Should credit risks be marked to market in crisis? Re-examining subprime securities 'irrationality' 2008-2010

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March 2016

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1. Introduction

Many policy makers, academics and politicians blame the Global Financial Crisis (GFC) of 2008 - 2009 on*, inter alia*, bank and 'shadow' bank overexposure to bonds linked to US subprime mortgages (Longstaff, 2010; Shiller, 2012). However, some scholars further claim that, during the depths of the crisis, subprime indices overshot their fundamental value on the downside (Blundell-Wignall, 2008; Bhat *et al*, 2011; Stanton and Wallace, 2011), supporting practitioner views such as those of the Bank of England (2008) that valuing (marking) such residential mortgage-backed security (RMBS) positions based on the observed prices of these 'ABX' indices may have exacerbated the crisis by forcing investors to sell subprime mortgage-related and other assets to shore up capital (Acharya *et al*, 2013; Frame and White 2014; Ellul *et al*, 2014).

The question of whether or not to mark to (the current observable) market (price) is an important one for risk takers and risk managers, and therefore company directors, creditors and shareholders. If extremes in ABX market prices can not be said to be fundamentally based (on reasonable expectations), marking to market may overstate risk and make institutional balance sheets appear overly fragile. This dominant view that fair value is contraindicated in times of crisis is held by, for example, Allen and Carletti (2008), Plantin, Sapra and Shin (2008) and, especially, Kolasinski (2011). Such scholars conclude 'that reliance on prices can be counterproductive when secondary markets are stressed and illiquid' and, as such, '[p]olicy makers contemplating greater regulatory reliance on market prices ignore … findings [of irrational prices] at their peril' (Kolasinski, 2011). Indeed, it is difficult to find any defence of mark to market during these circumstances (but see Goodhart, 2010, stating that there is no better system). On the other hand, it seems that if depressed prices are informed by reasonable expectations, it would be reckless to not take into account such pricing in any risk analysis.

Figure 1: ABX.HE 2007-1 AAA CDS prices, 2007-2013
Source: Markit Partners

Recent research from Gorton (2009), Fender and Scheicher (2009) and Gorton and Metrick (2012, hereafter, 'GM') has claimed that crisis pricing of ABX indices referencing subprime securities can not be explained by a fundamental analysis of the underlying mortgage loan markets, often concluding that marking portfolios to such 'irrational' benchmarks may have contributed to severe distress in the financial sector. With hindsight it does appear from figure 1 that ABX index prices got 'too low' during the depths of the crisis, bottoming out in early 2009, and it is easy to identify the results of the mightiest infusion of liquidity in history. However, if prices were rationally reflecting the expectations of market participants, fair value accounting might not be such a villain, and those who failed to roll over lending backed by such bonds (causing a 'run on repo') might not have been behaving as irrationally as is often claimed.

This paper first introduces and expands on a naïve backward looking model utilised by Stanton and Wallace (2011, hereafter, 'SW') to dismiss ABX price observations during the crisis as irrational. My revised model is then used to explain the problems with Gorton (2009) and GM's similar conclusions as to ABX irrationality. In the second part of my paper I then approximate contemporary expectations by

