Nomura Fixed Income Research

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Constant Maturity CDS (CMCDS) – A Guide

May 20, 2005

I. Introduction

The constant maturity default swap (CMCDS) is a type of credit derivative that provides protection against default losses. Unlike a regular credit default swap (CDS), however, a CMCDS has a "floating" premium that is reset periodically. This feature makes the value of a CMCDS less sensitive to changes in the levels of credit spread. Accordingly, a CMCDS, when combined with a regular CDS, allows separation of default risk from so-called "spread" risk, or volatility in valuation caused by fluctuations in market spreads.

II. How Does a CMCDS Work?

The basic construction of a CMCDS is very similar to that of an ordinary CDS. As in a plain vanilla CDS, two parties enter into a contract where one party sells to the other party protection against default risk of a reference entity. The buyer of protection, in return, pays the periodic premium (*i.e.*, spread) to the protection seller. If default occurs during the term of the contract, the protection seller either purchases the defaulted debt at par from the protection buyer or compensates the protection buyer for the amount of loss suffered.

The main difference for a CMCDS is that the periodic spread payment is not fixed, but *floating*. The premium payment of a CMCDS is linked to a pre-specified benchmark of a fixed maturity (called "constant maturity"), such as the current 5-year CDS of a particular reference entity. Another variation is the use of a CDS index as a "reference" CDS. Over the term of the CMCDS, the amount of spread payment is periodically reset based on the then current level of the reference CDS.

The protection premium of a CMCDS is often expressed as a percentage (80%, for example) of the reference CDS spread. This ratio is called the "gearing factor" or the "participation rate." The reset usually occurs quarterly or semiannually.

Sometimes, a CMCDS may come with a cap that sets a ceiling on the level of the floating spread. For example, a cap at, say, 100 bps means that the CMCDS spread will not go up above 100 bps. A spread cap generally weakens the unique characteristics of a CMCDS relative to a regular CDS. In particular, if the current spread level increases and approaches the cap's level, a CMCDS becomes more like a regular CDS with the fixed spread at the cap level.

A. CMCDS Example

Let's consider a 5-year CMCDS with a 5-year single-name CDS as the reference CDS. For simplicity, assume that the floating spread is paid and reset annually at 80% of the current level of the reference CDS. The ordinary CDS spread is fixed at 50 bps, while the spread of the CMCDS

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fluctuates with the reference 5-year CDS. For example, the reference 5-year CDS spread may widen steadily from 50 bps to 70 bps over the 5-year period. (See Table 1.)

Table 1: Example of CMCDS Spread Determination

Date	Observed level of reference 5-year CDS*	CMCDS spread payment (p = 80%)	Fixed 5-year CDS spread payment	Difference (CMCDS – fixed CDS)
0	50			
1	55	40	50	-10
2	60	44	50	-6
3	65	48	50	-2
4	70	52	50	+2
5		56	50	+6
Average	60	48	50	-2

* The floating payment is based on the level of the reference CDS at the beginning of the period.

In this example, the spread differential between the CMCDS and the regular CDS is negative at first, but turns positive as the reference CDS spread widens over time. In general, the gearing factor of a CMCDS is set initially so that the values of spread payments of the two transactions are equivalent. In this example, however, the gearing factor is too low, and the ordinary CDS has a higher value than the CMCDS. Assuming a 0% discount rate, we can simply compare their average spreads. The CMCDS has an average spread of 48 bps, while the regular CDS spread is fixed at 50 bps.

In order to calculate a "breakeven" gearing factor, we can equate the average spread of the CMCDS with the fixed spread of the regular CDS;

(Fixed spread) = (Gearing factor) x (Average of the realized "reference" spread)

50 bps = g x 60 bps ==> g = 83.33%

It turns out that a gearing factor of 83.3% makes the values of the two transactions equivalent, assuming a 0% discount rate.

CMCDS Pricing

Pricing a CMCDS contract, in many aspects, is just like pricing an ordinary CDS contract. Like an ordinary CDS contract, the value of a CMCDS contract to a protection seller (*i.e.*, an investor) is the difference between the present value of the "premium leg," which the investor expects to receive, and that of the "contingent leg," which he expects to pay, or,

$$Value\ of\ CMCDS = PV[premium\ leg] - PV[contingent\ leg].$$

Again, similar to ordinary CDS, we have

$$PV[contingent\ leg] = (1-R)\sum_{i=1}^{N} D(t_i)(q(t_{i-1}) - q(t_i))$$

and

$$PV[premium\ leg] = \sum_{i=1}^{N} (D(t_i)q(t_i)d_i + D(t_i)(q(t_{i-1}) - q(t_i))\frac{d_i}{2})gS_i\ ^*$$

Here, R is the recovery rate as a percentage of the notional, $D(t_i)$ is the discount factor for the particular payment date, $q(t_i)$ is the survival probability at time t, d_i is the day count fraction between payment dates, g is the gearing factor, and S_i is the reference CDS spread. As in the case of an ordinary CDS, these values, except for the reference CDS spread, can be inferred from survival probability curve, yield curve, and contract terms. Unlike an ordinary CDS contract, however, S_i is not a predetermined constant. The key to get an accurate pricing is, obviously, to find a way to calculate the expected reference CDS spread for each coupon payment.

