

INVESTIGATING THE CMBX-CASH BASIS

by

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Bachelor of Commerce, University of Alberta 2006

PROJECT SUBMITTED IN PARTIAL FULFILLMENT OF
THE REQUIREMENTS FOR THE DEGREE OF
MASTER OF FINANCIAL RISK MANAGEMENT

In the Faculty of Business Administration

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SIMON FRASER UNIVERSITY

Summer 2009

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Abstract

This paper investigates the effect of the market convention for quoting CMBX spreads on the CMBX-Cash basis. Using the CMBX Series 5 spreads between 22 May 2008 and 15 July 2009, we compute the value of the upfront payment for each trade date based on the market's assumed notional schedule of the underlying CMBS. From this upfront payment, we calculate the implied deal spread under alternate notional schedules of the underlying CMBS and recalculate the basis.

We find that for most trade dates in our sample, the market deal spread trades far wider than is implied under a scenario of severe defaults in the underlying. The degree of distortion on spreads is amplified as the level of subordination and credit quality declines. The technical factors underlying CMBX trading dominate movements in spreads to such a degree that the level of default risk in the constituent CMBS is obscured. These distortions impair the CMBX-Cash basis as an indicator of relative value between the synthetic and cash markets.

Keywords: CMBX; CMBS; Credit Default Swap Basis

Dedication

This paper is dedicated to my FRM and GAWM colleagues, who made the program as enjoyable as it was challenging.

Acknowledgements

Deepest thanks to Dr. Anton Theunissen, whose continued support and mentorship made this paper possible.

I am grateful to Todd Jaeger at RBS Securities for providing data and invaluable insights on this issue.

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1 Introduction

This paper investigates the effect of the market convention for quoting spreads implied by CMBX prices on the CMBX-Cash basis.¹As shown in Figure 1, in the first year of CMBX trading, the spread differential between the CMBX and commercial mortgage-backed securities (CMBS) indices of the same credit quality remained near zero. Beginning March 2007, the differential between BBB and BBB- CMBX and CMBS spreads began to diverge—pushing the differential to a positive level until March 2008, when the differential turned highly negative and volatile, reaching a low of approximately -600 bps in November 2008. Since the CMBX was devised as an instrument to allow investors to synthetically assume or hedge credit exposure to underlying CMBS, the significant gap between the cash and synthetic spreads is puzzling.

We contend that the market convention used to map the value of the CMBX contract to its quoted spread implies an unreasonable notional schedule that has distorted both the CMBX spread and CMBX-Cash basis. The timing and speed of losses under this implied notional schedule is inconsistent with reasonable loss expectations for the various tranches in the underlying CMBS, which pushes the quoted CMBX spread wider. We demonstrate this by using the market value of the CMBX contract for each trading day in our sample and recompute the CMBX spread under three alternate default scenarios for the constituent CMBS that comprise the index. We then compare these recomputed spreads to their respective traded market spread and recompute the basis.

We find that for most trade dates in our sample the trading mechanics of the CMBX have pushed spreads to levels higher than would be implied assuming severe losses in the underlying loan pool, particularly so in the subordinate tranches. Exceptions to this relationship occur for trade dates earlier in the sample (prior to November 2008) and for lower-rated indices. The relationship between the traded and alternate spread is driven by assumptions in the timing, speed and total expected losses, in addition to other risks such as prepayment and extension.

Spreads for indices with the most credit enhancement (AAA and AJ) should be relatively insensitive to term default risk in the constituent CMBS, but the impact of extension risk on the spread should be considered. The spreads for the remaining indices with lower subordination are more sensitive to term default risk, as changes in the assumed notional trajectory of the underlying

¹ Prior to April 20, 2009, the CMBX traded on spread. During this period, the upfront payment and price of the contract were implied from the spread. Since April 20, 2009, the CMBX quoting convention has reversed to trade on price. CMBX spreads are now implied from the price of the contract.

loans produce significantly different implied spreads. Lastly, the implied spreads under the market trading convention for CMBX are highly sensitive to changes in interest rates. All together, these findings suggest that the CMBX-Cash basis is not a clear indicator of relative value between the synthetic and cash market. The basis should be interpreted with caution and further consideration given to extension risk and the timing of losses in the underlying loans.

The paper is organized as follows. Section 2 discusses the meaning of the basis and explores potential explanations for its existence. Section 3 outlines the data and methodology used to calculate alternative CMBX spreads. Section 4 provides a discussion of our results, while Section 5 concludes. We provide a background discussion of the origin of the CMBX market, trading mechanics and settlement in the appendices.

2 The Basis

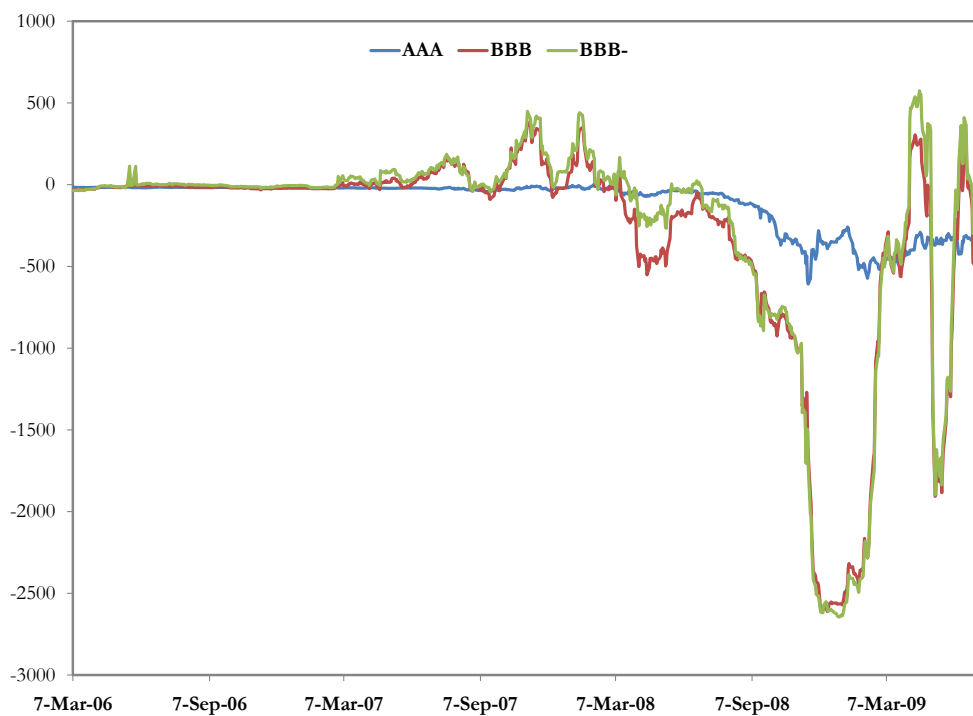
Throughout this paper we refer to “the basis” as an indication of some mispricing between the synthetic and cash market. However within the broader financial economics literature, the basis is a term often used to describe a wide range of distinct pricing relationships.² Our usage of “the basis” refers to the CDS-Cash basis, which relates the spread on CDS to the spread on the underlying cash bond of the same reference entity. More specifically, our study examines the spread on CMBX indices to constituent CMBS spreads. An obvious question that may arise is why we compare an index of CDS spreads (the CMBX spreads) to the CMBS spreads rather than the CDS spreads of the individual constituents. Due to thin trading in single-name CMBS CDS, CDS spreads for CMBX constituents are difficult to acquire. This contrasts with the corporate market, where trading in single-name CDS is higher and spreads are easily available.

2.1 The CMBX-Cash Basis

To assess the relationship between the synthetic and cash credit markets, we will use the observed CMBX-Cash basis as an example to ground our discussion. Figure 1 presents the CMBX basis for three ratings categories: AAA, BBB, and BBB-. The synthetic side of the basis is the spread for the on-the-run CMBX series, while the cash side of the basis is an index of CMBS spreads. However, although the CMBX provides credit exposure to a basket of 25 names, it is common practice in the market to compare the index to one single-name cash spread. This single-name cash spread may or

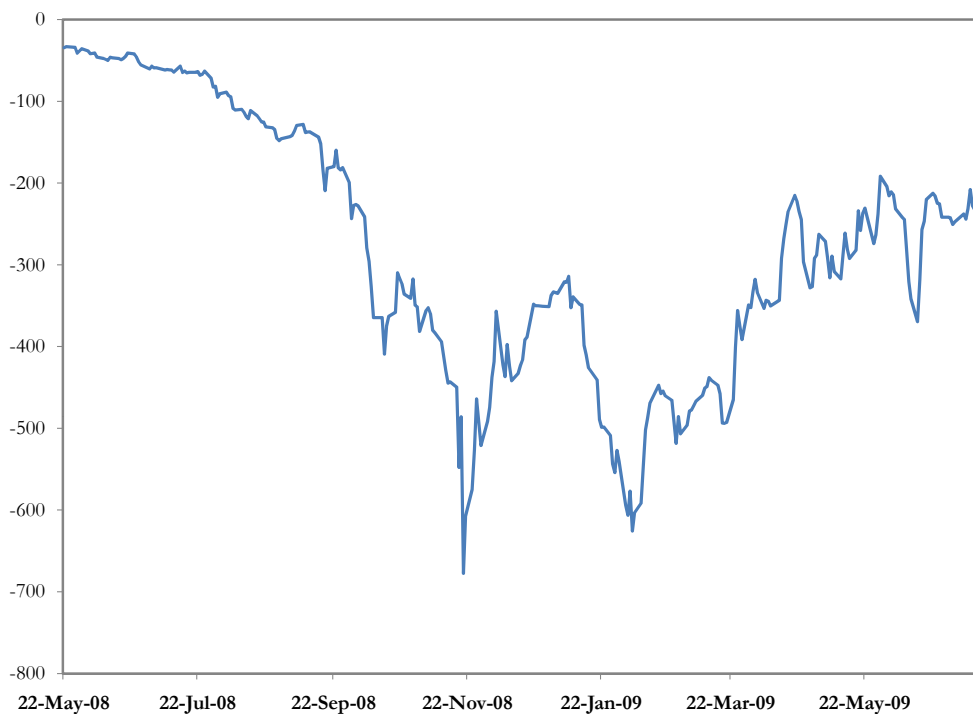
² For example, the deviation between the spot and futures price of commodities is referred to as the basis.

Figure 1: CMBX-Cash Basis



Source: Barclays Capital

Figure 2: AAA CMBX-GG10 Basis



Source: CMBX Series 5 spread from Barclays Capital; GG10 spread from RBS Securities

may not be an actual constituent of the CMBX series it is compared to. For example, a frequently quoted basis in the market is between the AAA CMBX spread and the spread on the A4 bonds from Goldman Sachs Mortgage Securities Corp. II, 2007-GG10. We term this basis the GG10 basis hereafter, and is charted in Figure 2. Despite the fact that this GG10 bond is not a constituent in any series of the CMBX, features such as its liquidity and vintage designate it as a benchmark bond in the CMBS market. Regardless of how the CMBX-Cash basis is defined, whether it be against another index of cash spreads or a single-name cash spread, three observations are immediate: (1) the basis is volatile, (2) the basis is negative, and (3) the basis is persistent.

If cash and synthetic spreads diverge significantly, leading to a non-zero basis, an arbitrage opportunity seems apparent. Recall that the CDS basis is calculated as follows:

$$\text{Basis} = \text{CDS Spread} - \text{Cash Spread}$$

where a positive basis suggests an arbitrage profit could be generated by taking a long position in the credit of the reference entity by selling CDS protection, and selling the bonds of the entity. Conversely, a negative basis can be capitalized upon by taking a long position in the entity's bonds and buying credit protection through the CDS market. By taking opposite positions in the credit of the entity, the synthetic and cash spreads should converge to some degree.

2.2 Explaining the Basis

The arbitrage relationship between CDS and cash spreads has been discussed in the literature by Duffie (1999) and Hull and White (2000). The motivation behind our study is to examine how the CMBX payment structure and assumptions made with respect to the notional schedules of the underlying loans may distort the basis. We make no attempt to test whether or not the arbitrage relationship between the CMBX and CMBS spreads hold. However, given the observations in Figure 1 and 2, a brief discussion of the commonly cited reasons for the existence of the basis is worthwhile. O'Kane and McAdie (2001) discuss potential explanations for the basis in the general cash and CDS market. We briefly review explanations most applicable in the CMBX-Cash market:

1. *Funding*: The cost of taking a position in the cash market may be higher than doing so in the synthetic market. Whereas a position in CDS secures funding costs at the US dollar London Interbank Offered Rate (Libor), most investors in the cash market must fund at a rate higher than Libor. This may induce investors to accept a lower spread in the CDS market than in the cash market, pushing down the CDS basis.

2. *Counterparty Risk*: Unlike a cash bond, CDS trade over-the-counter with a counterparty taking the opposing position. This counterparty introduces a new type of risk into the transaction, which may push the buyer of protection (BoP) to pay a lower protection premium.
3. *Accrued Premium*: Under a CMBX contract the BoP must continue to pay the fixed premium despite a credit event occurring. In the cash market, an investor who has a long position in the CMBS cannot collect the accrued premium in the event of default. This implies that the spread on CMBX should trade slightly narrower than the spread on the bond, decreasing the basis.
4. *Funding Risk*: By assuming a position in the synthetic market, an investor can fix their funding cost at Libor until the contract expires. An investor may accept a lower CDS spread in exchange for the elimination of changes in funding costs, which would drive the basis downwards.
5. *Liquidity*: Differences in liquidity in the cash and synthetic market may explain the deviation in spreads. An investor may accept a lower spread in the synthetic market in exchange for greater liquidity.

While the literature and the market may dispute the validity of the above explanations, we simply wish to acknowledge them. Any or all of the explanations may indeed be driving the basis. However, our motivation is to show that regardless of why it exists, the impact of assumptions and trading conventions in the market on the basis make it a meaningless indicator of relative value between the cash and CMBX market.

3 Data and Methodology

3.1 Data

Our analysis focuses on the on-the-run CMBX Series 5. Both CMBX spreads and cash spreads cover the period between May 22, 2008 and July 15, 2009. CMBX spreads and the cash spread indices were collected from Barclays Capital. While single-name CMBS spreads for the individual constituents of the CMBX series are ideal, the availability of the data is limited. Nonetheless, we examine the GG10 basis quoted in the market to provide insight on how the market views the CMBX-Cash basis. The quoted GG10 spread is provided by RBS Securities.

The projected notional schedules for each index were obtained from Intex, a leading provider of structured fixed-income cash flow models.³ Our analysis considers three alternate loss scenarios for the constituent CMBS: base/no default (notional balance of the underlying declines purely due to amortization), moderate and a severe default scenario. The constant default rate (CDR) and cumulative default rate assumed in the moderate default scenario is shown in Figure 6, while the severe default scenario loss curve is shown in Figure 7.

US dollar Libor rates are collected from Thomson ONE for the following maturities: overnight, 1-week, 2-week, and 1 to 12-months. US dollar swap rates were collected from Bloomberg, for maturities of 2 to 12 years, 15, 20, 25 and 30 years. The US dollar Libor-Swap curve was bootstrapped for each day in the sample period to obtain the appropriate risk-free discount factors.

3.2 Methodology

The change in CMBX quoting convention to price has made the value of the upfront payment visible in the market.⁴ However, we compute the upfront payment to verify that our calculated risky discount factors and implied CMBX spreads are consistent with the upfront payment quoted in the market.

