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The ABX: how do the markets price subprime mortgage risk?[1]

The ABX family of indices has become a key barometer of subprime mortgage market conditions during the recent financial crisis. Simple regression analysis illustrates the relationship between observed index returns and proxies of default risk, interest rates, market liquidity and risk appetite. The results suggest that declining risk appetite and heightened concerns about market illiquidity have provided a sizeable contribution to the observed collapse in ABX prices since the summer of 2007.

JEL classification: E43, G12, G13, G14.

The evolution of derivatives products based on indices of credit market exposures has allowed market participants to trade standardised contracts on pools of a variety of underlying instruments. This, in turn, has added a degree of transparency and liquidity to market segments as diverse as leveraged loans or mortgage-backed securities (MBS). For instance, the so-called ABX indices, which are based on credit derivatives written on MBS backed by subprime mortgage loans, track the price of credit default insurance on a basket of such deals. Since the start of the recent financial turmoil in the summer of 2007, the ABX index family has served as a widely followed barometer of the collapsing valuations in the US subprime mortgage market, which have been at the core of observed credit market developments. Despite some shortcomings, ABX price information also seems to have been widely used by banks and other investors as a tool for hedging and trading as well as for gauging valuation effects on subprime mortgage portfolios more generally.[2]

[1] The views expressed in this article are those of the authors and do not necessarily reflect those of the BIS or the ECB. Any errors and omissions also remain those of the authors, who would like to thank Patrick McGuire, Nikola Tarashev and Haibin Zhu for useful comments as well as Emir Emiray and Jhuvesh Sobrun for assistance with the data and graphs.

[2] According to *The Wall Street Journal* (2007), when Swiss bank UBS wrote down its subprime mortgage investments by $10 billion in December 2007, it looked to the ABX as a guidepost in determining values for its holdings. Likewise, Morgan Stanley and Citigroup reportedly cited the ABX as a factor in the sizeable writedowns announced in late 2007.

Understanding the specific factors driving the variation of ABX prices is important for market participants and policymakers because changes in the weight of credit- and non-credit-related elements may have different implications. For instance, indications of changes in risk appetite with regard to subprime mortgage risk may help explain any discrepancies between observed ABX prices and projections of default-related losses on the underlying pool of subprime MBS. These discrepancies, in turn, can have consequences for investors, for example when ABX quotes are used to value existing holdings of subprime MBS. Yet despite the importance of these issues, empirical work on the ABX indices has so far been scarce.[3]

In what follows, ABX prices are analysed to establish the importance of different pricing factors and how they have changed over time. For this purpose, the first section provides a brief overview of the ABX indices and how they work. The second section applies simple regression analysis to investigate the determinants of ABX index returns, illustrating the relationship between ABX pricing and macroeconomic news as well as market-based proxies of default risk, interest rates, market liquidity and risk appetite. The final section concludes.

The ABX: an introduction

Index mechanics

The ABX allows trading of subprime mortgage risk …

The ABX family of indices, which started trading on 19 January 2006, consists of a series of equally weighted, static portfolios of credit default swaps (CDS) referencing 20 subprime MBS transactions.[4] The ABX indices were introduced on the back of strong issuance activity in subprime MBS markets (Graph 1, left-hand panel) and the successful launch of MBS-based CDS contracts in 2005. These contracts, which allow investors to buy and sell protection against the default risk of subprime mortgages, had seen particularly strong growth due to their inclusion in synthetic collateralised debt obligations. Growing volumes, in turn, eventually triggered demands for a tradable benchmark index that would make it easier for investors to establish and adjust subprime MBS exposures.

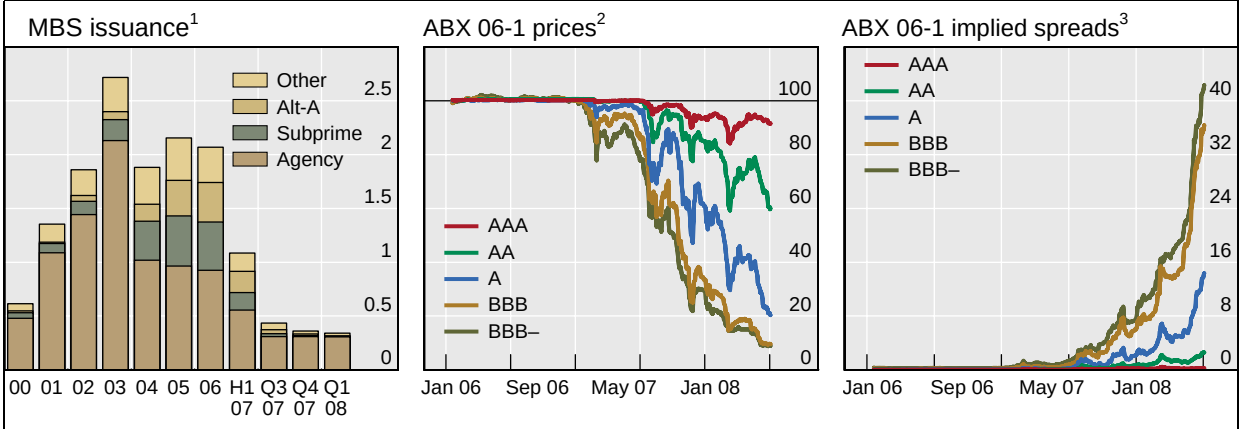
The mechanics of the ABX indices, which are offered for trading by a consortium of major credit derivatives dealers, are determined by vintage- and credit rating-related considerations. New on-the-run ABX series are introduced every six months,[5] and each of these index vintages references 20 completely

[3] Related research includes Mizrach (2008), who analyses the jump risk in ABX prices and its determinants. Perraudin and Wu (2008) examine the determinants of prices for asset-backed securities in two distinct crisis periods.

