5. Hedging Instruments with Credit Risk

Duration of a set of risky cash flows

We have previously seen that, for a single cash flow, we can specify the market interest rate r_T and z-spread z_T that causes the cash flow to match its current price:

$$V = Ne^{-(r_T + z_T)T}$$

It is worthwhile to consider what sensitivity this value has to its two main pricing variables.

We recall from our initial definition of yield that, in this context, the yield of the single cash flow $y = r_T + z_T$, and thus…

$$\frac{dV}{dy} = -TV$$

…and since in this case…

$$\frac{dy}{dr_T} = \frac{dy}{dz_T} = 1$$

…we conclude that

$$\frac{dV}{dr_T} = \frac{dV}{dy}\frac{dy}{dr_T} = \frac{dV}{dy}$$

$$\frac{dV}{dz_T} = \frac{dV}{dy}\frac{dy}{dz_T} = \frac{dV}{dy}$$

In this case, it is quite straightforward to recall the definition of duration and say:

$$D = -\frac{1}{V}\frac{dV}{dy} = -\frac{1}{V}\left(-TV\right) = T$$

That is, the addition of credit risk to our picture does not change this cash flow's duration. Moreover, the result will be the same whether we think of duration as a sensitivity to interest rates alone, to credit alone, or indeed to the total yield, which incorporates both risk factors.

In cases where cash flows are known in advance, all of these measures are equivalent under our simple reduced-form model of credit risk. However, when a credit spread is applied, there is definitely an effect on the duration of any instrument involving multiple cash flows. While it is true that the durations of the individual cash flows do not change, we recall that:

$$D_\Pi = \frac{\sum_i V_i D_i}{\sum_i V_i}$$

…relates the duration of the whole to each of its constituents. This value is affected by changes in credit, since cash flows farther in the future receive a greater additional discount due to credit risk.

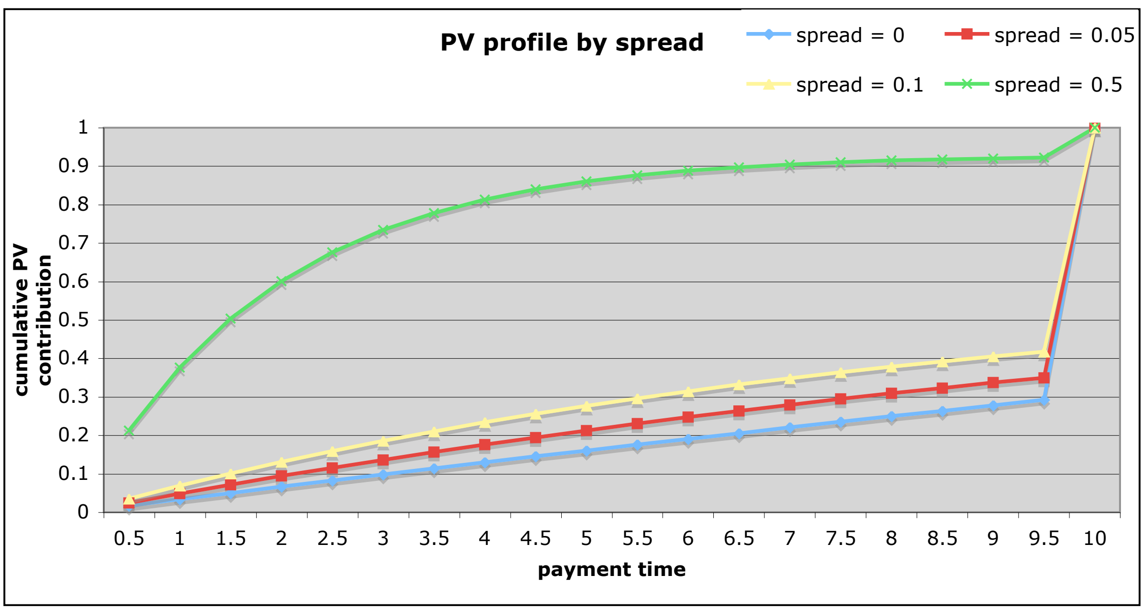
Imagine the simple case of two cash flows at times $T_1 < T_2$; in the absence of credit risk, these cash flows would have present values V_1 and V_2. So the duration in the risk-free case is given by:

$$D_{risk-free} = \frac{V_1}{V_1+V_2}T_1 + \frac{V_2}{V_1+V_2}T_2$$

Now imagine applying a constant z-spread to the instrument to model a risky version of the same security. In essence, the greater credit risk associated with the later cash flow gives it a smaller contribution to the present value of the security, and correspondingly the earlier cash flow contributes a greater share, thus making the duration shorter:

$$D_{risky} = \frac{V_1 e^{-zT_1}}{V_1 e^{-zT_1} + V_2 e^{-zT_2}}T_1 + \frac{V_2 e^{-zT_2}}{V_1 e^{-zT_1} + V_2 e^{-zT_2}}T_2 = \frac{V_1}{V_1 + V_2 e^{-z\Delta T}}T_1 + \frac{V_2}{V_1 e^{z\Delta T} + V_2}T_2$$

