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Pretrade and Risk-based Clearing: A Case Study of American International Group's Super Senior CDS Portfolio 2005-2008[1]

William Balson and Gordon Rausser

Risk-based clearing has been proposed by Rausser, Balson, and Stevens [2010] for over-the-counter (OTC) derivatives. This paper illustrates the application of risk-based margins to a case study of the derivative portfolio of American International Group (AIG) during the period 2005-2008. The Board of Governors of the Federal Reserve Board (FRB) [2011] recognize that clearing requires collateral or margin to be posted in order to assure a high likelihood of protection for the clearinghouse from default of its covered contracts. Readily implemented and well understood methodologies are available for setting margin levels at both the contract and portfolio level.

The bespoke nature of many OTC contracts is sometimes offered as an objection to the application of real-time risk-based clearing. Yet, risk-based margin computations can be implemented to operate in a pretrade real-time transaction environment for OTC contracts. Moreover, margin computations are straightforward to apply for even highly complex bespoke products such as mortgage-back securities (MBS).

We choose a case study of the MBS derivative portfolio of American International Group (AIG) during the period 2005-2008 in part because those events posed a significant systemic risk. It was during this period that AIG Financial Products (AIGFP) executed over $2 trillion in notional OTC contracts and was subsequently restructured. Due to the ensuing Congressional investigation, there exists sufficient publically available information to examine AIGFP's derivative portfolio and how that portfolio would depend on conjectural changes in margin requirements imposed on its OTC derivatives positions. Due to the rarity of detailed OTC derivatives position disclosures becoming publically available and published; there are few published risk analyses of derivative portfolios.

In our analysis, we will first provide an overview of the pertinent aspects of risk-based clearing. We will also briefly describe the specific financial contracts that were the proximate source of AIGFP's financial losses. We then compute conjectural margins for risk-based clearing using a risk-based methodology and compare that margin to the actual margin calls imposed on AIGFP.

Our analysis reveals that a risk-based margin procedure would have led to earlier margin calls of greater magnitude initially than the collateral calls actually faced by AIGFP. The total margin ultimately required by the risk-based procedure, however, would be similar in magnitude to the collateral calls faced by AIGFP by August 2008. It is likely that a risk-based clearing procedure applied to AIG's OTC contracts would have led to AIG undertaking significant hedging and liquidation of their OTC positions well before the losses built up to the point they had, perhaps avoiding the restructuring that occurred in September 2008.

Overview of Risk-based Clearing

Risk-based clearing is conducted for standardized derivatives such as options and futures. See, for example Eurex [2007]. Risk-based margin covers both periodic changes in the value of the contract and also an additional amount to cover potential future changes in the value of the contract.

OTC derivative contracts historically were treated differently. These are contracts that are usually a bilateral contract between two counterparties. These contracts are generally, but not always, governed by standardized contract language developed by the International Swaps and Securities Association (ISDA). All of the relevant AIG-related contracts that are the subject of this paper were executed using the ISDA Master Agreement. One aspect of that agreement is the Collateral Annex, which can trigger collateral requirements. AIG received collateral requests from counterparties totaling many billions of dollars during 2008 from some but not all of its counterparties. Unlike futures margin, which is collected at the time of a transaction, collateral called under the annex is on an *ex-post* basis after the value of the contract changes. Thus, at any point in time, the collateral a counterparty has received after making a call, will at best be sufficient to cover losses in the event of a default. In most cases, collateral would be insufficient to make the nondefaulting counterparty whole due to changes in the valuation that occur after the call is made and even after a default. In this paper, we will usually refer to assets posted pursuant to third-party clearing as *margin* and assets posted pursuant to a bilateral contract as *collateral*.

The Dodd-Frank Act and its implementing regulations will substantially change this historical practice by requiring clearing by a clearinghouse for some OTC contracts and imposing margin requirements. The CFTC [2011] has conducted rulemaking and set margins for OTC contracts at an increased level compared to comparable futures contracts. One implication of this case study is that the prescribed increased margin level is not needed when margin is computed using risk-based methods such as we will demonstrate.

It is possible to extend the use of risk-based margin used for standardized products into the OTC contract markets. This will necessarily require a third-party to be the guarantor to both sides of the contract. The necessity arises from the need to reserve margin for both daily changes in the mark-to-market valuation of the contract and also for the potential future changes in value. Thus, at any point in time the guarantor would hold margin from both counterparties. This feature of risk-based margin provides an important bulwark against propagation of systemic risk. Although at first it may seem less capital efficient to require additional margin for an OTC transaction, in fact, it merely shifts the burden of financing credit risk from a firm's counterparties to a potentially defaulting firm. By making margin highly sensitive to measurable financial risk, risk-based margin encourages firms to reduce their own default potential through financial risk reduction measures such as hedging. AIGFP, for example, failed to materially hedge the portion of its OTC portfolio related most directly responsible for the losses at the center of AIG's financial distress.

Margin requirements can be computed using a form of value at risk (VaR). VaR is described by Jorion [2006], Duffie [1997], and Anderson, et al [2009]. Value at risk is a well understood procedure, which has both advocates and critics. The computation of VaR is based on the price variation of the contracts over some historical period. The price variation data permits a calculation of the anticipated potential change in value over a given time horizon at some probability level. A common level of risk is frequently taken to be a 99th %-tile change in value over a ten-day period, but other points can be chosen based on the characteristics of the contract and market. VaR can be extended to a portfolio of contracts and the price variability is then expanded to the covariance of prices, which allows margin to be sized with the correlation of the contracts in mind, offering a credit for hedged positions. VaR can be calculated using historical data alone, analytic summary functions calibrated to the data, simulation techniques, or combinations of those three methods.

Criticism of VaR is widespread and Taleb [1997] is an excellent presentation. Generally, the criticism is focused on the nature of VaR as a backward looking price analysis rather than a forward looking analysis. While many criticisms of VaR have merit, we reject such criticisms for margin applications for three reasons. First, the purpose of margin is to enable a liquidation of portfolios over the short period of liquidation following default. Second, VaR is clearly not a sufficient statistic for measuring strategic risk. Incorporating subjective assessments into margin computations would inject artificial unpredictability into the margining process. Third, criticism of VaR often applies when it is used inappropriately as a surrogate measure for risks it does not measure.

Embrechts et al [2000] also point out that VaR is not a subadditive risk measure. Subadditivity is a property of risk measures such that the risk measure of a portfolio is the sum of the risk measures of its components. Since VaR is not subadditive, it is possible that the VaR of a portfolio is larger than the sum of VaRs for the components of the portfolio. However, Danielson et al [2005] show that, when the region of interest is the lower tail of the return distribution, under very general conditions, VaR is subadditive. For example, Student-t and jump processes are subadditive in the tails, but distributions with infinite mean are not.

Offsetting the criticism are substantial benefits. First, VaR provides a well-understood and replicable framework for evaluating liquidation risks following default. This reliability allows a reproducible third-party framework to underlie the margin calculation procedure, which is currently lacking in the OTC contract markets. Second, VaR changes dynamically to adjust to changing market dynamics. Volatility varies over time and thus risk-based margin would rise and fall correspondingly. Third, portfolio VaR would raise or fall as correlations among the portfolio of contracts change over time. This feature of dynamic correlations enables the procedure to capture the margin implications of periodic liquidity crises during which historical correlations are frequently observed to change, and thus influence potential losses given default.

Overview of financial contracts leading to AIG's losses

The Financial Crisis Inquiry Commission (FCIC) [2011] makes it clear that an important aspect of AIG's financial collapse lay in its failure to understand, quantify and hedge the risks it took on when selling credit default swaps (CDS) on securities called collateralized debt obligations (CDO). In this section we will briefly review the characteristics of these financial contracts to emphasize their complexity and bespoke nature. We follow the terminology adopted in Duffie and Singleton [2003], Hyder [2002], Flanagan et al [2001] and Mahadevan, et al [2005]. In principle, a CDO can be viewed as merely a loan pool managed to meet investors' preferences for income and capital appreciation. Similarly, a CDS can be viewed as merely a periodic payment to transfer default risk. However, that simplicity belies their complexity from structural, valuation and risk management perspectives.