[4] Mortgage-backed securities are based on large pools of individual mortgage loans that are financed through the issuance of bonds (tranches) at different levels of seniority. The most senior tranches of the resulting liabilities structure are the first to receive any cash flows generated by the asset pool and are protected against default until the more junior tranches are depleted. See, for example, Ashcraft and Schuermann (2008).

[5] Four such vintages have been initiated since January 2006, before the scheduled index "roll" into a new set of underlying MBS deals in January 2008 had to be postponed due to a lack of eligible collateral – a direct consequence of collapsing subprime issuance volumes.

Subprime MBS: issuance and pricing



[1] In trillions of US dollars. [2] As a percentage of par. [3] Over Libor, in thousands of basis points.

Sources: JPMorgan Chase; UBS; authors' calculations. Graph 1

new subprime MBS deals issued during a six-month period prior to index initiation. Trade documentation excludes any form of physical settlement, thus decoupling ABX trading from the availability of the underlying cash instruments. This has aided market development, supporting the adoption of ABX index contracts as a tool for trading and hedging. However, with markets reportedly overwhelmed by large speculative short positions, market liquidity in the ABX indices has been impaired during the recent turmoil even as trading continued throughout the crisis.

… across vintages and rating levels …

Each index vintage consists of five individual subindices, each referencing exposures to the same 20 underlying subprime mortgage securitisations, though at different levels of the liability structure. The ABX 06-1 AAA index, for example, represents tranches with an original rating of AAA from a pool of MBS originated in the latter half of 2005. The other subindices, in turn, are backed by tranches of the same securitisations at the AA, A, BBB and BBB– levels of credit quality.[6] Underlying MBS are selected on the basis of set criteria, targeting large and liquid structures with at least $500 million of deal size at issuance. Concentration limits apply, among other things, to the number of deals with the same originator, and each underlying obligation is required to carry ratings at a corresponding level by both Moody's and Standard & Poor's. Once created, index composition remains static, implying that underlying credit quality can migrate to ratings that are lower than indicated by the index name. The maturity of each ABX contract corresponds to the longest legal maturity among the individual CDS contracts backing the index, which results in exposures that are very similar to those of the underlying MBS tranches. Trading is conducted in price terms, where prices are quoted as a percentage of par for each individual index of a given vintage.[7]

[6] Supplementary indices, called ABX PENAAA, were introduced in May 2008 to provide additional pricing information for all four existing index vintages. See the box in Fender and Hördahl (2008).

[7] See, for example, Lehman Brothers (2006).

… but for only part of the MBS universe

Importantly, the combined ABX indices capture only part of the underlying universe of subprime MBS. For all four index vintages taken together, the original outstanding balance has averaged about $31 billion at issuance (an average of $1.54 billion per underlying MBS deal). This compares to average monthly MBS issuance amounts of about $36 billion over the 10 quarters up to mid-2007 or almost a month's worth of MBS issuance per ABX vintage (Graph 1, left-hand panel).[8] Coverage of actual MBS transactions, however, is lower than these numbers suggest. This is because only parts of the capital structure of the underlying deals are actually referenced by the various indices of a given series. Of the 15 or so tranches per MBS deal, only five were originally included in the ABX indices of the respective series (one AAA, AA, A, BBB and BBB– quality tranche each). This is particularly relevant at the AAA level, which accounts for around 80% of the outstanding balance at issuance, as the AAA tranches referenced by the corresponding ABX indices are not the most senior pieces in the capital structure of their constituent MBS deals.[9] As a result, limited deal coverage makes it difficult to translate price data for, say, the ABX 07-1 AAA index into information on how other AAA subprime bonds originated in the second half of 2006 have or should have performed.

Pricing basics

ABX prices reflect the willingness of investors to buy or sell default protection on the basis of their views about the risk of the underlying subprime loans. With the terms and coupon payments of the respective CDS contracts fixed, premia or discounts relative to par indicate the amount that is to be exchanged upfront. This amount, in turn, reflects the present value of the difference between any expected payments due to principal writedowns or interest rate shortfalls and the fixed coupon of the index plus accrued interest (see box). Spreads can be calculated from observed prices on the basis of duration assumptions. These implied spreads are then broadly comparable to the basis point spreads quoted on other credit products (Graph 1, centre and right-hand panels).

ABX pricing is a complex task

Reflecting the nature of the underlying MBS instruments, ABX pricing involves the use of cash flow models to project payments, delinquencies, defaults and losses. Modelling is based on collateral characteristics (such as FICO scores,[10] loan-to-value ratios and loan size), as well as assumptions about house price appreciation. These, in turn, result in cash flow projections across various house price paths, which can then be aggregated to derive the

[8] Limited market coverage has raised questions about whether the ABX indices are representative of the overall subprime MBS market. See eg *The Wall Street Journal* (2007).