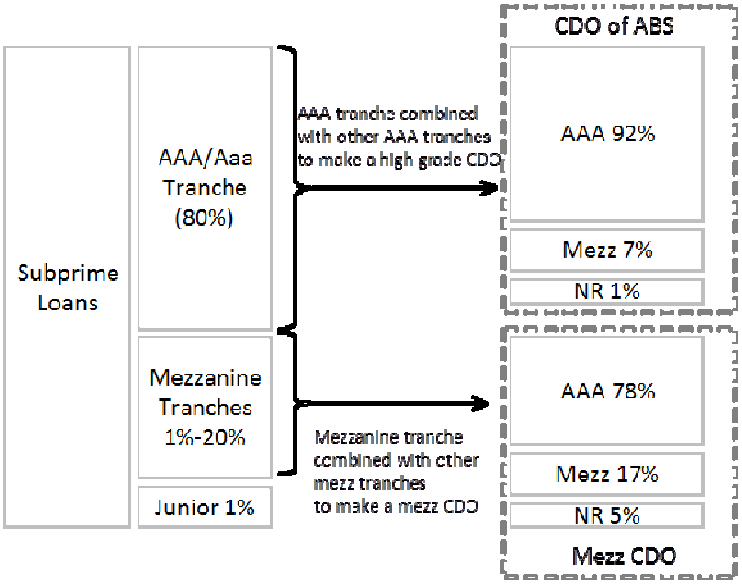
extrapolating fundamental data using forward looking modelling ('roll rate analysis') that was available and well accepted by contemporary investors. Only by modelling expectations extant at the time can we legitimately assess the degree of rationality in ABX prices, and to my knowledge this paper is the first to model expectations during the crisis using such historical methods. I show that fundamental factors explain ABX prices with very high R squared and, as such, while global liquidity and risk preferences were likely a significant factor in changes in ABX pricing, especially in 2009, pricing can not be said to have been irrational. Benchmarks must therefore be considered reasonable, though imperfect, guides for determining fair value when considering financial institution health and ongoing risk profiles.

While most studies of subprime mortgage markets rely solely on uncontextualised quantitative price and macroeconomic data, this work benefits from the author's personal archive of research reports, market studies and market making communications beginning in early 2008 and continuing to the present day. This archive includes monthly reports from most of the major investment dealers (including, for example, Goldman Sachs and Morgan Stanley) most of whom had major positions in subprime mortgage-backed products, as well as (often) being market makers in the ABX and cash securitized bonds. A reading of the reports and trader emails allowed me to piece together an understanding of what major market participants believed could happen to market fundamentals during the crisis and beyond.

2. Subprime mortgages, the ABX and the global financial crisis

Securitization is the transformation of a portfolio of (generally) debt contracts into instruments that have differing risk profiles from the original underlying contracts, with one or more parties providing credit enhancement through subordination. Non-conforming mortgages, not eligible for a government or even quasi-government guarantee, were, before, 2008, securitized into non-Agency (or private label) RMBS. Many non-Agency mortgages are 'subprime' in nature; made to borrowers with less than stellar credit ratings and/or evidence of their creditworthiness. Such securitizations usually consist of at least three tranches, one of which, the most senior, is usually originally rated AAA, the highest rating possible (see Figure 2). Mezzanine (middle) tranches (rated between AAA and, frequently, BBB-) and an unrated 'first loss' tranche (the latter sometimes called equity) provide protection from portfolio losses to the senior tranche investors.

Figure 2: Simplified non-Agency securitization structure and repackaging into CDOs



Subprime mortgages became increasingly risky up to 2007 (Acharya *et al,* 2013), and so, while pre-2007 non-Agency modeling focused, as with 'safer' Agency mortgages, on safety of principal and, therefore, prepayment risk (getting principal back before an investor wanted it), post mid 2007 pricing needed to take into account expected credit losses that had the potential to affect investors all the way up to the most senior tranche.

The ABX indices consist of credit default swaps (CDSs) on RMBS tranches. Though legally different from insurance, it is sometimes helpful to think of a (purchased) CDS position as insurance against default losses (losses are paid to the 'protection buyer' upon a 'credit event'), in return for the payment of an ongoing insurance premium (called the 'fixed amount'). The CDS premium (or yield) is usually fixed for the life of the contract, and so any change in market value (for mark to market, or if the contract is offset) is added or subtracted using an upfront premium or discount (so if the coupon is 100 basis points (1%) and the market spread is currently higher, the buyer of protection would pay an upfront premium and then pay 1% per annum (usually quarterly)). In this way, CDS can be traded on a price basis. If the prices on a CDS falls, its yield will rise, as it appears that these (now higher than market) coupons will be received without any insurance payout before the end of the contract's life. That is, the yield assumes zero loss. The CDS protection buyer will receive a payment if RMBS contractual payments are missed and/or writedowns occur in the underlying bonds. Specialized CDS language is needed because most securitized bonds do not default until they miss a legally-required amount of interest or principal, even if the pool performance implies that they will default with 100% likelihood at a later date.