* Note that, for a regular CDS, S_i = S (fixed today) and g = 1.

B. Enter Uncertainty – Forward Spreads and Spread Volatility

The problem, however, is that *we do not know how the reference CDS spread will change* over the term of a CMCDS. Accordingly, we use the market expectation about the future path of the reference spread. The future level of a 5-year CDS is *implied* in today's credit spread curve as a "forward" spread. For example, the 5-year CDS spread one year from today (one year forward) can be estimated using the 1-year and 6-year CDS spreads.

The spread curve and the forward spreads are very important in valuing a CMCDS. A forward spread reflects the *expected* level of spread in the future. Under no uncertainty, the future is predictable, and the *expected* spread would be the same as the *realized* spread. In the above example, if the future spreads were totally predictable, the forward spreads would reflect an upward-sloping curve, indicating that the reference CDS spread increases over time. Of course, the future is NOT predictable. However, market participants generally view forward spreads as good approximations of future spread levels. Using forward spreads, we can approximately calculate the gearing factor;

(Fixed spread) = (Gearing factor) x (Average of the "forward" spreads)

Since the credit curve is often upward sloping, forward spreads tend to be higher than the current spread level. This is one reason why the gearing factor is often less than 100%. In contrast, if the credit curve is flat, the gearing factor will be close to 100%.

Finally, we need to make a small adjustment to account for uncertainty about the future. The need for this adjustment arises because the *realized* spread level in the future may in fact not be the same as the level *implied* by forward spreads. This uncertainty is often referred to as the "volatility" of the spread process. If spread volatility were zero, the future would be perfectly predictable, and the realized spread would equal the forward spread. However, as volatility is not zero and the future is not predictable, the realized spread may be higher or lower than the level implied by the forward spread. In fact, due to the convex nature of the forward spread payment, volatility always increases the value of this payment relative to the floating spread. Hence, the necessary adjustment, often called the "convexity adjustment," pertains to reducing the gearing factor of a CMCDS by an appropriate amount. The gearing factor adjusted for the convexity makes the present value of predetermined spread payments and that of the *expected* floating spread payments equivalent.

The exact method of this "convexity adjustment" varies among market participants. The adjustment depends on the assumptions about the dynamic process of spread movements. In general, higher volatility results in a larger adjustment, and vice versa. The degree of convexity also affects the magnitude of the adjustment. See *Technical Appendix* for a detailed illustration of this convexity adjustment.

Forward Spread

Forward spread is defined as the par spread of a forward starting CDS contract. The only difference between a forward starting contract and a regular contract is that regular CDS starts immediately, while a forward CDS starts on a future date. Recall from our CDS Primer,* the present value of a CDS contract starting on t_k with maturity t_N, from a protection seller's point of view, can be expressed as

$$Value\ of\ CDS = \sum_{i=k+1}^{N} (D(t_i)q(t_i)d_i + D(t_i)(q(t_{i-1}) - q(t_i))\frac{d_i}{2})S_{FWD} - (1-R)\sum_{i=k+1}^{N} D(t_i)(q(t_{i-1}) - q(t_i))$$

Here, S_{FWD} is the contract spread for the forward starting CDS. Since the contract is struck with 0 value today, the forward spread is

$$S_{FWD} = \frac{(1-R)\sum_{i=k+1}^{N} D(t_i)(q(t_{i-1}) - q(t_i))}{\sum_{i=k+1}^{N} (D(t_i)q(t_i)d_i + D(t_i)(q(t_{i-1}) - q(t_i))\frac{d_i}{2})}$$

The quantity

$$\sum_{i} (D(t_i)q(t_i)d_i + D(t_i)(q(t_{i-1}) - q(t_i))\frac{d_i}{2})$$

is commonly referred to as the spread DV01, risky DV01, or risky PV01. Risky PV01 represents the value change of the CDS when the spread moves by 1 bps. Note that the numerator in the above formula is the difference between the value of the contingent leg of a "long-term" CDS contract maturing on t_N and that of a "short-term" CDS contract maturing on t_k. The denominator is the difference between PV01 of the long-term CDS contract and PV01 of the short-term CDS contract. Also note that, in general, the value of the contingent leg is the market spread times PV01. So, after some manipulation of the formula, we get