[9] This implies that the AAA bonds referenced by the ABX AAA index have longer durations (expected average lives) than other AAA bonds from the same subprime securitisations, which makes them riskier. See the box in Fender and Hördahl (2008) for details.

[10] FICO (Fair Isaac Corporation) scores measure the credit risk of individual borrowers based on a statistical analysis of their credit files. FICO scores range between 300 and 850, and subprime loans are often defined as those to borrowers with limited income and/or a score of 620 or below. See Frankel (2006) for details.

ABX pricing mechanics

Prices for ABX index instruments are determined by two payment legs.[1] The first leg, which is paid by the protection buyer, is based on the index coupon,[2] which, in turn, is fixed as a percentage of notional over the life of the index on the day of the index roll (ie on initiation of a new on-the-run index vintage). As payments are made on a pay-as-you-go basis, the fixed valuation leg can be approximated by the present value of the monthly stream of fixed, default-free coupon payments, adjusted for any prepayments on the underlying bonds.[3] The second, floating leg is paid by the protection seller, who makes conditional payments equivalent to any principal writedowns or interest rate shortfalls as determined by Markit, the administration and calculation agent for the ABX indices.

In simplified terms, ABX prices can therefore be written as:

$$price = 100 + PV(coupons) - PV(writedowns, shortfalls)$$

where the PV expressions denote the present values of the fixed (coupons) and floating (writedowns, shortfalls) payment legs, respectively.

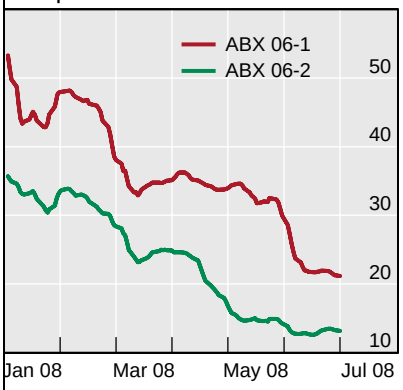
On this basis, market participants' expectations regarding future writedowns of tranche principal are key factors in determining ABX prices. These, in turn, depend on information such as prepayments and delinquencies, while writedown timing assumptions and discount rates are important parameters in calculating present values. Specifically, if writedowns are assumed to occur immediately (zero months to default) and with coupon payments given, prices will be determined by the number of bonds written down. Broadly put, 10 immediate writedowns (ie half of the underlying MBS tranches) will result in a price of 50, whereas 15 writedowns (75% of all tranches) imply a price of 25.[4] Alternatively, if all tranches are assumed to be written down, expectations about writedown timing, combined with any risk premia, will translate directly into ABX prices.

Recent ABX pricing can be used to illustrate the interaction of different pricing factors. While house prices had been weakening and delinquencies on the rise for some time, 2007 particularly saw very severe deterioration in the subprime mortgage segment. As mortgage delinquencies ramped up, so did loss projections on subprime mortgage bonds, implying loss rates far exceeding historical precedents?[5] As a result, the most junior indices of the more recent ABX series (which are backed by lower-quality exposures than the original 06-1 index vintage) quickly started to trade on an interest-only basis, ie at levels essentially pricing complete principal writedowns of all 20 underlying MBS tranches. The 06-1 BBB– index, in turn, began to follow the same pattern during the first quarter of 2008, suggesting that writedown expectations were approaching 100%.

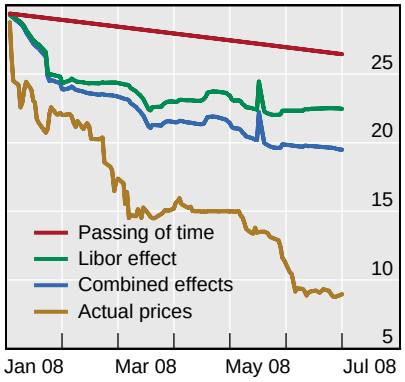
With total loss of principal seen as increasingly certain, observed prices (abstracting from any risk premia) thus turned into a broad reflection of traders' expectations as to when tranche

ABX index analytics

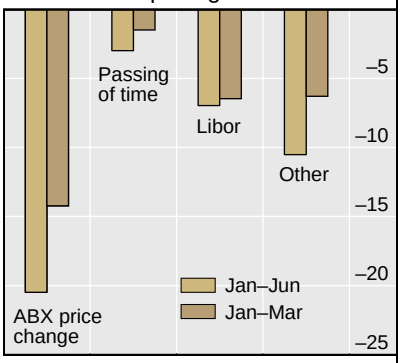
Implied time-to-writedown[1]



ABX price decomposition[2]



Effect of ABX pricing factors[2]



[1] Implied time to full writedown of tranche principal in months; calculated from prices for the ABX 06-1 and 06-2 BBB– index series, assuming that all underlying bonds are completely written down; five-day moving averages. [2] Actual and implied ABX 06-1 price changes over the January–March and January–June 2008 periods; actual change decomposed on the basis of end-December 2007 implied time-to-writedown and one-month Libor rates; assumes full writedown of tranche principal.