Collateralized Debt Obligations

A CDO is an asset-backed security in which fixed income financial assets are purchased by a special-purpose vehicle (SPV) that has no other assets other than its initial capital. The SPV's assets may be corporate bonds, mortgages, or other securities that usually but need not pay a fixed periodic coupon.[2] The SPV issues one or more securities, also called *tranches* that specify coupon rates, priority of payment, and contingent rights to the loan pool assets. There are more than a dozen types of CDOs classified by type of loan pool, structure of the SPV, and motivation of the issuing institution. CDOs can include securities of other CDOs or CDSs in which case they are called *CDO squared* or *synthetic* CDOs. Manzano et al [2011] describe the Biltmore CDO 2007-1 in which the loan pool consisted of 2,025 asset pools structured as 256 different CDOs that served as the asset pool for 16 CDOs whose securities were purchased. In AIG's case, we are concerned primarily with cash-flow CDOs backed by mortgages. AIG referred to these as "Multi-sector CDOs", which the GAO [2010] described: "A multisector CDO is a CDO backed by a combination of corporate bonds, loans, asset backed securities, or mortgage-backed securities."

In a typical CDO, purchasers of the SPV's issued securities have only the SPV assets as collateral in the event of default of an issued security. In a typical CDO, the issued securities are ordered according to seniority. The most senior tranche pays a lower periodic coupon but is partially protected from loan defaults by other tranches that bear losses first. Each tranche is characterized also by *attachment* and *detachment points*. These points are usually expressed as percentages of the total loan principal losses that will be applied when the underlying loan assets default. If an underlying loan defaults, then those losses would be applied in order from least to most senior tranche beginning at the attachment percentage and ending at the detachment percentage. A tranche called the *super senior* tranche is frequently employed to represent the most senior security. Super senior tranches are the principle subject of AIGs financial collapse. Securities with intermediate levels of risk are frequently called *mezzanine tranches*. Additional modifications to the risk profile for each tranche can be employed in which some of the cash flows are retained or guaranteed in a procedure known as *overcollateralization*. There are dozens of specific techniques used to provide overcollateralization. These can be challenging to model analytically and AIG's 10k for 2007 revealed material weaknesses in their derivative valuation as a result.

An SPV raises capital by selling the securities it issues, usually via a marketing contract with an investment bank, and purchases the SPV's loan pool assets with a portion of the proceeds. The selling price of each issued tranche depends on its coupon and its exposure to default losses, when compared to similar securities. Cash flows from the loan pool assets are contractually prioritized, with separate rules governing for administrative costs, periodic payments from the loan pool assets, repayments of principal from the loan pool assets, and recoveries from assets in default. These cash flow rules are collectively referred to as the *waterfall*.

Valuing a CDO requires both a theoretical model of the security and data to calibrate the model. The challenges arise mostly due to poor data, which often motivates theoretical and modeling approximations. Since, a CDO is composed of discrete debt obligations, it is theoretically possible to enumerate all possible combinations of default of the loan pool assets and to use the same arithmetic as for valuing cash flows from a bond for each such combination applying the coupon rate to discount coupon payments or default obligations. In this spirit, Manzano et al [2011] describe the application of the Monte Carlo procedure which can be repeated thousands of times to produce a comprehensive range of scenarios. Their analysis operated at the most granular level with each mortgage pool specifically modeled and hypothetical default scenarios traced through the cash flow waterfall. Mortgage-foreclosure data is imperfect as a forward-looking risk measure even though databases covering every mortgage are maintained. And other valuation challenges exist.

The correlation among geographic regions, the correlation between CDOs issued in different years, and the potential effect on CDO prices of negative home appreciation are all key issues for which good data was lacking. The default rate on mortgages is strongly influenced by the vintage, or year of issue.

The extreme level of complexity embedded within CDOs led to a search for parsimonious models with relatively few parameters representing default rates and volatility of default rates to be calibrated to observed market quotes for credit-sensitive securities. It was this search that led to the introduction of parsimonious models for CDO valuation, whose parameters could then be used to value other CDOs with similar properties. Goodman et al [2008] describe indexes such as the ABX.HE series by Markit that were developed to be used for market pricing purposes. Thus, valuations for CDOs used by the majority of the market came to be estimated from indexes such as the ABX.HE series. There are several commercial services dedicated to performing these calculations and Burtschell et al [2008] and Schlösser [2011] describe at least six different computational algorithms, each posing a different estimation methodology

An additional issue affecting CDO valuation lies in the correlation between the prices of different tranches in a CDO. Clearly tranche values are interrelated though the cash flow waterfall of a CDO since the use of every dollar received over the life of a CDO is specified in advance. Li [2000] observed that a Gaussian copula would allow use of marginal distributions on tranche values, which is directly observed from market data, to create the joint distribution on tranche values, which is not directly observed. Burtschell et al [2008] describe flaws in that methodology due to the embedded assumption on correlation and alternatives that reject the assumption. Thus, although the super senior tranches were designed to be protected, a feature AIG relied upon, they were correlated with the price of less protected tranches in surprising ways. Risk-based margin computations need to be robust to dynamically changing market data reflecting that correlation, so we next examine the AIG contracts.

Credit Default Swaps (CDS)

AIGFP was a protection seller on tranches of CDOs. We follow Duffie and Singleton [2003], Kakodkar [2006] and O'Kane [2003] in describing these securities. A CDS is a security in which a *protection buyer* makes a periodic payment to a *protection seller* and the seller promises to pay a fixed amount in the event of default of a *reference* entity. In AIGFP's case, they sold protection against the default of super senior tranches of various CDOs. The majority of the loans in those CDOs were subprime mortgages. The value of such a CDS depends on the value of the underlying tranche protected since that is the payoff on default. We can write the value of a CDS as it depends on the present value of the periodic payments (P), the probability of default (p), and the value of the reference CDO tranche given default:

$$(1)\, V(CDS) = P - p(d)\, V(CDO \vee d) \quad .$$

We can rewrite this to emphasize dependence on a common risk factor S, where S might be the price of a less senior tranche or a design feature of the underlying CDO:

$$(2)\, V(CDS|S) = P - p(d|S)\, V(CDO|d, S) \quad .$$

In the majority of CDSs written by AIGFP, the ABX.HE data imply the probability of default would increase while the value of the obligation would increase in tandem with a common risk factor, i.e. subprime mortgage concentration in the loan pools. Cespedes et al (2010) describe this phenomenon as wrong-way risk and offer an efficient method of estimating its magnitude. ISDA defines wrong-way risk as the risk that occurs when the exposure to a counterparty is adversely related with the credit quality of that counterparty. As a result, wrong-way risk implies the CDS structure could magnify losses experienced by the underlying loan pool. AIGFP executives expressed the view that $p(d|S)$ was zero for super senior tranches for all S, implying that the CDSs were riskless. We instead adopt a view more consistent with the data using the convention that $\frac{\Delta p(d \vee S)}{\Delta S} = a$. With this convention, changes in the value of a CDS would be proportional to changes in the value of the referenced CDO, implying that the value at risk for the CDS equals the value at risk for the underlying CDO tranche against which protection was written. Accordingly, our analysis focuses on the value at risk for a portfolio of underlying CDOs.

Value at Risk for CDOs

Value at risk is a point on the lower tail of the probability distribution on future value at a specified point in time for a CDO tranche. An MBS has a nonlinear dependence on its key input parameters due to the embedded optionality. This nonlinear dependence can be modeled using Monte Carlo simulation techniques, partial differential equations, or analytic approximations using a Taylor series approximation. These methods are useful for calculating VaR when transaction data for the MBS security of interest is not directly available. Poon, et al [2011] show that there can be substantial differences in calculated VaR among the methods. This should not be surprising since the methods produce theoretical approximations and not directly observed market values.

We employ the delta-gamma VaR approximation described by Jorion [2006], which is a variation on the Taylor-series method. Following Jorion, the relative change in the value of a security *(V)* is estimated from the relative changes in the value of a risk factor *(S)* using the Taylor-series approximation:

$$(3)\, dV = \frac{\partial V}{\partial S} dS + \frac{\partial^2 V}{\partial S^2} d S^2 + \frac{\partial V}{\partial t} dt + \ldots$$

Jorion presents the well-known solution to this partial differential equation. Poon, et al [2011] show that for MBSs during the time fame of interest, that the first term in a Taylor series expansion dominates the VaR results for MBSs. This finding supports the intuition that, during the financial crisis, the prepayment option was of secondary importance relative to other risk factors in valuing mortgage-backed securities. Since the purpose of this paper is to illustrate the use of risk-based margin, we will simply use this first-order approximation for VaR without refinement, while recognizing that extending to higher orders is straightforward.