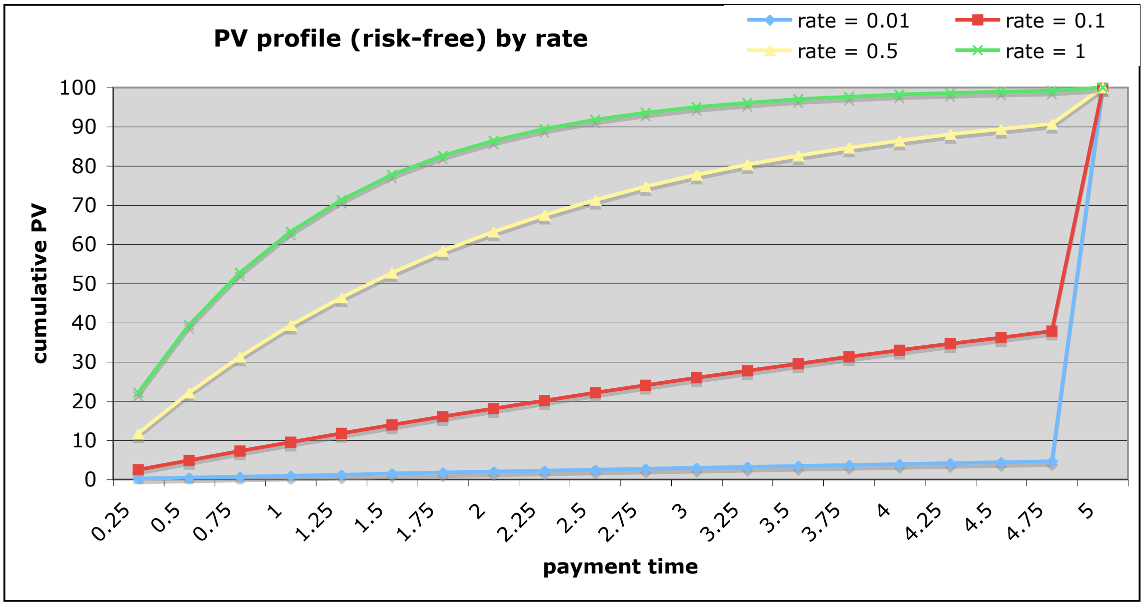
In the fixed-coupon case, we can visualize this in terms of each cash flow's contribution to present value. In the simple case where we choose the risk-free rate of 2% to all maturities, a 10-year bond paying a 4% coupon with semiannual payments has the following profile at different z-spreads:



As spread increases, the proportion of the bond's value due to the repayment of principal, sensibly, decreases. At extreme values, the bullet contributes essentially nothing. It seems reasonable, then, that the duration of a fixed-coupon bond shortens with increasing spreads just as it does with increasing interest rates.

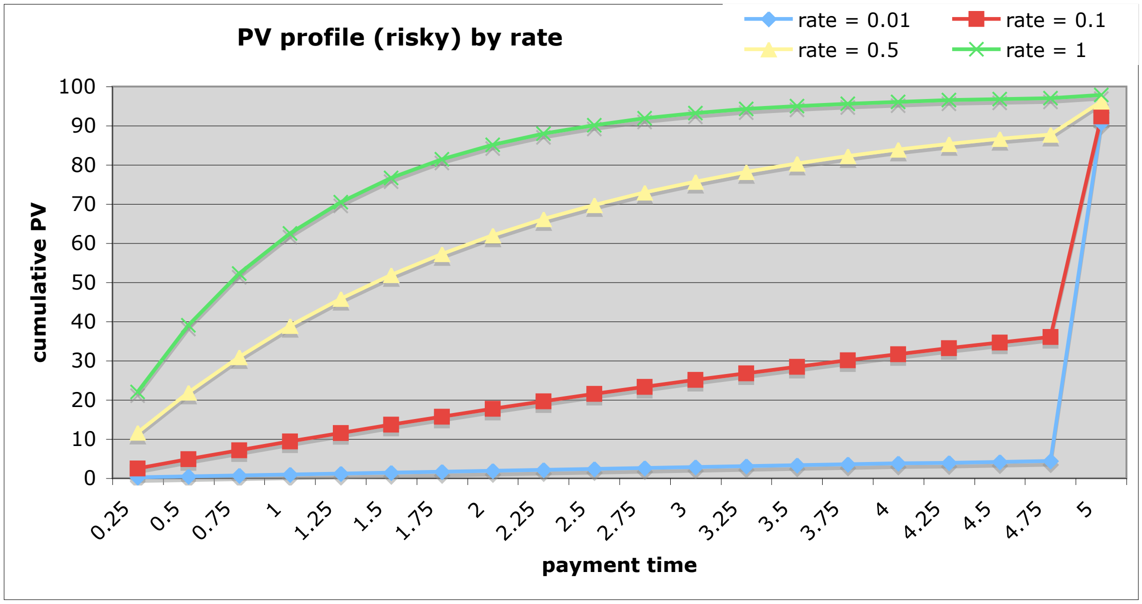
Duration of a risky FRN

We have seen already in the risk-free case that an FRN paying LIBOR flat has a duration of zero immediately before a reset. We explained this in terms of the behavior of the floating-rate annuity, whose value increases to offset the loss of value on the bullet when interest rates rise. Representing this in terms of the contribution of the various cash flows to the bond’s value, we can see this qualitatively in the case of a 5Y risk-free FRN paying LIBOR flat quarterly in different interest rate scenarios:



This, then, is the behavior of an FRN with zero duration, shown at several exaggerated interest rates to demonstrate it clearly. We have shown the absolute cumulative PV (assuming 100 face) to illustrate that while the profile changes under interest rate shocks, the total aggregate PV remains unchanged. At high interest rates, the bullet is all but worthless, but the instrument responds by increasing the value of cash flows before maturity enough to make sure that the total value remains unchanged.