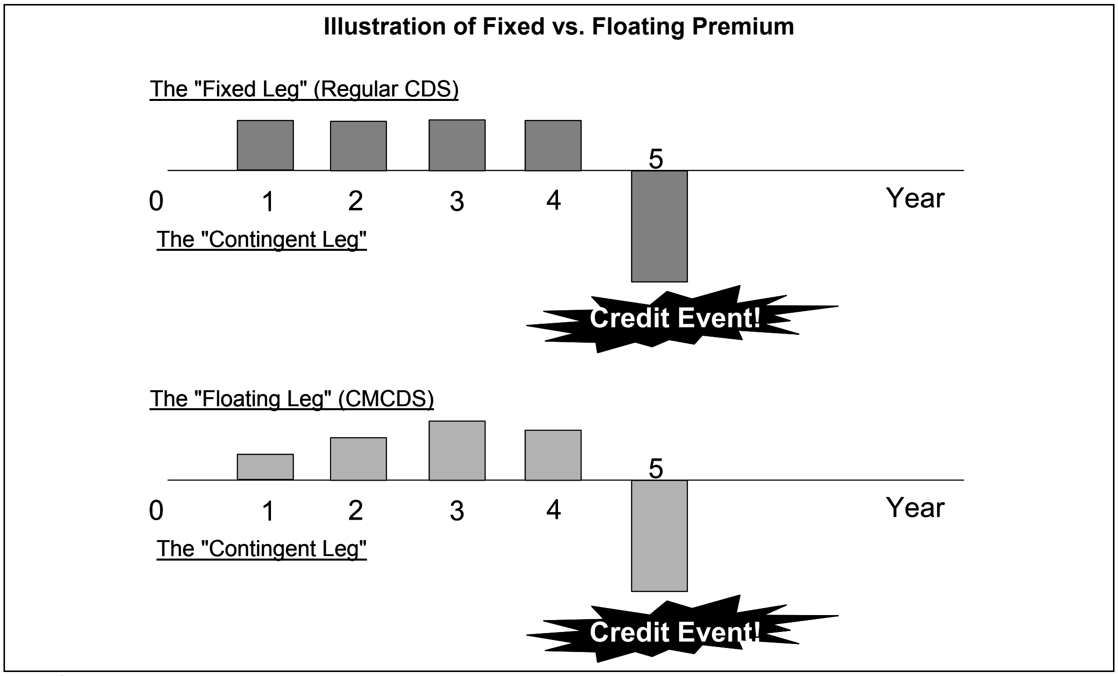
$$S_{FWD} = \frac{S_{t_N} PV01(t_N) - S_{t_k} PV01(t_k)}{PV01(t_N) - PV01(t_k)}$$

where St_k and St_N denote CDS spreads of maturities t_k and t_N, respectively, observed today. The equation above shows the forward spread expressed in terms of par spreads of a long-term CDS contract and a short-term CDS contract.

* See *CDS Primer*, Nomura Fixed Income Research (12 May 2004).

III. Comparison of CMCDS and Ordinary CDS

An ordinary CDS and a CMCDS both protect the protection buyer from default losses. In an ordinary CDS, the fixed spread payment is calculated so that the present value of spread payments (*i.e.*, the premium leg or "fixed leg") is equal to the present value of expected losses (*i.e.*, the contingent leg). Likewise, the gearing factor of a CMCDS is determined to equate the present value of *expected* spread payments and the present value of the expected losses. In the illustration below, one can see that the regular CDS and the CMCDS provide the same protection against a credit event of a reference entity. It follows that the values of protection premium (*i.e.*, the fixed leg for the regular CDS and the floating leg for the CMCDS) should be equivalent for the two instruments. The difference is, one comes with a fixed spread over the life of the contract while the other with a floating spread, giving the two instruments different risk characteristics.