While the method just described works for multiple risk factors, we further simplify the procedure to a single risk factor and choose that factor to be the Markit ABX.HE index most closely matching the CDOs underlying the AIG CDS contracts. Stanton and Wallace

[2008] describe how the Markit indexes are computed on the basis of quotations obtained by Markit. The method defines a portfolio of 20 CDO tranches for each of several combinations of rating levels and period of origination. Thus the indexes are labeled according to their rating and year. For example, the index ABX.HE-AAA 06-02 refers to the index created from quotations on the price of the portfolio of 20 tranches from various residential mortgage-backed CDOs each having a AAA rating and each being originated during the timeframe for the 06-02 series, which was January-June 2006. We obtained data from Markit for the period 2006 through 2011.[3] Exhibit 1 illustrates the data obtained from Markit for the AAA tranches. The ABX.HE indexes exhibit positive skew, excess kurtosis, and are not stationary. These are typical challenges for OTC markets.

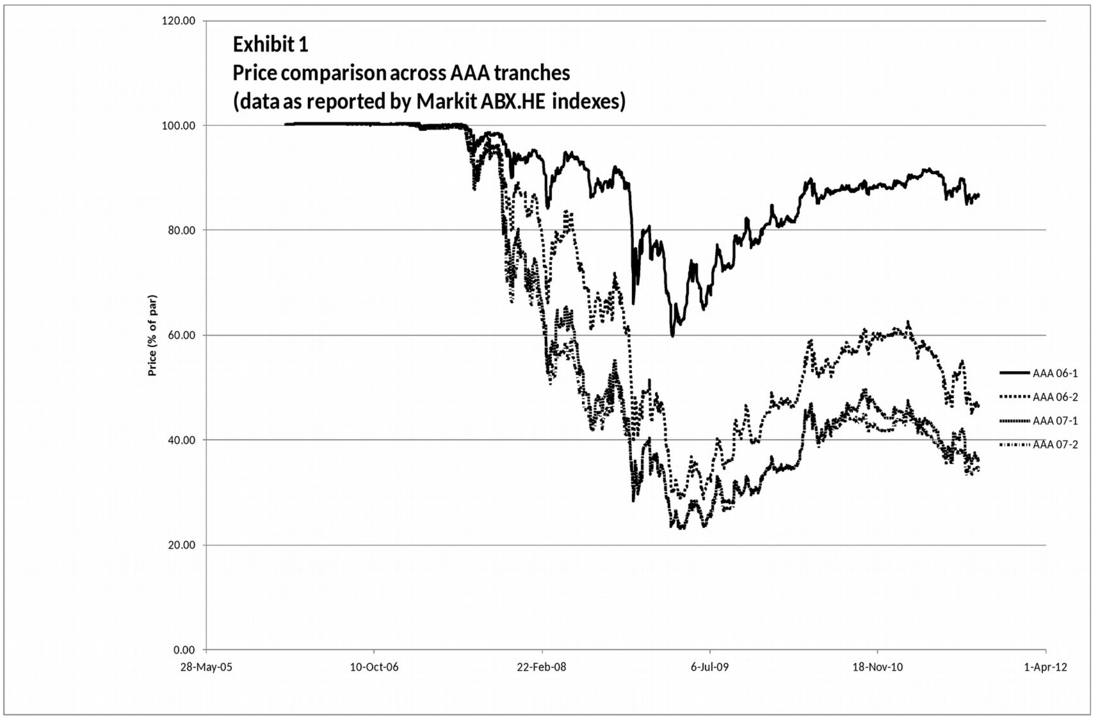


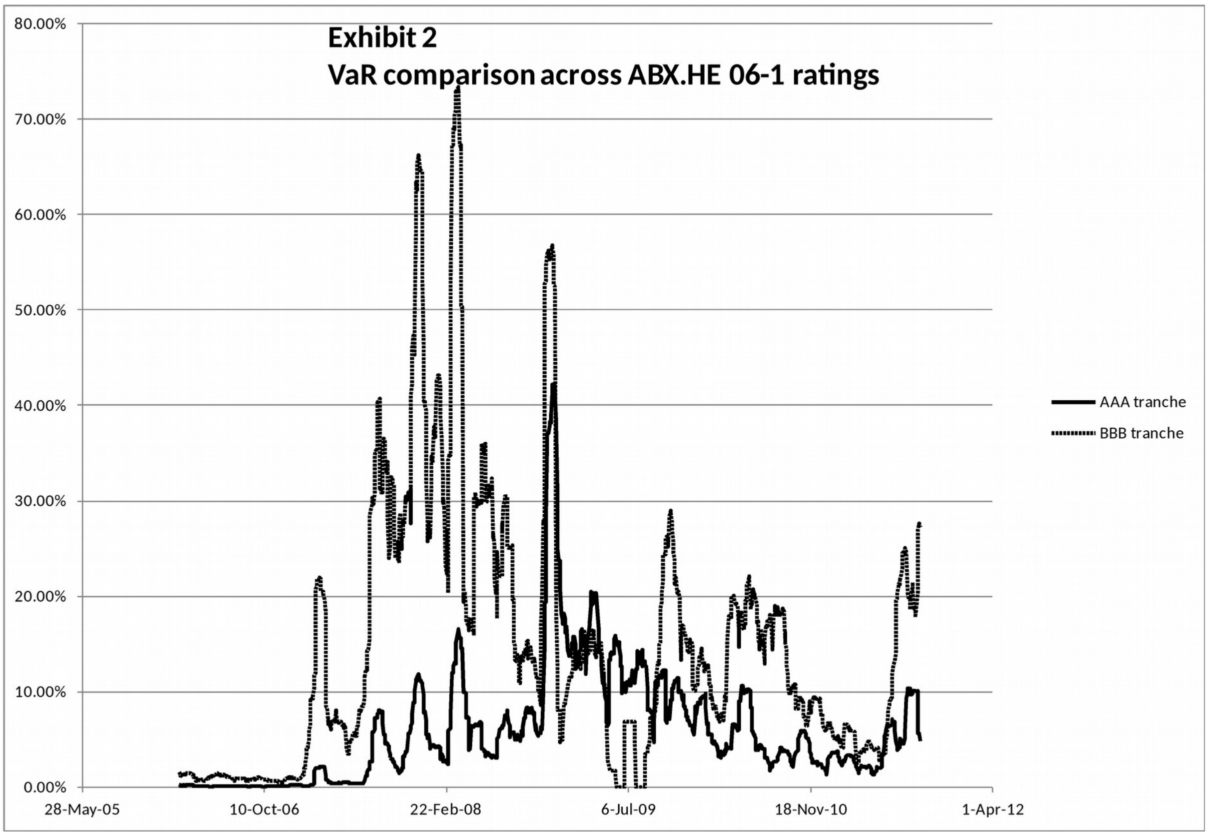
Exhibit 1
Price comparison across AAA tranches
(data as reported by Markit ABX.HE indexes)

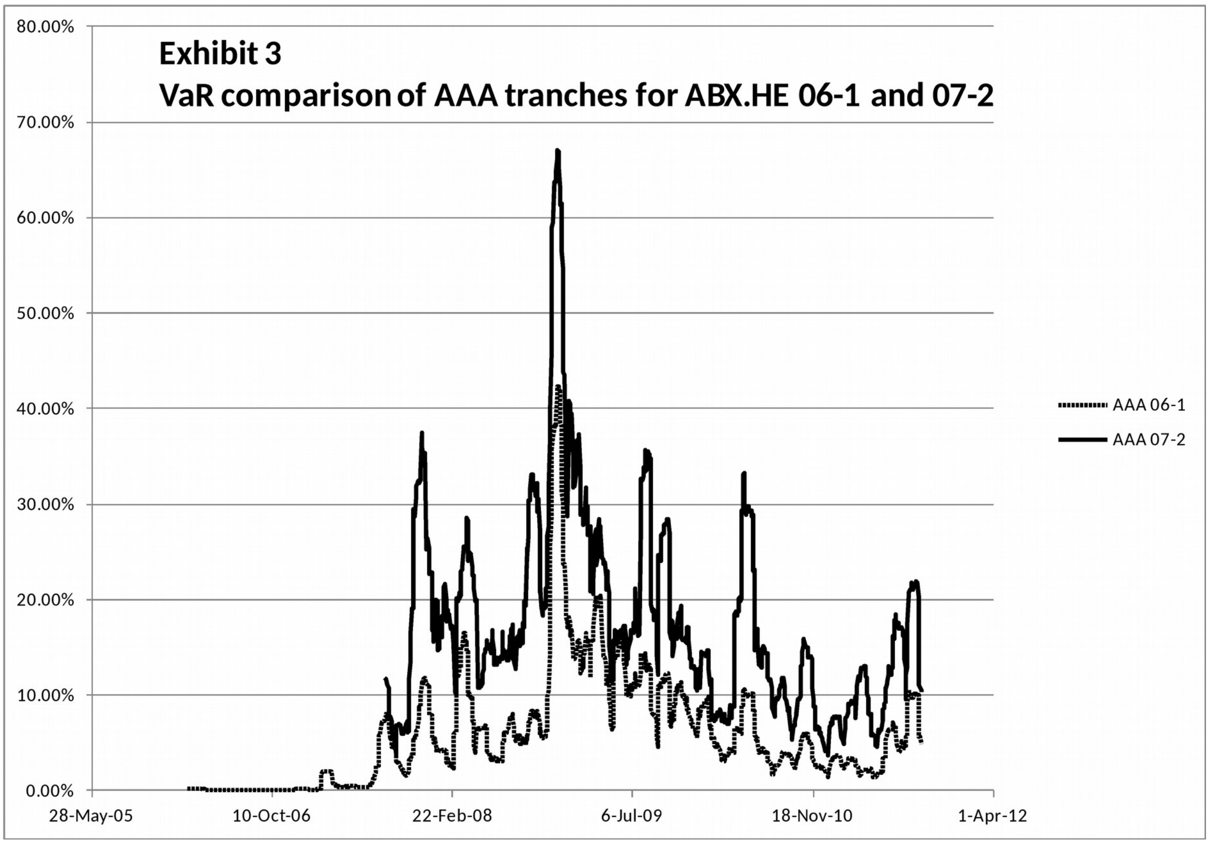
Following Jorion again and simplifying to the first term to calculate VaR for the *i*th underlying CDO mapped to the *j*th ABX.HE index:

$$(4)\ VaR_i = \frac{\Delta V}{\Delta S}\alpha_c \sigma_t S_j$$

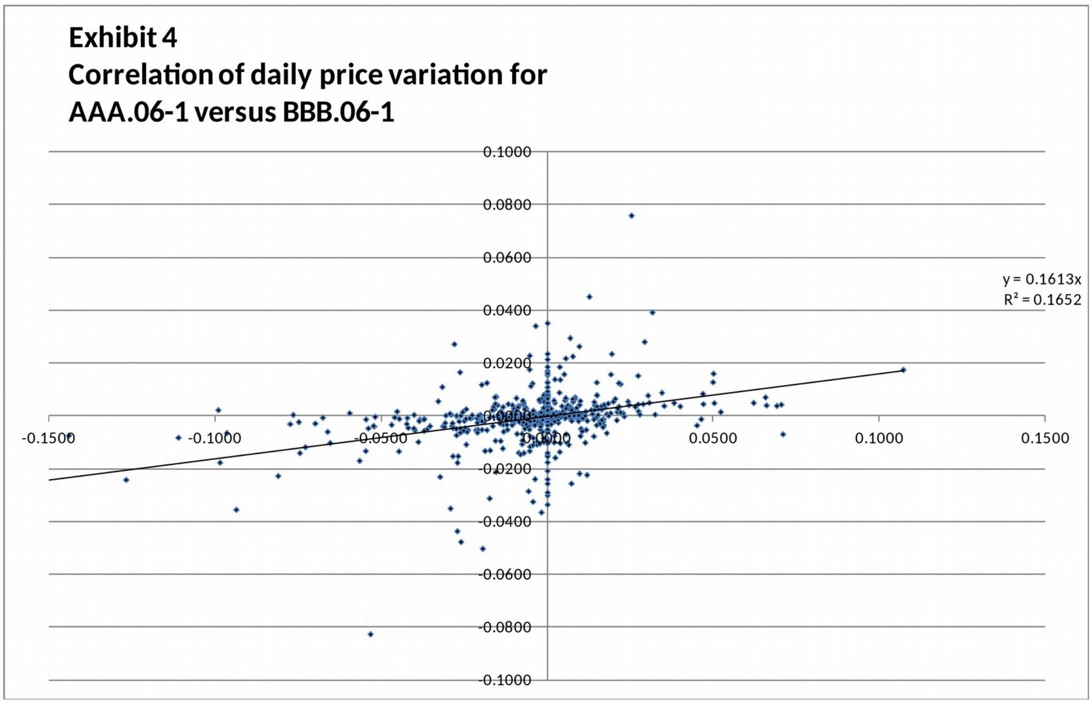
where α is the standard deviate for a given confidence-level percentile, *c*, on the cumulative normal distribution and σ_t is the standard deviation of daily returns over the time period, *t*, of interest. We use the formula even though the underlying price changes do not follow a normal distribution and are not stationary. To compensate for those features and for the illiquidity, we compute VaR using a one-month time period. Markit ABX.HE indexes are tabulated as a percent of par, so percentage changes in *S* carry over to percentage changes in the underlying CDO that corresponds to the index, implying a delta of one (i.e. delta = $\frac{\Delta V}{\Delta S}$ = 1).

In order to facilitate replication of our results, we describe the procedure. We first calculate the daily variation in prices for the index. We next calculate the moving average of the standard deviation of the daily price changes over the trailing 22 trading days. We then multiply the moving average by the square root of 22 trading days to obtain a monthly standard deviation. Finally, we multiply by 2.33, which is the normal deviate corresponding to a 99%-tile deviation. Jorion [2006] describes variations on this approach that could be used. We do this for all rating levels and origination dates in the ABX.HE dataset. Exhibit 2 illustrates the result of computing VaR for the AAA and BBB tranches of the ABX.HE AAA.06-1 index. In the exhibit, we display the 99% one-month VaR. Note that VaR reached levels exceeding 30% of par during the height of the financial crisis during late 2008 and early 2009 even for the AAA rated tranche. This is broadly consistent with data Morgan Stanley [2008] presented to the New York Federal Reserve Board.





We can also examine the correlation between the daily price variations for each time series finding that there is very low correlation among most tranches. Exhibit 4 illustrates one of the higher correlation pairs. We choose to drop the diversification terms from the VaR computation in light of this finding. This time series has a Durbin Watson statistic of 1.79 suggesting minor autocorrelation.



Wide variation in the CDO characteristics occurs for the individual ABX.HE indexes. Stanton and Wallace [2008] examined the statistics of the attachment and detachment points for ABX.HE indexes. They found that the attachment points could vary from 23% to 60% for individual CDOs within a single ABX.HE index for AAA rated securities. It's clear from the wide variation in attachment points within a given rating that the other cash-flow related CDO structuring features play a large role in the rating and therefore also the price. This relationship follows from the substantial effect bespoke CDO design features such as credit default triggers and overcollateralization can have on the CDO tranche waterfall.

One aspect of the rapid deterioration of CDO prices during 2007 was the divergence of price-variation of CDO tranches compared to bonds with similar credit ratings. Ratings are a measure of expected loss or probability of default over a period of time, such as one year. Some investors, who utilize ratings as a measure of the potential for future changes in future value, found that divergence troubling. Fender et al [2008] provide several illustrative examples. Starting with a corporate bond and a CDO tranche having similar expected loss and probability of default, they demonstrate the dramatically different sensitivities of each security to various scenarios. Credit VaR for the CDO tranche in their example is more than ten times greater than for the corporate bond even though ratings and expected loss are nearly identical. The heightened sensitivity largely stems from the CDO waterfall structure, which can magnify the changes in expected loss over time when the shape of the loss distribution also changes. Thus, commonly used risk-factoring methods cannot be applied to compare CDOs to corporate bonds. This fact was a motivation for our use of the ABX.HE data in contrast to more liquid contracts from other bond markets.

Overview of AIGFP's Portfolio of Super Senior Credit Default Swaps

Although credit default swaps are simple in concept, AIG's portfolio was deeply complex. Virtually every contract specified a unique combination of contractual features. AIG's super senior CDS contract counterparties included more than a dozen of the largest financial institutions covering a notional value exceeding $63 billion with subprime exposure. Although AIG [2007] revealed that its total exposure to the CDS market exceeded $500 billion, we focus on the super senior CDS exposure because that is where the greatest losses occurred. AIGFP's Risk Monitoring Flash Report [2008b][4] reveals that "CDS on Multi Sector CDO represents less than 1/5 of total synthetic credit exposures, but accounts for almost 100% of the losses. A 1% move in the price of the underlying Multi Sector CDO equates to a $710mm loss."