This ability of the instrument to shift its value profile has an interesting consequence when the FRN has credit risk. In this case, the resets on the FRN are determined by consulting the forward risk-free rates as usual, but the resulting coupon cash flows are discounted by taking into account the survival probability of the issuer at the bond’s payment times. For example, if we apply a z-spread of 0.02 to the FRN above, the corresponding picture for this bond is:



As before, increasing interest rates causes the instrument to shift value away from the bullet at maturity and toward the earlier coupons. While in the risk-free case the tradeoff was exact, here it is not. As you can see, at higher interest rates the risky FRN paying LIBOR flat is actually worth *more*.

The reason for this is that the bullet repayment of principal is the riskiest of all the bond's cash flows, since it occurs last. So when interest rates rise, the FRN shifts more of the bond's value toward cash flows with less credit risk, causing the value of the instrument to rise.

Previously, we saw that the coupon strip for a risk-free FRN has negative duration, meaning that its present value actually increases when interest rates do. We now see that, in the presence of credit risk, this floating coupon strip becomes a greater proportion of the bond's value than in the risk-free case, meaning that a risky FRN paying LIBOR flat, as an instrument in aggregate, also has negative duration.

Of course, in this discussion we have neglected the possibility of the FRN paying a coupon spread. The above discussion applies only when the FRN is trading at a discount to face, as of course all FRN's with credit risk will if they merely pay LIBOR. The addition of a coupon spread—a fixed-rate annuity, which of course has positive duration—to this instrument complicates matters a bit. Indeed, it is because FRN's have credit risk that it is common for most of them to pay some small spread over the risk-free rate.

Discretely compounded z-spread
Recall that a risky cash flow has present value:
$V = c_t P_t S_t$
…where S_t is the survival probability to time t. In the continuous-time case, we saw that this reduces to:

$$V = c_t e^{-(r_t + z_t)t}$$

The value z_t, the z-spread, is simply the average from zero to t of the continuous-time hazard rate λ if we disregard the possibility of a recovery in the event of default. In a discrete model with m compoundings per year, it therefore seems natural to say:

$$V = c\left(1 + \frac{r_m}{m}\right)^{-mt}\left(1 + \frac{\lambda_m}{m}\right)^{-mt}$$

…for some discrete hazard rate that produces the same term structure of survival probabilities as the continuous-time rate above. Under the equivalent assumption that this discrete hazard rate is constant, the expanded expression becomes:

$$V = c\left(1 + \frac{r_m + \lambda_m}{m} + \frac{r_m \lambda_m}{m^2}\right)^{-mt} = c\left(1 + \frac{r_m + \lambda_m\left(1 + \frac{r_m}{m}\right)}{m}\right)^{-mt}$$

…which illustrates an unfortunate consequence of the use of discrete-time z-spreads. In the continuous-time case, if the hazard rate is constant, then it is also the z-spread. Here, however, even when the hazard rate is constant, the analogous quantity is:

$$z_m = \lambda_m\left(1 + \frac{r_m}{m}\right)$$

This bears resemblances to other discrete-time conversions we have seen before (modified duration, for example), but its dependence upon r_m makes it problematic to use this quantity in determining interest rate sensitivities. Even if the credit risk of the issue remains the same, an interest-rate shift results mathematically in a change in the discretely compounded z-spread.

Notwithstanding these observations, the characterization of a cash flow's value in these terms:

$$V = c\left(1 + \frac{r_m + z_m}{m}\right)^{-mt}$$

…is common in practice and offers a convenient view of certain instruments—particularly risky FRN's.

Fair coupon spread of a risky FRN

When an FRN entails credit risk, a coupon spread is often paid over and above the floating coupon to compensate for this risk. It seems sensible to ask what coupon spread is adequate to offset a particular credit risk. We will assume for simplicity that the z-spread is constant to the bond's maturity, expressed in the manner we saw in the previous section with the same frequency as the FRN's coupons. We wish to determine what coupon spread prices the bond to par.

Immediately before the final reset, it is clear that:

$$V = N\left(1 + \frac{r_t + s}{m}\right)\left(1 + \frac{r_t + z_m}{m}\right)^{-1}$$

…and so, if the issue is to be priced at par:

$$\left(1+\frac{r_t+s}{m}\right)\left(1+\frac{r_t+z_m}{m}\right)^{-1}=1$$

$$s=z_m$$

That is, for a single reset, the fair coupon spread is the z-spread. Similarly, for a single-period FRN forward, we expect as in the case of no credit risk that the value of this reset is equivalent to the notional paid at the time the reset rate is observed:

$$NP_t=N\left(1+\frac{r_{t,T}+s}{m}\right)P_t\left(1+\frac{r_{t,T}+z_m}{m}\right)^{-1}$$

$$s=z_m$$

It seems clear, then that the fair coupon spread on a risky FRN is equal to the issuer's z-spread over the term of the bond, expressed with the appropriate frequency. The fact that this value is dependent upon interest rates is not pleasing, but indeed once recovery on the bond is factored into the question, such a dependency cannot be avoided in any case.

Leaving technical details aside, then, it seems most natural to think of the fair spread *s* on a risky FRN that causes the instrument to price to par as the issuer's credit spread to that maturity. And indeed this concept of credit spread is carried over into credit derivatives.

Shorting an FRN

In practice, it can be expensive to short corporate bonds. A bondholder or bondholders with the appropriate quantity must be found, the instruments must be borrowed (often, depending on the bonds' scarcity, at unfavorable terms), and then the instruments must be sold into the market.