For each index and trade date in our sample period, we determine the value of the upfront payment to be exchanged between the Buyer of Protection (BoP) and the Seller of Protection (SoP) using the market convention. Recall that the upfront payment is the net present value of the fixed and floating payments over the life of the CMBX contract, adjusted for any fixed premium accrued from the last payment date:

$$upfront_{t, mkt} = \sum_{i=1}^N pmt_{i, mkt} - accprem_t, \quad (1)$$

where the subscripts t and mkt denote the trade date and market quoting convention.

The upfront payment is simply the product of the spread differential and notional balance at the start of the calculation period, adjusted using the actual/360 accrual convention and discounted using the appropriate risk-free discount factor and probability of survival:

$$pmt_{i, mkt} = \frac{traded_t - fixed}{10000} \times \tau_i \times notional_{i-1, mkt} \times z_i \times s_i, \quad (2)$$

³ Intex provides cashflow models for a range of structured finance products, including CMBS deals. Intex determines notional schedules for the CMBX tranches based on given performance assumptions for the underlying collateral in the index. The performance assumptions for the underlying loans were provided from RBS Securities.

⁴ See Appendix C.2 for details on the relationship between the quoted price and upfront payment.

where $traded_t$ is the traded spread of the index, $fixed$ is the fixed coupon rate, τ_i is the accrual period between i and $i - 1$, $notional_{i-1, mkt}$ is the notional balance of the reference obligations at the start of the accrual period, z_i is the risk-free discount factor for the $t = 0$ to t_i period, and s_i is the survival probability from $t = 0$ to t_i . We apply the same methodology as Markit to calculate the survival probability at each payment date i :

$$s_0 = 1 \tag{3}$$

$$s_1 = \frac{s_0(1 - \delta)}{traded_t \times \tau_1 + 1 - \delta} \tag{4}$$

$$s_n = \frac{(1 - \delta) \sum_{i=1}^{n-1} z_i(s_{i-1} - s_i) - traded_t \sum_{i=1}^{n-1} z_i s_i \tau_i + z_n s_{n-1}(1 + \delta)}{z_n(\tau_n traded_t + 1 - \delta)} \tag{5}$$

where the recovery rate $\delta = 0$. Using the appropriate adjusted notional schedule for each default scenario: base, moderate and severe; we perform a similar calculation as in equation (2). However, the projected notional schedules of the reference obligations for the three default scenarios are substituted for $notional_{i-1, mkt}$ and risk-free discount factors are applied to solve for a new scenario-specific spread that equates the stream of net fixed and floating payments to the upfront payment calculated in equation (1):

$$upfront_{t, mkt} = upfront_{t, b} = \sum_{i=1}^B pmt_{i, b} - accprem_t \tag{6}$$

$$= upfront_{t, m} = \sum_{i=1}^M pmt_{i, m} - accprem_t \tag{7}$$

$$= upfront_{t, s} = \sum_{i=1}^S pmt_{i, s} - accprem_t \tag{8}$$

where the subscripts b, m, s denote the upfront payment under the base, moderate and severe default scenarios, respectively, and B, M and S represent the number of payment dates under each scenario.⁵

⁵ The number of payments under each default scenario will vary as writedowns and amortization determine the rate at which the notional balance approaches zero. Additionally, the number of payments across rating categories will also vary for the same default scenario due to the subordination structure of the reference obligations. For example, the moderate default scenario for the AJ tranche will have 105 payments following the trade date, while the BBB tranche will have 136 payments following the trade date.

We solve for the scenario-specific spread as follows:

$$upfront_{t, mkt} + accprem_t = \sum_{i=1}^B \left(\frac{spread_{t,b} - fixed}{10000} \times \frac{actual}{360} \times notional_{i-1,b} \times z_i \right) \quad (9)$$

$$= \sum_{i=1}^M \left(\frac{spread_{t,m} - fixed}{10000} \times \frac{actual}{360} \times notional_{i-1,m} \times z_i \right) \quad (10)$$

$$= \sum_{i=1}^S \left(\frac{spread_{t,s} - fixed}{10000} \times \frac{actual}{360} \times notional_{i-1,s} \times z_i \right) \quad (11)$$

where z_i is the risk-free discount factor for payment date i . The discount factor for each payment date is extracted from the curve using linear interpolation.

By computing the spread under various default scenarios, we can determine an alternate spread that each index would trade at if the market priced the index according to its alternate notional schedule, rather than the notional schedule implied by the market convention for quoting CMBX spreads. We do not assume that any of the three default scenarios considered represents the true degree of default risk in the underlying CMBS. Rather, we select these three scenarios to illustrate that for the same given CMBX contract value, the spread can vary considerably as the assumed timing, speed and total expected losses in the underlying CMBS are varied.

4 Results

4.1 Traded Spreads Relative to Scenario-Specific Spreads

While the spreads have been recomputed for all seven ratings categories of the CMBX Series 5, we limit our discussion to two ratings tranches (AAA and BBB) for the sake of brevity. However, the results for the remaining five tranches are provided in the appendix.

4.1.1 CMBX.NA.AAA.5

The recomputed spreads for the AAA tranche are shown in Figure 8. The recomputed spread shows little variation across the three default scenarios under consideration. Even under a scenario that assumes significant cumulative losses in the underlying CMBS by the balloon date, the subordination structure keeps the AAA spread tightly bound to the spread under the no default scenario.⁶

⁶ The balloon date is the date at which a large, remaining lump sum of the loan must be repaid to the CMBS investor.

Moreover, we observe that the spread under severe default is lower than the spread under no default. As writedowns occur, AAA CMBS have the highest priority in recovering payment—therefore under a severe default scenario, default-induced prepayments are pushing down the spread.⁷ An important observation from Figure 8 is the relationship between size of the gap between the traded and alternate spreads, and the level of the traded spread. As the traded spread trends further away from the fixed rate of the index, the differential between the traded spread and the recomputed spreads grows. Leading up to November 2008, the AAA spread traded below 250 bps and the differential remained below 50 bps. However, the deviation between the recomputed spreads and the traded spread peaks sharply during November 2008. Moreover, this gap is at its widest on the same date (November 20, 2008) that the traded spread is at its highest level of 848 bps. This relationship holds true in terms of minimizing the gap between the traded spread and recomputed base spread. The AAA traded spread reached a low of 100 bps on June 17, 2008, the date on which the gap is minimized.

Figures 16 and 15 illustrate the notional schedule implied under the market convention for the highest and lowest spread of the AAA-rated index. The alternate notional schedules under the three default scenarios show that the AAA-rated index has zero term risk, while the notional schedule implied by the trading mechanics of the CMBX indicates otherwise. The implied notional schedule on November 20, 2008 suggests significant losses before the balloon date. Conversely, the implied notional schedule on June 17, 2008 resembles the alternate schedules more closely but still indicates some term risk. Each figure shows that for the same upfront payment, the spread can trade at various levels depending on the assumed rate of decline in the notional schedule.

4.1.2 CMBX.NA.BBB.5

Figure 12 presents the traded spread relative to the recomputed spreads of our three default scenarios. The sudden divergence between the traded spread and recomputed spreads coincides with the same divergence point of the AAA-rated index, leading into November 2008. However, unlike Figure 8, the spreads under each scenario are easily distinguished from each other. Prior to November 2008, the spread under the severe default scenario trades tightly to the market spread of the

⁷ This effect of credit enhancement can also be observed in the AJ CMBX index, where the spread under no default exceeds the spread under severe default. See Figures 17 and 18 for a spread comparison. The AAA-rated CMBX index exhibits minimal prepayment convexity relative to the AJ-rated CMBX index, which is more affected by default-induced prepayment.

index.

Figures 23 and 24 show the implied notional schedule for the BBB index on the date of the index's minimum and maximum spread. We first consider the notional schedules on May 22 2008, the lowest traded spread in the trading history of CMBX.NA.BBB.5. Under the moderate default scenario, losses begin to impact the index between six and seven years following the trade date. If the index were to trade under this alternate notional schedule, the justified spread would be 973 bps, 200 bps lower than the traded spread on that date. Conversely, the severe default scenario projects losses beginning into year three. By year four, the remaining notional balance under severe default falls beneath the notional balance implied by the traded spread. Under this scenario, the severe spread is higher than the traded spread.

Next we consider the market implied notional on April 14 2009. The traded spread on this date reached over 6400 bps, implying that the notional schedule has already burned off 50% of its beginning balance by the first year of the CMBX contract. In comparison, the severe default scenario burns off completely before the implied schedule, yet its justified spread of 2631 bps is less than half the traded spread.

4.2 Spread Duration

We next examine the PV01 of each index to observe how the value of the CMBX contract changes for a 1 bp change in traded spread. We adopt Markit's methodology of calculating the PV01:

1. Add 0.5 bps to the traded spread to obtain the new upfront payment: $upfront_{+\Delta 0.5}$
2. Subtract 0.5 bps from the traded spread to obtain the new upfront payment: $upfront_{-\Delta 0.5}$
3. The PV01 is simply: $PV01 = upfront_{+\Delta 0.5} - upfront_{-\Delta 0.5}$

As expected, the relative PV01s of the CMBX indices are consistent with their respective credit quality. As shown in Figure 29, the PV01 of the AAA index is the highest of the series, while the BB index is the lowest. The sharp movements in the level of the PV01 over the sample period coincide with the same movements in the traded spread of the index. On average over the sample period, an increase or decrease of 1 bp to the traded spread impacts the AAA price by 0.054%. The lowest credit-quality index, BB, has been the least sensitive to basis point changes in the spread, with an average PV01 of 0.006%. This range is driven by the disparate spread levels of each index—as an increase of 1 bp to the BB CMBX spread is a considerably smaller fraction of the traded level than it is for the AAA CBMX spread.

However, the convex relationship between the change in the upfront payment and the change in the traded spread is important to note. Tables 2 to 4 show the change in the upfront payment across all indices for small changes in spread, for three trade dates: 22 May 2008, 20 November 2008 and 15 July 2009. As expected, decreasing(increasing) the spread results in a(n) decrease(increase) in the upfront payment for all indices. However, the magnitude of the decrease in the upfront payment exceeds the magnitude of the increase for the same change in spread. Recalling that the price of the CMBX index is the par value minus the upfront payment (adjusted for any accrued premium), the price of the index is more sensitive to spreads tightening than widening.

4.3 Interest Rate Sensitivity

For each index and date in our sample period, we allow a ± 25 bps shift in the Libor-Swap curve to determine how the spread varies as the upfront payment is held constant. For each given trade date, the upfront payment is calculated based upon the actual Libor-Swap curve and traded spread for that index. We then assume a parallel 25 bps shift in the Libor-Swap curve. Under each of the three default scenarios, we solve for the spread that keeps the upfront payment constant after adjusting the risk-free discount factors. This methodology is also applied to determine the implied spread based on the market's assumed notional schedule. To solve for this implied spread, the survival probabilities are recalculated as well as the risk-free discount factors.

Figures 30 to 36 show the change in the implied deal spread in response to parallel yield curve shifts of 25 bps. The change in the implied deal spread is calculated under four different notional schedules: the assumed notional in the market and our three default scenarios. This change in spread is relative to the implied spread under the actual Libor-Swap curve, for the same notional schedule and is calculated as follows:

$$\Delta Spread_{i,+\Delta 25} = Spread_{i,+\Delta 25} - Spread_{i,actual} \quad (12)$$

$$\Delta Spread_{i,-\Delta 25} = Spread_{i,-\Delta 25} - Spread_{i,actual} \quad (13)$$

where i denotes the assumed notional schedule of the index (market, base, moderate, and severe).

The sensitivity of the implied CMBX index spread to shifts in the yield curve is inversely related to the index's level of subordination. As shown in Figure 36, the CMBX index of the lowest credit quality is the most sensitive to shifts in the yield curve. The implied spread of the BB-rated CMBX index increases and decreases by as much as 400 bps in response to a 25 bps increase and decrease, respectively. Conversely, the implied deal spread of the AAA-rated CMBX index is the

least sensitive to shifts in the yield curve, with the spread never increasing or decreasing by more than 10 bps during the sample period. However, as discussed in Section 6.3, the price impact of these changes in spread differ across indices. Thus, while the BB-rated CMBX spread is more sensitive to yield curve shifts, the price impact of this change in spread is less than the price impact for the AAA-rated CMBX index.

The key observation in Figures 30 to 36 is that the market convention of calculating the upfront payment based on a notional schedule that declines at a rate determined by the traded spread translates into extreme sensitivity to interest rates. The implied spreads under alternate notional schedules are considerably less sensitive to yield curve shifts—the change in the implied spread never exceeds the size of the yield curve shift. The degree of distortion between the alternate notional schedules and the market implied notional schedule is amplified as the credit quality of the index declines.

While Markit explains its decision to change CMBX trading from spread to price as an effort to increase the transparency of the upfront payment, the wide spreads and high sensitivity to interest rate movements can also account for this change in convention. Since the change in trading convention is relatively recent, whether or not this has reduced volatility in the CMBX and CMBS market is difficult to evaluate.

4.4 Revisiting the Basis

Based upon the three default scenarios considered, the AAA-rated CMBX index has negligible term default risk. Yet despite the known credit enhancement of the index, the traded spread indicates market expectations of losses in the reference obligations. In addition to the distortions caused by the trading mechanics of the index, the wide spread may suggest that market participants are pricing more than pure default risk of the constituent CMBS. The risk that the underlying collateral may be unable to refinance and pay the principal at the balloon date could be a potential explanation for wide AAA spreads. The AAA spread began its sharp ascension to its November 20, 2008 peak in early November 2008, coinciding with the period during which the Treasury-Eurodollar (TED) spread also peaked. Assuming the TED spread accurately represents the strain in credit markets, the spread on AAA CMBX was valuing the refinancing risk of the underlying obligations.

Since lower-rated tranches do not have the obvious credit enhancement of the AAA index, it is more difficult to explain the sheer magnitude of the CMBX-Cash basis and gap between the traded spread and scenario-specific spreads. Moreover, the notional schedules of the three default

scenarios considered are not necessarily the appropriate trajectory for writedowns in the underlying. However, as we observe in Figure 23, the spread is driven by not only how soon writedowns take place, but the rate at which they occur once they do. While the notional schedule implied by the market may assume immediate writedowns, the traded spread may be less than a spread implied by a notional schedule where writedowns are deferred, but occurring at higher rate.

Using the implied spreads under the alternate notional schedules, we recompute the basis for AAA and BBB CMBX. Figures 37 and 38 show the basis as observed in the market, compared to alternate measures of the basis. It is important to note that the cash spread is the index of cash spreads from Barclays Capital, shown in Figure 5. The spreads for BBB CMBS appear stale with little movement over our sample period, which may be a reflection of low trading in subordinate tranches or simply data quality issues specific to Barclays Capital.

However, given that the synthetic side of the basis has been adjusted for alternate notional schedules, the cash side may no longer be comparable to our alternate CMBX spreads. Since the Barclays Capital cash spreads are an index with an unknown composition and notional schedule, no adjustment is made to the cash side of this basis measure. However, we use the GG10 basis measure to explore the effect of adjusting both components of the basis. By adjusting both the synthetic and cash components, we may get a CMBX-Cash basis that is a better indicator of relative value in the two markets. We implement this adjustment for a single date (July 22 2009), rather than our full sample to simply illustrate how the basis can vary with the alternate notional schedule assumed. The traded spread for GG10 A4 is based on a 0 CPY, 0 CDR notional schedule that assumes the loan pays down as expected under the terms of the contract. This traded spread is equivalent to the base spread for the GG10 A4 bond. However, using this 0 CPY, 0 CDR schedule, we apply the moderate and severe default scenarios to calculate alternate spreads. The alternate spreads for GG10 A4 are then compared to our alternate AAA CBMX spreads to see how the basis changes under these assumptions.