The Federal Reserve Board New York (FRBNY) maintained in collaboration with AIG a list of the super senior CDS that were included in the transactions that ultimately ended up being acquired by Maiden Lane III. These transactions were initially disclosed to the public in January 2010 when the so-called "Schedule A" to the Forward Purchase Agreements was released by FRBNY [2008b]. We rely on the more detailed listing in FRBNY [2008a] that contains information for each security on: Deal type, Name, Counterparty, Underwriter, Manager, Currency, Inception Date, Inception Notional, Inception Attachment, Total Tranche Notional, Position Notional, Cusip, Tranche Rating, Collateral Type, Current Balance, Date of Call, Counterparty Call Amount, Implied Price from Call, and AIGFP's internal pricing at three points in time. This listing included 190 transactions. Of these, we drop commercial MBSs such as Rome Airport and Orkney, which are not representative of the residential subprime exposure contained in most of the deals, leaving 177 deals in the dataset. This list may include some deals not acquired by Maiden Lane III. Eight deals had missing data, which we estimated from other sources, which we constructed from prospectuses in the Federal Reserve Bank of New York and AIG discovery records.

AIG [2007] describes AIGFP's use of Moody's CDOROM model, which AIGFP called BET[5], for each of their super senior CDSs to compute a price that they believed was consistent with the available market data. It is not possible to fully replicate AIGFP's use of the BET model using publically available data. This is because transaction-specific modifications were made by AIGFP to the BET model to capture the cash flow implications of each transaction's unique features. Nonetheless, the dynamic change in risk levels of AIGFP's super senior portfolio occurred due to market price changes for the underlying loan pools not transaction specific features. Therefore, we will consider a reduced portfolio, sometimes called a compressed portfolio, that matches the notional amounts by initial credit rating and align those with the same credit rating for the ABX.HE indexes. This ratings-based equivalence is essentially how AIG [2007] presented its portfolio to investors in late 2007.

AIGFP [2008b] also displayed the distribution by notional value of its super senior portfolio across ratings, subordination levels, and vintages.[6] The report for October 9, 2008 summarized the rating distribution as shown in Exhibit 5.

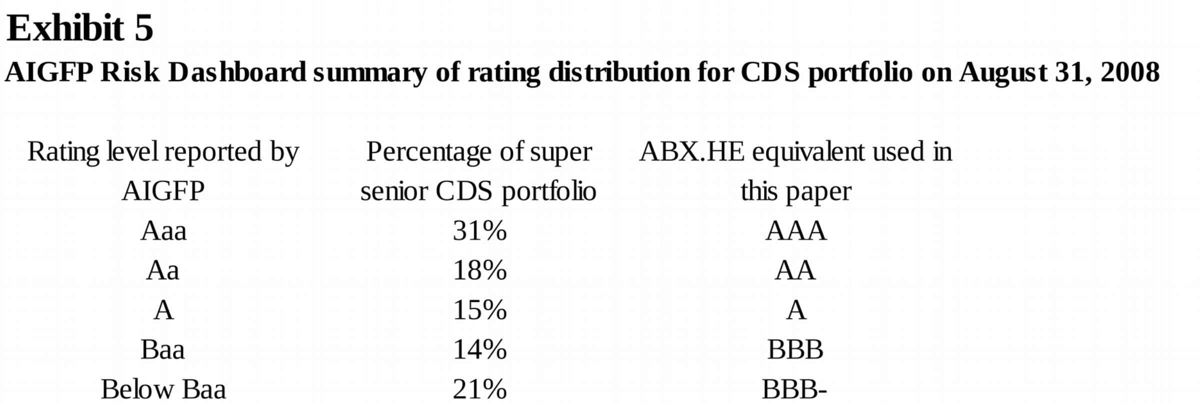


Exhibit 5

AIGFP Risk Dashboard summary of rating distribution for CDS portfolio on August 31, 2008

Rating level reported by AIGFP	Percentage of super senior CDS portfolio	ABX.HE equivalent used in this paper
Aaa	31%	AAA
Aa	18%	AA
A	15%	A
Baa	14%	BBB
Below Baa	21%	BBB-

An important influence on pricing and VaR is the year of a security's issuance. Exhibit 1 compared the ABX.HE indexes for the AAA tranche for each of the four series. The deteriorating credit quality of the underlying loan pool is apparent in the dramatic price differences. In AIGFP's super senior portfolio 39% of the notional exposure was composed of 2006 and 2007 vintage loans. The remaining deals were composed of loans from prior years with 18% and 39% in 2004 and 2005 respectively.[7] Blackrock Solutions [2008], retained by both AIG and FRBNY to analyze the CDSs[8], surmounted this issue by constructing hypothetical index series for 2004 and 2005 composed of 20 deals that were designed to be similar to the ABX.HE indexes in spirit[9]. They then used proprietary price data to value the 2004 and 2005 vintages. They did not report the reconstructed index nor did they produce an historical time series. To the authors' knowledge no publically available index for 2004 or 2005 exists. Moreover, Blackrock's methodology suffers from the problem that the dealer quotes on a 20-deal portfolio are not necessarily produced by each dealer averaging their quotes on the 20 individual deals. Blackrock's base case cumulative loss estimates, which were founded in a national scenario regarding home price depreciation, for the underlying loan pools are shown in

Exhibit 6.

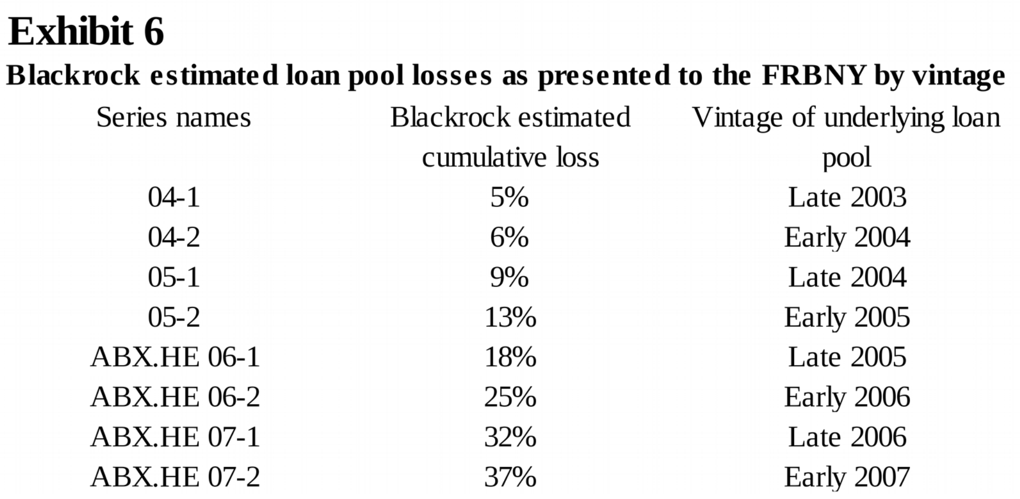


Exhibit 6

Blackrock estimated loan pool losses as presented to the FRBNY by vintage

Series names	Blackrock estimated cumulative loss	Vintage of underlying loan pool
04-1	5%	Late 2003
04-2	6%	Early 2004
05-1	9%	Late 2004
05-2	13%	Early 2005
ABX.HE 06-1	18%	Late 2005
ABX.HE 06-2	25%	Early 2006
ABX.HE 07-1	32%	Late 2006
ABX.HE 07-2	37%	Early 2007

Computing risk-based margin for AIGFP's Super Senior CDS Portfolio

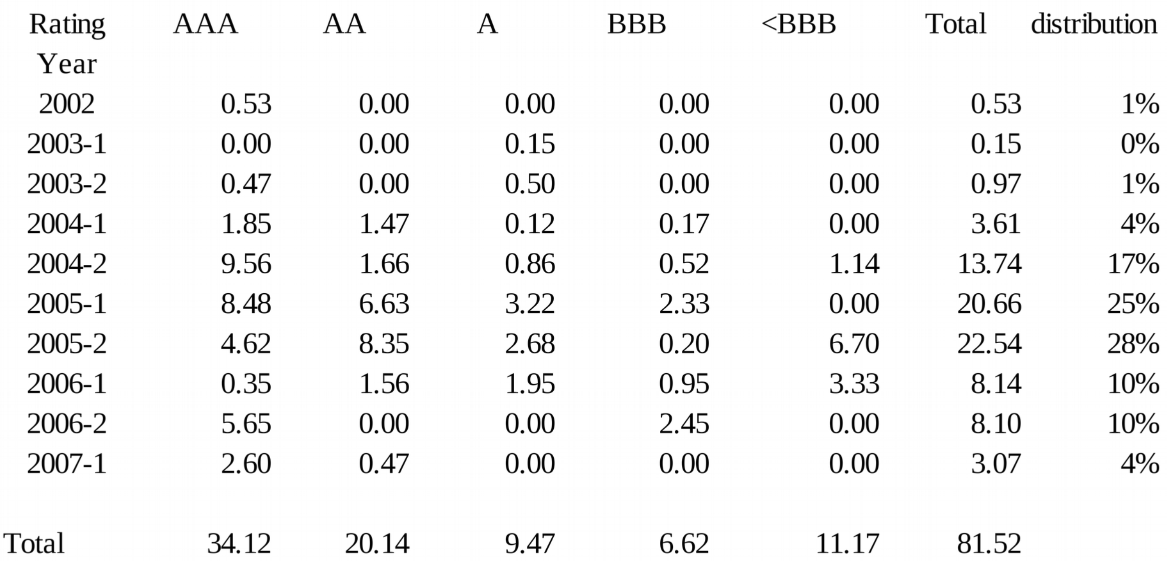
We turn now to the task of applying a VaR-based margin procedure retrospectively to AIGFP's CDS portfolio in order to create a conjectural scenario and compare the likely financial incentives that might have been created. We described earlier in this paper the transactions in the CDS portfolio and the ABX.HE indexes upon which we compute a VaR for the portfolio.