If we ignore the practical difficulties for a moment, however, the transaction does have value if it can be carried out. Suppose for the sake of argument that an investor has an exposure of amount *N* to the credit of a particular risky issuer. Suppose additionally that an FRN from the same issuer, priced at par with the same maturity and seniority, is available in the market; of course, in order to be priced at par, this bond must pay a coupon spread that compensates investors exactly for the credit risk of the instrument.

If the investor is able to short the issuer's FRN's at the market price, he or she receives an initial cash flow of *N* and becomes liable for whatever cash flows the risky FRN produces. Suppose the investor takes the proceeds of the risky FRN's sale and invests it in a risk-free FRN with the same maturity and coupon frequency as the risky one. Since this instrument is risk-free, of course it pays no coupon spread.

As each coupon time arrives, the risk-free FRN supplies the floating coupon owed on the short risky FRN position. The investor must pay, out of his or her own capital, the coupon spread on the risky bond. At maturity, the investor passes the principal payment from the risk-free bond through to the counterparty in the short FRN transaction, concluding the arrangement.

At first glance, there would seem to be little benefit to this transaction: All that has happened is that the investor has paid the coupon spread on the risky FRN to the counterparty over its entire lifetime.

But if default occurs during the life of the bond, then there is value to the investor. Since he or she is liable only for the actual cash flows generated by the bond, the only cash that must be paid on default is the recovery amount. The investor cashes in the risk-free FRN position to supply this cash. The remaining cash—what we earlier called the loss given default (*LGD*)—remains with the investor.

At the same time, the investor's original investment in the obligor will default. Assuming it is of equivalent credit quality to the risky FRN, it will pay the same recovery. Thus, upon default, the investor receives *NR* from the original bond position and *N(LGD)* from the short FRN position, meaning that the total cash received in the event of default is *N*.

In other words, the short FRN position serves as a form of default insurance against the risky issuer. For the price of the coupon spread on the FRN, the investor can synthesize a contract that supplies the loss, should default occur.

In the cash market, such transactions are usually impractical. In the credit derivatives market, a transaction replicating this strategy—called a credit default swap—is the most common and fundamental instrument.

Credit default swap

The credit default swap (CDS) is an over-the-counter agreement between two parties originally conceived as insurance against issuer default. Now such contracts have become liquid enough to become the instrument of choice for hedging against, or speculating on, moves in an issuer's credit quality.

In a CDS transaction, the protection buyer agrees to pay a set premium to the protection seller, who agrees to make up for losses on debt of a particular issuer (often called the "name"). The premium is paid with a set frequency in arrears, meaning that if a credit event occurs between premium dates, the protection buyer owes the protection seller the amount of the premium accrued since the last payment.

Settlement may be specified as either physical or cash. In a physical settlement, the protection buyer delivers a qualifying obligation (a bond in the case of standard CDS) in exchange for full payment of the notional amount. In cash settlement, a calculation agent examines the market values of qualifying obligations and determines the loss that the protection seller should pay.

Taking all features into account, we may represent the present value of the premium leg using the time of the credit event τ, a random variable, by…

$$V_{premium} = \sum_{i=1}^{n} N \frac{s}{m} P_{t_i} P\left(\tau > t_i\right) dt + \sum_{i=1}^{n} \int_{t_{i-1}}^{t_i} Ns\left(t - t_{i-1}\right) P_t P\left(\tau = t\right) dt$$

…where the first term represents the expected present value of all premia paid in full, while the second term is the expected present value of the accrued premium paid when a credit event arrives.

If we denote the risky annuity with unit notional that includes the accrued premium payment:

$$A_{m,T}^{*} = \sum_{i=1}^{n} \frac{1}{m} P_{t_i} P(\tau > t_i) dt + \sum_{i=1}^{n} \int_{t_{i-1}}^{t_i} (t - t_{i-1}) P_t P(\tau = t) dt$$

…then:

$$V_{premium} = NsA_{m,T}^{*}$$

Similarly, for a recovery rate *R*, the protection leg has value:

$$V_{protection} = N(1-R) \int_{0}^{T} P_t P(\tau = t) dt = NL_T^{*}$$

…where we define the final variable as the expected present value of the credit loss on the name. Each of these integrals is quite amenable to numerical approximation for a given term structure of interest rates and hazard rates, and some choice of the recovery rate *R*.

Valuation of a CDS contract

As usual, it makes sense to ask the question of what the fair spread is on such a contract, assuming all other variables are known. One method of setting the price of a CDS contract is to choose the spread so that the present value of the instrument is zero, meaning that:

$$V_{premium} - V_{protection} = 0$$

$$Ns^{*} A_{m,T}^{*} = NL_T^{*}$$

$$s^{*} = \frac{L_T^{*}}{A_{m,T}^{*}}$$

This expression is reminiscent of the one we encountered in the determination of the par yield given an interest rate curve. The spread s^* is known as the par CDS spread, and typically it too has a term structure.

As a practical matter, the distribution of the default time τ is not known *a priori*, and for valuing a particular contract struck at some arbitrary spread *s*, survival probabilities are bootstrapped from par spread quotes.

As we have seen, there are analytic continuous-time expressions for the values of the two legs, but often these expressions are too unwieldy to be useful. Thus, numerical approximations are often used to value contracts in practice.