Source: Nomura

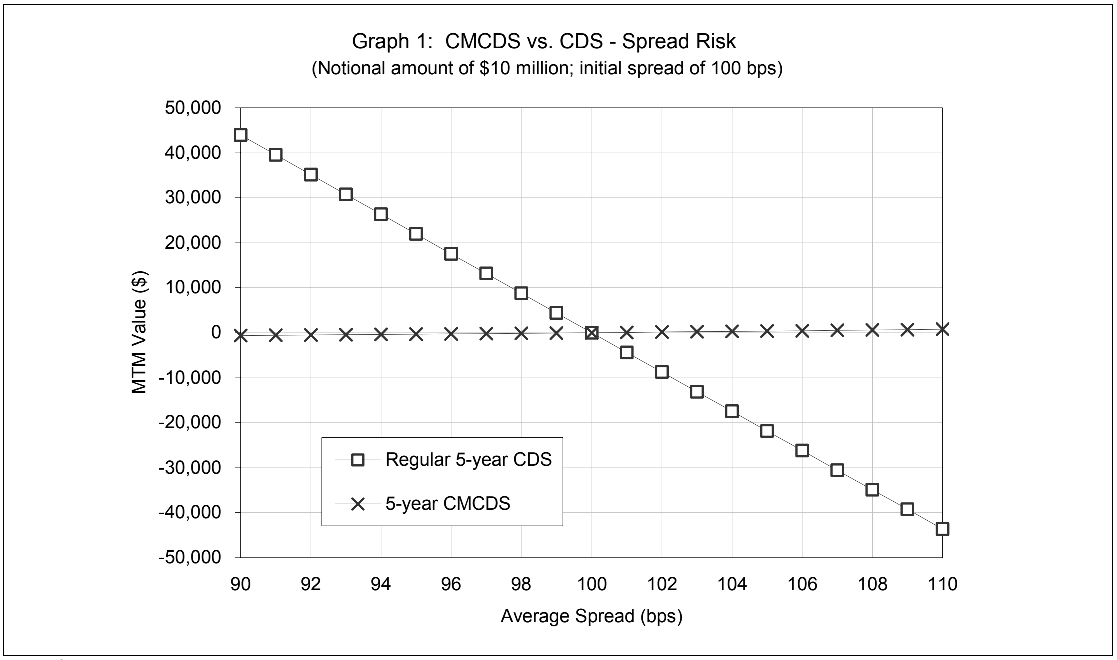
The market value of a CDS fluctuates as the default risk of the reference entity changes. The current level of default risk for a reference entity is reflected in the market spread. Accordingly, the value of an outstanding fixed-spread CDS changes with the market spread of the same maturity. For instance, if the market spread widens, the protection seller of the outstanding fixed-spread CDS contract suffers a mark-to-market loss, because the spread payment he receives is no longer enough to compensate for the amount of default risk implied in the market spread. On the other hand, if the spread tightens, the protection seller would benefit, because he continues to receive the fixed premium which is now greater than the market level. In contrast, movements in general spread levels little affect the value of a CMCDS, since the spread is periodically reset in sync with the market level.

Unlike an ordinary CDS, however, a CMCDS is sensitive to the shape of the spread curve. As discussed above, the gearing factor of a CMCDS is determined based on the *expected* levels of future spreads of the reference CDS, as reflected in the forward spreads. An upward-sloping spread curve implies that the reference CDS spread is likely to widen in the future. If that happens, the CMCDS spread will also increase. Therefore, the gearing factor, g, for the CMCDS is low when the spread curve is upward sloping and steep. If the spread curve gets steeper after the gearing factor is set, it will benefit the protection seller of a CMCDS (*i.e.*, investor), because the breakeven level of g declines. The opposite is true when the spread curve gets flatter.

We can gain an exposure to just spread risk, but not default risk, by combining a fixed-spread CDS and a CMCDS. The combined position is sometimes called a “credit spread swap.” This in a sense is closer to the original definition of a “swap,” where two parties exchange series of floating payments and fixed payments.