The results are shown in Table 5. The first row shows that on July 22, 2009, the observed basis in the market—using the spreads that are implied by the synthetic and cash market’s respective pricing convention—is nearly -250 bps. However, as we adjust the synthetic and cash notional schedules to reflect our three alternate default scenarios, we see that the adjusted basis becomes wider as the speed and timing of defaults intensifies. Interestingly, the AAA CMBX spreads across our alternate notional schedules are approximately equal, while the GG10 spread is more sensitive to changes in the default schedule. Both Figure 37 and Table 5 show that the CMBX-Cash basis

can take on any possible value once you impose any alternate notional schedule.

5 Conclusion and Discussion

The introduction of the CMBX has provided the market with an efficient instrument to synthetically gain or hedge exposure to the CMBS market, across a range of credit ratings. However, the quotation convention of the index has distorted the perceived level of default risk in the commercial real estate market—this distortion is exacerbated as the deviation between the traded spread and fixed premium grows larger. By calculating new implied spreads under alternate notional schedules of the constituent CMBS, we find that following November 2008 the deal spreads on the indices trade far wider than spreads under a scenario of severe default. The implications of this finding suggest that the true, or justified, CMBX-Cash basis is in fact more negative than observed in the market. However, the impact of synthetic spreads on the cash market is unknown. While recent CMBS issuance has been low, secondary trading has remained robust. If synthetic spreads are artificially wide due to trading mechanics, and these spreads in turn lead the cash market, then both components of the CMBX-Cash basis are distorted.

Arbitrageurs looking to profit from a perceived mispricing between the CMBX-Cash market should be aware that this distortion may limit the ability of the basis to move towards its equilibrium relationship. Moreover, an observed negative or positive basis is not a clear indication of relative mispricing between the two markets. The observed basis as shown in Figures 1 and 2, is calculated using the spreads implied under each market’s quoting convention. However, given the differences in quoting conventions, the quoted basis in the market is not an appropriate measure of relative value in the two markets. Additionally, amongst the CMBX dealers in the market, there may be different conventions as to which cash spread is designated the benchmark for quoting purposes. Even after adjusting the notional schedules for the CMBX and cash sides of the basis, its meaningfulness as an indicator is questionable. As we have demonstrated, the spread is highly sensitive to assumptions in how the notional balance declines, interest rates, and risks such as prepayment and extension. As the aforementioned assumptions vary, we can push the basis to take on any value we choose.

The persistence of the basis remains a puzzle. Firstly, the ability to enforce arbitrage in the CMBX market is made more difficult given that it references 25 names. As an arbitrageur, the ability to find all 25 CMBS in the index is limited. The initial offering size across all 25 names is not equal, nor is the relative trading volume. This explains the practice in the market of using the

single-name basis as a proxy for the true CMBX-Cash basis. Another consideration, mentioned in Section 4.4, is the impact of extension risk. Under the market convention of quoting the basis, we compare the CMBX spread to a single-name cash spread. However, the CMBX is essentially a basket of CDS referencing 25 names. The impact of extension risk on the CMBX spread versus the cash spread may be less given the effect of diversification. Returning to the example in Table 5, we observe that impact of prepayment on the cash spread is greater than the impact on the CMBX spread.⁸ The limited impact of extension risk on the diversified CMBX may be pushing the synthetic spread down, while the single-name cash spread trades wider due to greater exposure.

⁸ We do not know the price impact of the change in the GG10 spread. However, as discussed in Section 4.2, the price of AAA CMBX is the most sensitive to changes in spread of the seven CMBX indices.

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A CMBX Indicative Terms

Table 1: CMBX Indicative Terms

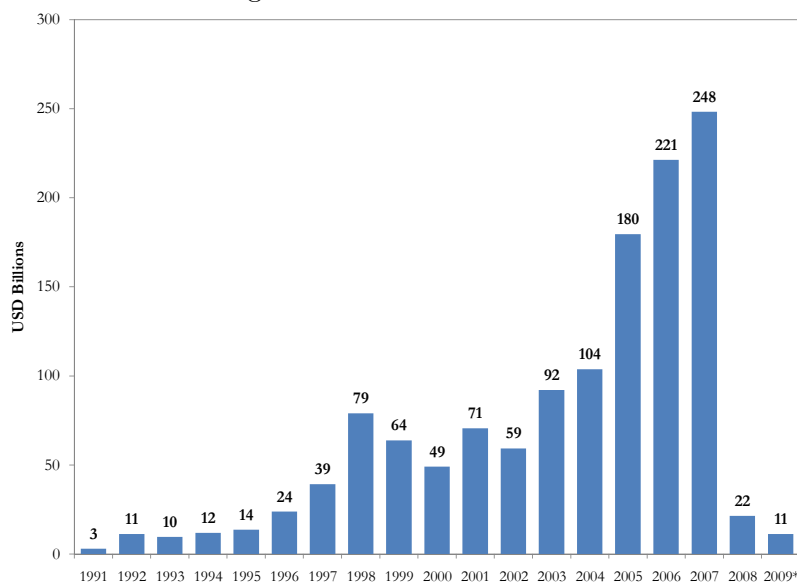
	Index Name	Fixed Rate (bps)
Indices:	CMBX.NA.AAA.5	35
	CMBX.NA.AJ.5	98
	CMBX.NA.AA.5	175
	CMBX.NA.A.5	350
	CMBX.NA.BBB.5	500
	CMBX.NA.BBB-.5	500
	CMBX.NA.BB.5	500
Notional:	Amortization mirrors underlying bonds	
Fixed Rate:	Established 1-day prior to roll date	
Floating Rate Payments:	Interest Shortfall, Writedown, Principal Shortfall	
Additional Fixed Payments:	Floating rate payment event reimbursements	
Quotations:	Quoted on price (difference between the par value and upfront payment). Upfront payment based upon the difference between the current traded spread and the Fixed Rate.	
Physical Settlement:	Does not apply	
Accruals:	25th to the 25th of each month	
Payments:	Made on the 25th of each month	
Day Count:	Actual/360	

Source: Markit

B Origins of the CMBX Market

CMBS have been a prominent source of financing for the commercial real estate market over the past twenty years. The development of the securitization market has facilitated lending by improving liquidity and creating a secondary market for the loans. As illustrated in Figure 3, CMBS issuance in the US has grown remarkably since 1990, peaking at \$248 billion in 2007. Moreover, the growth potential for the CMBS market remains considerable as the percentage of securitized commercial loans represents 27% of the total commercial debt market. However, credit markets have remained strained since mid-2007 due to the prolonged effects of the subprime residential mortgage crisis. Consequently, CMBS issuance in 2008 and 2009 has fallen sharply. Issuance in the US totalled \$22 billion in 2008, and stands at \$11 billion as of July 2009.

Figure 3: US CMBS Issuance



Source: Bloomberg; *As of July 2009

On March 7, 2006 the first series of the CMBX initiated trading and allowed investors to gain or shed broad synthetic credit exposure to the CMBS market. Markit both owns and acts as the administrator of the CMBX. On the launch date of each series of the CMBX, the series is initially an equally-weighted basket of credit default swaps (CDS) that references 25 single-name CMBS. The weights may vary as the CMBS underlying the index pay down at different rates. The index does not reference the 25 entities, but rather a specific obligation for each entity. Hence, a default by an entity in one tranche of the issue does not force default in senior tranches. Each series

is further partitioned into indices by credit rating. Upon the initial launch of CMBX Series 1, there were five ratings categories: AAA, AA, A, BBB, and BBB-. Since the initial Series 1 roll, two additional ratings categories have been added to CMBX Series 2 through 5: AJ and BB.⁹ Approximately every six months, a new series is rolled out with 25 new constituent CMBS. As a new series is introduced, trading in the previous series continues. There are currently five CMBX series trading.¹⁰

Prior to April 20, 2009, the CMBX indices traded on spread. Following a dealer vote, the CMBX trading convention switched to price in an effort to increase transparency of the upfront value of the contract. Thus, both the CMBX spread and price are publicly available on all CMBX series and indices. Since the CMBX indices are effectively an index of CDS referencing the obligations of 25 entities, market participants frequently compare the differential between the CMBX spread and spread on a constituent CMBS. Many traders attempt to exploit this differential, known as “the basis”. A non-zero basis is often interpreted as a dislocation in credit markets that can be profited upon. However, we will examine how the market trading convention can distort the pricing of CMBX indices—particularly as the traded spread widens significantly relative to the index’s fixed premium.

C CMBX Trading Mechanics

We begin with a basic overview of trading in CMBX, which is structured identically to trading in single-name CMBS CDS. Under a CMBX trade, there are two involved parties: the seller of protection (SoP) and the buyer of protection (BoP). In the absence of a credit event, the BoP pays the SoP the fixed rate on the contract’s notional balance. This fixed rate is also referred to as the coupon or premium, and is established and disclosed by Markit for each rating category one day prior to the series’ roll date following a survey from dealers in the market. The SoP merely collects the premium and need not pay any amount to the BoP. Under this scenario, the payments of a CMBX contract are identical to a standard corporate CDS contract. However, once a credit event occurs, the payments exchanged under a CMBX contract no longer resemble a corporate CDS. This is the key distinction between the “Cash and Physical Settlement” (CPS)

⁹ The AJ tranche (the most subordinate of the AAA tranches), was incorporated into CMBX Series 1 on January 4, 2008. CMBX Series 1 does not include a BB tranche.

¹⁰ The majority of CMBX dealers voted to defer the CMBX Series 6 launch, originally planned for October 25, 2008, due to thin CMBS issuance.

and the “Pay-As-You-Go” (PAUG) formats, which are standardized by the International Swaps and Derivatives Association (ISDA). Corporate CDS follow the CPS structure, while single-name CMBS CDS and CMBX follow the PAUG format with cash settlement. Since physical settlement does not apply, the CMBX-Cash basis is not influenced by the cheapest-to-deliver (CTD) option embedded in corporate CDS contracts.¹¹ In order to understand the how the CMBX is priced, a discussion of the PAUG structure is required.

C.1 PAUG Settlement and the CMBX

PAUG settlement contrasts sharply with the CPS format when a credit event occurs. As summarized in Table 1, three defined credit events trigger a floating payment from the SoP to the BoP:

1. *Writedown*: occurs in the event of a reduction in the principal of a constituent reference CMBS, not owing to a scheduled or unscheduled principal payment
2. *Failure to pay principal*: the reference CMBS fails to make the required principal payment
3. *Interest shortfall*: failure by the reference entity to either pay an expected interest amount, or the actual interest amount paid is less than the expected interest amount.

The floating payment is intended to compensate the BoP for losses suffered. However, the compensation payments under PAUG settlement are spread out over remaining scheduled payment dates—as opposed to a single compensation payment that terminates the contract under corporate CDS contracts. Moreover, the fixed rate payments made by the BoP continue. The continuing exchange of payments over the life of the contract better reflect the actual cashflows of the underlying CMBS. If interest shortfalls and writedowns in a reference CMBS are reversed in a future period, a reimbursement payment is made by the BoP to the SoP. The ongoing exchange and adjustment of payments at scheduled dates enable the CMBX to synthetically replicate the cash flows of the reference obligations. Since the reimbursements are not limited to one point in time, the settlement method is termed “pay-as-you-go”. A credit event under PAUG settlement does not result in termination of the contract, unlike corporate CDS under the CPS.

¹¹For corporate CDS with physical settlement, the BoP is given delivery optionality. When a credit event occurs, the BoP has the option to deliver some equivalent-seniority bond of the reference entity in exchange for the bond’s par value from the SoP. Thus, there is an incentive for the BoP to search the market for the CTD bond. The impact of the CTD option on the basis is discussed in Blanco et al. (2005).

C.2 CMBX Pricing and Trading

Effective April 20, 2009 the CMBX indices began trading on price rather than quoted spread. The quoted price is the difference between the par value and any required upfront payment to be exchanged between the BoP and SoP, adjusted for any accrued premium from the last payment date:

$$\text{price per \$1 par} = 1 - \frac{\text{upfront payment} - \text{accrued premium}}{\text{notional}} \quad (14)$$

$$\text{accrued premium} = \text{notional} \times \text{fixed rate} \times \frac{\text{actual}}{360} \quad (15)$$

The upfront payment reflects the change in the value of the contract as the traded spread of the index deviates from the fixed coupon rate—it is the net present value of the contract’s expected fixed and floating payments on the date the trade is initiated. The traded spread and fixed coupon rate differential are applied to the notional schedule of the index that assumes no default or prepayment, adjusted for the probability of survival.

If the traded spread of the index exceeds the fixed coupon rate, it implies that the perceived credit risk of the reference obligations has increased since the roll date of the index. Therefore, the BoP must make an upfront payment to the SoP to compensate the SoP for assuming this increased default risk. Conversely, if the traded spread falls below the fixed rate of the index, the SoP must pay the BoP since the risk of default by the reference obligations has fallen. The adjustment to the upfront payment accounts for the premium accrued since the last fixed payment date. In the case of an upfront payment from the BoP to the SoP, the upfront is reduced by the accrued premium.

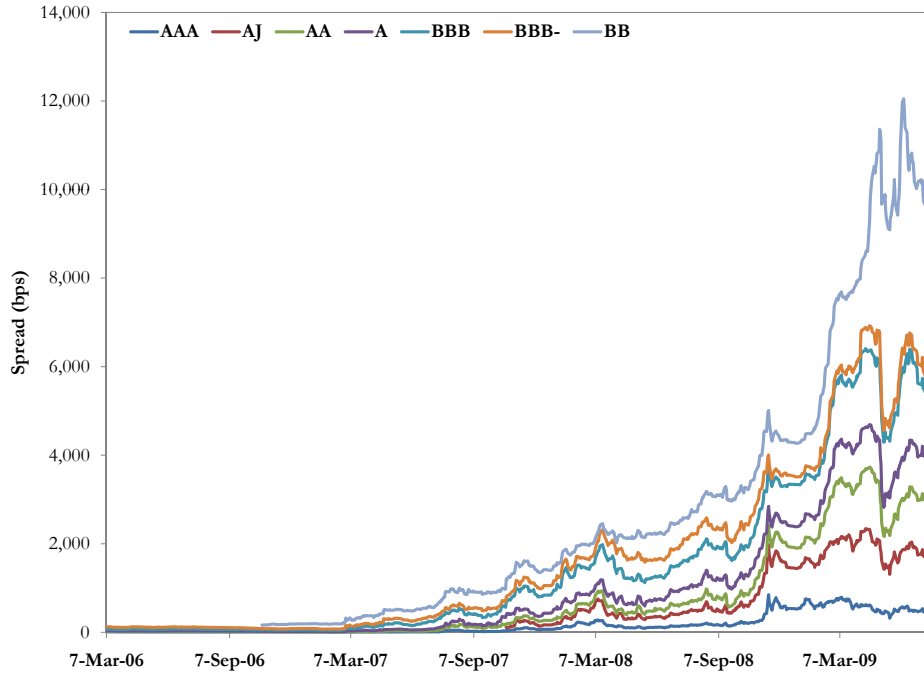
C.3 Risk Indicator in the Commercial Mortgage Market

The CMBX indices have been constructed to allow investors to synthetically assume a long or short position in the 25 constituent CMBS. The CMBX’s partitioning by rating category, standardized documentation, construction transparency and pre-defined roll dates have made the indices an appealing, liquid alternative to the underlying cash bonds. Despite active trading of CMBS in the secondary market, thin issuance during 2008 and 2009 has led to a greater focus on the synthetic market to assess risk in the commercial real estate market. As such, the record spreads of the CMBX Series 5 have been interpreted by the market as a worrying indicator of default. As shown in Figure 4, traded spreads for the current on-the-run series have widened considerably since their initial roll date of May 22, 2008. For example, the traded spread on CMBX.NA.AAA.5 reached

a peak of nearly 850 bps on November 20, 2008—implying market expectations of 850 bps losses per year on the constituent CMBS. However, the credit enhancement provided by subordination in AAA CMBS protects the investor from principal shortfalls and has historically translated to tight spreads over swaps. Figure 5 presents historical CMBS spreads over swaps since early 2006. The notable widening in spreads coincides with the onset of the August 2007 US residential subprime mortgage crisis, suggesting that the commercial mortgage market is not entirely insulated from the problems of the residential market.