Sources: JPMorgan Chase; UBS; authors' calculations. Graph A

writedowns would take place.[⑥] After an initial adjustment during the first quarter of 2008, these implied times-to-writedown declined markedly up to June 2008 for the 06-1 and 06-2 BBB– indices (Graph A, left-hand panel). Part of the underlying decrease in prices was attributable solely to the passage of time and its effect on the discounted value of the (large) floating leg of the respective ABX contracts. The impact of declining Libor rates, however, turns out to have been a more important price determinant, particularly during the first quarter. Under the assumption of total principal writedowns (ie a writedown rate of 100%, discounted over the assumed time-to-writedown), lower Libor rates contributed about half of the price decline for the most junior ABX 06-1 exposures between early January and end-March 2008. Other factors, which would include any risk premia, accounted for the rest of the price movement (Graph A, centre and right-hand panels).

[①] A second fixed leg may be paid to reimburse the protection seller for reversed writedowns and interest rate shortfalls. [②] The 2006-1 AAA index is quoted with a coupon of 18 basis points, whereas the corresponding BBB– index has a coupon of 267 basis points. [③] See, for example, Lehman Brothers (2006). [④] See UBS (2007); calculation of writedowns requires deal-level knowledge about the effective attachment and detachment points of the various tranches of ABX constituent deals, which will depend on the amount of overcollateralisation and accumulated excess spread. [⑤] See Box 1 in Fender and Hördahl (2007) for an illustration. [⑥] See UBS (2008) for methodological details; cash flows are discounted using one-month Libor; the calculation abstracts from any interest rate shortfalls and payment reversals as these will be dominated by the assumed principal writedown event.

appropriate price, given probability assumptions for the various scenarios. Other price determinants will include interest rates (both via discounting and in determining prepayments, defaults and effective subordination)[11] as well as factors such as market liquidity and risk appetite (which will influence any risk premia). Time is another factor in that, for given expected writedowns and writedown timing, ABX prices will tend to fall as the projected losses draw closer. Similarly, as default as well as prepayment performance are known to have strong seasoning effects, average loan age (which grows over time) will feed into prices.

What drives ABX prices?

Econometric setup and data

Regression analysis is used to …

Econometric methods in the analytical literature on credit spreads have been applied to address some of the complexities described above.[12] An advantage of such a regression-based approach is that the analysis is not constrained by any particular pricing model, and allows for a wide set of explanatory variables to be used. A disadvantage is the reliance on rather indirect proxies for factors such as market liquidity and risk tolerance, which suggests that any results will have to be interpreted with care.

The specific approach adopted below proceeds in three steps. First, ABX returns will be analysed by way of a factor decomposition, to illustrate broad

[11] Sensitivities for assets (ie mortgage loans) and liabilities (ie issued tranches) in MBS transactions will be different in that interest payments on liabilities will tend to reset faster. Abstracting from any hedges that may be in place, declining interest rates will thus translate into higher "excess spread" earned on the assets relative to what is paid out on the liabilities. Excess spread, in turn, offers additional protection for investors. See UBS (2007).

[12] For the regression-based approach to analysing the determinants of credit spreads. see eg Collin-Dufresne et al (2001). Scheicher (2008) performs similar analyses of the market pricing of CDX and iTraxx index tranches.

correlation patterns between ABX prices and other financial market variables. Second, simple panel regressions are used to establish the effect of these variables on ABX returns for the ABX 06-1 vintage in more detail. Finally, blockwise regressions of individual ABX indices are employed to investigate changes in the importance of different pricing factors over time. In implementing these three steps, the various pricing factors will be proxied by macroeconomic and financial market variables combined with, where available, survey information and publication dates to capture any announcement effects. Specifically, the following variables are used:

... explain the response of ABX returns to ...

Dependent variables. The analysis focuses on the ABX 06-1 index, which is the oldest of the four available vintages, offering the longest time series. While trading in subsequent index vintages, especially the latest so-called on-the-run series, is likely to have diminished some of the activity in the 06-1 market, index underlyings are different from series to series. This should help limit any adverse effects on activity in the 06-1 index from the trading of other index vintages. At the same time, the underlying credit quality of the 06-1 series is known to be better than that of subsequent vintages, as mortgages originated in the second half of 2005 have benefited from the tail end of the strong house price appreciation that was observed in the United States until 2006 (and the associated build-up in home equity values). This will have to be taken into account when interpreting any results on the basis of 06-1 prices.

Casual inspection of ABX price data yields a number of interesting observations. One is the steep decline in prices (massive increase in implied spreads) observed since June 2007, following an initial price correction early in 2007 (Graph 1, centre and right-hand panels).[13] The developing subprime crisis then caused price deterioration across the entire liability structure of the various ABX indices, with prices up to the A index plummeting to very low levels. A closer comparison of three pricing snapshots (Table 1) for the first two ABX vintages shows that the AAA tranches were quoted close to par in June 2007, whereas they were quoted at around 93 and 87, respectively, at end-December 2007. By end-June 2008, valuations had deteriorated further, illustrating how the market had started to differentiate between the two adjacent vintages, particularly for the higher-rated indices. In total, the strongest price declines were observed in the BBB segment, where prices dropped from levels around 94 to near 9.6 for the 2006-1 BBB index, which is close to the price of the originally A-rated index of the 2006-2 vintage.