ABX indices are calculated as an arithmetic average of 20 CDS on specific subprime RMBS tranches from the same 'vintage' (issuance window) and of the same initial rating. ABX had four vintages, corresponding to six-month issuance windows for new RMBS; 2006-1, 2006-2, 2007-1 and 2007-2, with a penAAA (second last cash flow time-tranched senior tranche), a last cash flow (LCF) AAA, a AA, a single-A, BBB and BBB- index for each. If the price of an ABX index is 98, for example, the buyer of protection (insurance) would pay 100% - 98% = 2% upfront plus the running yield (quarterly). ABX prices are calculated theoretically by estimating writedowns (and principal and interest shortfalls) as:

Price = 100 + PV(premium) – PV(writedowns, shortfalls).

All three of the right hand side variables are dependent on portfolio loss assumptions, both in size and in timing. A true CDS or index CDS expected return (or yield) can only be calculated after the amount of losses that are to be expected are estimated. The above inputs themselves require significant analytical capacity as well as multiple parameter estimation.

3. A simple model for subprime and ABX

SW's back of the envelope model for subprime bond pricing calculates the net present value (NPV) of the ABX CDS protection as:

$$NPV = \min(1, \max\left\{\frac{D(1-R)(1-Y)-S}{1-H-S}, 0\right\})$$

Where D is the default rate for the entire period, R is the recovery rate of loans once they have defaulted (1 – R is then the loss given default (LGD)), Y is the annualized constant prepayment rate (CPR), S is the attachment point of the tranche (after which losses begin to affect the tranche) and H is the face value amount of tranches senior to the tranche in question. SW claim that there was no combination listed that resulted in a loss to the ABX 2006-2 index as at 30 June 2009: 'if recovery rates exceed 34% (a value well below anything observed in the U.S. mortgage markets), there is no default rate high enough to support observed prices'. They show that net present value of buying protection at 1 minus the ABX price equal to 66.835% of par is equal to the cost of protection (insurance) of 66.835%. That is, the insurance never had a positive 'value', as there is no possibility of any loss to the AAA CDS index analysed.

There are many issues with using such a model, including:

1. The model assumes that any prepayment happens at the beginning of the period. All this does is create a smaller initial notional and/or effectively reduce the default rate actually applied. This is hardly the worst error, however.

2. The default insurance contract in the above model expires after one period. But, of course, the ABX CDS actually lasts for a very long time – as long as any underlying tranche has 1$ left outstanding. This SW model effectively assumes Y=25% CPR in year zero and 100% CPR (on non-defaulted assets) at the end of the period. So if a non-zero default rate needs to be applied (which is generally an annual figure, usually called the constant annual default rate, or CDR), not adjusting the model for multiple periods of default and prepayment is a fatal problem.
3. The final problem involves the choice of parameters. For example, a CPR of 25% was much too high then (and today). [1] I go through this below.

For the sake of simplicity and conservatism, I adapt the SW model to account for a three-year contract length (so, with now 100% CPR at the end of 3 years).[2] My equation states, for t = 3:

$$NPV = \min(1, \max\left\{\frac{\sum_t D(1-R)(1-Y)^t) - S}{1-H-S}, 0\right\})$$

Extending to a 3 year model with a more reasonable CPR of 10% (see below), multiple realistic combinations of default and recovery that result in losses to the AAA tranches (yellow shading) are obtained as follows (formatted as per SW table 1):

REVISED RESULTS t = 3					
	NPV				
			Default		
		10%	20%	30%	50%
	50%	-0.66835	-0.66835	-0.66835	0.3317
RR	40%	-0.66835	-0.66835	-0.3212	0.3317
	20%	-0.66835	-0.6081	0.3317	0.3317
	10%	-0.66835	-0.3212	0.3317	0.3317