We note that, if a term structure of survival probabilities can be extracted from today's term structure of par spreads, all CDS pricing can be performed by pricing the risky annuity, since if a party has bought protection at some spread *s*, we can imagine canceling out the protection leg by selling protection at today's par spread s^* to the same maturity. The resulting portfolio value is:

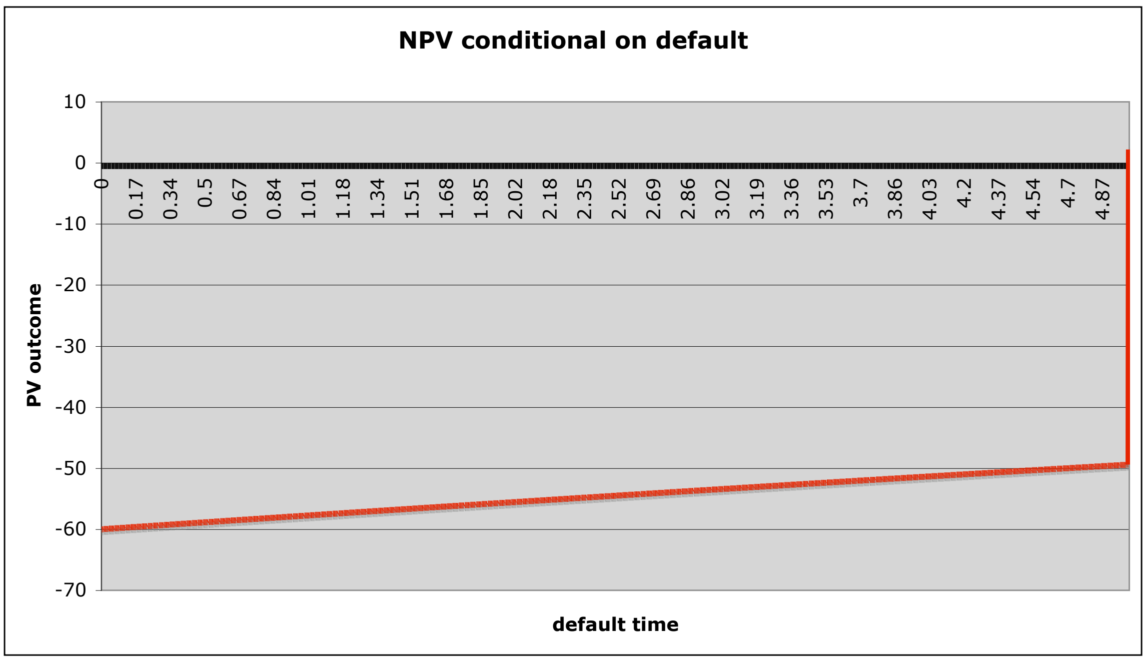
$$V_s = N\left(s^* - s\right)A^*_{m,T}$$

…and has the same value as our original contract, since the par contract by definition has zero present value. This valuation formula, then, shows how to price CDS at premium levels other than par.

Upfront versus running CDS

Suppose we have an issuer with a hazard rate λ of 0.008 and wish to write a 5-year contract on this name. If we assume that risk-free rates are 3% to all maturities and that the recovery on the name is 40%, then using the methods above we see that the fair spread on this contract is roughly 48 basis points.

It is worthwhile to consider, as the writer of protection, what the value is to us of various possible outcomes on the contract. Below is shown the NPV per 100 notional of default at each of the possible times from now to year 5; the final point shows the NPV of the outcome in which the name does not default:

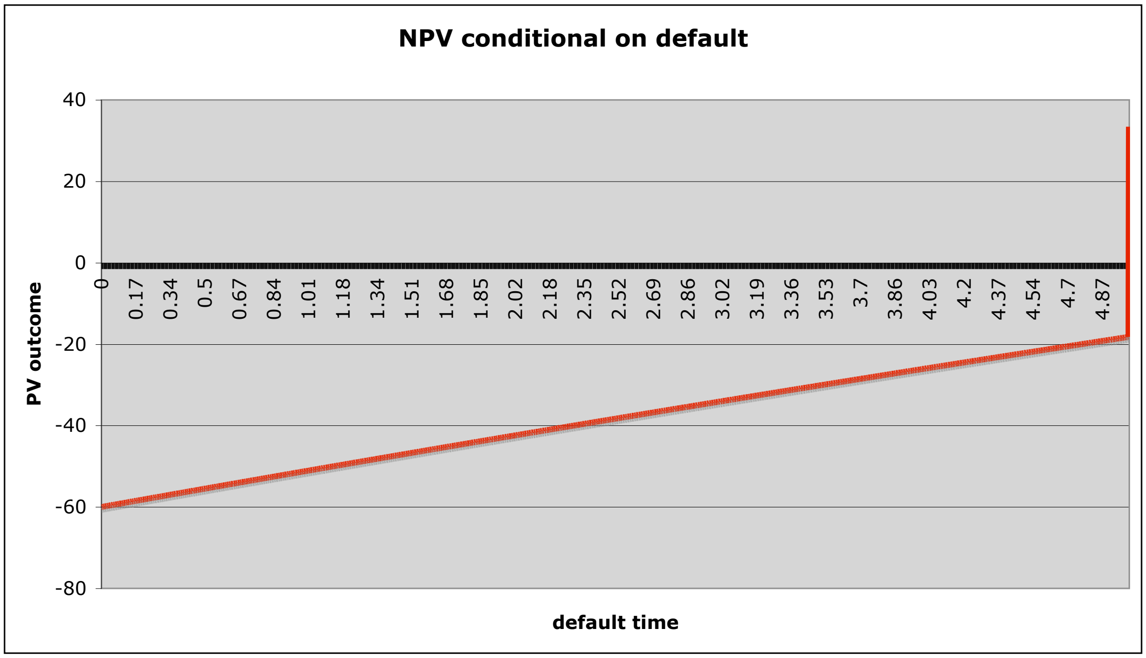


We see that the net value, should the name default within 5 years, ranges between a loss of 50 and 60 to the writer of protection. Should the name not default over the term of the contract, then the NPV of the premium payments alone is roughly 2.23.

