score but do not meet one or more of the other agency requirements for loan-to-value ratios, income documentation, property type, etc. Subprime loans are loans to borrowers with blemished credit histories. The subprime sector generally does not include second mortgages such as home equity loans, which are part of the other category in Graph 2. For a more detailed discussion of some of these market segments, see Heike and Mago (2005) and Pennington-Cross (2002).

Mortgage defaults and credit scores[1]

Normalised default rates[2]

Credit scores by risk percentile

[1] The graph employs a validated sample of mortgages originated between 1995 and 2001. The loans are divided into 20 percentile groupings, from the 5% with the highest credit scores (low risk) to the 5% with the lowest credit scores (high risk). The graph shows the default rate (normalised) for the risk groupings.
[2] The normalised default rate is the ratio of the default rate for the percentile subsample to the default rate for the entire sample of loans.

Source: Zorn (2005).   Graph 3

national credit data repositories, distilled by a credit score, often called a FICO score.[5] Statistical evidence confirms that lower credit scores are systematically associated with a higher probability of default on mortgage loans (Graph 3). The use of these scores for the pricing of non-agency mortgages has become standard: information that in the past might have been acquired by virtue of an ongoing banking relationship is now often summarised in a credit score. This in turn has probably increased the economies of scale in mortgage origination: indeed, the market share of the top 25 mortgage originators has increased from 30% in 1990 to more than 80% today (OFHEO (2005)).

There have also been innovations in the organisational structure of mortgage providers that encourage the growth of the market by facilitating the transfer of risk from MBS originators. A large share of non-agency mortgage loans is originated by specialised financial firms, many of which have been organised as real estate investment trusts (REITs), effectively open-end equity funds. In fact, the capacity of most non-agency mortgage originators to respond to market demand has been encouraged by innovations permitting the better structuring and management of their equity capital positions. The box on page 71 discusses one securitisation technique of relatively recent vintage, the issuance of net interest margin securities (NIMS), that has been employed by non-agency mortgage securities issuers to reduce their residual exposures and economise on costly equity capital.

---

[5] The acronym FICO is derived from "Fair Issac & Co". This firm is a producer of statistical models. Other companies are the actual compilers of credit history files. FICO scores rank the relative risk of consumers defaulting or becoming seriously delinquent.

Net interest margin securities (NIMS)

A typical subprime mortgage securitisation is collateralised by loans carrying interest rates well in excess of those paid to debt securities investors. Excess spread not paid out to senior creditors to cover loan losses is paid to the investor in the equity tranche, the investor frequently being the firm that originated the mortgage loans and issued the mortgage-collateralised securities. It has become standard for an MBS issuer to securitise its own residual interests in deals through the issuance of net interest margin securities (NIMS).

Figure A sets out the structure of mortgage loan securitisations that incorporate NIMS; Figure B sets out the cash flows involved. The charts are simplifications: mortgage-related securities structures can have multiple layers, and NIMS structures can also be layered in multiple tranches. NIMS are typically bought by specialist investors in private placement transactions. The prevalence of the private placement format is fully consistent with the idiosyncratic nature of individual NIMS issues.