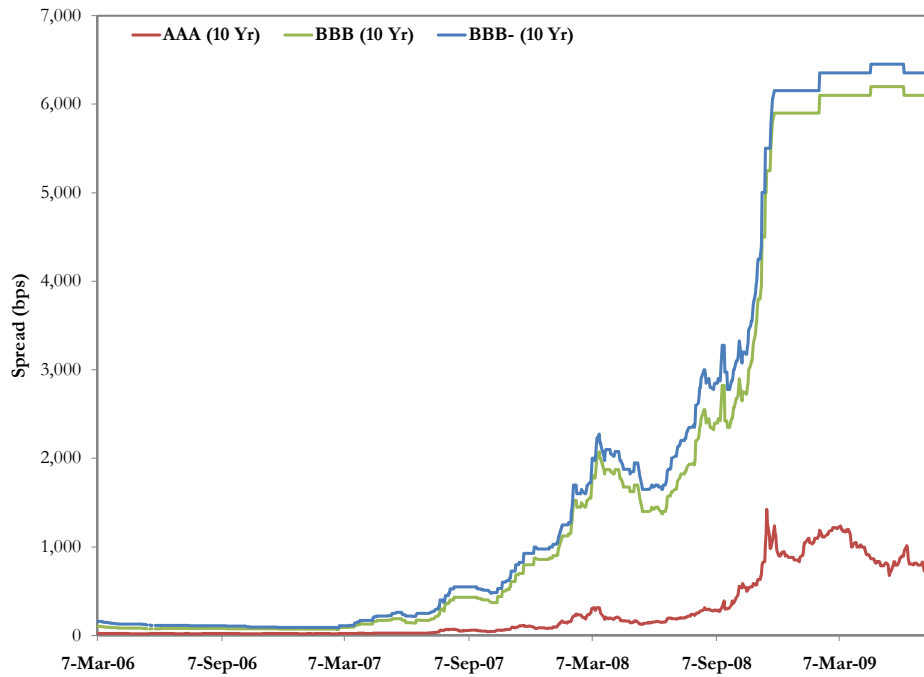
D Figures and Tables

Figure 4: On-The-Run CMBX Spreads



Source: Barclays Capital

Figure 5: CMBS Spreads



Source: Barclays Capital

Figure 6: Moderate Default

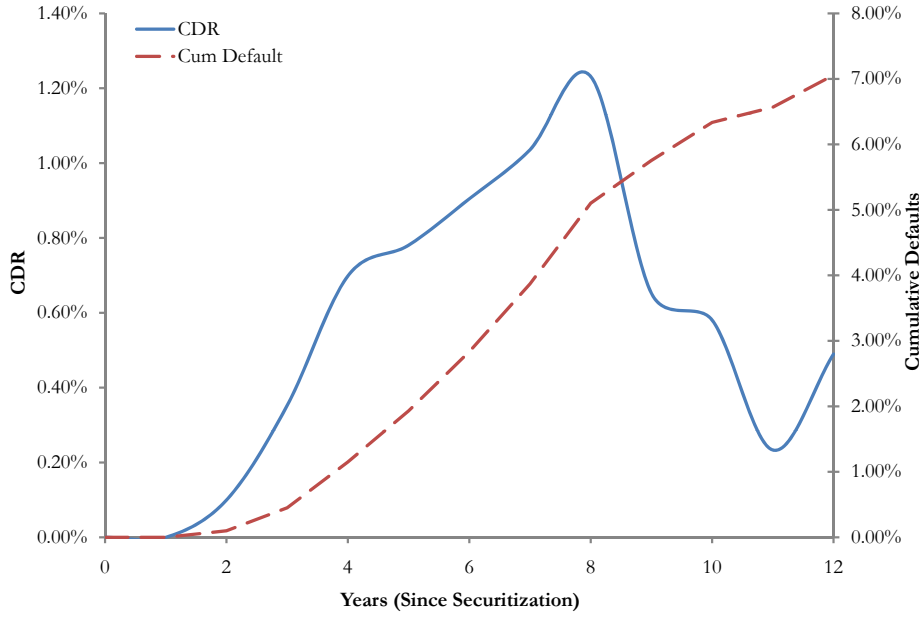


Figure 7: Severe Default

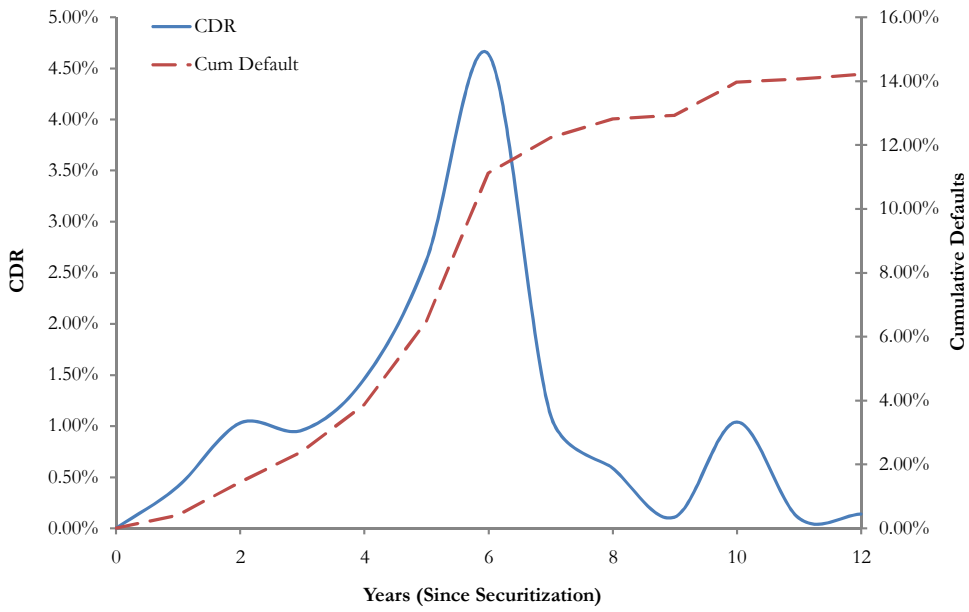


Figure 8: CMBX.NA.AAA.5 Spreads

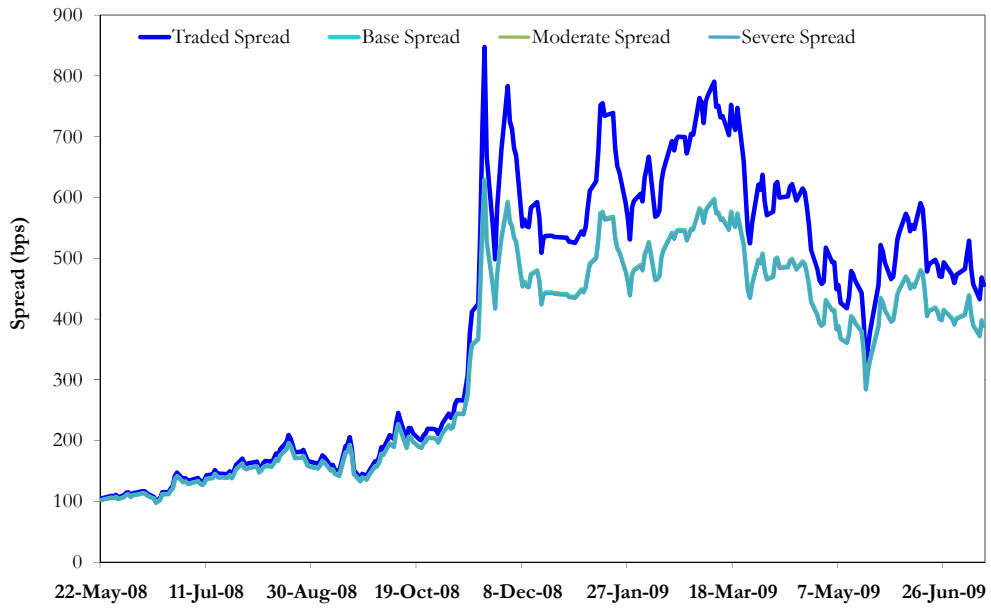


Figure 9: CMBX.NA.AJ.5 Spreads

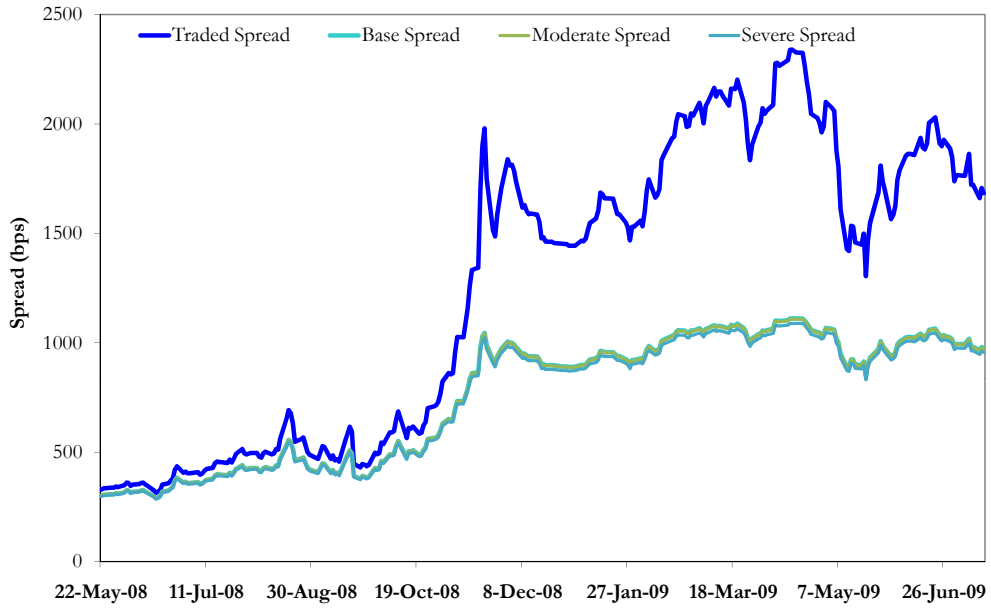


Figure 10: CMBX.NA.AA.5 Spreads

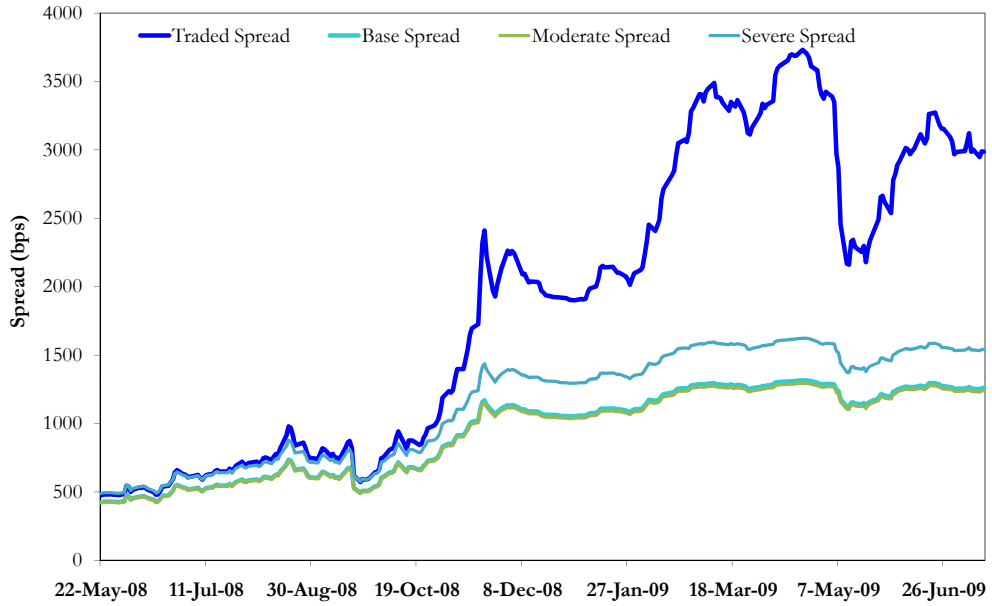


Figure 11: CMBX.NA.AA.5 Spreads

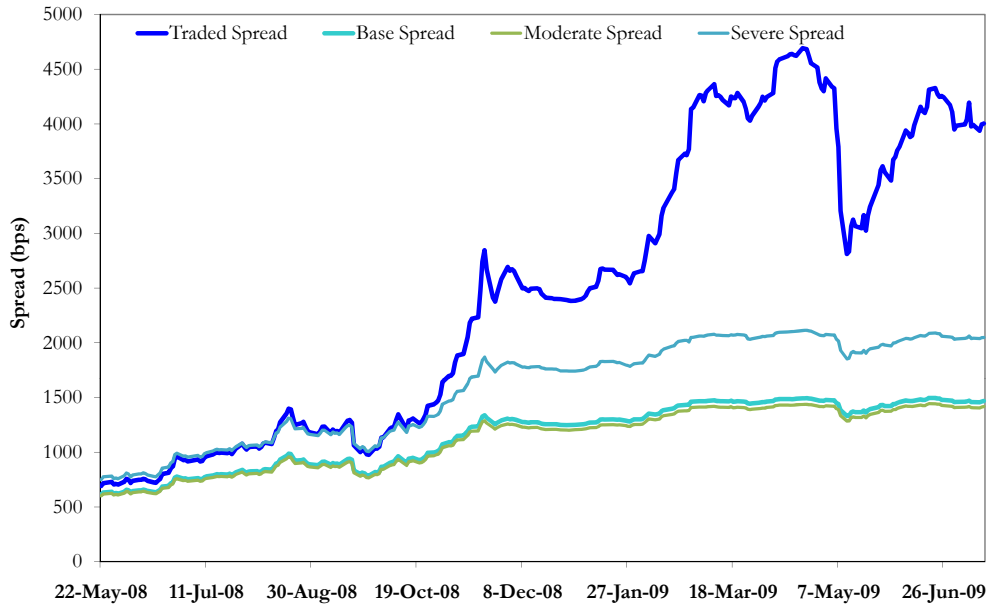


Figure 12: CMBX.NA.BBB.5 Spreads

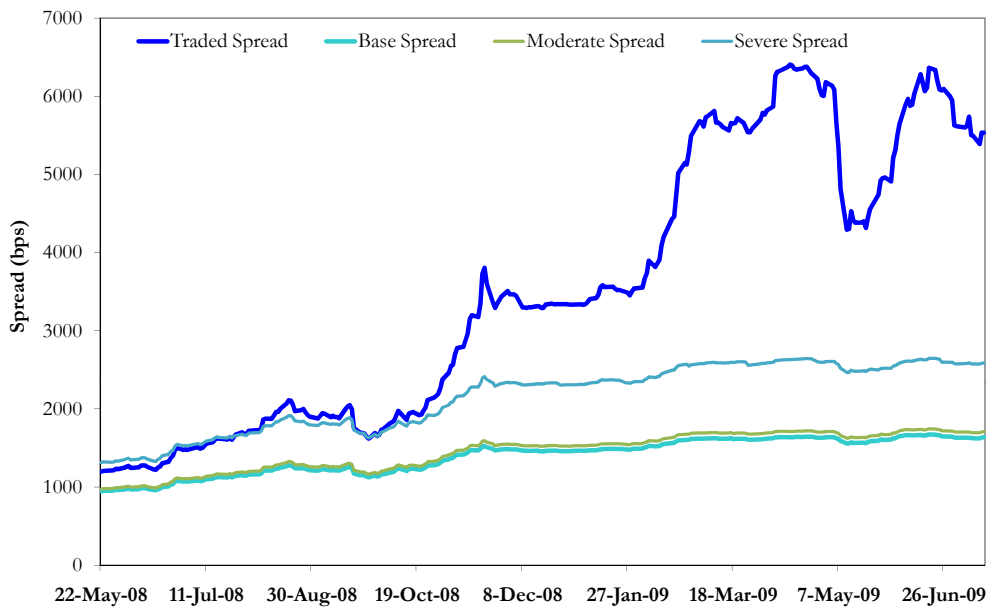


Figure 13: CMBX.NA.BBB-.5 Spreads

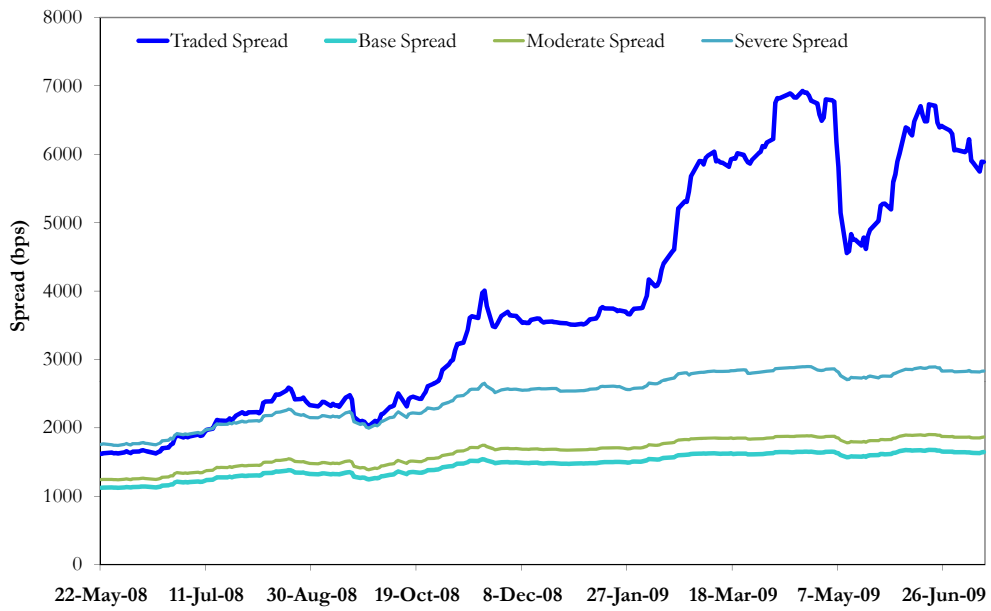


Figure 14: CMBX.NA.BB.5 Spreads

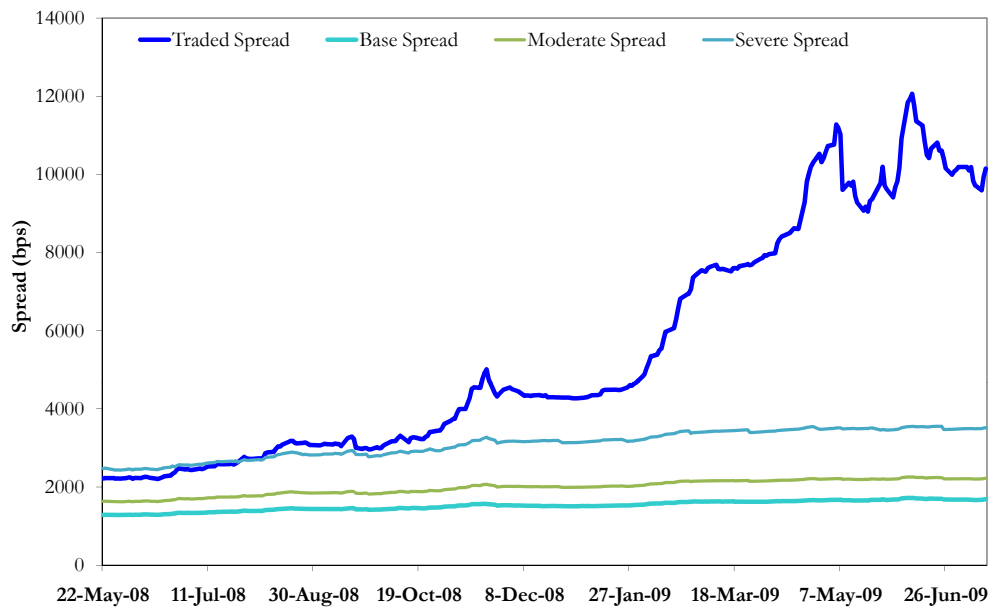