The AIGFP portfolio included securities that originated in 2003, 2004 and 2005. Markit was not collecting quotation data for CDOs originated in those years. We therefore construct conjectural indexes based on an extrapolation from AIGFPs internal valuations and the Markit indexes. Before describing that, we will first summarize the AIGFP portfolio in terms of several key statistics.

Exhibit 7 summarizes the total original notional position of AIG's CDS portfolio arranged by date of origination and rating. About 52% of the notional value corresponds to the available ABX.HE price indexes. So, capturing the characteristics of the remaining portion is important.

Exhibit 7

AIGFP Super Senior CDS portfolio by year of origination and rating of underlying CDO tranche (billion $ notional)

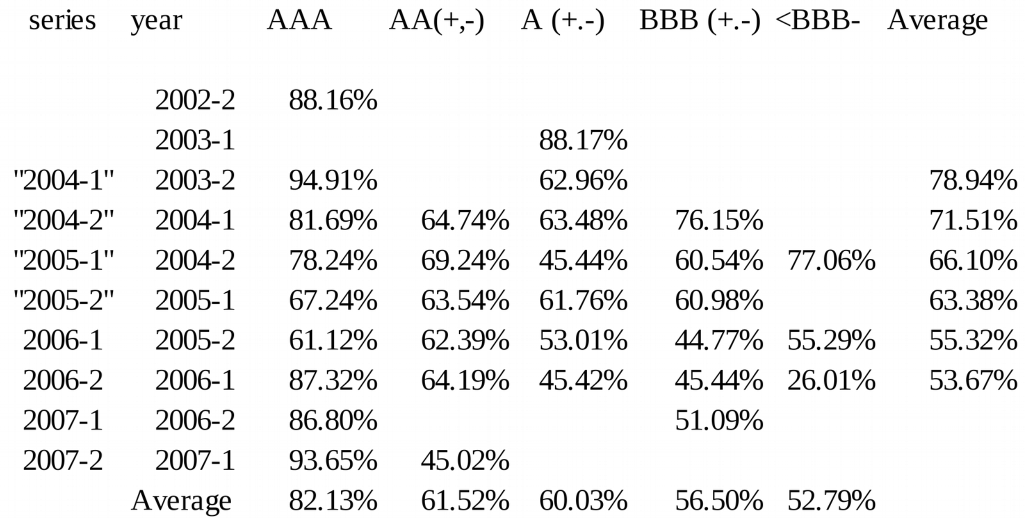


Rating	AAA	AA	A	BBB	<BBB	Total	distribution
Year							
2002	0.53	0.00	0.00	0.00	0.00	0.53	1%
2003-1	0.00	0.00	0.15	0.00	0.00	0.15	0%
2003-2	0.47	0.00	0.50	0.00	0.00	0.97	1%
2004-1	1.85	1.47	0.12	0.17	0.00	3.61	4%
2004-2	9.56	1.66	0.86	0.52	1.14	13.74	17%
2005-1	8.48	6.63	3.22	2.33	0.00	20.66	25%
2005-2	4.62	8.35	2.68	0.20	6.70	22.54	28%
2006-1	0.35	1.56	1.95	0.95	3.33	8.14	10%
2006-2	5.65	0.00	0.00	2.45	0.00	8.10	10%
2007-1	2.60	0.47	0.00	0.00	0.00	3.07	4%
Total	34.12	20.14	9.47	6.62	11.17	81.52	

Blackrock, in its work for the FRBNY, constructed new series it created to mimic the Markit procedure. Instead, we will use AIG's internal valuations to develop conjectural series that are proportionally consistent with each combination of origination date and rating level. Exhibit 8 presents the AIGFP internal pricing arranged by year of origination and rating of the underlying CDO tranche. We also adopt a naming convention similar to that developed by Markit for the series. The term "2004-1" refers to securities originated in late 2003, and so forth. For example, AIGFP's internal valuation placed a value of 94.91% of par on securities originated in late 2003 and carrying a AAA rating. This exhibit was computed from AIGFP data released by FRBNY [2008a] as of June 30, 2008. The pricing data illustrate the expected monotonic decrease by declining rating and also by increasing year of origination for 2002-2005.

Exhibit 8

AIGFP Price by year of origination and rating as of June 30, 2008 (% of par)



series	year	AAA	AA(+,-)	A (+.-)	BBB (+.-)	<BBB-	Average
	2002-2	88.16%					
	2003-1			88.17%			
"2004-1"	2003-2	94.91%		62.96%			78.94%
"2004-2"	2004-1	81.69%	64.74%	63.48%	76.15%		71.51%
"2005-1"	2004-2	78.24%	69.24%	45.44%	60.54%	77.06%	66.10%
"2005-2"	2005-1	67.24%	63.54%	61.76%	60.98%		63.38%
2006-1	2005-2	61.12%	62.39%	53.01%	44.77%	55.29%	55.32%
2006-2	2006-1	87.32%	64.19%	45.42%	45.44%	26.01%	53.67%
2007-1	2006-2	86.80%			51.09%		
2007-2	2007-1	93.65%	45.02%				
	Average	82.13%	61.52%	60.03%	56.50%	52.79%	

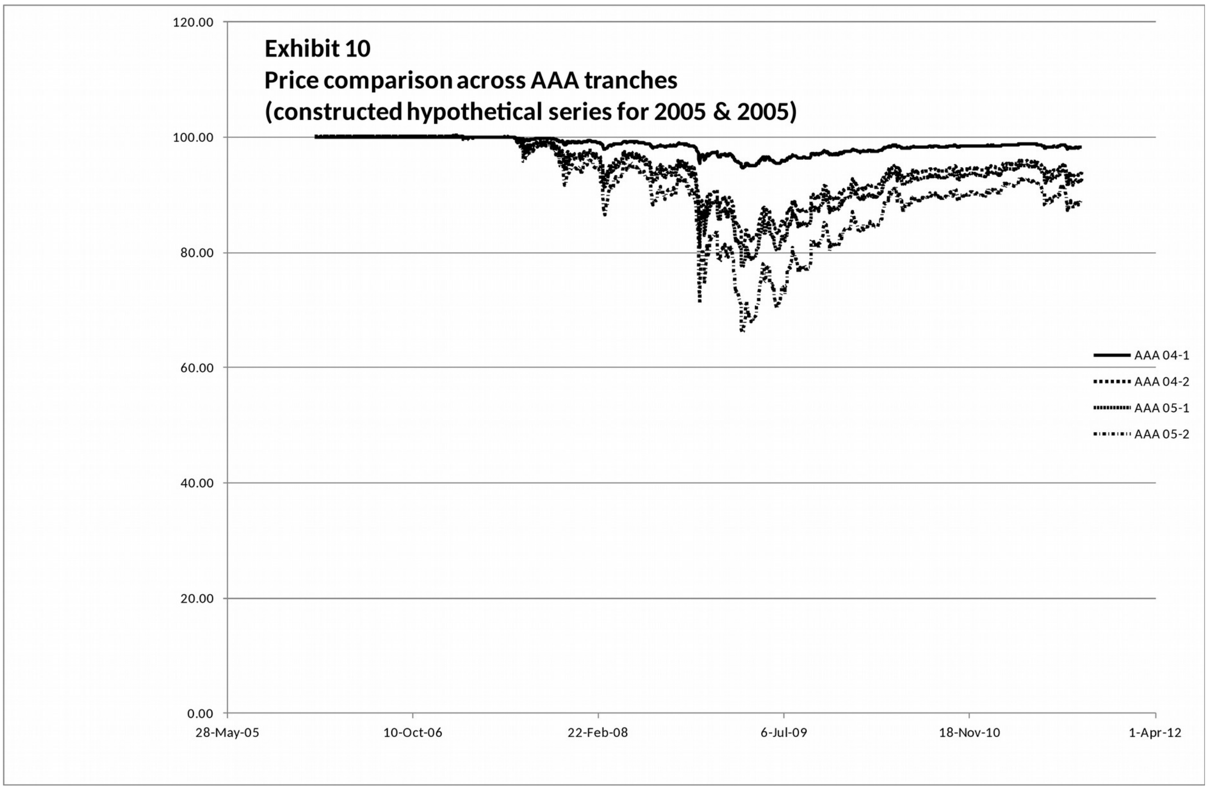
We extend the Markit indexes from the first Markit series (ABX.HE.2006-1) to earlier periods by using a ratio based on AIG’s internal valuations. We compute the ratio of the value AIGFP reported for securities originated in 2003, 2004 and 2005 to the value reported for securities originated in the second half of 2005. The second half of 2005 was the period Markit used for assembling its ABX.HE index 2006-1. Exhibit 9 reports the results. For example, the ratio of prices comparing deals originated in late 2005 compared to those originated in early 2004 for AAA rated tranches was 0.13. This ratio reflects the dramatic deterioration by late 2008 in the relative value of mortgages originated later in time.