The earliest NIMS transactions in the mid-1990s (manufactured housing securitisations) performed poorly. Many of the deals had structural elements that paid at a slower rate than had been anticipated. Lessons were learned from the modelling mistakes made in early deals. Recent
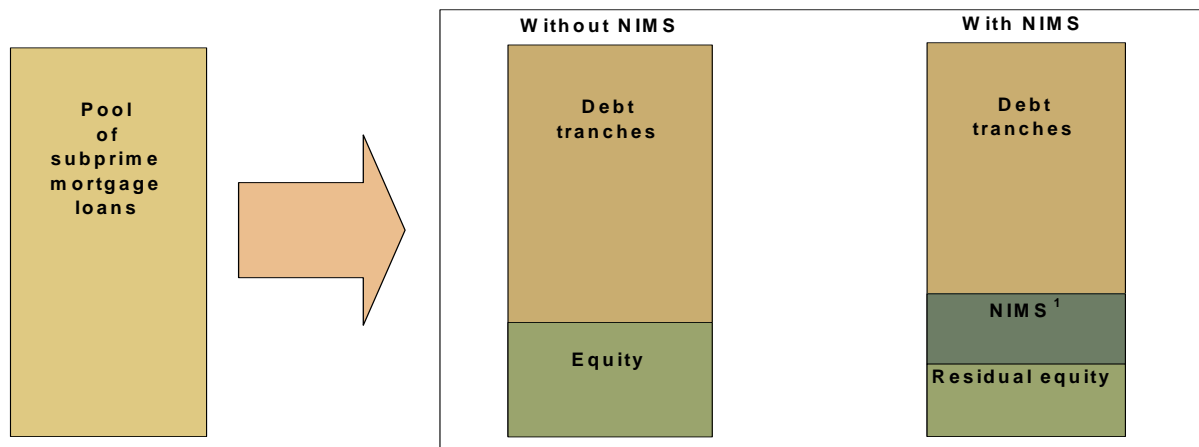
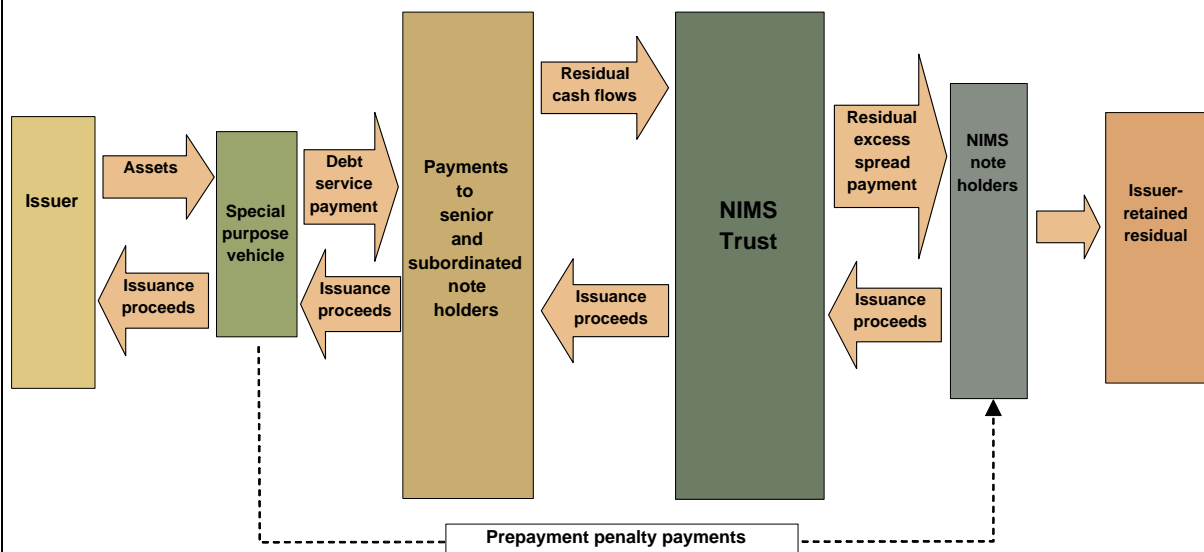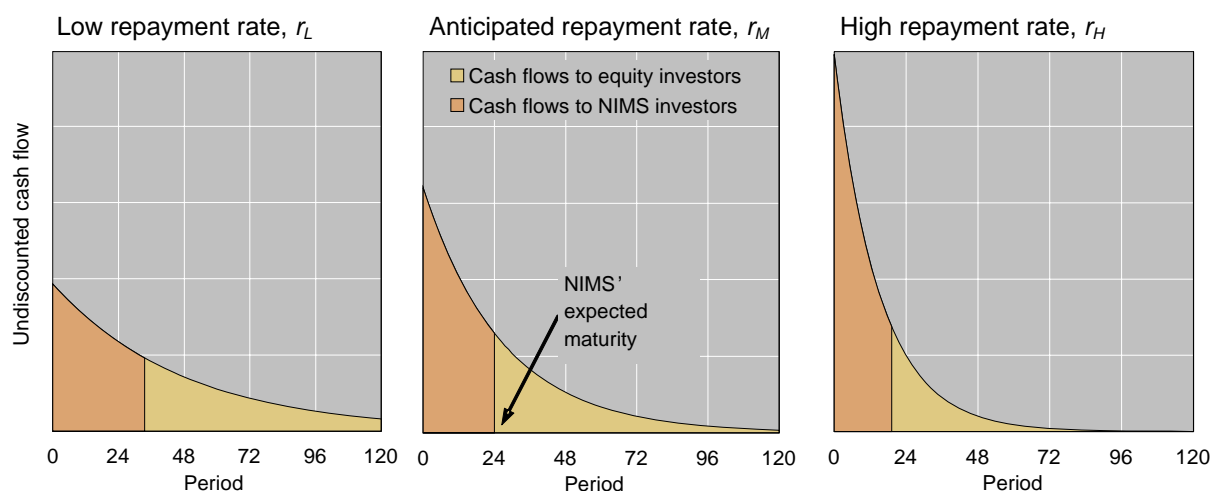## Financing structure