Figure 15: AAA Notional Schedule: 17 June 2008

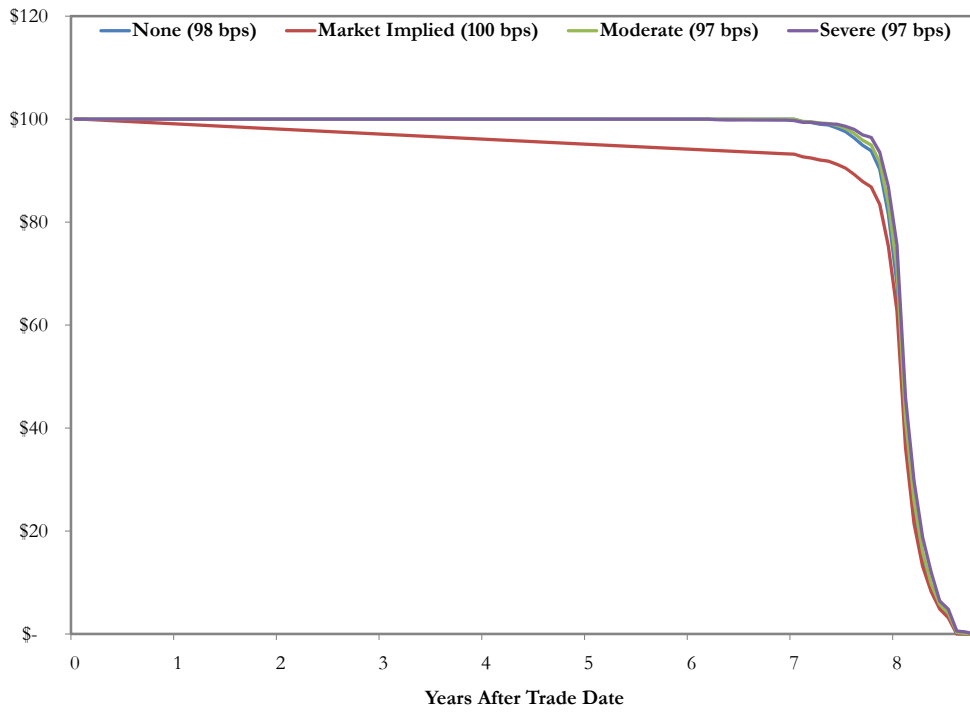


Figure 16: AAA Notional Schedule: 20 November 2008

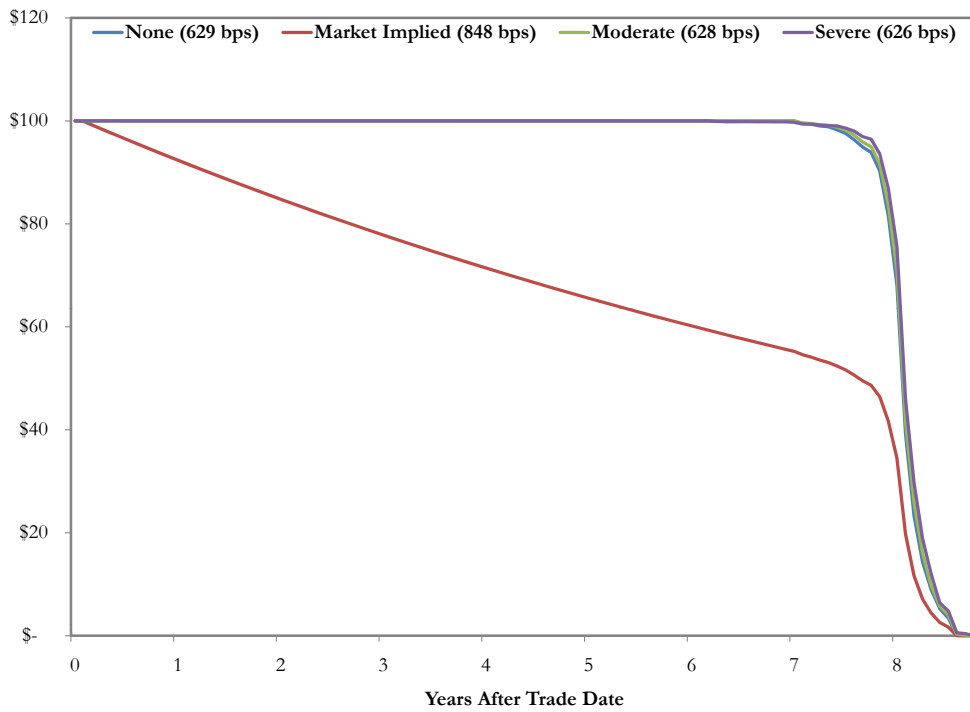


Figure 17: AJ Notional Schedule: 17 June 2008

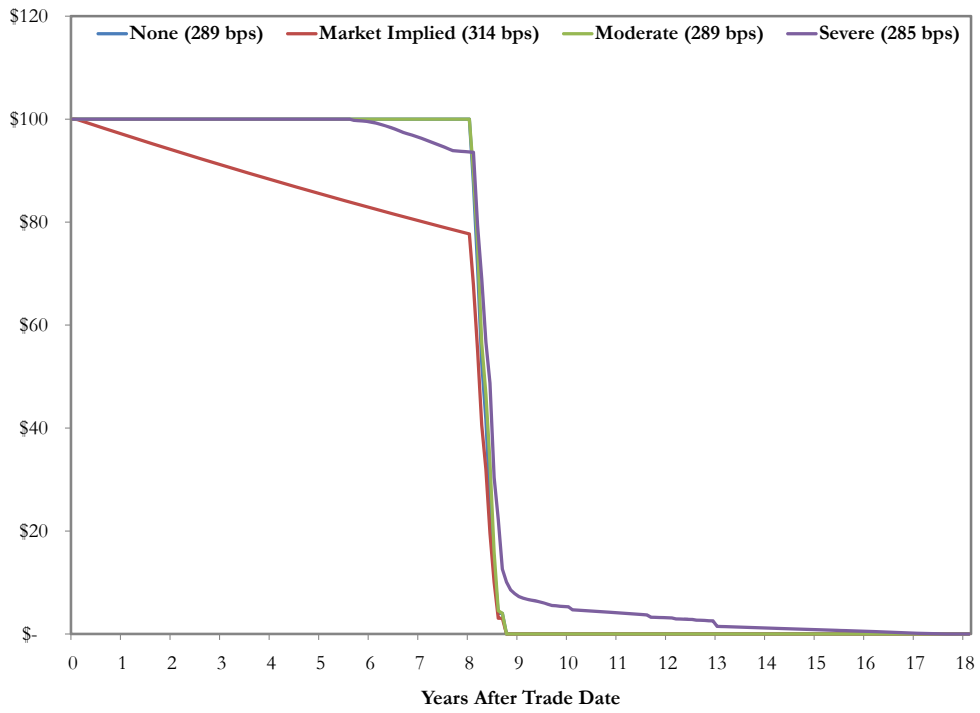


Figure 18: AJ Notional Schedule: 15 April 2009

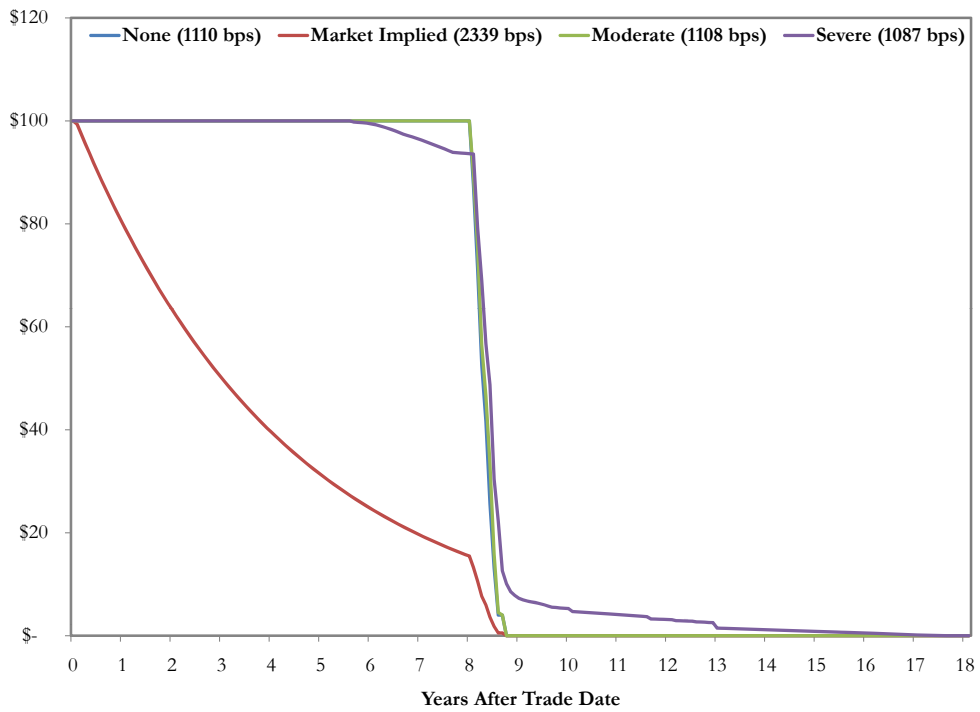


Figure 19: AA Notional Schedule: 22 May 2008

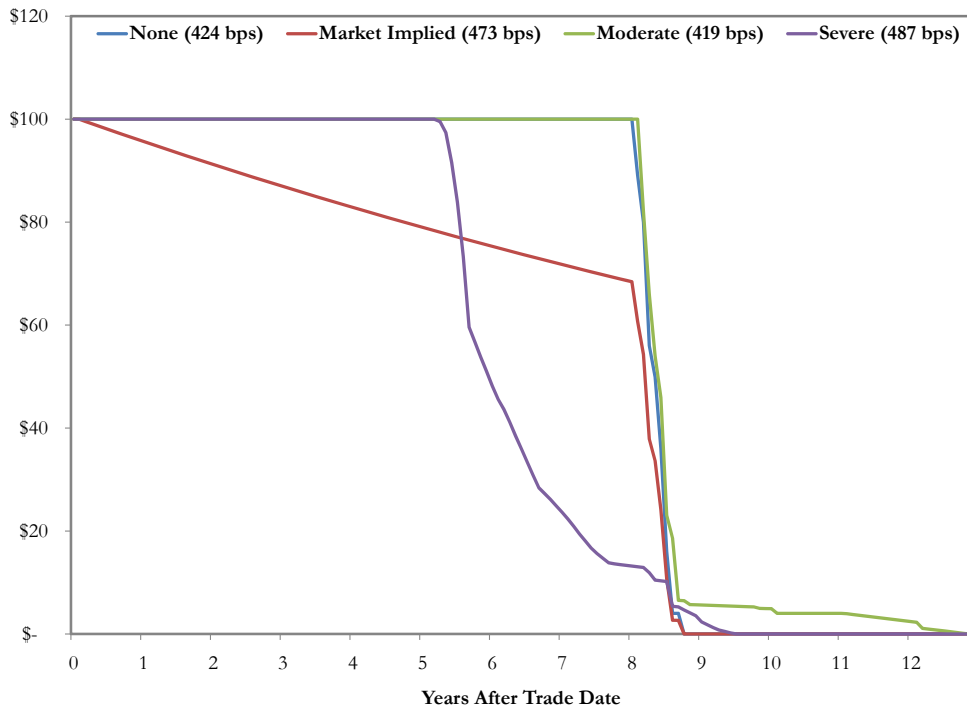


Figure 20: AA Notional Schedule: 20 April 2009

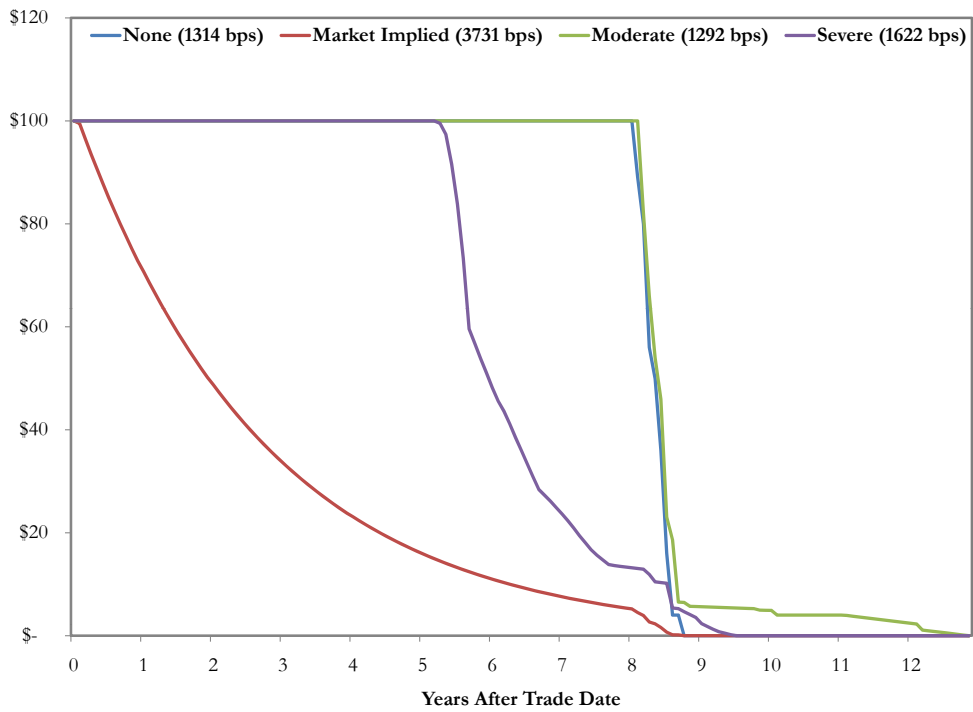


Figure 21: A Notional Schedule: 22 May 2008

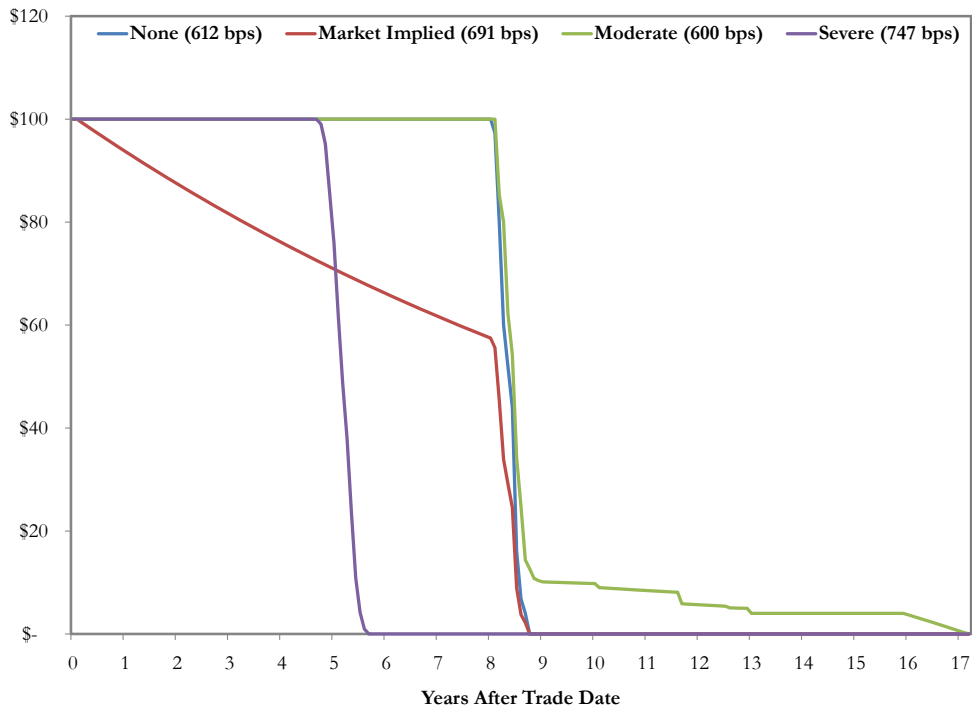


Figure 22: A Notional Schedule: 20 April 2009

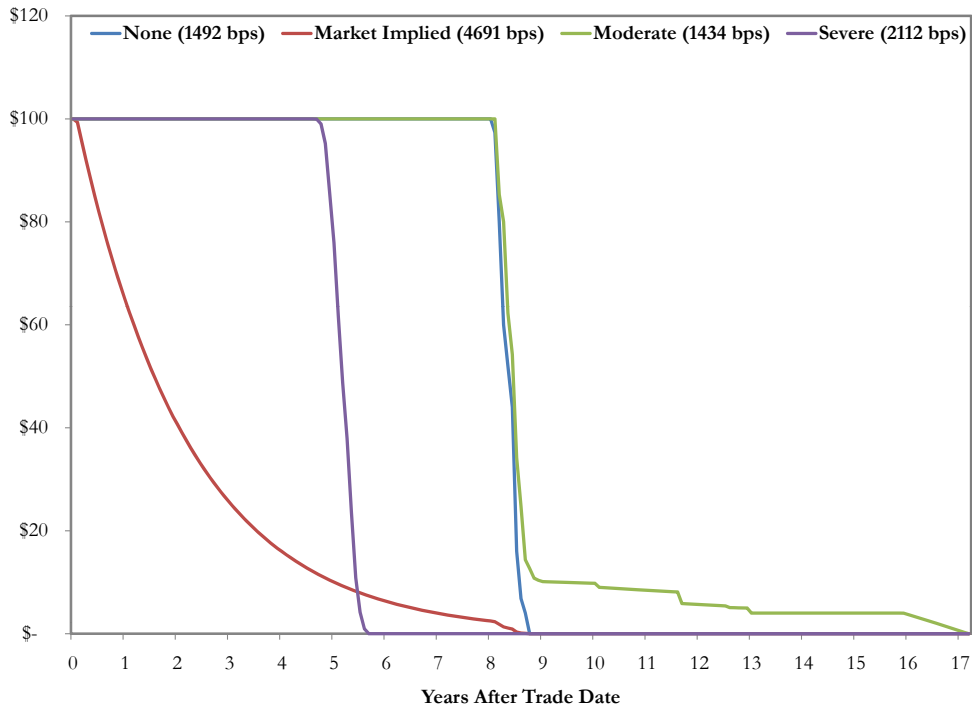


Figure 23: BBB Notional Schedule: 22 May 2008

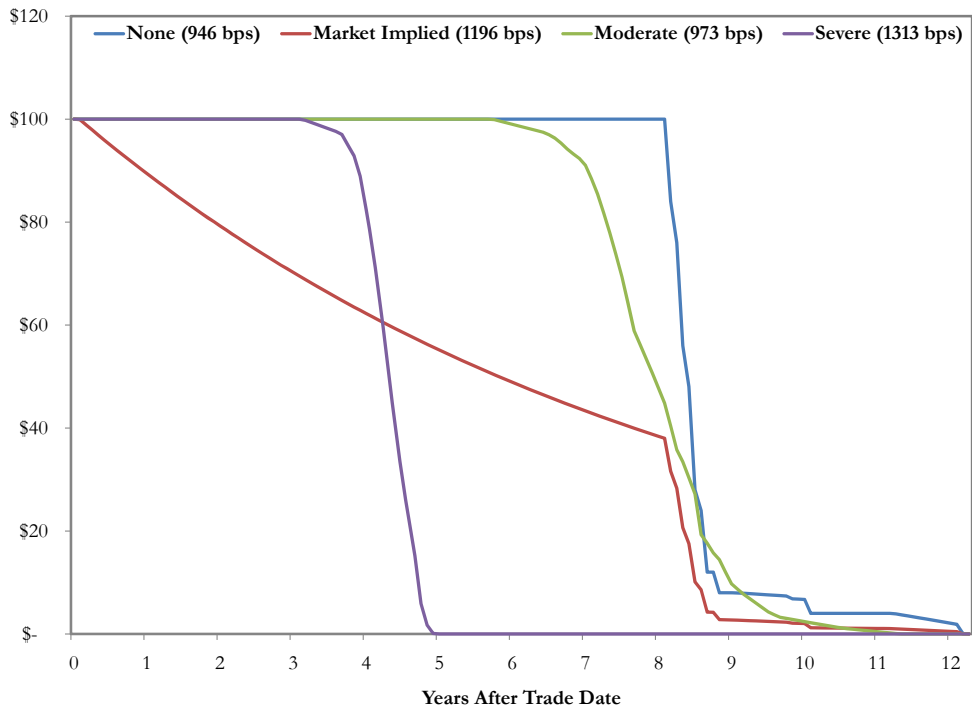


Figure 24: BBB Notional Schedule: 14 April 2009