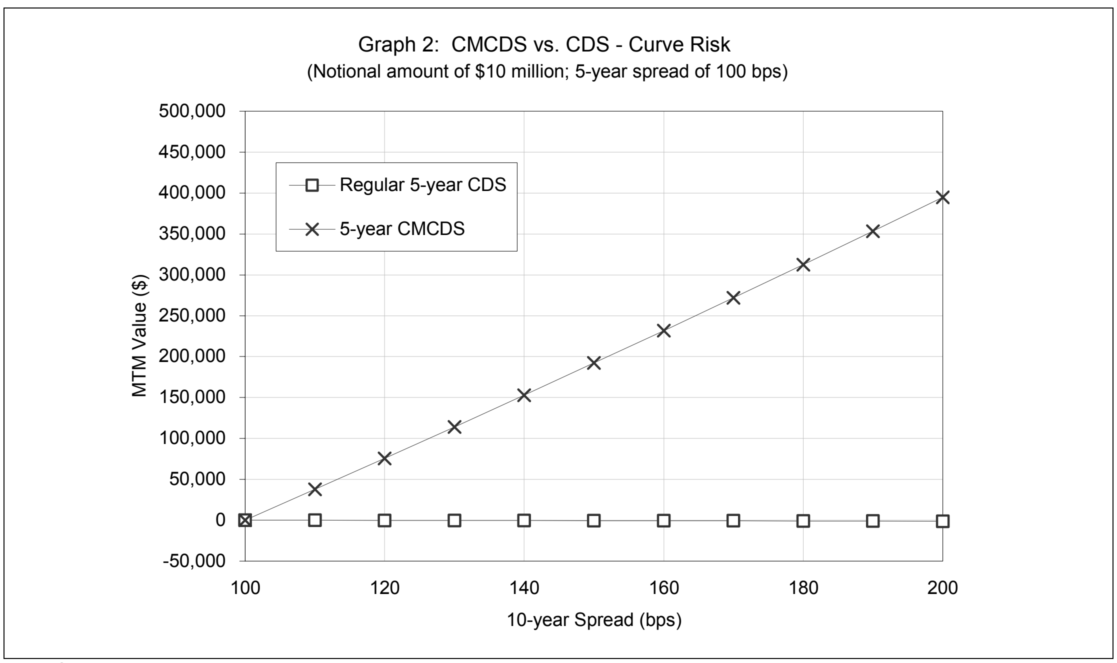
A. Risk Profile

As mentioned above, the value of a CMCDS is much less sensitive to spread movements than an ordinary CDS. For example, the value of a CMCDS is virtually unchanged when the overall spread level widens by 1 basis point, while a 5-year fixed-spread CDS would see its value drop by nearly 5 bps. Graph 1 compares the value changes of a CMCDS and a regular CDS as we shift the spread curve in a parallel manner, assuming a notional value of $10 million and a flat spread curve of 100 bps initially. As we can see in Graph 1, the value of a regular CDS declines as the spread increases. In contrast, the value of a CMCDS is not very sensitive to changes in overall spread levels.



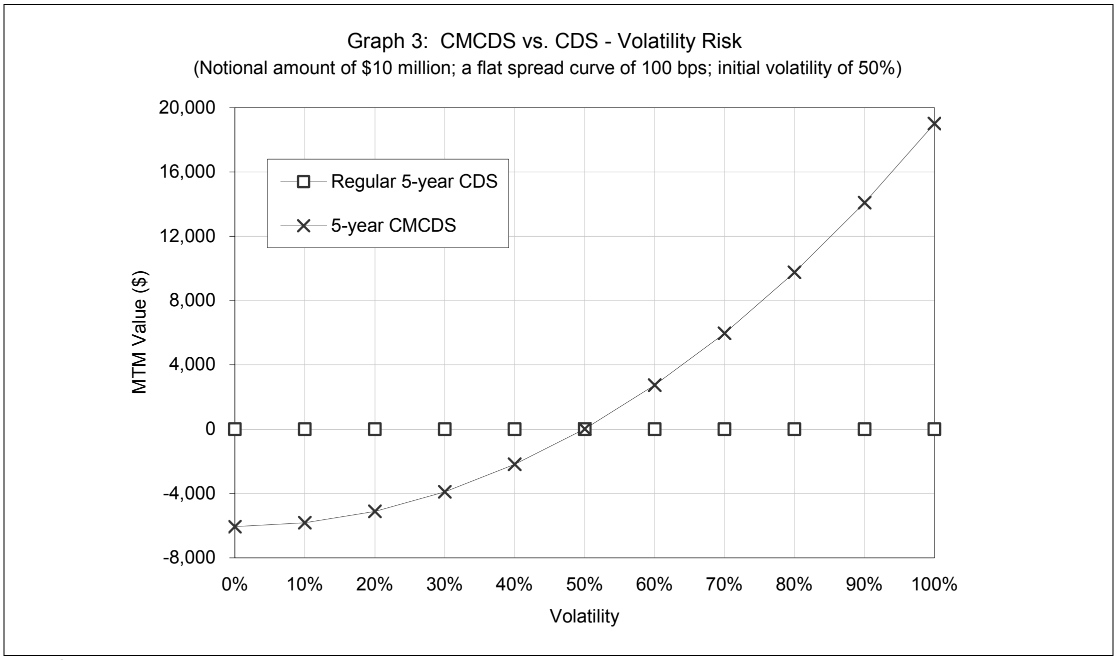
Source: Nomura

On the other hand, the value of a CMCDS varies significantly as the spread curve gets steeper or flatter. Graph 2 plots the values of a CMCDS and a regular CDS as the credit spread curve gets steeper between the 5-year and 10-year zones, from an initial flat curve at 100 bps to an upward sloping curve. (For Graph 2, we altered spread levels between 5 years and 10 years using a linear interpolation.) Graph 2 shows that the steepness of the spread curve affects the value of the CMCDS, while the regular CDS is insensitive to changes in the shape of the spread curve.