Correlation patterns also offer some insights into how the market perceives the riskiness of different ABX tranches. For example, rolling 90-day correlations between AAA and BBB– index prices show a pronounced increase during the onset of the subprime crisis in the summer of 2007. This followed a brief spike in January–February 2007, consistent with the initial subprime jitters during that period, and correlations around 0.3 throughout much of 2006. These observations are broadly consistent with observed correlation patterns between senior ABX and investment grade CDS prices, which suggests that

[13] See BIS (2008, Chapter VI) for a description of market developments during the unfolding financial crisis.

The pricing of subprime mortgage risk: three snapshots

Observed market prices (as a percentage of par) for the ABX 06-1 and 06-2 index series, by original rating

Price series	1 June 2007	31 December 2007	30 June 2008
ABX 06-1 AAA	100.1	93.5	91.8
ABX 06-2 AAA	99.6	86.8	69.3
ABX 06-1 AA	100.1	85.0	60.6
ABX 06-2 AA	99.5	62.2	20.5
ABX 06-1 A	98.7	61.0	21.2
ABX 06-2 A	96.2	39.5	9.3
ABX 06-1 BBB	94.5	33.5	9.7
ABX 06-2 BBB	82.7	20.5	5.5
ABX 06-1 BBB–	88.2	29.4	9.0
ABX 06-2 BBB–	73.1	19.3	5.2

Source: JPMorgan Chase. Table 1

factors other than the risk of mortgage default may have played an important role in driving ABX returns (Graph 2, left-hand panel).

... mortgage market fundamentals ...

Housing and other mortgage market fundamentals. Detailed data on the subprime mortgage market are scarce, which makes it difficult to come up with appropriate proxies for fundamental drivers of mortgage default. Three groups of housing-related indicators were considered for inclusion. The first of these consists of contemporaneous indicators, such as macroeconomic data releases, which tend to be available at a weekly or monthly frequency. The second group contains daily pricing factors with forward-looking information, such as those derived from prices for financial products. The third group is based on ABX-specific performance data.

Contemporaneous data. From a modelling perspective, the inclusion of most lower-frequency measures of market fundamentals in the regression setup is challenging, as precise announcement dates and estimates of analysts' forecasts are required in order to properly test the reaction of daily market prices to these fundamental factors.[14] Only four such variables turned out to be significant drivers of ABX prices, proxying the overall state of the US economy and related mortgage market developments: building permits, an indicator of private residential real estate activity; new home sales, which track sales of new one-family houses; and the RPX residential property composite index, which is based on daily transaction prices per square foot paid for US residential real estate in 25 regional markets. The RPX property price series enters the analysis both in levels and in terms of observed volatilities over a moving 20-day window to capture housing market trends as well as associated uncertainties. The fourth proxy is the surprise component in the monthly net

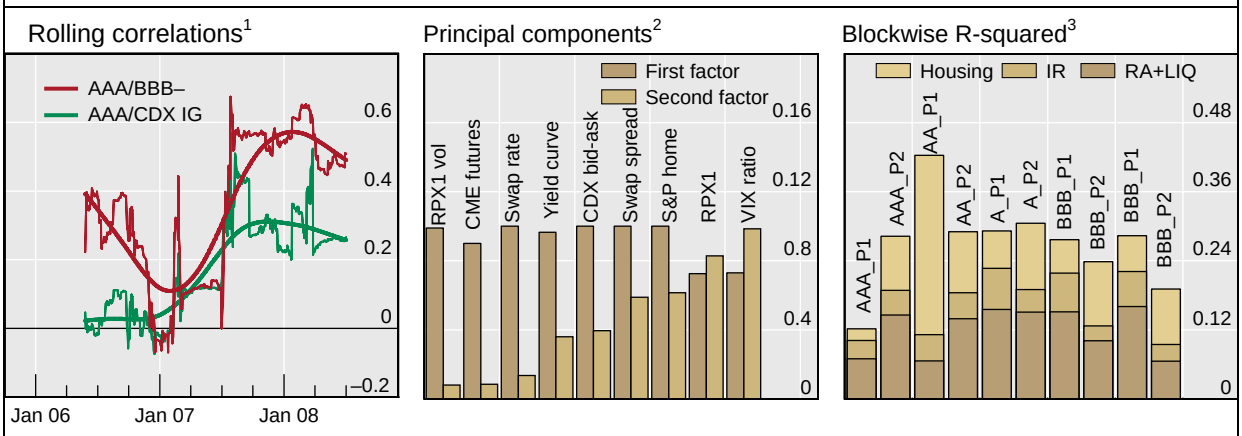
[14] Asset pricing theory suggests that observed prices reflect publicly available information about the state of the economy. Therefore, it is not the published level of a macroeconomic variable that affects the prices of securities or derivatives, but the unexpected component of the new information (see eg Fleming and Remolona (1997)). On this basis, whenever possible, survey data are used to calculate the surprise component of economic data releases. If no such survey information is available, changes from the previous release are employed as an, admittedly crude, proxy for the surprise effect.

change in US employees on non-farm payrolls, which serves as the key macroeconomic control variable.