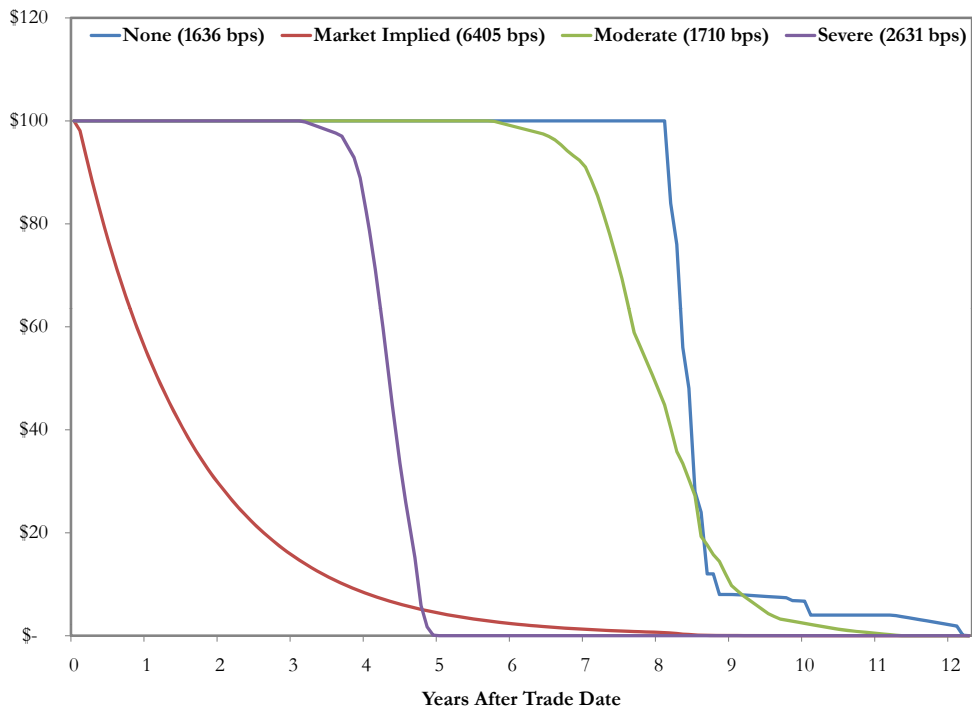


Figure 25: BBB- Notional Schedule: 22 May 2008

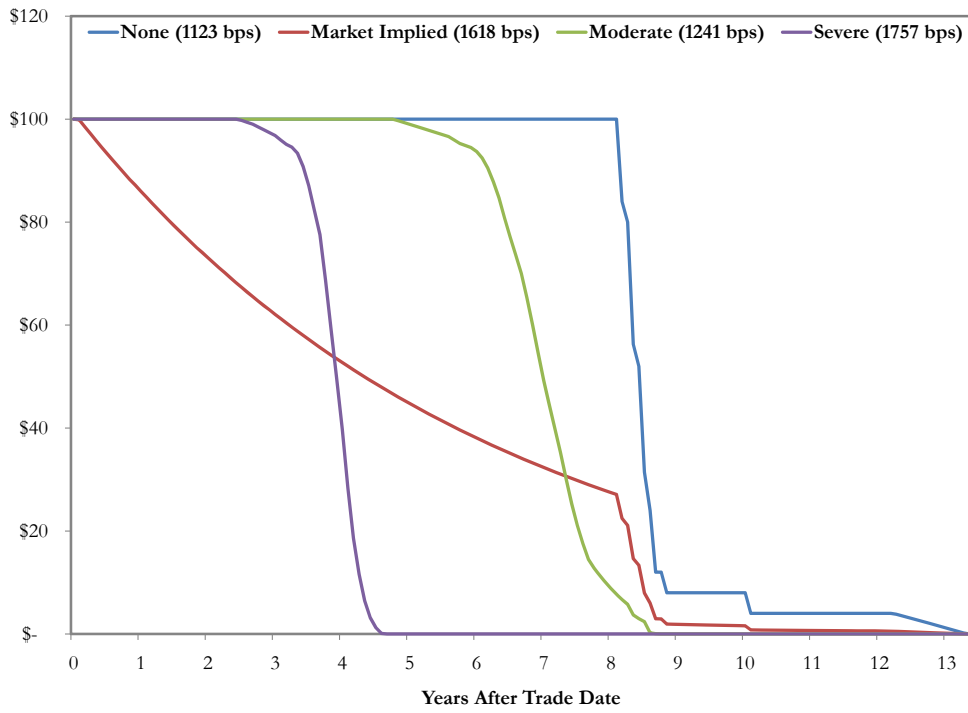


Figure 26: BBB- Notional Schedule: 20 April 2008

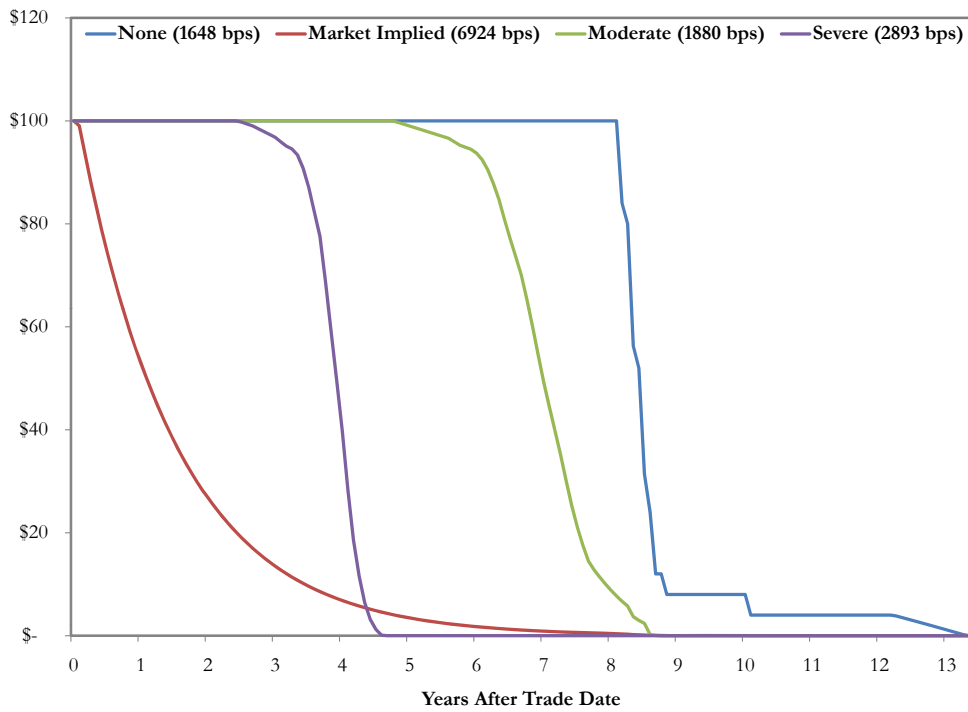


Figure 27: BB Notional Schedule: 17 Jun 2008

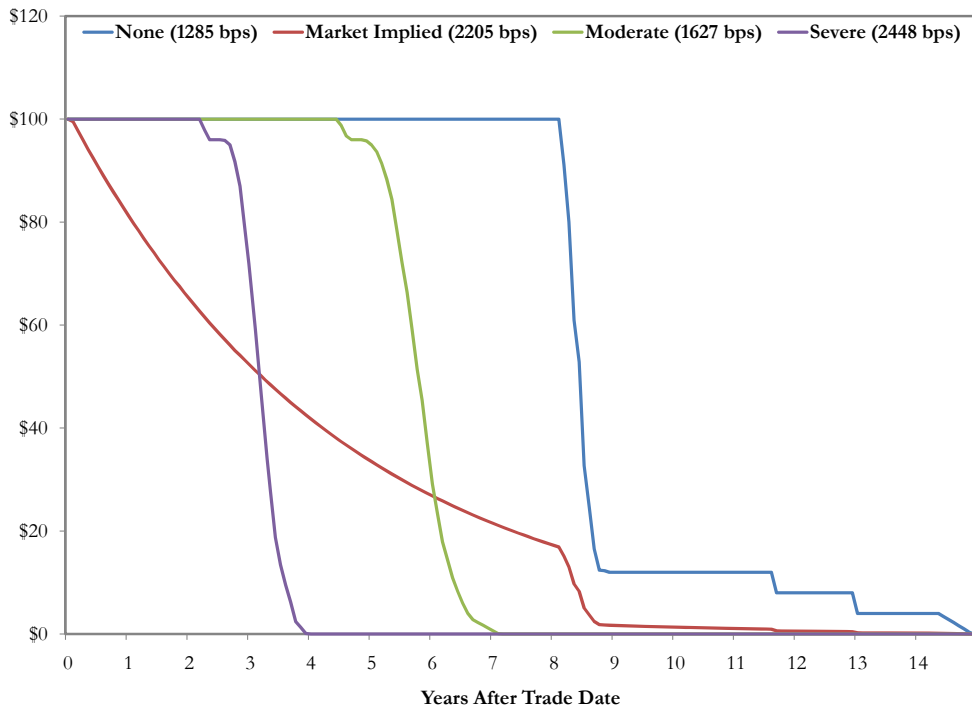


Figure 28: BB Notional Schedule: 20 April 2009

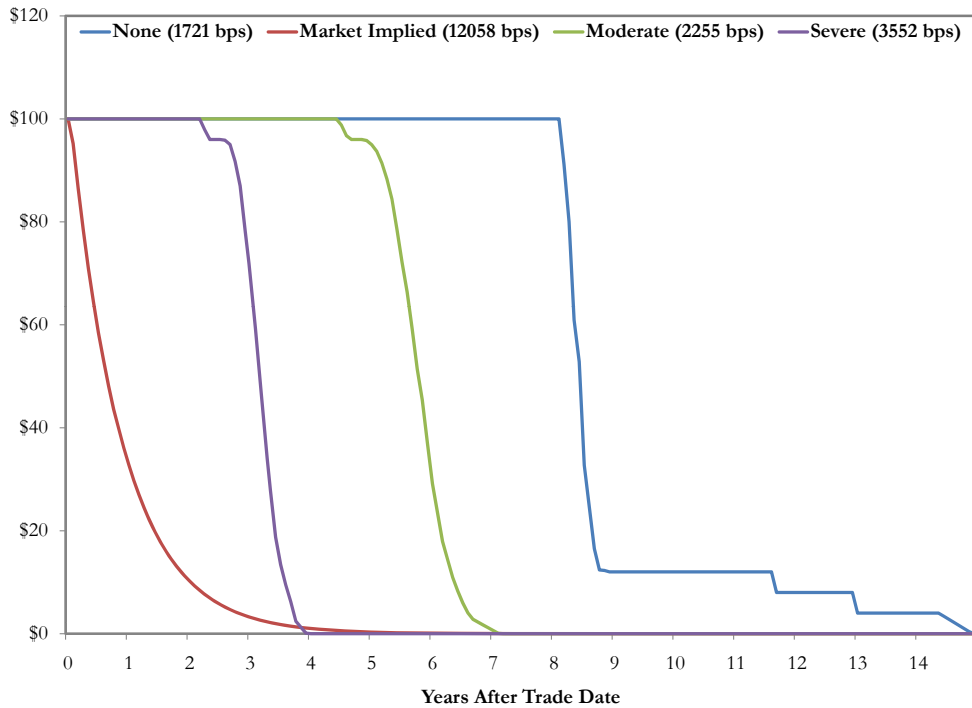


Figure 29: Price Value of a Basis Point

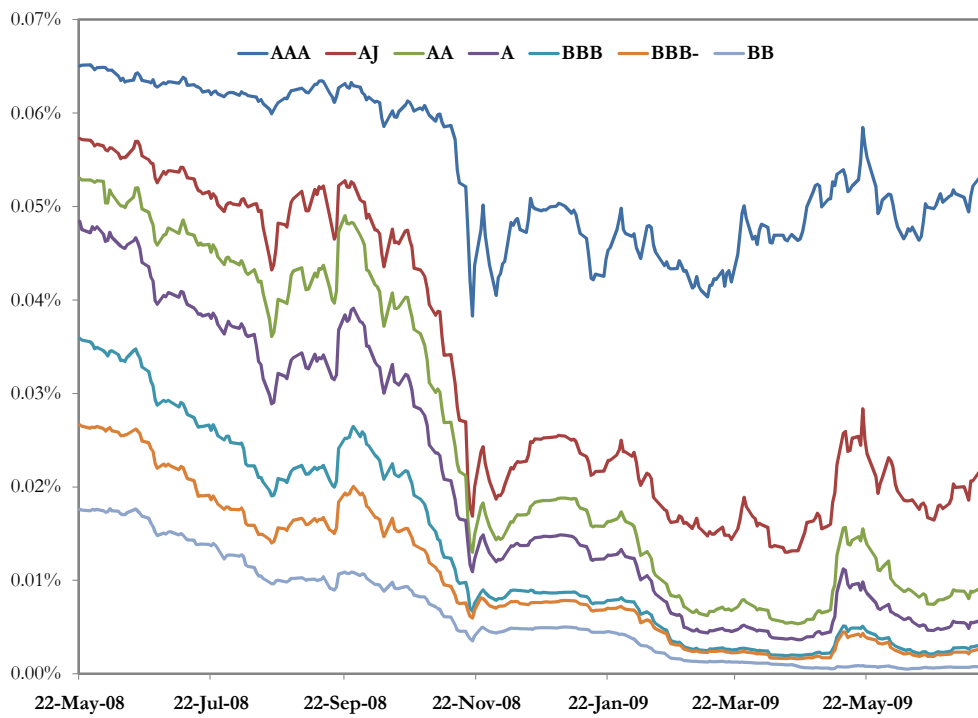


Table 2: Change in Upfront Payment: 22 May 2008

Spread Change	-10 bps	-5 bps	+5 bps	+10 bps
AAA	-\$652,917	-\$325,831	\$324,583	\$647,921
AJ	-\$575,140	-\$287,012	\$285,901	\$570,695
AA	-\$532,141	-\$265,561	\$264,546	\$528,080
A	-\$485,920	-\$242,509	\$241,610	\$482,324
BBB	-\$360,224	-\$179,788	\$179,142	\$357,641
BBB-	-\$267,264	-\$133,399	\$132,936	\$265,410