Figure A

Cash flows

Figure B

Consequences of repayment rates for NIMS[2]

Low repayment rate, r_L | Anticipated repayment rate, r_M | High repayment rate, r_H

☐ Cash flows to equity investors
☐ Cash flows to NIMS investors

Undiscounted cash flow

NIMS' expected maturity

Period

[1] Residual cash flows pass to equity holders only after NIMS have been paid off.   [2] The net present value of a NIMS stake is the discounted amount of the total cash flows represented in the shaded area of the three panels. When the repayment rate is lower (slower) than anticipated, the net present value captured by a NIMS stake is less, ie $NPV(r_L) < NPV(r_M)$; conversely, a higher (faster) repayment rate corresponds to a higher net present value, ie $NPV(r_H) > NPV(r_M)$.

Source: BIS.   Figure C

NIMS transactions have employed a number of structural upgrades, eg NIMS investors have been given senior claims on receipts of prepayment penalties, which hastens the repayment to NIMS investors when household mortgage prepayments are surprisingly high (Figure C, right-hand panel). In the absence of this feature, mortgage prepayments only have the effect of reducing net spread income and, therefore, *reduce* the speed of repayment to the NIMS tranche and its net present value (Figure C, left-hand panel).

New risks in the new century

One distinction of non-agency underwritten mortgages is that pricing is much more sensitive to credit risk. Agency-backed mortgages continue to have a uniform interest rate for almost all (prime or near prime) qualified contracts, a pattern which is sustainable in part because the credit quality of the underlying household panel is rather homogeneous. However, for non-agency mortgage loans, observed mortgage rates tend to vary in line with the default probabilities suggested by the standard distributions of households' credit scores.

Mortgage rates have become more sensitive to credit risk

The dependence on credit scores has become even more pronounced over time. Credit scores are constructed from all available credit histories and were initially designed as a measure of the likelihood that a consumer would become seriously delinquent on consumer loans. It was only after their introduction in consumer finance that it became apparent that the scores could also be used to predict mortgage loan defaults. The market has over time come to rely on credit scores as the primary input for the prediction of mortgage loan default probabilities.[6]