That is, at 10% CPR, 20% recovery rate and 20% default rate (in the table, above), some loss hits the ABX 2006-2 tranche. At 30% CDR (listed as 'Default' in the columns in the table above), the ABX tranches are written down to zero, as shown by the NPV (of paying 66.853% upfront for the CDS insurance) being (100-66.853 =) 33.17% in many scenarios in SW's table 1. How realistic is a 20% default rate and 20% recovery rate such that real losses could begin to hit the AAAs? By mid 2008, ABX observable CDR was running at 20% by mid 2008 and recovery rates were seen as low as 10% in Michigan/Ohio/Indiana, 40% in Florida/Nevada and 50% for other states. But recovery rates plummeted thereafter, and by June 2009 recoveries were averaging around 30% for all ABX deals.

The market expectation of forward CPR of 10% is based on a wide and deep survey of analyst reports from most of the major investment dealers. By April 2008, Credit Suisse, for example, was using 5% and 10% CPR (calling the 10% input the 'higher' CPR, with 5% as the base case) as alternative future scenarios for analysing the ABX index and its components (Credit Suisse, 2008) when ABX voluntary CPRs were running between 14.1% (ABX 2006-2) and 7.0% (2007-1). Indeed, as per remit reports, CPR was running at a one year moving average of 4.1% as at 1 June 2009.

SW claim that their results using a simple model 'cast serious doubt on the practice of using the AAA ABX.HE index CDS for marking mortgage portfolios to market', concluding that 'expected future defaults are not going to be able to explain' ABX prices on 30 June 2009. However, I have shown above that an *accurate* simple model with reasonable parameters shows quite the opposite.

[1] It is possible that SW had estimated CPR (what is known as voluntary CPR to distinguish it from involuntary CPR (recoveries from defaulted assets)) for the model by observing total CPR (voluntary plus involuntary) for subprime deals. However, this would create a double counting effect, as the term CDR * (1 – RR) in their (and my) model already takes into account recoveries on defaulted loans of CDR * RR. Even in such a case, 25% is too high.
[2] Three years is still much too short a life for an RMBS CDS, but this simple model does show enough that a longer model is not required at this point in the paper.

Many more complicated models of ABX distress also suffer from parameter estimation problems. SW produce a *monte carlo* model estimated with 2005-2009 data and simulate rate and house price appreciation (HPA) paths. They find that 'the results are again similar to those from the back-of-the-envelope model, above.' Again we should eliminate any calculations using high recovery rates. There is ample proof that participants knew that recovery rates would be much lower than historical norms by early 2008 at the very latest. The highest that should be considered as an input for 30 June 2009 is 40%, and I would argue that 30% is the best estimate from the time. Using SW's own data and model, some loss affects the AAA index of each series of ABX, as per an excerpt from their own table 5, below, showing NPVs of purchasing protection:

	06-1	06-2	07-1	07-2
40%	-0.296	-0.559	-0.554	-0.300
20%	-0.256	-0.383	-0.399	0.035

For ABX 2007-2, their own model shows that losses could reasonably be expected, and for low but not overly conservative recovery rates we can approximate the then-current market price. The shaded cell in the table above shows close to zero NPV, indicating that the CDS insurance is valued by the SW model at approximately what the market implied it was worth. As their own model show that prices in 2009 could be considered rational, there becomes no need to critique the model on more technical grounds, even though there are serious weaknesses in their approach.

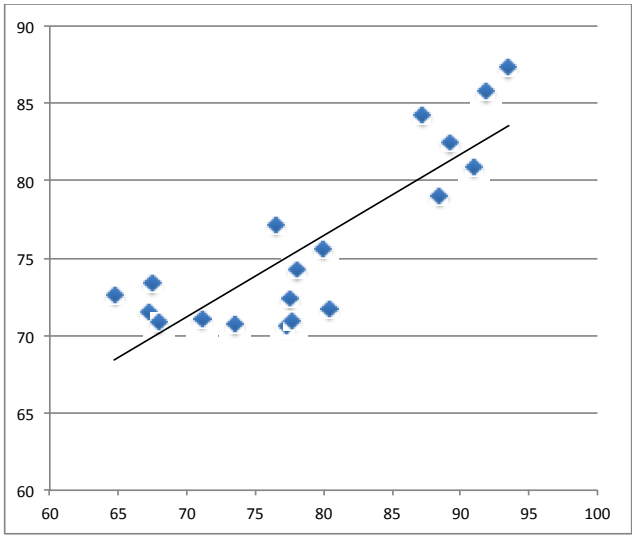
Table 1: Regression Results: Price on 60 day delinquencies and total cumulative loss