BB	-\$176,680	-\$88,193	\$87,902	\$175,513

Table 3: Change in Upfront Payment: 20 November 2008

Spread Change	-10 bps	-5 bps	+5 bps	+10 bps
AAA	-\$384,357	-\$191,811	\$191,078	\$381,426
AJ	-\$169,350	-\$84,519	\$84,208	\$168,105
AA	-\$130,417	-\$65,094	\$64,864	\$129,500
A	-\$109,528	-\$54,675	\$54,497	\$108,816
BBB	-\$67,074	-\$33,489	\$33,395	\$66,696
BBB-	-\$59,907	-\$29,912	\$29,830	\$59,579
BB	-\$35,486	-\$17,722	\$17,681	\$35,320

Table 4: Change in Upfront Payment: 15 July 2009

Spread Change	-10 bps	-5 bps	+5 bps	+10 bps
AAA	-\$518,648	-\$258,826	\$257,834	\$514,680
AJ	-\$212,628	-\$106,117	\$105,726	\$211,062
AA	-\$89,463	-\$44,657	\$44,509	\$88,872
A	-\$55,240	-\$27,581	\$27,503	\$54,929
BBB	-\$29,253	-\$14,611	\$14,579	\$29,127
BBB-	-\$25,200	-\$12,587	\$12,562	\$25,098
BB	-\$7,094	-\$3,545	\$3,541	\$7,078