Source: Nomura

Finally, volatility of credit spreads is also important in valuing a CMCDS. Volatility affects the value of a CMCDS through the convexity adjustment discussed earlier. When volatility is high, the amount of convexity adjustment is relatively large, pushing the breakeven gearing factor lower. It follows that, after a CMCDS is entered, an increase in volatility will, *ceteris paribus*, benefit the protection seller, and vice versa.



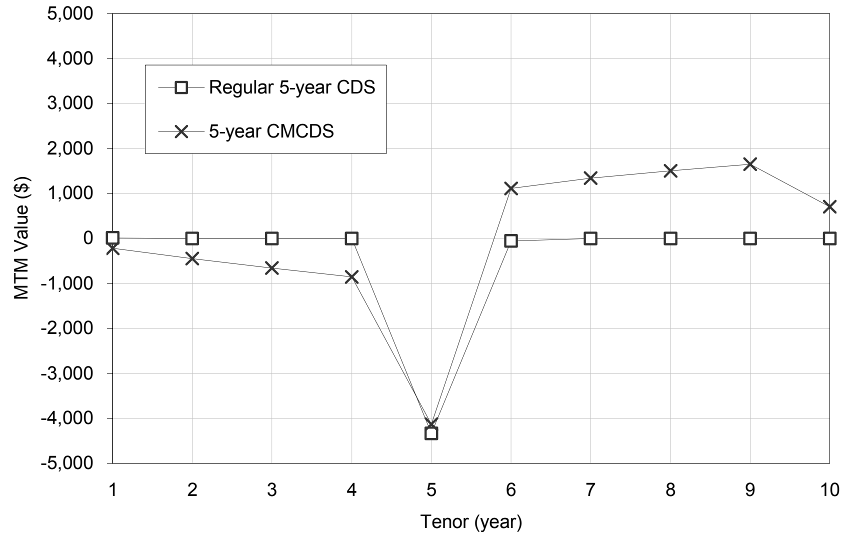
Source: Nomura

B. Hedging

Hedging the curve risk in a CMCDS involves selling and buying ordinary CDS of various tenors up to the term of CMCDS *plus* the term of the constant-maturity (*i.e.*, 5 years). Graph 4 shows the sensitivity of a CMCDS and a CDS to a 1-bp spread change between 1-year to 10-year sectors of the spread curve. As we can see, the value of the regular 5-year CDS is only affected by the 5-year spread, while the value of the 5-year CMCDS changes when spreads at various tenors move.

Based on the amount of value change, we can calculate a "delta" (*i.e.*, hedge ratio) for each tenor. Interestingly, the direction of sensitivity switches as the tenor increases from one year to 10 years. For example, delta is negative between the 1-year and 5-year points, which suggests that spread widening in this area causes the value of a CMCDS to decline. This happens because spread widening in a short tenor, while spreads of other tenors are kept unchanged, causes forward spreads to decline, dragging down the value of a CMCDS. On the other hand, spread widening in a longer tenor (5-10 years), while spreads of other tenors are unchanged, causes forward spreads to increase, pushing up the value of the CMCDS. Of course, spread widening in the 5-year point affects the values of both the regular CDS and the CMCDS, because the 5-year spread reflects the default risk of the reference entity and drives the amount of expected loss.

Graph 4: CMCDS vs. CDS - Delta
(Notional amount of $10 million; a flat spread curve of 100 bps)



Source: Nomura

IV. Some Current Issues

A. Ongoing Debate on Index-referenced CMCDS

A popular type of CMCDS is one linked to a CDS index. An index-referenced CMCDS can use one series of a CDS index throughout the life of the CMCDS, or it may use the current on-the-run series as a reference CDS that rolls every quarter. At each roll date of a CDS index, some of the credits included in the index will be switched. Using a fixed CDS index involves less uncertainty, because the underlying reference credits in the index remain the same over the term of a CMCDS. However, using a fixed series of a CDS index can be problematic, because trading liquidity tends to drop for an old series after the index rolls into a new series. The single-name CDS of a reference entity that is dropped from the index is also likely to suffer a decline in liquidity, causing problems in valuation and hedging.

Some market participants support using the on-the-run series of an index. Under this approach, the floating spread is calculated based on spread changes of the on-the-run index between reset dates. However, this second approach can also be problematic, because there is no knowing what credits will be included in a future series of the index. As some names in the index pool are dropped or added, predicting the future spread levels becomes nearly impossible and the hedging cost is enormous. As of the time of this writing, the credit derivatives market remains split into two camps as to which approach is more appropriate, using a fixed index series or the on-the-run index.