Why would an investor write such a contract? First, note that this protection can be written with a minimum of capital outlay; while the spread earned on the position is only 48 basis points, if it can be collateralized with, for example, a tenth of the notional amount, then the proposition becomes more attractive. Second, although the best-case outcome is worth less than 2.5% of the notional, at a hazard rate of 0.008 this outcome has a more than 96% chance of occurring. This is a fairly common—although systemically, of course, possibly dangerous—feature of short derivatives strategies: They often feature frequent small gains and rare but far larger losses.

Nevertheless, we can see that the present value of the positive outcome, weighted by its probability of occurrence, is 2.14 per 100 notional. Since the contract is entered at par, it follows that the expected present value of the loss to the writer of protection must be the same.

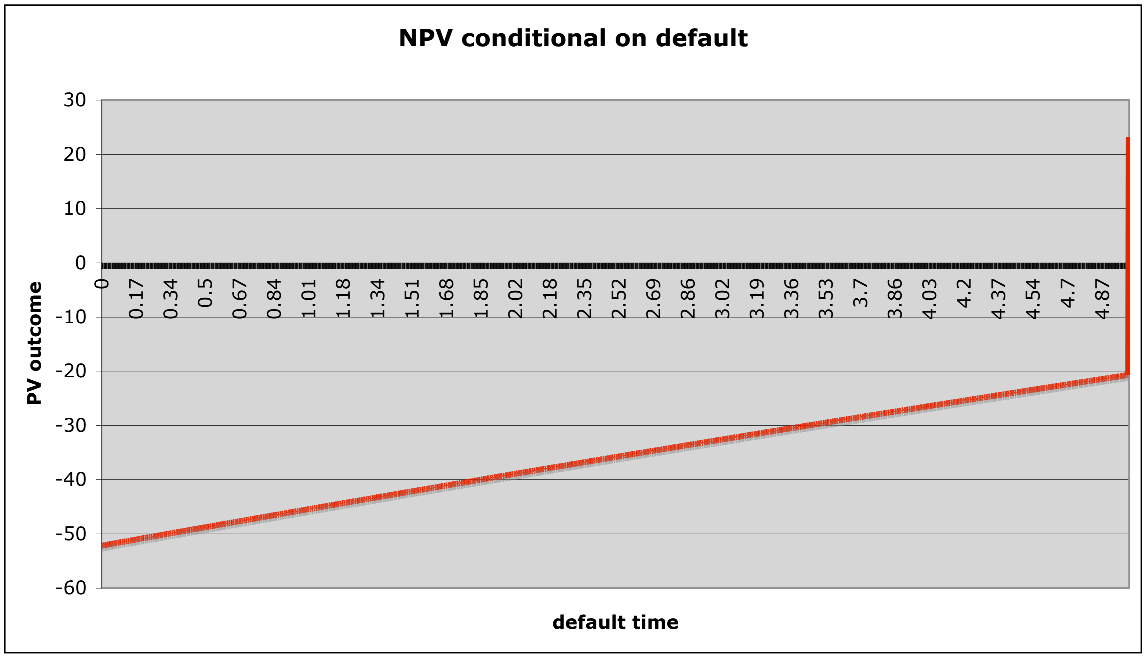
If we choose instead the much larger hazard rate of 0.12, then now the par spread is roughly 723 basis points, and superficially the graph of the various outcomes' values looks similar:



In the case, the only positive outcome for the protection seller is once again the case in which the name does not default. In this case, however, the present value of the total premium payments is 33.43. Of course, the likelihood of this outcome is lower—only 55%—but even so the expected present value of this payment is nearly 18.35. Consequently, the expected loss in the default cases is the same amount, and as a result the variance in possible outcomes is far larger for issuers with a high likelihood of default. In this case, the standard deviation in the present value of the outcomes is more than 37.73—that is, more than a third of the notional! Thus, while both this contract and the one above are priced at par and are in that sense fair, the risk in the second case to the protection writer is substantially higher.

Fortunately, the CDS pricing formula we have seen above provides an alternative to help solve this problem. While it is true that, in the second case, the par spread is over 700 basis points, a contract can be entered into at any spread the parties to the trade agree upon. If, for example, the premium—or the so-called "running" spread—is chosen to be 500 basis points, then by our valuation formula above, the present value of this contract to the protection buyer is roughly 7.81. The transaction can thus be made fair if the protection buyer agrees to pay 500 basis points running and pays the protection seller the excess value of the contract upfront—that is, at the time the contract is entered into.

The result, as you can see below, is to make both the worst and best outcomes less extreme…



…and, as a consequence, reduce both the expected loss and the variance of the outcomes. Now, the expected loss on the contract is only 12.69—a reduction of about a third from the running contract—and the standard deviation of value outcomes is noticeably less, roughly 31.13.

