Should a Derivatives Dealer make a Funding Value Adjustment?

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ABSTRACT

Derivatives models are used by dealers for two purposes. They are used to calculate the fair value of the derivatives book for accounting purposes and they are used by traders to choose trades that improve the profitability of the derivatives group, as measured by senior management. Given the way that the performance of the derivatives group is typically measured, it is not possible to develop a single model that serves both purposes. Traders want to incorporate a funding value adjustment (FVA) in valuations to reflect the funding costs they are charged, but this can lead to prices that are different from fair value. This paper examines this problem and considers alternative solutions.

Should a Derivatives Dealer make a Funding Value Adjustment?

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One of the most controversial issues for a derivatives dealer in the last few years has been whether or not to make what is known as a "funding value adjustment" (FVA). This is an adjustment to the value of a derivative or a derivatives portfolio designed to reflect the dealer's average funding costs. Theoretical arguments indicate that the adjustment should not be made. But, in practice, many dealers find these theoretical arguments unconvincing and choose to make the adjustment anyway. This paper examines the case for and against FVA. It is more comprehensive and has a more managerial focus than Hull and White (2012b)

The theoretical valuation of a derivative requires risk-neutral expected cash flows to be estimated and discounted using a "risk-free" interest rate. The interest rate serves two purposes. It is used as the discount rate and it enables risk-neutral growth rates to be calculated. The FVA for a derivative can be defined as the difference between a) the value of a derivative when it is calculated in the normal way by using an assumed "risk-free" rate, whatever this may be, and b) the value of the derivative when it is calculated by using the dealer's average funding cost in place of the assumed "risk-free" rate. In effect, the FVA changes the interest rate from the assumed "risk-free" rate to the dealer's average funding cost. It can be shown that b) is the value of the derivative to a trader if it is hedged and the net funds required (generated) are charged to (credited to) the trader at the dealer's average funding cost.

The FVA adjustment emphasizes that derivatives dealers have never really accepted the idea that the interest rate used when risk-neutral valuation is implemented should be truly risk-free. Prior to the credit crisis that started in 2007, dealers assumed that interest rates could be calculated from LIBOR and LIBOR-swap rates. If asked why they made this assumption, it might be thought that they would reply that these rates are the best proxies available for risk-free rates. In fact, it is more likely that they would say that LIBOR is a good approximation to their short-term funding costs and LIBOR-swap rates are the longer-term rates corresponding to continually refreshed LIBOR rates.[1]

Post-crisis, most dealers have used overnight-indexed swap (OIS) rates to determine the interest rate for fully collateralized transactions. The argument usually given for this practice is that fully collateralized transactions are funded by collateral. If this collateral is cash, the interest rate paid is usually the overnight federal funds rate and the OIS rate is a longer-term rate corresponding to a continually refreshed overnight federal funds rate.[2] For non-collateralized transactions, they continue to use interest rates based on LIBOR and LIBOR-swap rates. The argument given for this again involves funding. When a derivative is not collateralized, LIBOR is an estimate of the derivative's short-term funding cost.

FVA provides further evidence that funding costs are of key importance to dealers in determining interest rates. As just mentioned, the most common current market practice is to use an interest rate of LIBOR for uncollateralized transactions because this is an estimate of the dealer's short-term funding cost. If a dealer cannot in fact fund at LIBOR, it calculates an FVA equal to the difference between the value of its uncollateralized portfolio when LIBOR is used as the interest rate and the value of the portfolio when its average funding cost is used as the interest rate.

To understand the arguments concerning FVA it is necessary to understand the procedures dealers go through in calculating the value of a derivatives portfolio with a counterparty. The first step is to calculate the no-default values of the derivatives in the portfolio. This provides a total value of the portfolio assuming that neither side will default. A credit value adjustment (CVA) is then made to reflect the possibility that the counterparty will default. This is followed by a debit (or debt) value adjustment (DVA) to reflect the possibility that the dealer will default. A further adjustment may be necessary if transactions are collateralized and the interest rate paid on cash collateral is different from the assumed risk-free rate. This leads to the valuation of the portfolio being

[1] See Collin Dufresne and Solnik (2001) for a discussion of the continually refreshed argument. For example, the five-year LIBOR-swap rate has a risk corresponding to 20 three-month loans made to qualifying borrowers, not to a single five-year loan.
[2] See Hull and White (2012a) for a discussion of this.

$$\text{NDV} - \text{CVA} + \text{DVA} - \text{CRA} \tag{1}$$

where NDV is the no-default value of the portfolio and CRA is a collateral rate adjustment reflecting the cost to the dealer arising from the interest paid on cash collateral being different from the discount rate.