Growing dependence on credit scores to differentiate borrowers

---

[6]   Credit scores are based on limited data sets, the information being submitted by credit granting firms. One example of a reporting firm would be a bank that has issued a credit card. The bank would report information such as the amount of the approved credit limit,
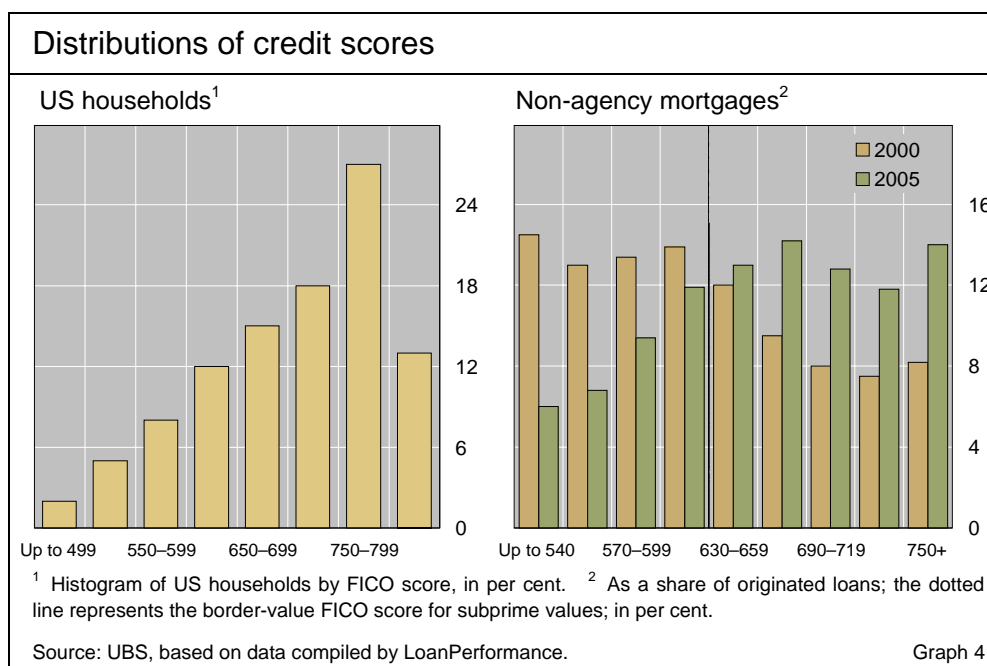
A few stylised facts stand out about the distribution of households' credit scores and non-agency mortgages. First, credit scores for households taking out non-agency backed mortgages tend to be lower than those for the entire US household sector, indicating a lower credit quality on average (Graph 4). At the same time, credit scores for these households are higher than they were at the turn of the century, in part the product of an influx of good credit households and consistent with the increase in Alt-A loans described above (Graph 4, right-hand panel). This suggests that the new developments in mortgage finance are making it easier for households to leverage their credit scores to gain increased exposure to the housing sector.

"Affordable" loan products

A large number of non-agency originators specialise in the underwriting of "affordable" loan products, such as option ARMs (adjustable rate mortgages) and IO (interest-only) loans. The former grant borrowers the option to make partial interest payments and thus negatively amortise the balance on their loans. Doing this as house prices rise is equivalent to an automatic withdrawal of equity. The latter grant borrowers the option to defer the start of their mortgage amortisation payments. Normally, a household can qualify for a larger loan amount by choosing these types of mortgages (see Hancock et al (2005)).

The screening of households for suitability for affordable loans relies heavily on credit scores, as few affordable loans are made to low FICO score borrowers (Table 1). Credit rating agencies have reinforced the tendency to screen the loans in this fashion, by markedly raising the required credit

Distributions of credit scores

US households[1] Non-agency mortgages[2]

[1] Histogram of US households by FICO score, in per cent. [2] As a share of originated loans; the dotted line represents the border-value FICO score for subprime values; in per cent.

Source: UBS, based on data compiled by LoanPerformance. Graph 4

outstanding balances, late payments and delinquent payments. Information on households' income or households' net worth positions is not captured by such reporting. For further discussions of credit scores and their usage, see Avery et al (1996) and Ben-Shahar (2005).