Note: Change in the upfront payment is based on \$100 million notional

Figure 30: CMBX.NA.AAA.5: Change in Spread for ± 25 bps Yield Curve Shift

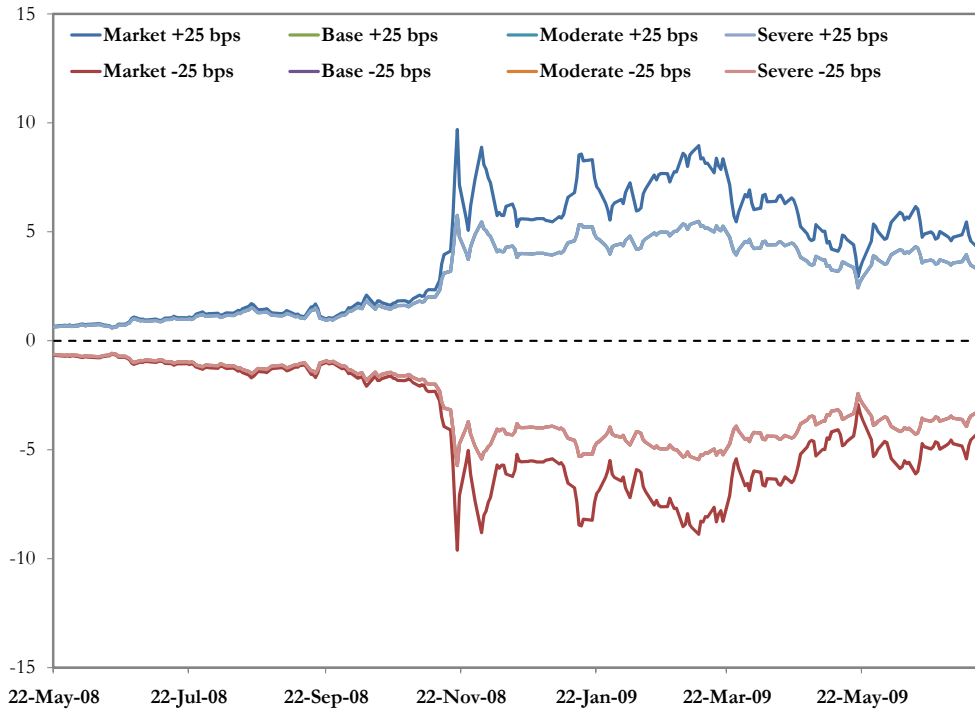


Figure 31: CMBX.NA.AJ.5: Change in Spread for ± 25 bps Yield Curve Shift

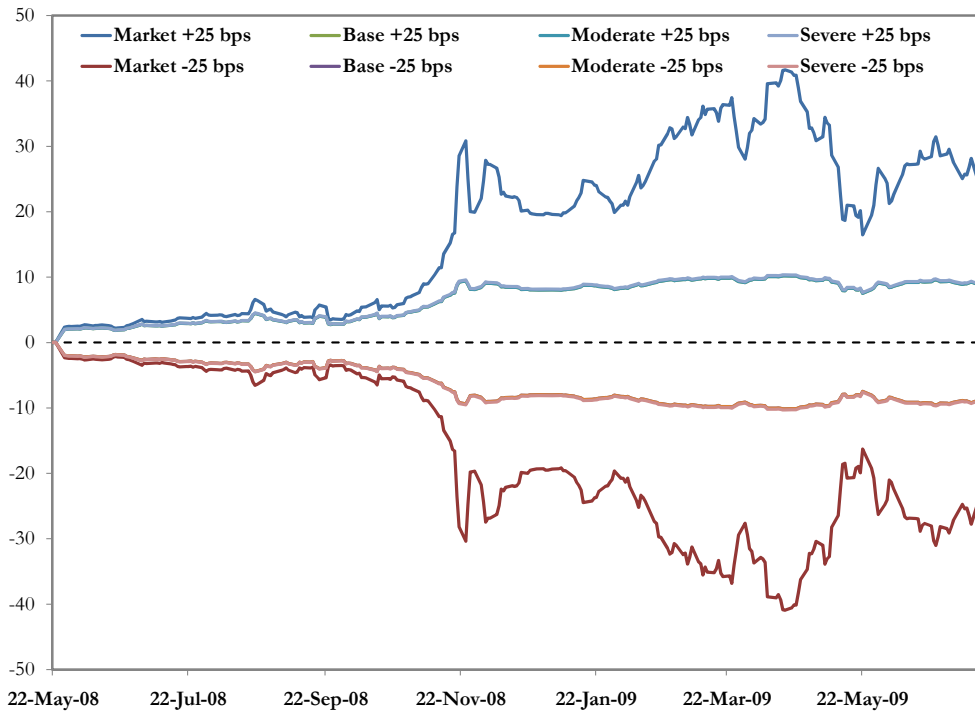


Figure 32: CMBX.NA.AA.5: Change in Spread for ± 25 bps Yield Curve Shift

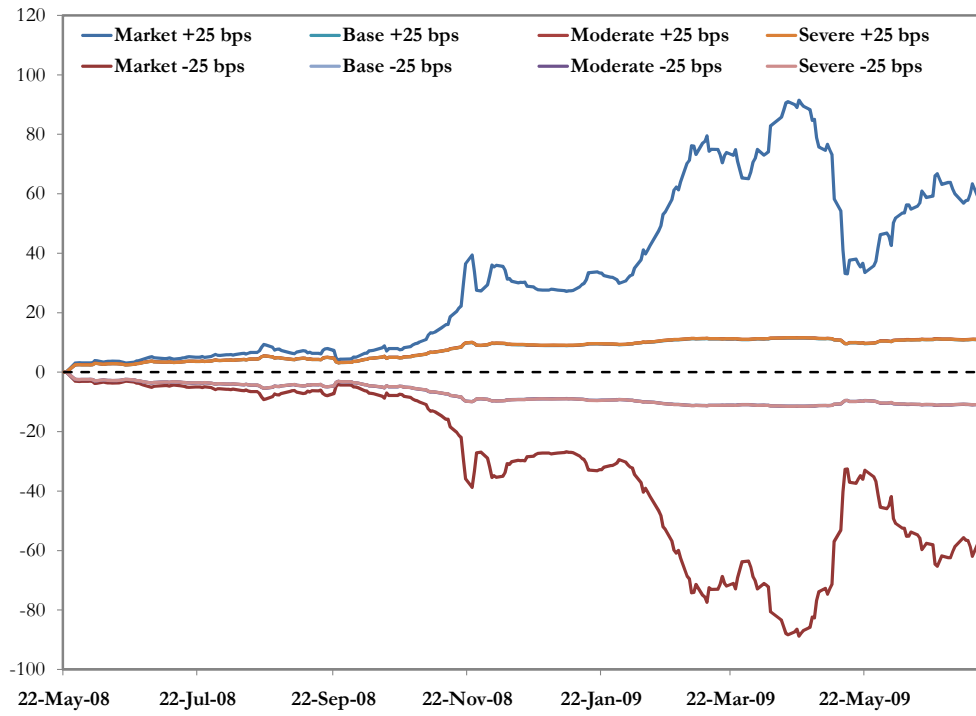


Figure 33: CMBX.NA.A.5: Change in Spread for ± 25 bps Yield Curve Shift

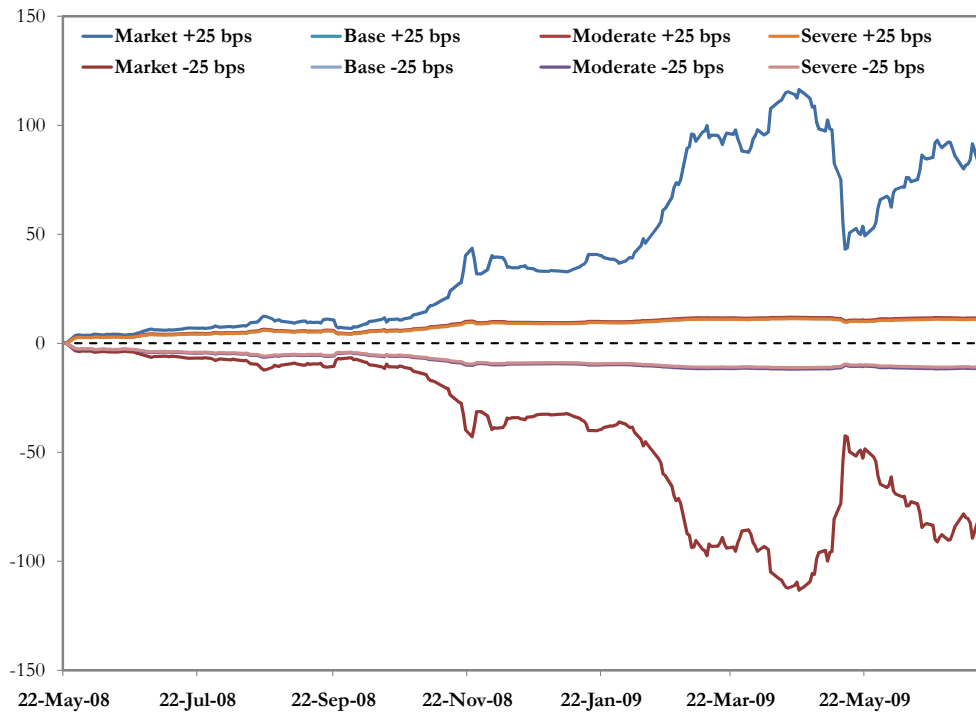


Figure 34: CMBX.NA.BBB.5: Change in Spread for ± 25 bps Yield Curve Shift

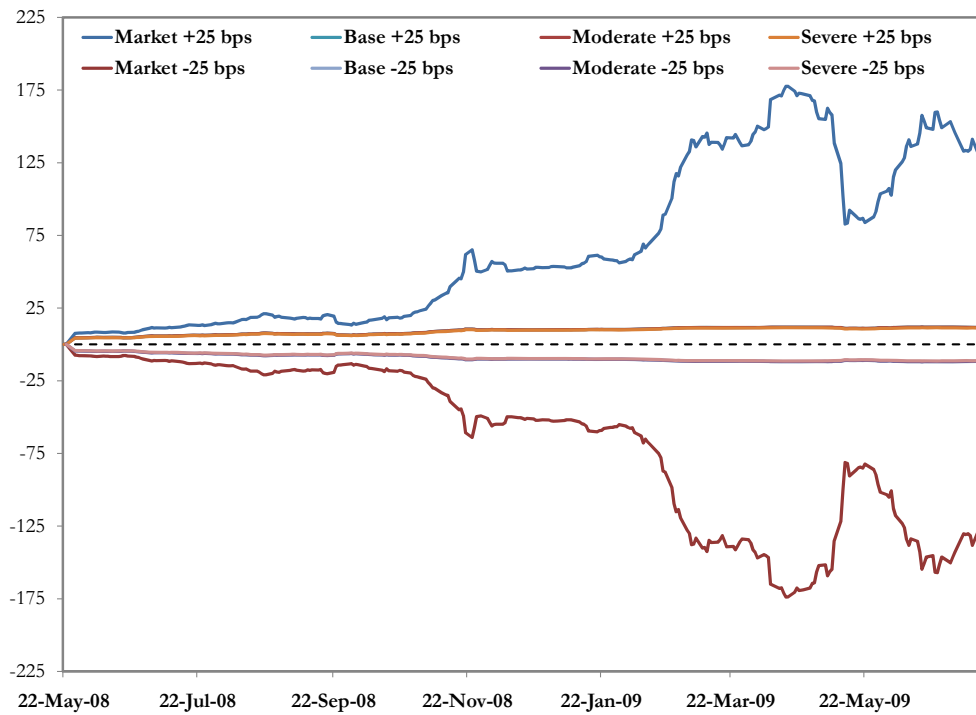


Figure 35: CMBX.NA.BBB-.5: Change in Spread for ± 25 bps Yield Curve Shift

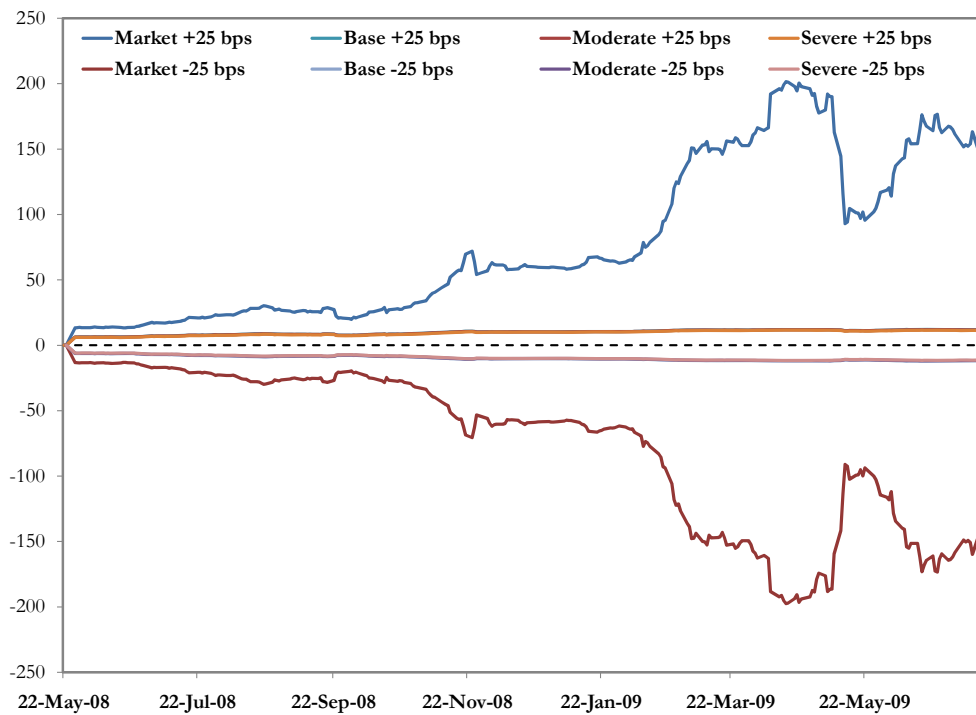


Figure 36: CMBX.NA.BB.5: Change in Spread for ± 25 bps Yield Curve Shift

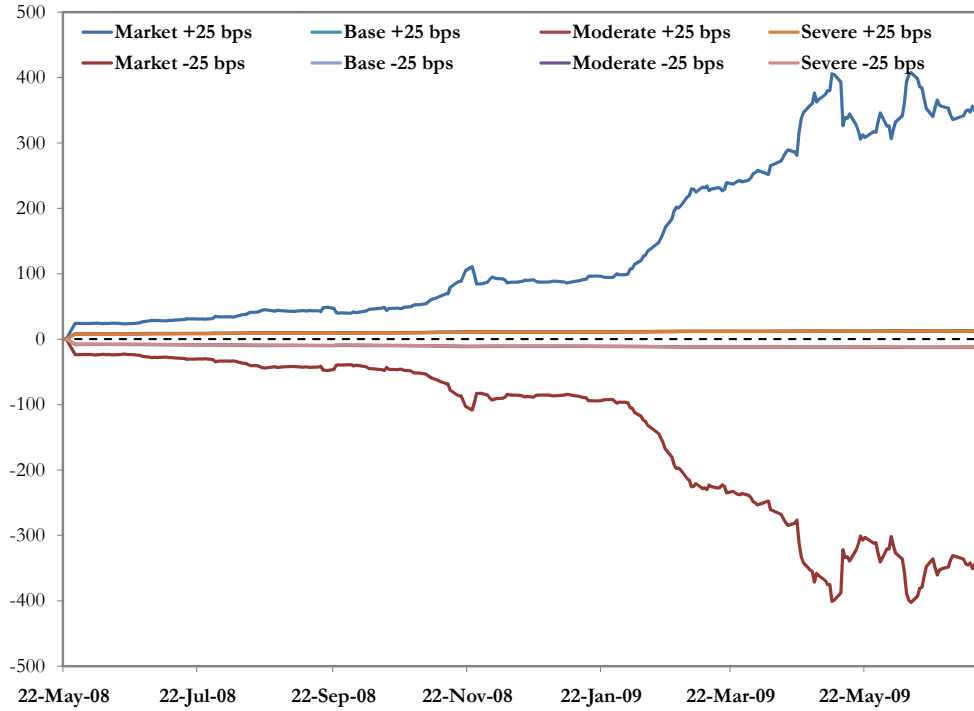


Table 5: CMBX.NA.AAA.5 versus GSMS 2007-GG10 A4

	CMBX.NA.AAA.5	GG10 A4	Basis
Traded Spread	388.36	637.30	-248.94
Base Spread	339.92	637.30	-297.38
Moderate Spread	339.37	642.90	-303.53
Severe Spread	338.66	656.70	-318.04

Notes: Spreads as on July 22 2009

Figure 37: Revisiting the AAA Basis

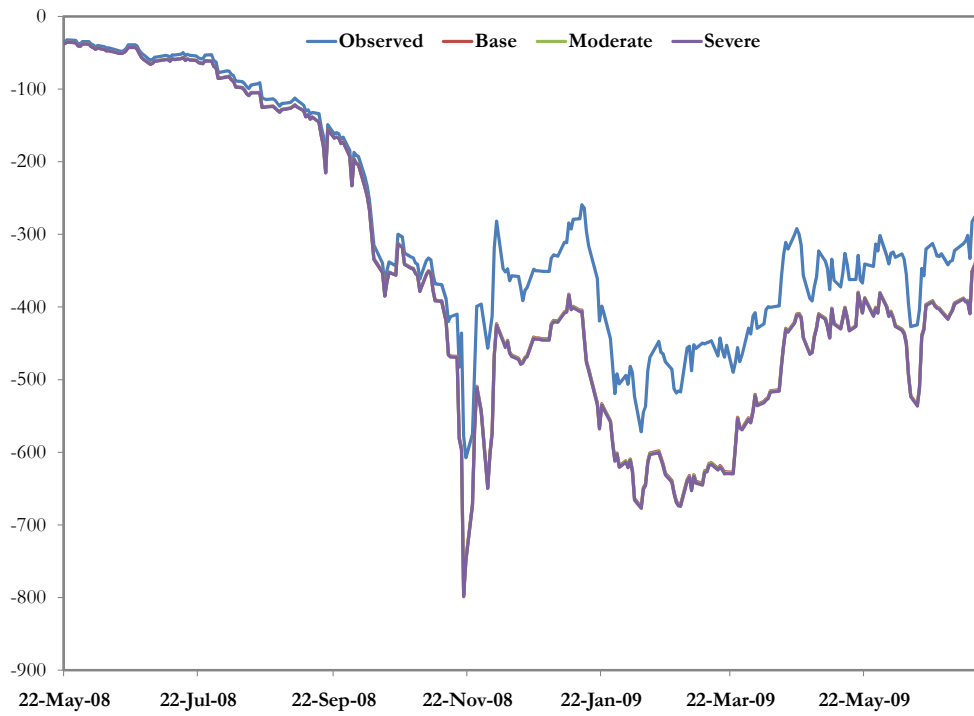


Figure 38: Revisiting the BBB Basis