	Intercept	60+ delinquencies (%)	Cumulative loss (%)
Estimate	**99.4445*** **	**-0.7358*** **	**-1.9764*** **
Std Error	**2.6393**	**0.1106**	**0.1984**

R squared = 0.8864

Signif. Code: *** p < 0.001

Figure 3: ABX 2006-1: Predicted price for t=3 and 40% RR (y axis) vs. Actual price, May 2008 – November 2009 (72% R^2)



Understanding now the parameter issues explained above, we can refine our research question to: given reasonable *expectations* for CPR and RR, are there reasonable levels of default rate (CDR) that can explain ABX pricing throughout the crisis? Though CDR dramatically lags distress, short- to medium-run CDR is reasonably predictable by observing delinquencies and their recent migration from benign (early stage) to severe (and eventually to distressed sales by the lender). Indeed, the two most common measures of portfolio distress – delinquencies over 60 days and cumulative loss – closely track ABX prices through the credit cycle beginning in 2007. One month fundamental observations of these two

variables are highly correlated with ABX prices. In fact, delinquencies over 60 days (as a percentage of current balance) and pool cumulative loss to date explain 89% of the price level of ABX 2006-2 to 2007-2 using a simple linear model (see Table 1 and figure 3, above). It does appear that we can reject any attempt to declare ABX prices irrational using any simple model available in the current literature.

Our goal, and that acknowledged by GM (as independent variable) and SW (as dependent variable), is to determine whether or not ABX prices reflected or influenced reasonable expectations of underlying fundamental credit performance. But both studies (as well as Fender and Scheicher) focus on returns (changes in price). SW specifically conclude that, '[ABX] price changes are only weakly correlated with observed changes in the default performance of the underlying loans in the index, casting serious doubt on the suitability of these CDS as valuation benchmarks.'

One major issue with the ABX analyses in GM (as well as in Gorton (2009), who conclude that 'changes in the ABX are no better than noise at predicting changes in the spreads of other assets') is that the ABX prices converted into discount margins by a well-respected investment dealer are incorrectly calculated. Specifically, the yields were calculated given accepted pricing methodology used *before* the crisis, which *assumes zero default losses and high prepayments*. Remember that, in return for an upfront payment equal to par less the ABX price (and an ongoing fixed spread), the seller of protection must pay interest shortfalls (capped at the fixed payment preciously mentioned) plus writedowns to principal of the underlying BBB tranches. Yield calculations using a model of risky duration as per pre-crisis technology that did not take almost certain writedowns into account are incorrect. At the end of 2014, the BBBs of 2007-1 and 2007-2 were completely written down, and 2006-1 and 2006-2 are around 95% written down (with further losses expected), and market participants were well aware of this by the end of 2007: 'even under the most positive scenarios for subprime collateral, we continue to believe that BBB stacks of 2006-2007 vintage will face a nearly complete writedown, on average, making them fairly insensitive to all but the most extreme reversals of US housing. We think that the current prices of ABX BBB and BBB- indices reasonably reflect this view of the fundamentals' (Morgan Stanley, 2007; see also Lehman Brothers, 2008a and Lehman Brothers, 2008b). As these previous papers did not take expected writedowns into account, the expected return for one BBB CDS index of 390 basis points in Lehman Brothers' base scenario above is a far cry from Gorton's (2009) observed nearly 5000 basis points on 1 January 2008. [3] Any quantitative analysis based on the changes of yields that are incorrectly calculated must be dismissed as irrelevant, and so any evidence of irrationality stemming from such studies must be viewed with skepticism.