Selected characteristics of non-agency loans made in 2005

By FICO bucket

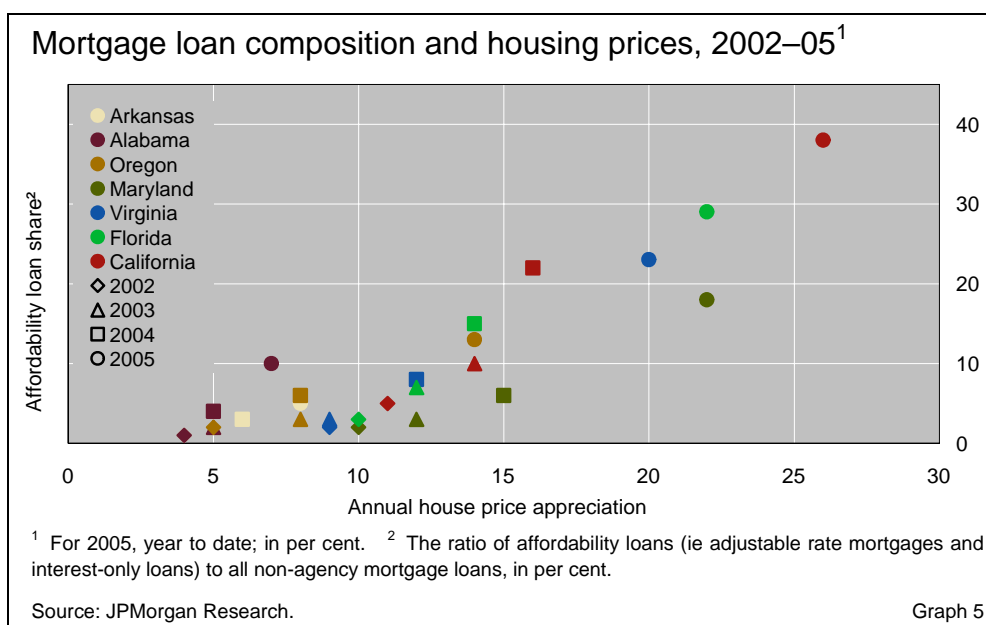| FICO range	Loan size (USD thousands)	LTV	% option ARM	% IO	% California	% non-conforming
<540	162	74.5	0.0	2.2	25.5	11.8
540–569	168	78.6	0.0	6.9	25.0	14.6
570–599	172	82.1	0.0	19.4	25.3	16.2
600–629	192	84.0	4.8	26.8	29.3	22.6
630–659	222	83.0	14.5	29.2	36.1	32.1
660–689	259	80.7	22.4	32.0	41.4	43.5
690–719	285	78.8	22.6	36.0	44.4	51.2
720–749	291	78.3	18.7	38.1	44.4	55.3
750–780	327	74.4	18.2	39.7	45.4	63.1

Note: "LTV" is the average loan-to-value ratio for the loans in the FICO range. "% option ARM" and "% IO" are the percentage of those types of loans (described in the text) in the FICO range. "% California" is the percentage of loans in the FICO range originated in California. "% non-conforming" is the percentage of loans in the FICO range of a size greater than the GSE cap amount applied at the time of loan origination.

Source: UBS, based on data compiled by LoanPerformance.   Table 1

enhancements for securities backed by loans to households with low credit scores.

The expansion of new mortgage loan products shows a strong correlation with the strength of the real estate market. In particular, the market share of the new mortgage loan products in individual US states tends to be higher in states where there are high rates of house price inflation (Graph 5). As rising housing prices result in lower loan default rates and loss severity, the providers of affordability loans are prepared to increase their supply in robust housing markets. But, by the same token, were housing market conditions to worsen,

New products are much more common in strong real estate markets

Mortgage loan composition and housing prices, 2002–05[1]

Legend: Arkansas, Alabama, Oregon, Maryland, Virginia, Florida, California; ◇ 2002, △ 2003, □ 2004, ○ 2005

Y-axis: Affordability loan share[2]
X-axis: Annual house price appreciation

[1] For 2005, year to date; in per cent.   [2] The ratio of affordability loans (ie adjustable rate mortgages and interest-only loans) to all non-agency mortgage loans, in per cent.

Source: JPMorgan Research.   Graph 5

both the performance and provision of these products might go into reverse as well (see Downing et al (2005) and Longstaff (2004)).