It has long been the case that issuers with par spreads above 500 basis points trade upfront plus 500 running. It is now the case that all North American corporate CDS, for example, trades at two standard running spreads: 100 and 500 basis points. For names whose par spreads are less than 100 basis points, it is the protection seller who makes an upfront payment to the protection buyer. In addition to mitigating risk in some cases, this arrangement has the advantage of making CDS contracts on the same name more closely comparable to one another. European names have followed suit by setting a standard range of tradable spreads for both corporate and sovereign CDS. These are all steps to increasing the centralization and liquidity of these contracts, permitting central clearing and, before too long, exchange trading of credit derivatives.

Basket CDS

In equity investing, baskets are used to gain exposure to groups of names selected for a particular purpose: broad indexes can be used for exposure to the larger equity market;

indexes by sector or market capitalization can be used for more targeted exposure; custom baskets may be used to exploit perceived regularities or anomalies in price behaviors, or to express highly technical and specific market views.

It should hardly come as a surprise, then, that baskets are also popular in credit markets. A basket of CDS with original notional N is written on a collection Π of n different names with initial weights $w_1, w_2, \ldots, w_n$, a common maturity T, and a single spread s_Π. If name i experiences a credit event during the term of the contract, then the protection seller pays the protection buyer the amount $w_i N(1 - R_i)$—that is, the loss on the name. That name is then removed from the basket, and the notional amount on the basis of which the spread s_Π is paid is correspondingly reduced by the quantity $w_i N$.

It should be clear that, expressed in terms of initial weights, the value of protection on each individual name in the basket is equivalent to the amount available via the purchase of a single-name CDS with notional $w_i N$. This makes the value of the protection simply the linear combination of the protection-leg values:

$$NL^*_{\Pi,T} = \sum_{i=1}^{n} w_i NL^*_{i,T}$$

$$L^*_{\Pi,T} = \sum_{i=1}^{n} w_i L^*_{i,T}$$

Similarly, the common spread is paid on each name according to its weight until it experiences a credit event and is removed from the basket. We can therefore express the risky annuity value in terms of the individual names' risky annuity values:

$$Ns_\Pi A^*_{\Pi,m,T} = \sum_{i=1}^{n} w_i N s_\Pi A^*_{i,m,T}$$

$$A^*_{\Pi,m,T} = \sum_{i=1}^{n} w_i A^*_{i,m,T}$$

Each of the single names' protection and annuity values are determined from market data available for the individual names. Then, just as in the single-name case, to determine the par spread we set the values of the two sides of the contract equal:

$$Ns^*_\Pi A^*_{\Pi,m,T} = NL^*_{\Pi,T}$$

$$s^*_\Pi = \frac{L^*_{\Pi,T}}{A^*_{\Pi,m,T}} = \frac{\sum_{i=1}^{n} w_i L^*_{i,T}}{\sum_{i=1}^{n} w_i A^*_{i,m,T}}$$

We recall that, for each individual name in terms of its par spread…

$$s^*_i = \frac{L^*_{i,T}}{A^*_{i,m,T}}$$

$$L^*_{i,T} = s^*_i A^*_{i,m,T}$$

…leading us to conclude that…

$$s_{\Pi}^{*}=\frac{\sum_{i=1}^{n}s_{i}^{*}w_{i}A_{i,m,T}^{*}}{\sum_{i=1}^{n}w_{i}A_{i,m,T}^{*}}=\frac{\sum_{i=1}^{n}s_{i}^{*}w_{i}A_{i,m,T}^{*}}{A_{\Pi,m,T}^{*}}$$

The par spread on the basket is thus a weighted average of the individual names' par spreads, but with each name's notional weight adjusted by its risky annuity value (what credit traders, just to make things less clear, will sometimes call the "duration" of the contract).

The need for this adjustment is clearer if we consider an equally weighted basket consisting of two names at the two extremes of credit quality. One name will almost certainly default instantly, while the other will almost certainly not default at all. If the investor were to purchase protection on the two names separately, he or she would pay an exceptionally high spread on the low-quality name, but would only expect to do so for a short time; at the same time, he or she would pay an exceptionally low spread on the high-quality name, and would be very likely to do so over the entire life of the contract.

If the two names are combined in a basket, then the basket spread will be paid on the full notional for as long as the high spread is paid in the single-name case, and will be paid on half the notional for, in most cases, the entire life of the contract. If we imagine lengthening the maturity of the basket trade, it seems logical that the fair basket spread should more and more nearly approach the par spread on the low-risk name, since as T grows arbitrarily large, the contract becomes essentially indistinguishable from a contract on the high-quality name alone.

To compute the value to a party receiving some s_{Π} other than the par spread at the moment, we may use the same hedging argument we used above for single names and conclude that:

$$V_{basket}=N\left(s_{\Pi}-s_{\Pi}^{*}\right)A_{\Pi,m,T}^{*}=Ns_{\Pi}A_{\Pi,m,T}^{*}-Ns_{\Pi}^{*}A_{\Pi,m,T}^{*}$$

We recall that we can decompose the risky annuity for the entire basket in terms of the constituent names' risky annuities, so…

$$Ns_{\Pi}A_{\Pi,m,T}^{*}=Ns_{\Pi}\sum_{i=1}^{n}w_{i}A_{i,m,T}^{*}=\sum_{i=1}^{n}w_{i}Ns_{\Pi}A_{i,m,T}^{*}$$

…and, as we have just seen, the fair par spread can be expressed in terms of the individual names' par spreads, so…

$$Ns_{\Pi}^{*}A_{\Pi,m,T}=N\frac{\sum_{i=1}^{n}w_{i}s_{i}^{*}A_{i,m,T}^{*}}{A_{\Pi,m,T}^{*}}A_{\Pi,m,T}^{*}=\sum_{i=1}^{n}w_{i}Ns_{i}^{*}A_{i,m,T}^{*}$$

…thus making the value of the basket:

$$V_{basket} = \sum_{i=1}^{n} w_i N s_\Pi A^*_{i,m,T} - \sum_{i=1}^{n} w_i N s^*_i A^*_{i,m,T} = \sum_{i=1}^{n} w_i N\left(s_\Pi - s^*_i\right) A^*_{i,m,T}$$

That is, the value of the basket is the sum of the values of its constituent single-name contracts at the common spread s_Π, which is the result you would of course expect.