Exhibit 9

Ratio of AIGFP prices for 2003-2005 relative to prices for 2005-2

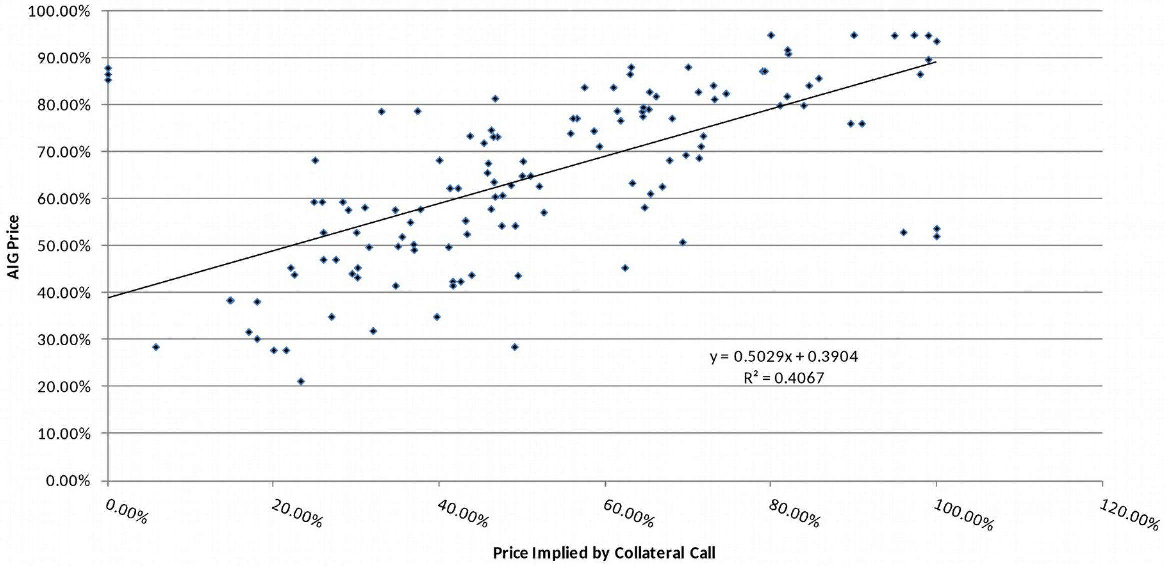
							ratio avg
"2004-1"	2005-2 vs 2003-2	0.13		0.79			70%
"2004-2"	2005-2 vs 2004-1	0.47	0.94	0.78	0.43		77%
"2005-1"	2005-2 vs 2004-2	0.56	0.82	1.16	0.71	0.51	84%
"2005-2"	2005-2 vs 2005-1	0.84	0.97	0.81	0.71		87%
2006-1	2005-2 vs 2005-2	1	1	1	1	1	1
	ratio avg	50%	91%	89%	62%	51%	

Finally, we use these ratios to construct price series corresponding to periods prior to the earliest Markit ABX.HE index. Exhibit 10 illustrates the resulting price series. It’s immediately apparent that the valuation declines during 2007-2008 were not as severe for these origination periods as for MBSs originated in 2006-2007. This difference is largely the consequence of the amount (or lack thereof) of home price appreciation for the mortgages in each loan pool.



It’s important to note that we did not use AIG’s pricing directly in part because AIG systematically overvalued its portfolio relative to its counterparty’s collateral calls and relative to the Markit indexes. Exhibit 11 compares the AIG value to the price on June 30, 2008 implied by the collateral calls for each of the 177 deals. Rather than use either AIGFP’s valuation or their counterparties, in this analysis we used the major source of independent data from the ABX.HE indexes.

Exhibit 11
AIG Price Versus Price Implied by Collateral Calls on June 30, 2008



We then compute the change in mark-to-market value and the VaR-based margin for each time series. Exhibit 12 illustrates this calculation for the 2006-1 AA-rated series.

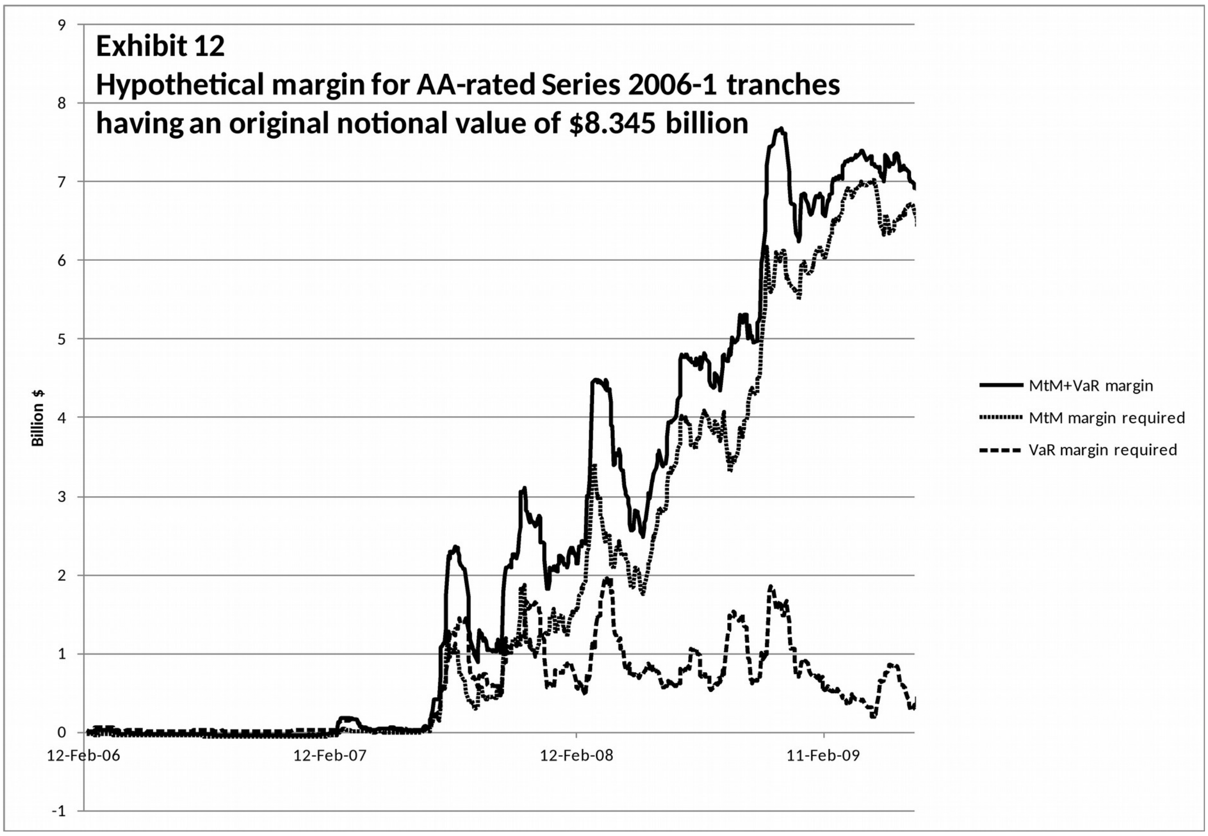


Exhibit 12
Hypothetical margin for AA-rated Series 2006-1 tranches having an original notional value of $8.345 billion

Conclusions

To reach meaningful conclusions, we aggregate both the change in mark-to-market value and the VaR-based collateral across all ratings and origination dates. Exhibit 13 illustrates the resulting aggregation. The red squares represent the aggregated collateral calls from all counterparties as they were reported by AIG. We drew the following insights from this calculation:

1. Counterparty collateral calls related to the changes in mark-to-market value were too little and too late compared to independent valuations using the Markit data. Substantial calls were not issued against AIGFP until mid-2007 while principles of fair valuation would have justified similar level of collateral calls at least by February 2007. The period from later 2006 through early 2007 was a crucial time for hedging and liquidation possibilities with minimal losses.