4.Expectations modelling, roll rate models and rationality

The fact that the early parts of papers that dismiss straw man rationality in ABX markets are at best misleading is important in understanding such papers' conclusions. Once scholars find little evidence of fundamental influence on ABX prices (which I have shown is not the case using simple models), generally the next step is to examine other relationships.[4] So even if simple models can be shown to return rational prices for ABX prices during the GFC, it still may be the case that actors were acting irrationally in pricing ABX at the time. It turns out, however, that models incorporating the expectations of market participants at the time can also explain market prices of the period 2008-2010.

Expectations are even more important than realizations during a regime change (mainly because expectations can rapidly diverge from previous history, with 'no historical precedent'), which undeniably occurred in subprime in particular from 2007-2009 (Alphaville, 2007; Morgan Stanley, 2007; Rodriguez, 2007; Barclays Capital, 2009). Model prices for ABX and subprime bonds continued to be revised down

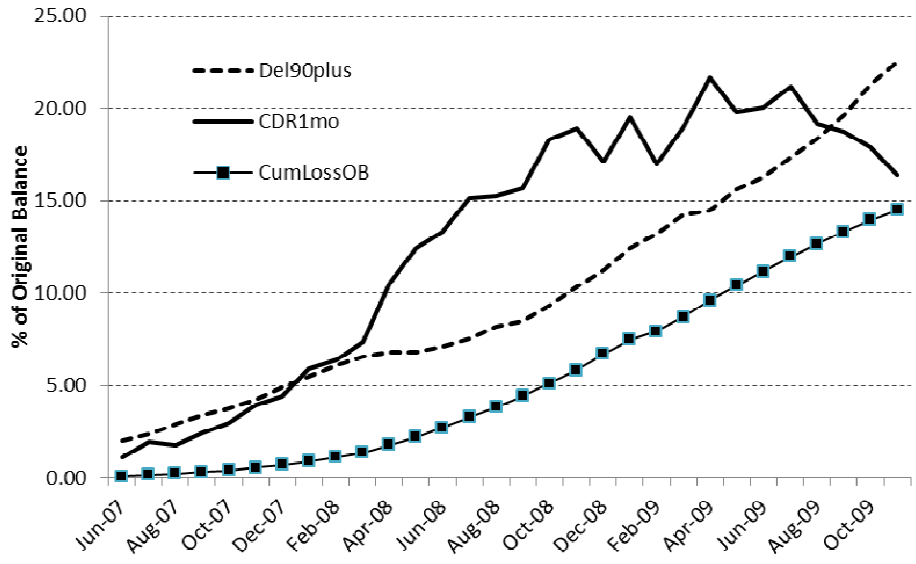
[3] Space doesn't allow me to present a full argument as to why Gorton and Gorton and Metrick yields are incorrect, but I believe this evidence suffices.
[4] For example, Gorton and Metrick (2012) examine Libor-OIS (a common measure of bank funding costs), while Stanton and Wallace (2011) look at short sale activity in investment bank shares.

as new surprises in 2008 and 2009 required a readjustment of parameters in what were fast becoming obsolete models (see JPMorgan 2008, for one such readjustment). Dealers issued 'buy now' recommendations that appeared reckless only months or even days later: JPMorgan on 13 June 2008 recommended buying 2006-2 AA at 24.38. The lowest price was 6.94 and even at the end of 2013 the price remained at less than half the initial recommendation price.

While realised default losses were actually low throughout 2007, expectations were rapidly adjusting to new delinquency data. By May 2008, Moody's had downgraded 60% of 07-2's Aaa tranches to an average of Aa3 (S&P 50% to an average of AA-) (Credit Suisse 2008b). Around this time, dealers were beginning to realise that their econometric models did not reflect reality. ABX price movements caused JP Morgan, for example, to rethink their assumptions and, as a result, they adjusted their model in mid 2008 (JPMorgan 2008), and ABX AAA 2007-1 was expected to have between 36.08% and 30.81% in lifetime cumulative losses (JPMorgan 2008). By June 2008, JPMorgan's (2008) econometric modeling for ABX 2007-1 was using 10% CPR (versus historical averages in the high teens and running CPR of 6%), peak CDR of 25% (versus observed of 12%) and loss severity of over 70% (where it was only 25% the year previously).