Forward-looking information. Expected developments in the housing sector are captured by the daily logarithmic excess return of the homebuilders subindex over the S&P 500 equity index and daily average price changes for futures contracts on the Case-Shiller composite index, which is based on recorded changes in home values in 10 geographical areas in the United States. These futures, which are traded on the Chicago Mercantile Exchange, are available for the contract months of February, May, August and November, and are cash-settled on the day the Case-Shiller index is released.

ABX-specific data. Deal-specific news for each of the constituent MBS bonds of the ABX indices is proxied by information on rating downgrades by the three major rating agencies and delinquency data from the monthly so-called remittance reports. For the first of these ABX-specific indicators, downgrade events by Moody's, Standard & Poor's and Fitch for the underlyings of the 06-1 ABX indices are coded by date and ABX rating category.[15] The second indicator summarises underlying deal performance on the basis of observed changes in average 60-day-plus delinquencies for the same set of MBS instruments.

ABX 06-1 pricing



[1] Rolling 90-day correlations of observed daily changes in AAA and BBB– ABX 06-1 and CDX investment grade index prices. Thin lines indicate the HP-filtered trend. [2] Significance (1 minus p-value) of the estimated correlation between the two principal components of daily ABX 06-1 log returns and selected explanatory variables: 20-day rolling volatility in the RPX1 housing index (RPX1 vol), average price of housing index futures (CME futures), one-year swap rate (swap rate), difference between 10-year and three-month Treasury yield (yield curve), average bid-ask spreads for CDX index tranches (CDX bid-ask), spread on 10-year US dollar interest rate swaps (swap spread), daily excess log return of the homebuilders subindex over the S&P 500 (S&P home), RPX one-day US residential property prices (RPX1) and the ratio of the VIX volatility index over realised S&P 500 index volatility (VIX ratio). [3] R-squared goodness of fit measures from bivariate regressions of ABX 06-1 returns by rating category. The three blocks of explanatory variables are housing market fundamentals (housing), interest rates (IR) and risk appetite and liquidity (RA+LIQ). Values marked P1 and P2 indicate estimates over two different subperiods; cutoff date is 9 August 2007.

Sources: Bloomberg; JPMorgan Chase; authors' calculations. Graph 2

[15] The resulting downgrade counts, aggregated into an index covering all five rating categories, identify 35 days with downgrades on at least one underlying instrument. The maximum count for the 06-1 vintage is 14 downgrades per day on 8 April 2008. With 100 MBS bonds referenced by each individual ABX vintage, individual index readings can be interpreted as the percentage of underlyings downgraded (in numbers of bonds).

Interest rates. The series that is commonly seen as market participants' preferred discount rate is Libor and, by extension, the rate on US dollar swaps. In addition to its impact on the present values of the two payment legs via the discount factor, as argued above, interest rates are also going to influence the effective subordination of the various ABX tranches. Finally, the slope of the yield curve of interest rates will capture expectations of monetary policy and the economic climate, including those regarding mortgage prepayment behaviour. In the econometric setup, these interest rate effects are going to be proxied by the one-year US swap rate[16] and by the spread between 10-year and three-month US Treasury yields.

… interest rates …

Investor risk appetite and liquidity. Spreads for credit-risky products are known to compensate investors for more than pure expected losses from default (see eg Berndt et al (2005)). That is, they include various risk premia, which are typically assumed to correlate with investor risk appetite.[17] Given its forward-looking character, the VIX implied volatility index derived from option prices on the S&P 500 equity index is a common measure used to capture these effects. Here, risk appetite is proxied by the ratio of the VIX and realised S&P volatility over a leading 20-day window, where higher readings of the VIX ratio (ie positive forecast errors of the VIX relative to realised volatility) correspond to declining risk appetite. In addition, specific market liquidity proxies are included to better gauge associated risk premia. As bid-ask spreads or other direct market liquidity measures for the ABX indices are not readily available, two more indirect indicators are used in the empirical analysis. First, bid-ask spreads are proxied by the average of observed bid-ask spreads across tranched CDX investment grade contracts (ie credit derivatives drawn on portfolios of US corporate credit exposures). Second, US dollar 10-year swap spreads are used. These are known to contain a liquidity premium, along with a premium reflecting the default risk embedded in the Libor rate, due to banks' funding operations in the interbank market.[18]

… and risk appetite as well as …

… market liquidity measures

The sample period extends from 19 January 2006, the first trading date of the ABX 06-1 series, to end-June 2008. Price and interest rate observations are daily, enhanced with macroeconomic and financial data releases at a monthly or weekly frequency. Regressions are based on pooled ordinary least squares (OLS) with cross-sectional fixed effects and White period-robust covariance matrices to account for heteroscedasticity-induced bias in the estimated standard errors. A time trend is included to capture maturity effects. All right-hand side variables except the surprises and S&P excess returns are

[16] Part of the observed movement in the swap rate is going to reflect changes in counterparty credit and liquidity premia; see below.

[17] Risk appetite is generally defined as a measure of the degree to which investors dislike uncertainty surrounding the future consumption implied by their asset holdings as well as the level of that uncertainty. See Gai and Vause (2006).

[18] Longstaff et al (2005) show that the non-default component in credit spreads is positively related to average bid-ask spreads, which, in turn, capture changes in market liquidity. See Huang and Neftci (2003) for details on the importance of liquidity premia in swap spreads.

specified as first differences, and the left-hand side variables are logarithmic ABX price changes.