B. The Reason Why CMCDS is *Not* Popular Lately

While there has been much talk about CMCDS over the last year or so, the credit derivatives market has yet to embrace the product in a meaningful way. There are three main reasons for the lack of widespread interest. First, liquidity is still very low for CMCDS, and the bid-ask spread remains relatively wide. This also makes investors dependent on a dealer calculation for the premium or the value of a CMCDS. Second, with a relatively steep credit curve, the gearing factor for CMCDS remains low, making the absolute level of spread unattractive to protection sellers. Third, while a CMCDS has low sensitivity to spread movements, it is very sensitive to shifts in the spread curve. With liquidity in tenors other than the most liquid 5-year point improving only recently, the spread curve may not be well defined, let alone, be forecasted.

C. Using CMCDS to Express a Spread/Curve View

Despite some impediments for more widespread popularity, a CMCDS can be used as a tool to mitigate spread risk or to capitalize on a specific view. As noted before, one strategy is to express a view about future spread levels, but not default risk, by combining a CMCDS with a regular CDS. The combined positions cancel out the default risk. For example, an investor who expects spreads to widen in the future could pay fixed spread (*i.e.*, buying protection) in a regular CDS while receiving floating spread (*i.e.*, selling protection) in a CMCDS. In fact, most transactions to date appear to be in this category.

Alternatively, one can use a CMCDS to enter into a "curve play" on the term structure of CDS. If an investor expects that the future spread will be wider than the current spread curve (*i.e.*, the forward spread) indicates, he could receive a floating spread with the gearing factor that is set higher than the corresponding level for his expectation. On the other hand, if an investor thinks the spread curve is likely to flatten, he could pay a floating spread to capitalize on the mark-to-market gain as the breakeven gearing factor increases.

Some synthetic CDOs use CMCDS to allow floating spreads. For example, one managed synthetic CDO issued last fall, called Saphir CDO, included several tranches with a floating spread. With their lower sensitivity to spread movements, CDOs with a floating spread may become more popular as market participants prepare for the mark-to-market accounting. Also, some CDOs use CMCDS in a leveraged format; for example, a floating spread may be expressed as Libor + (reference CDS spread) x 400%.

V. Conclusion

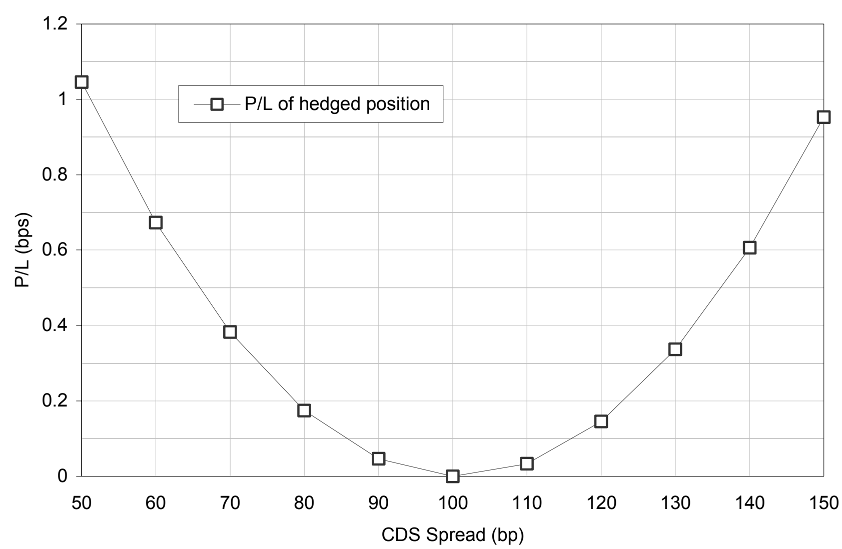
This report introduced constant-maturity CDS, one of the second-generation products. We showed that a CMCDS has very low spread risk. However, the instrument is not entirely mark-to-market risk-free, since the shape of the spread curve and the assumed spread volatility affect its value. In our view, a CMCDS is an interesting instrument that can be used on a stand-alone basis, or on an embedded basis in a more complex product, to express a more specific view about the term structure of credit risk.

VI. Technical Appendix: Convexity Adjustment

It may seem natural to hedge a CMCDS coupon payment with a forward-starting CDS contract with the same maturity and start date. This implies the forward spread as an approximation for the expected reference spread. However, this introduces a bias, because the value of a floating coupon payment is a linear function in forward spread (*i.e.*, changes by a fixed amount per basis point as the forward spread changes), while the CDS contract is a convex instrument (positive convexity from protection seller's point of view). As a result, when the market spread goes up, the gain in the floating coupon payment is more than the loss in the hedging CDS contract; and, when the market spread declines, the loss in the floating coupon payment is less than the gain in the CDS contract.