Pre-2007 econometric models with historically-derived parameters could not be and were not used by market participants during the crisis. On the other hand, *roll rate* models incorporating adaptive expectations in the industry were very popular as the crisis persisted and econometric models were found to be less useless, especially when relying on pre-2007 econometric relationships: 'There is large uncertainty around future performance as there is no historical precedent akin to what is being observed today. That makes an early read on moderating or worsening trend as compared with current expectations all the more critical to making meaningful future projections... The key is to spot quickly any shift in performance relative to current expectations – for the better or the worse' (Barclays Capital, 2009). Essentially, these 'roll rate models with burnout' assume that distressed borrowers 'transition' to default at certain rates, based on current observables as well as some assumption as to the change in these rates as the loans season (age). The goal is to forecast future pool losses by supposing the likely shape of such transitions as the pool seasons, while using constantly updated transitions to reality check the model. Roll rate models quickly replaced econometric models during the GFC (Scholtes, 2008), as investors understood that money would be made by those who could forecast in such a brave new world where old econometric relationships had broken down.

Figure 4: ABX 2007-1 Pool distress



We can see in Figure 4 that, for ABX 2007-1, losses (CumLossesOB = cumulative losses as a percentage of the original pool balance) lag serious delinquencies (Del90plus = delinquencies more than 90 days past due) by many months. Also we can see that 'burnout' with respect to a peaking CDR (CDR1mo in Figure 4) was beginning to affect ABX tranches by mid 2009. Both of these phenomena need to be incorporated into any roll rate model. For the purposes of simplicity I assume in the next analysis that CDR peaked in March 2009, and I therefore construct an over-simplified roll rate model incorporating a burnout beginning in the current period and with lagging losses as per Figure 4, and then measure the error to the actual price of ABX in March 2009.

So our equation for a simple roll rate model will begin with my extended SW model for (now) t=5:

$$NPV = \min(1, \max\left\{\frac{\sum_t D(1-R)(1-Y)^t) - S}{1-H-S}, 0\right\})$$

Y is once again set at .10, S = 0.38 and H = 0.45. But now, D*(1-R) is a function of time, delinquency and CDR as follows: D*(1-R) = 6mo lagged Del90plus for the first 6 months and then = 6mo previous Del90plus + CDR1mo*.8, where CDR1mo declines by 2 percentage points per year (declining monthly) over the last 4.5 years.

For such a set of assumptions, reality checked as per my above study, the price for month end March 2009 for ABX 2007-1 is modelled at 29%. This is very close to the month end actual mark to market of 25.25%, far from irrational.

5. Conclusions

Blaming ABX for deepening the crisis may be akin to blaming the meteorologist for the weather. The TV weather forecast is not always correct, and sometimes is horribly wrong. But it is not generally irrational, and we ignore forecasts at our peril. The ABX, like other reasonably liquid markets, may reveal sentiment and potentially any fundamental weakness before less liquid instruments do. While shorting a subprime bond is quite difficult, shorting the ABX as a hedge was quite possible for much of 2007 and even deep into the crisis, allowing some of market participants such as Goldman Sachs to avoid some losses on their trading and investment books.