2. Collateral calls issued to AIGFP did not reach independent valuation levels until September 2008. There have been claims that collateral calls were AIG's undoing. The independent data reveal that, in fact, AIG's counterparties delayed issuing collateral calls far past the point of prudence. At is maximum point of divergence; AIG's collateral calls fell over $20 billion short of the actual mark-to-market losses implicit in AIG's CDS portfolio.

3. Risk-based margin covers the potential for future losses rather than existing mark-to-market losses. If VaR-based margin were to have been collected from AIG, the amount would have been substantial and early. By February 21, 2007 as much as $5 billion in VaR-based margin would have been called on top of about $3 billion in mark-to-market margin. That amount

dwarfs the $1.8 billion that was called more than six months later by counterparties.

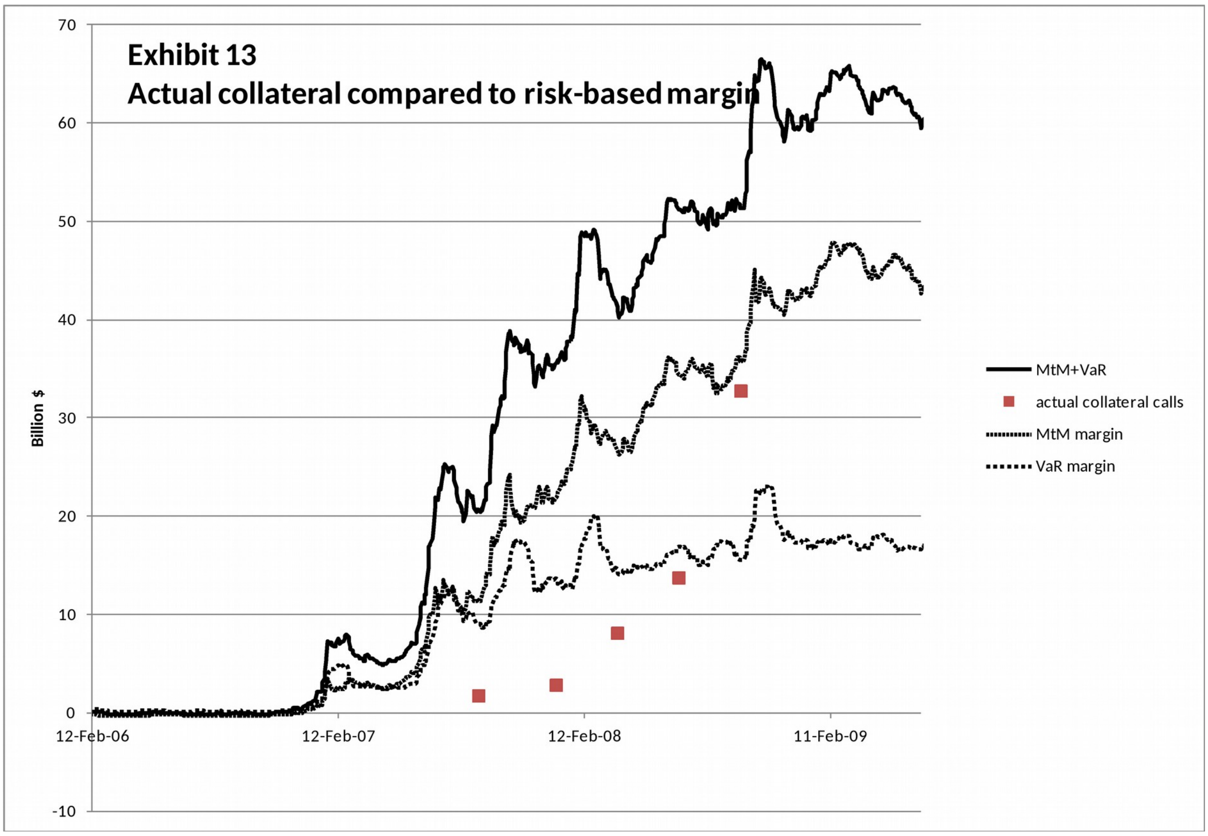


Exhibit 13
Actual collateral compared to risk-based margin

A summary of the actual and VaR-based margin at key dates is provided in Exhibit 14. Based on Markit's ABX.HE indexes AIGFP had already experienced over $11 billion in mark-to-market losses by September 2007 when it began posting collateral. By that date, a risk-based margin system would have required over $20 billion in margin. Had a risk-based margin procedure been in place, AIG would have faced margin calls in early February 2007 on the order of $7.68 billion, composed of both mark-to-market changes in value and risk-based margin, at a time when its mark-to-market losses were under $3 billion. The actual collateral calls issued by AIG's counterparties did not reach the level of unrealized losses implied by the Markit indexes until September 2008. By then, the implied credit exposure of AIG's counterparties was an additional $18.9 billion measured by the value at risk for additional losses.

A counterfactual analysis would expand on this to examine quantitatively the likely effect of margin procedures on derivative trading decisions of AIG and other market participants. It is possible that changes in trading strategies motivated by the presence of risk-based margin would influence the likely prices of derivatives and other aspects of derivative markets. That counterfactual analysis is beyond the scope of this article, but we can make some observations about the relative direction of those influences.

Exhibit 14

Comparison of actual collateral and VaR-based margin for AIGFP's super senior CDS portfolio at key points in time (billion $)

date	actual collateral	VaR-based collateral	Mark-to-market loses		
Dec. 31, 2006	0	$1.10	$0.40		
Mar. 31, 2007	0	$5.60	$2.90		
Jun. 30, 2007	0	$17.50	$7.10		
Sept. 30, 2007	$1.80	$20.70	$11.30		
Dec. 31, 2007	$2.88	$35.50	$21.80		
Mar. 31, 2008	$8.17	$41.70	$27.00		
Jun. 30, 2008	$13.80	$51.30	$34.40		
Sept. 30, 2008	$32.80	$51.70	$36.10		

One of the defining features of AIG's position was the failure of AIG management and its advisors to act to reduce the buildup of financial risk within the CDS portfolio. Had an external guarantor issued an $8 billion margin call in February 2007, the attention of its Board members would have been riveted on identifying and solving the mismatch of expectations. As happened at firms with effective risk-management programs, a hedging program would have been quickly implemented. And for AIG, that would have occurred while it still had the financial resources to absorb $8 billion in margin calls. Instead, by delaying action for a crucial year, losses accumulated to over $40 billion and collateral calls came due at a time of restricted financial flexibility. Risk-based margin procedures, as we demonstrate in this paper, offer the prospect of creating incentives for early hedging that can reduce the likelihood and mitigate the consequences of future systemic crises. Additionally, the methods described in this paper can provide a reproducible computational procedure that can also assure that margin withheld by a third-party guarantor is sufficient but not excessive.

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1 Support for this paper was provided by the Coleman Fung Risk Management Center at the University of California at Berkeley.

2 It is occasionally seen in the literature that the assets in a CDO are referred to as collateral since they are the security defined when loans in the loan pool were originated. We will refer to this type of collateral as a “loan pool” to avoid confusion with the use of the word collateral in this paper.

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4 We are indebted to The Office of the Special Investigator General for the Troubled Asset Relief Program (SigTarp) for providing access to electronic copies of records produced to the U.S. House of Representatives Committee on Oversight and Reform. Those documents were produced by the Federal Reserve Board, American International Group, and various related parties pursuant to a request by Representative Darrell Issa dated October 17, 2010. We cite to the Bates stamps for documents that are not otherwise published.

5 BET refers to the binomial expansion theorem, which is a mathematical expression for the probability of events taken in various combinations.

6 FRBNY-TOWNS-Rl-210152

7 *Ibid*

8 FRBNY-TOWNS-R1-213604

9 FRBNY-TOWNS-R1-213613