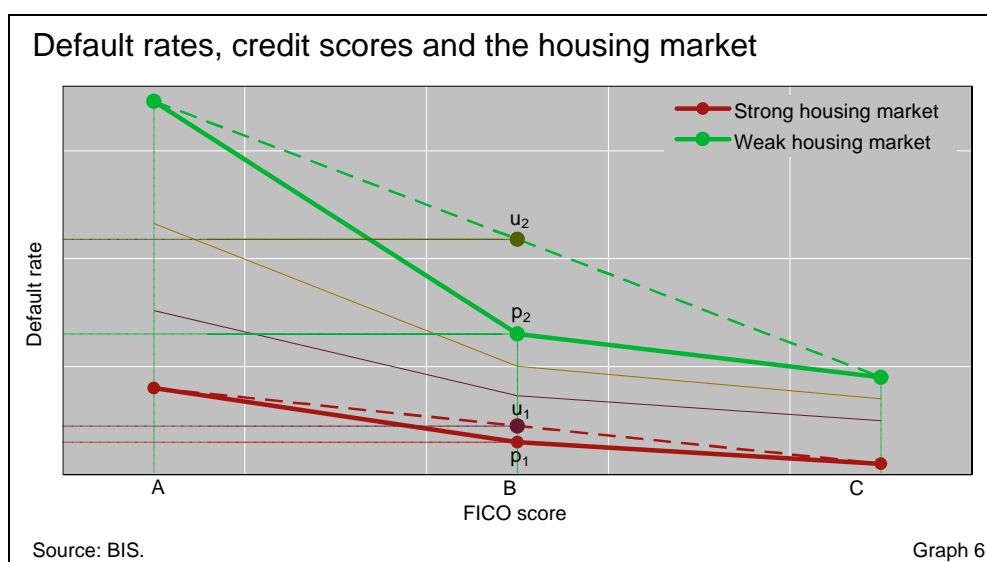*The risk of keying to average credit scores*

Investment and pricing of mortgage pools are often keyed to the average FICO scores of all the underlying credits, rather than to a more complex function of the distribution of scores.[7] The costs of such a simplifying assumption could be considerable. Our conjecture is that housing market conditions matter greatly for the economic significance of differences in the credit scores of borrowers combined in a single pool. Namely, persistently strong housing markets offer less incentive for investors to be concerned with pool composition than do persistently weak housing markets.

Graph 6 illustrates the systematic underprediction of defaults that can result from pricing a mortgage pool off the average credit score. Because the relationship between default rates and FICO scores is convex – ie a deterioration in the scores increases default rates more than a commensurate improvement lowers default rates – the average of the expected default rates for a sample of FICO scores is greater than the default rate for the average of the same sample's score.[8] For instance, between the solid red and dashed red lines in the graph, the distance $u_1 p_1$ is the increase in the default rate associated with an investment in a pool of mortgages with scores A and C rather than only in mortgages which have score B, the average of A and C. These defaults are unanticipated when investors key to the average credit score rather than multiple characteristics of the distribution.

Graph 6 also illustrates a potential outcome for mortgage pool holders of a shift from strong to weak housing markets. The iso-curves relate credit scores to default rates for different states of the housing market. Curves move away

Default rates, credit scores and the housing market

Source: BIS.   Graph 6

---

[7] For a discussion of this issue, see UBS (2006b).

[8] This corresponds to the result for structural models of default that the expected probability of default of the average (representative) firm underpredicts realised default rates. For a further discussion, see Tarashev (2005).

from the origin as housing market conditions deteriorate, implying higher defaults for a given FICO score. Since default rates are likely to be convex in housing prices,[9] it follows that the relationship between default rates and credit scores will become increasingly convex as we move from more to less robust housing markets, which in turn produces an increase in unanticipated defaults, ie $u_2p_2 > u_1p_1$. One interpretation of the increase is that it signals that more effort needs to be expended to correctly price loan pools, especially in stronger housing markets, to avoid unanticipated losses should markets turn weaker. Because the US housing market has not been weak since the proliferation of new mortgage products, the scale of the resulting exposure should not be underestimated.

New challenges in forecasting prepayment[10]

Changes in the mortgage finance system also pose new challenges for investors in assessing their exposure to the exercise of prepayment options by borrowing households. Under the old system of mortgage finance, all "qualified" borrowers took up standard mortgage contracts with identical terms, while other borrowers were rationed out of the mortgage market. Owing to high transaction costs, individual borrowers refinanced only in response to sizeable reductions in mortgage rates. Improvement in a borrower's creditworthiness or increases in house prices, per se, provided little incentive to prepay. As a result, the investor's problem was centred on forecasting the levels and volatility of interest rates.