Generally, in finance scholarship, expectations are difficult if not impossible to measure, but in this case we have evidence from analyst publications that show that realistic parameters could be identified that would indicate that pricing for indices was reasonably efficient during the GFC. Rational (at the time) but defensive forward looking CPRs, CDRs and RRs can easily be identified in most ABX pricing during the crisis, contrary to the finding in other papers. I have found evidence that, during the crisis, some dealers often thought the fundamentals would get much worse than they actually did in 2010 through to the present. Prices for ABX observed in 2009 were easy to justify. Barclays Capital (2010) saw returns to 2007 vintage subprime bonds in early 2010 to be between 0% and 1% stress case[5] yield to maturity. They observed at the time that 'current credit performance in the non-agency sector remains dismal despite the recent slowdown in the pace of worsening. Close to half of all outstanding borrowers in 2007 subprime collateral (and 40% of 2007 option ARM) are classified as 60+days delinquent. Voluntary prepayment levels for these borrowers are languishing in the low single digits' (Barclays Capital, 2010).

'Sunlight is said to be the best disinfectant', according to Justice Brandeis (1914), and ABX, CDX and CMBX pricing did not allow dealers and other mark to market investors any place to hide. It is often argued that the requirement to mark down investments that exhibit other than temporary impairment (OTTI) is difficult to police in practice. Having transparent markets uncover the ongoing fundamental deterioration in subprime brings such risks out into the open. Lack of transparency (Enron, for example,

[5] Barclays Capital (2010) annual outlook projected overall subprime lifetime loss expectation as % of *original* balance to be 53% (based on 10% drop in Case-Shiller national HPA).

or the case of Structured Investment Vehicles in 2007) is likely much more of a problem in financial markets than too much transparency. Looking at ABX in the rear view mirror, the most irrational price of ABX 2007-1 was par (100%) in mid 2007! If institutions can not survive the marking of their portfolios to liquid markets, then perhaps they should not be holding such investments in the first place. Further, marking to ABX might have underestimated losses in certain cases, and I have heard anecdotally that firms used ABX to mark multisector (mezzanine) CDO of ABS seniors (see figure 1), which were known to be generally worthless by 2009.

It is beyond doubt that deterioration in market prices forced the unwinding of significant amount of leverage, and therefore the forced selling of financial assets, but many scholars and some practitioners conclude that such 'fire sale' pricing of the ABX indices, in particular, was irrational. Frame and White (2014) and many others recognize that market participants either agreed to use or were forced to use ABX levels in order to estimate the impairment to their US RMBS investments, and they therefore claim that this made the GFC worse than it needed to be. For example, Goldman Sachs used ABX prices to calibrate the amount of collateral AIG needed to provide to Goldman under its guarantee agreements. As such, the ABX index is one of the main financial innovations blamed for the GFC.

While AIG's problems may have been substantial under the requirement to post collateral based on Goldman's marks (based, in turn, on ABX), the problem was not market price deterioration as such but on the reliance on the collateral calls that were unaffordable when marked to market (Saleuddin, 2015). I would therefore agree with Bhat *et al* (2012) that 'critically, it is important not to consider the accounting treatment in isolation, but rather how the different treatments interact with capital regulations … to influence financial institutions' trading incentives.' Reverting to historical cost for subprime RMBS and ABX would not have stopped the run on ABCP, money market funds, SIVs and commercial paper. Given the true fundamental deterioration, non market triggers and higher capital charges look to be the only solution. Selling of ABX and illiquidity of RMBS on its own was not the problem. The correct solution is likely to be in the Admati and Hellwig (2014) vein of basing OTTI on a prolonged observed decline in market value, while require substantially more capital to cushion any such a blow, especially when investments are leveraged.

After scholars show that markets behaved irrationally during the GFC, and those irrational prices were the cause of other panics, the 'logical' conclusion then becomes that fair value accounting should be ignored during crises. However, I have argued that, for subprime and Alt-A RMBS and the ABX indices, fundamental deterioration combined with supreme uncertainty in a brave new world of crisis led to depressed prices that were closer to correct, even *ex post*, than was (a historical cost of) par. That the bottom of the market did not entirely reflect realized fundamentals is not proof of the irrationality postulate. In the depths of the crisis, however, who knew where the bottom was? Was 35% the right price for 2007-1 AAA? Was 55%? Was anything a better predictor of permanent impairments to subprime RMBS impairments than ABX? It is only in hindsight that signs of irrationality might be said to have entered ABX pricing.

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