CDS Indexes

Among the most liquid of credit derivatives are basket default swaps on published credit indexes. Two of the most popular are the CDX and iTraxx family of indexes. Perhaps the most commonly referenced for North American names is the CDX.NA.IG (CDX North America, Investment-Grade), which consists of 125 names chosen by a process set by the index creator.

There are several important differences between the ways single-name CDS trade and the way indexes trade. Market practice in single-name CDS bears a closer resemblance to the trading of interest rate swaps, in that they trade with a constant tenor from day to day. That is, each day a dealer will provide quotes on a set of maturities (3, 5, 7, and 10 years are common, with 5 years the most liquid) for the names they trade. Thus, in six months a contract entered into today has a maturity of 4.5 years, but desks will continue to quote 5-year CDS on that name as the most liquid point.

As we have mentioned, the spreads for North American corporate CDS are standard, but despite this standardization there are nevertheless liquidity concerns with a single-name contract. In order to close out the trade, one must either agree with the counterparty to settle in cash and tear up the contract, or else perform a novation (in which another party is found to take your side of the trade, again with an exchange of cash). Either of these options can be expensive: The trader is more or less at the counterparty's mercy when tearing up a trade with an odd maturity, and dealers may similarly charge a premium for taking a position facing another dealer via a novation.

CDS indexes circumvent this liquidity problem by trading their contracts all with a single maturity *date*. At the time of the index roll in CDX.NA.IG, for example, contracts with maturities of 1, 2, 3, 5, 7, and 10 years come into existence. In a manner similar to futures, as time passes the maturities of these contracts shorten, but they continue to be the traded contracts. Thus, the contract that once had a 5-year maturity for an index roll 3 years ago now has a 2-year maturity; no "new" 5-year contracts are created or traded as time passes, unlike the single-name case. This means that only 6 different contracts trade throughout the lifetime of each roll of CDX.NA.IG.

Further enhancing the liquidity of these contracts, each one trades throughout its life on a fixed premium that is set at the time of the index roll. In older rolls, the goal at inception was to set a premium that prices the swap near par—i.e., a present value of zero—but with the advent of changes in the credit derivatives markets, IG indexes now are all priced at a deal spread of 100bp. As circumstances change, this deal spread remains fixed. Opening or closing a position, long or short, thus is merely a matter of the appropriate party paying the upfront.

Finally, the quotation method for indexes varies a bit from index to index. Generally, an index such as CDX.NA.IG is quoted on spread, meaning that the quotation is the par common spread s_n* described above in the section on CDS baskets. However, the counterpart large North American index for high-yield issues—CDX.NA.HY—is quoted on price. Moreover, index prices are quoted not in raw PV terms, but using a method in which 100 signifies a contract priced at par, mimicking the price quotation method familiar from the cash bond market.

As an illustration, suppose that you wish to buy protection on CDX.NA.IG at a deal spread of 100bp. If you receive a spread quote that is also 100bp, then the deal is priced at par; no cash need be exchanged in order to purchase protection. (We assume here that you enter the deal a time when there is no accrued premium; otherwise, the protection seller pays that amount to the protection buyer upfront.)

If, on the other hand, you receive a spread quote that is higher than 100bp—say 147bp, for example—then an upfront payment must be exchanged. In the cash bond market, the buyer of a bond is, in credit terms, a protection seller; index price quotation conventions are formulated from this point of view. Thus, the index quotation method will assign this contract a value lower than 100 (par), just as a cash bond entered into at par with a 100bp credit spread would lose value if the credit spread subsequently widened to 147bp.

Suppose for the sake of argument that the risky annuity value on the basket, calculated as above, is 3.75. Then the value of the swap, per 100 notional to the protection seller, is now 100*3.75*(0.01 – 0.0147), or -1.7625. This is sensible, since after all if the protection seller receives only 100bps on a basket whose fair spread is 147bps, then the value of the swap is negative to the seller.

Quoted in price terms using the index convention, the index would be priced at 100 – 1.7625 = 98.2375. Still, the key value is the *difference* from 100 par, which is the actual value of the swap per 100 notional to the protection seller. To settle upfront, then, the protection buyer would need to pay 1.7625 per 100 notional on the deal in order to enter the contract under fair terms.

Making matters more interesting, the CDS indexes are quoted—and trade—in their own right. Since the names of which they are composed also trade, there is an opportunity for the basket spread calculated as above in terms of the constituent names' spreads to diverge from the traded spread on the entire basket. This difference—called the index basis—serves as the rationale for a family of credit derivatives trading strategies. Basis trading is an example of an instance where capital markets are clearly inefficient, and in that sense is a method of capitalizing on arbitrage. On the other hand, generally the basis is very small, meaning that extremely large notionals (with very little collateral) must be traded in order for the return to be worthwhile. If, instead of closing, the basis between the traded index level and the "fair" index spread widens for a time, mark-to-market losses and consequent demands for more collateral can lead to spectacular losses on this "arbitrage."