In contrast to the old system of housing finance …

By contrast, under today's mortgage finance system, the challenge of forecasting prepayments is more complex. All applicants receive mortgages whose pricing is based, in part, on LTV ratios measured on a mark to market basis. Mortgage refinancing rates are based on the households' current credit standing, and lower transaction costs imply that borrowers can exercise prepayment options more efficiently. Consequently, borrowers rapidly prepay to benefit from lower mortgage costs, which can be due to an improvement in a household's creditworthiness as much as lower market rates. This credit standing can in turn result from an improved credit history or an increase in house value. Thus, investors in mortgage securities have an increasing interest in anticipating moves in credit and real estate markets as well as interest rates.

… under the new system …

… housing prices can greatly affect prepayment risk

Concluding remarks

The character of US mortgage finance has changed markedly over the last few years. The new system is not a by-product of a regulatory reform initiative; it is largely a market-based response to incentives generated by very buoyant

---

[9]   Convexity of defaults is the norm for most collateral attributes, including LTV ratios and loan size, as discussed in UBS (2006b).

[10]   For more detailed discussions of the issues involved in the estimation and valuation of prepayment risk in MBSs, see Breeden (1994), Gan and Riddiough (2003), Department of the Treasury et al (2003) and Heidari and Wu (2004).

housing markets.[11] The key initial condition was the existence of institutions with a recognised capacity to invest in mortgage pools and structured finance securities. The key proximate factor was the willingness of households to leverage their credit scores to take outsized exposures in housing markets.

There are signs that the US housing market is cooling. As house price appreciation slows, mortgage defaults become more likely and, at the same time, voluntary prepayments become less likely. To the extent that some investors may have failed to recognise the degree of sensitivity of their MBS investments to housing market developments, they may be exposed to losses in excess of what they had anticipated.

References

Avery, R B, R W Bostic, P S Calem and G B Canner (1996): *Credit risk, credit scoring, and the performance of home mortgages*, July, pp 621–48.

Ben-Shahar, D (2005): *Default, credit scoring, and loan-to-value: a theoretical analysis under competitive and non-competitive mortgage markets*, Arison School of Business, July.

Breeden, D T (1994): *Complexities of hedging mortgages*, December, pp 6–41.

Committee on the Global Financial System (2005): *Housing finance in the global financial market*, December.

Department of the Treasury, Office of Federal Housing Enterprise Oversight and Securities and Exchange Commission (2003): *Staff Report: enhancing disclosure in the mortgage-backed securities markets*, January.

Downing, C, D Jaffee and N Wallace (2005): *Information asymmetries in the mortgage backed securities market*, University of California at Berkeley, May.

Gan, J and T J Riddiough (2003): *Piercing and then papering over the veil of ignorance: GSE monopoly and informational advantage in the market for residential mortgages*, AFA 2004 San Diego meetings, March.

Hancock, D, A Lehnert, W Passmore and S M Sherlund (2005): *An analysis of the potential competitive impacts of Basel II capital standards on US mortgage rates and mortgage securitization*, Federal Reserve Board, April.

Heidari, M and L Wu (2004): *What constitutes a good model? An analysis of models for mortgage backed securities*, August, available at www.ssrn.com/abstract=585622.

Heike, D and A Mago (2005): "The ABCs of HELs", *Journal of Fixed Income*, June, pp 5–39.

Longstaff, F A (2004): "Optimal recursive refinancing and the valuation of mortgage-backed securities", *NBER Working Papers*, 10422, April.

---

[11] There have also been common elements across countries in the global transformation of housing finance, which are discussed in detail in a recent report of the Committee on the Global Financial System (2005).

Office of Federal Housing Enterprise Oversight (2005): *Mortgage markets and the enterprises*, August.

Pennington-Cross, A (2002): "Subprime lending in the primary and secondary markets", *Journal of Housing Research*, vol 13, issue 1, pp 31–50.

Tarashev, N (2005): "Structural models of default: lessons from firm-level data", *BIS Quarterly Review*, September, pp 99–108.

UBS (2006a): *Mortgage Strategist*, 10 January, pp 20–21.

——— (2006b): *Mortgage Strategist,* 24 January, pp 19–24.

Zorn, P (2005): *Credit scoring and mortgage default modelling*, Freddie Mac, LoanPerformance Risk Summit, July.