Factor analysis

As a first step, the information content of observed ABX index returns for the 06-1 vintage is analysed by way of a simple factor analysis.[19] The results of this decomposition suggest that the correlation structure of logarithmic ABX returns can be explained by only two separate factors.

The first of these, which accounts for a variance share of some 86%, is strongly related to a number of financial market variables. This is apparent from highly significant correlations with indicators such as homebuilder excess returns, interest rates or bid-ask spreads. Changes in the last of these variables, for example, have a contemporaneous correlation of –0.27 with the first ABX return factor. The second factor, in turn, accounts for a much smaller share of the overall return variance and appears to be correlated significantly with measures of risk appetite, such as the ratio of the VIX volatility index over realised 20-day S&P index volatility (Graph 2, centre panel). These patterns suggest that variation in ABX returns may be due not only to changes in house prices and other drivers of fundamental mortgage risk, but also to more general pricing factors, such as liquidity and investor risk attitudes.

Factors other than mortgage risk …

Baseline results

In order to analyse these results in more detail, panel regressions are run to shed light on the effect of key explanatory variables on contemporaneous ABX returns.[20] The impact of the financial crisis is captured through interactions of the explanatory variables with a "crisis" dummy that takes values of one from 9 August 2007 onwards.[21] The same approach is taken to account for possible interactions of rating downgrades with other pricing factors. Bearing in mind the indirect nature of many of the proxies used to capture pricing fundamentals, several results are worth highlighting (Table 2).

First, the surprise components of non-farm payrolls and building permits have a positive, statistically significant effect on ABX returns over the sample period. As expected, ABX valuations tend to rise in response to news suggesting better than expected economic and housing market activity. The surprise component of new home sales, in contrast, is negatively related to ABX pricing, perhaps due to the effects of data revisions or other concurrent data releases (such as regional sales, houses for sale or sales prices). While

[19] The factor decomposition uses maximum likelihood estimation and determines the overall number of factors on the basis of their shares in total observed variance.

[20] Use of the panel approach, though somewhat restrictive, allows estimation of a system of equations with ABX returns as dependent variables and identical explanatory variables. An alternative setup on the basis of lagged explanatory variables (to account for potential endogeneity issues) yields broadly similar results at comparable levels of significance, though with a reduced R-squared. Further robustness tests allowing for non-linear relationships and the possibility of heterogeneous responses across indices are reserved for future research.

[21] This corresponds to the spilling-over of the subprime sell-off into interbank money markets, which first gave market participants a true sense of crisis. See BIS (2008, Chapter VI).

Regression results: ABX 06-1 pricing

Pooled least squares with cross-sectional fixed effects[1, 2, 3]

Variable	Coefficient (t-value)					
	Variable		Interaction with:			
			crisis dummy		ABX 06-1 rating changes	
Non-farm payrolls	**0.009**	(3.602)				
Building permits	**0.006**	(2.576)				
New home sales	**–0.004**	(–2.922)				
RPX house prices	0.007	(1.633)	**0.025**	(3.541)	**–0.022**	(–3.311)
RPX 20-day volatility	**0.065**	(2.178)	**–0.275**	(–3.690)	**0.233**	(4.328)
ABX 06-1 delinquencies	**–0.335**	(–3.416)				
ABX 06-1 rating changes	**–0.098**	(–4.015)				
CME housing futures	0.001	(0.128)	**0.146**	(3.524)	**1.516**	(4.311)
Homebuilder returns	**3.100**	(4.529)	**5.992**	(3.180)	**–1.384**	(–3.532)
Interest rates	**4.544**	(4.190)	**–1.661**	(–2.414)	**2.502**	(5.057)
Yield curve slope	0.716	(1.475)	**–1.867**	(–2.665)	**0.882**	(4.099)
VIX volatility ratio	*–0.297*	(–1.931)	0.323	(0.863)	*–0.167*	(–1.753)
Swap spreads	**–24.340**	(–3.203)	–3.486	(–0.713)	**4.186**	(5.751)
CDX bid-ask spreads	**–0.384**	(–2.945)	**–0.497**	(–3.067)	0.091	(1.278)

[1] Sample (adjusted): 22 May 2006 to 10 June 2008; pooled regressions of logarithmic ABX 06-1 returns on an identical set of explanatory variables as specified above; the crisis dummy is set at a value of one from 9 August 2007 to the end of the sample; the setup includes a constant and time trend (not reported). [2] Bold (italicised) values are significant at the 5% (10%) level; coefficient estimates have been multiplied by 100 for ease of presentation; standard errors are calculated using the White period-robust coefficient variance estimator. [3] The adjusted R-squared is 19.9%.

Source: Authors' calculations. Table 2

insignificant, changes in both current and CME futures-implied house price index values correlate positively with ABX returns when estimated over the entire sample. These positive effects appear to be even stronger during the latter part of the sample, as suggested by the highly significant positive coefficients found in conjunction with the crisis dummy. The same is true for homebuilder excess returns, whose positive influence on ABX prices is found to increase in the crisis period. Uncertainty around daily house prices, which would not necessarily be expected to have any particular directional effect, has a negative coefficient during the latter part of the sample. This is consistent with heightened market attention to such credit quality proxies in-crisis.