For example, assume that we receive a one-time payment of 5-year reference CDS spread (with a notional amount of $1) in 1 year. As a hedge, we enter into a forward-start CDS contract as a protection seller. Here, we assume flat credit spreads of 100 bps initially, and the curve moves in parallel. The following graph depicts the P/L (ignoring carry) in 1 year's time, when we know the level of the floating spread. If the realized floating spread turns out to be greater than the forward spread, for example, the floating side benefits from a wider spread, while the forward CDS position suffers a mark-to-market loss. On the other hand, when the realized floating spread is tighter than the forward spread, the opposite situation occurs. However, because of the convexity on the fixed payment side, the hedged position always ends up with a positive P/L when the realized floating spread is *different* from the forward spread. In other words, this is a free lunch situation.

Graph 5: Illustration of CMCDS Convexity



Source: Nomura

To correct this bias, we need to add a convexity adjustment to the forward spread when finding the expected reference spread for CMCDS coupon payment. The exact calculation of the convexity adjustment depends on assumptions about the spread dynamics. Here, we present a formal argument that leads to an approximation.

Now assume;

$S_{forward}$ = forward spread of 5-year reference CDS today

$\overline{S}_{start}$ = *expected* spread of 5-year reference CDS today

$\overline{S}_{end}$ = *observed* spread of 5-year reference CDS at the end date

$PV01_i$ = risky PV of the premium leg of 1 bp
$D(t_j)q(t_j)$ = risky PV of $1

The convexity adjustment is defined as the difference between the expected reference spread and the forward spread, which we denote $\bar{S}_{start} - S_{forward}$. To find this amount, note that the expected P/L of the hedged position should be zero. Ignoring carry, the gain/loss from the floating coupon payment is $\bar{S}_{end} - \bar{S}_{start}$. On the other hand, the mark-to-market change of the forward CDS contract is (number of contract used to hedge) * (CDS value on the floating coupon date). Let S_{start} and S_{end} denote the market spreads on the start date and the end date, respectively. Then, the mark-to-market change of the forward CDS is

$$(hedge\ ratio)(S_{start} - S_{end})(PV01_{end}) = \frac{1}{B(S_{start})} B(S_{end})(S_{start} - S_{end}),$$

$$\text{where } B(S_j) = \frac{PV01_j}{D(t_j)q(t_j)}.$$

The hedge amount is calculated as a ratio of the value change of the floating spread and PV01 of the forward CDS. Using Taylor expansion for $B(S)$,

$$B(S_{end}) \approx B(S_{start}) + B'(S_{start})(S_{end} - S_{start}).$$

Now, the value change of the hedging CDS position can be approximated as

$$S_{start} - S_{end} - \frac{B'(S_{start})}{B(S_{start})}(S_{start} - S_{end})^2.$$

Then, the total P/L of the combined position (the floating payment plus the hedging CDS) is

$$\bar{S}_{end} - \bar{S}_{start} + \left[S_{start} - S_{end} - \frac{B'(S_{start})}{B(S_{start})}(S_{start} - S_{end})^2 \right].$$

Since $\bar{S}_{end} = S_{end}$ at the end date, the P/L is simplified to

$$\left(S_{start} - \bar{S}_{start}\right) - \frac{B'(S_{start})}{B(S_{start})}(S_{start} - S_{end})^2.$$

Recall that the expected P/L should be zero. However, if we use $S_{start} = S_{forward}$, we get

$$Convexity\ adjustment = \bar{S}_{start} - S_{forward} = E[-\frac{B'(S_{forward})}{B(S_{forward})}(S_{forward} - S_{end})^2].$$

Assuming that S has a lognormal process with mean S_{start}, and volatility σ, we get the approximation formula for the convexity adjustment

$$-\frac{B'(S)}{B(S)} S^2 (\exp(\sigma^2 T) - 1)$$

where *T* is the time (in years) from the starting date till the coupon date.

Numerical Example:

In order to examine the magnitude of convexity adjustment, let's compare the breakeven gearing factors of a CMCDS with and without convexity adjustment. For simplicity, assume a credit curve with a 1-year spread of 100 bps and a10-year spread of 200 bps, linearly interpolated in between. Let's assume a spread volatility of 20% a year, and the breakeven gearing factors are:

$g_{with\ adjustment}$ = 71.7%

$g_{without\ adjustment}$ = 72.1%

As we can see, the amount of convexity adjustment is fairly small. If we assume the reference 5-year CDS level of 144 bps currently, the gearing factors translate into 103.25 bps with adjustment and 103.82 bps without adjustment, or a difference of 0.57 bps.

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- Corporate Relative Value – (17 May 17 2005)
- Corporate Weekly- For the week ended May 13, 2005 (16 May 2005)
- US Corporate Sector Review - April 2005 (9 May 2005)
- S&P Downgrades GM and Ford (5 May 2005)
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