Second, delinquency rates and rating downgrades on the securities referenced by the ABX 06-1 indices are found to have a negative effect on subprime mortgage pricing, as expected. In addition, the ratings variable is significant when interacted with some of the other factors, suggesting market sentiment effects associated with negative rating actions. RPX house prices, for example, are found to correlate negatively with ABX returns on days with rating downgrades, implying that the effects of any positive news from the RPX measure are broadly offset by ratings-related market technicals. A similar effect is found for homebuilder excess returns, though not for other variables.

Third, there are signs that decreasing risk appetite and rising market illiquidity lower the value of ABX instruments. Swap and bid-ask spreads, while

… such as risk appetite and liquidity …

being only indirect proxies of ABX liquidity, are found to negatively affect ABX prices over the sample period, with the estimated coefficient for the latter indicator rising during the crisis period. The VIX-based measure of investor risk appetite has the expected negative sign, although no significant additional effects are found in-crisis. Interest rate effects, in turn, are significant, with rising yield curve slopes associated with negative ABX returns during the latter part of the sample, perhaps reflecting the impact of interest rate expectations on projected prepayments.

Finally, the results are consistent with a considerable unexplained component in the variation of ABX prices, as the R-squared is only about 20%.[22] In line with the results of the principal component analysis of ABX 06-1 returns reported above (Graph 2, centre panel), this points to the existence of a sizeable unobservable driver of subprime mortgage risk that is not captured satisfactorily by any of the explanatory variables in the econometric setup.[23]

One possible interpretation of this finding is in terms of a broad version of the so-called "credit spread puzzle" (eg Amato and Remolona (2003)), which describes the observation that fundamental factors are usually found to explain only a small fraction of the level of observed credit spreads. These findings are also applicable to the present case if the unexplained component is time-varying, implying similar effects in terms of observed returns.

Blockwise regression results

The third and final step of the analysis focuses more closely on the impact of the recent financial turmoil on ABX pricing and the effects of heterogeneity across the various 06-1 indices. To illustrate changes in the weight of the different pricing factors over time (ie pre- and in-crisis, where the cutoff is again set at 9 August 2007) and across individual indices, the relative contributions of partial R-squared "goodness of fit" measures are compared on the basis of blockwise regressions of ABX 06-1 index returns. Following the description of the various data series above, the different blocks are: housing and other fundamentals; interest rates; and risk appetite and liquidity.

… are found to explain part of ABX variation …

Results are reported in Graph 2 (right-hand panel) and suggest some important changes in the relative explanatory power across the three sets of pricing factors. Importantly, for the entire sample, risk appetite and market liquidity factors seem to account for a sizeable part of the observed variation in ABX returns. Patterns, however, differ quite substantially across the various rating categories. Specifically, while risk appetite and liquidity risk appear to have grown in importance for the AAA and AA indices, they have tended to diminish in importance for the lower-quality indices. For the BBB– index, for

[22] Results for the 2006-2 vintage are broadly similar but omitted to conserve space.

[23] This value is somewhat lower than those documented elsewhere for corporate bonds, eg Collin-Dufresne et al (2001). A principal component analysis of the residuals of the baseline regression finds that correlations between the residuals are substantially smaller than those for the dependent variables, but that the remaining interdependence is still consistent with a sizeable unobserved common component in the regressions. Alternatively, the regression setup may be inappropriately specified.

example, the combined housing and interest rate factors seem to have become more important in relative terms, as risk appetite and liquidity became less of a factor. This reduced role of risk appetite and liquidity proxies for BBB– pricing may be consistent with an increasing likelihood for all underlying MBS bonds to be written down completely – that is, a transition to interest-only pricing for the BBB– index in 2008 (see box and Graph A, centre and right-hand panels). The increased importance of risk appetite and liquidity for the most senior ABX 06-1 indices, in turn, is consistent with the sort of technical market factors typically associated with times of crisis – that is, the use of these senior indices as a macro hedge or to express negative trading views on the US housing market, even as those indices remain less likely than their subordinated counterparts to take sizeable losses in the wake of a deteriorating housing market.

... though with differences across rating categories

Concluding remarks

The results presented above suggest that declining risk appetite and rising concerns about market illiquidity have provided a sizeable contribution to the observed collapse in ABX prices since the summer of 2007. While proxies for fundamental drivers of subprime mortgage risk, such as indicators of housing market activity, have continued to exert a strong influence on the subordinated ABX indices, the AA and AAA indices have tended to react more to the general deterioration of the financial market environment.

These results underline the well established view that risk premia are important components of observed prices for default-risky products, and that the relative importance of non-default-related risk factors will tend to increase in periods of strong repricing of risk. This suggests that theoretical pricing models that do not sufficiently account for these factors may be inappropriate, particularly in periods of heightened market pressure.

A related set of findings concerns the use of ABX price information by market participants and policymakers for the valuation of positions in US subprime instruments. Importantly, the empirical results provide tentative evidence suggesting that observed ABX prices are unlikely to be good predictors of future default-related cash flow shortfalls on outstanding subprime MBS, especially for tranches at the higher end of the capital structure. This is in part because coverage of the ABX indices extends only to a small fraction of the outstanding subprime MBS universe, which can lead to significant price divergence across like-rated products even in the absence of sizeable risk premia.

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