The FVA adjustment is a potential adjustment to NDV. If the adjustment is made, the value of the portfolio becomes

$$\text{NDV} - \text{CVA} + \text{DVA} - \text{CRA} - \text{FVA} \tag{2}$$

A key point here is that the FVA adjustment is not related to credit issues as these are taken into account in CVA and DVA.

This paper shows that the motivation for the funding value adjustment is the way the performance of the derivatives desk is assessed by senior management. This is different from the way the performance of the derivatives desk is assessed for accounting purposes. The latter involves the calculation of what accountants refer to as "fair value." The fair value of a derivative is in general not the same as its FVA-adjusted value. This creates a number of problems and has a number of unintended consequences.

1. Performance Measurement

The funding value adjustment arises from a difference between the way derivatives are valued in the market and the way the activities of a derivatives desk are assessed by dealers. This section explains this point.

Much of finance theory assumes that decisions are driven by valuation models. If a new project has a positive net present value it is undertaken; if it does not, it is not undertaken. But in practice for a financial institution, return on capital is often the key metric when projects are considered. Consider a lending opportunity. Suppose that the interest that can be charged to a particular set of borrowers is 6% per annum, the funding cost is 3% per annum, administrative costs are 0.8% per annum, and expected loan losses are estimated at 1% per annum. The expected annual before tax profit on the loans is 1.2% of the amount loaned. If the required capital (which might be either regulatory or economic capital) is 5% of the amount loaned, the pre-tax return on capital would be calculated as 24%. This would be compared with the return on capital for other opportunities in deciding whether to make the loans.

Note that all loans, regardless of their risk, are assumed to be funded at the bank's average funding cost in the return on capital measure. But the risk of a loan is not ignored in the measure. The risk of a loan is taken into account in both the expected loan losses and in the required capital. The return on capital approach is quite different from valuing the loan (something that rarely done). If we were interested in determining the value of the loan, we might determine the appropriate discount rate for the loan and discount the expected loan cash flows to determine their present value. The discount rate would reflect the risk of the loan and the expected cash flows would reflect expected losses due to default. Alternatively, we could adopt a derivatives approach and calculate the value of the loan assuming that it was risk-free so that there was no possibility of default and then make a CVA-type adjustment for the cost of a default.

The return on capital metric used to measure the expected profitability of loans is quite difficult to apply to determine the expected profitability of the derivatives activities of a financial institution. Some derivatives transactions require funding while others generate funding. Furthermore, it is much more difficult to determine the incremental capital that will be required for a new derivatives transaction than it is to do so for a new loan. This is because the value of the derivative can vary widely over its life so that its incremental contribution to risk is very hard to estimate.

However, the return on capital metric can be, and in practice is, used ex post to measure the performance of the derivatives desk. Often it influences bonuses. Although applying return on capital to derivatives activities is almost impossible ex ante, it is very easy ex post. The average capital actually required for derivatives during a year is known at the end of the year. Similarly, the average funding required by (generated by) derivatives activities can be calculated at the end of the year and charged (credited) at the bank's average funding cost.

An Example

FVA is a response on the part of derivatives traders to the return on capital approach to measuring their performance. This can be illustrated with a simple example.

Suppose that a client wants to enter a forward contract to buy a non-dividend paying stock in one years' time. Consider how the trader views this transaction. If she enters into a contract to sell forward, she will hedge the forward contract by buying the stock now so that she has it available to deliver one year from now. Her profit at the end of the year under the return on capital metric will be the delivery price less the current stock price compounded forward at her funding rate. If current stock price is $100 and her funding rate is 4% the delivery price must be $104 or higher in order for the trader to break even or earn a profit. The delivery price at which the trader is willing to sell in one year's time reflects her funding rate.

The use of funding costs in determining prices applies to more complex transactions as well. Suppose that at the beginning of a year a trader sells a one-year uncollateralized European call option on a non-dividend paying stock with a strike price of $100. The stock price is $120 and the stock price volatility is 30%. Suppose further that the bank's average funding cost is 4%,[3] but that the "risk-free" discount rate used in the bank's systems is 2%. The trader delta hedges the option perfectly for one year. At the end of the year, the trader liquidates the remaining hedge portfolio (if any) and makes the payoff (if any) on the option. The proceeds of these two terminal transactions are exactly equal in size but of opposite sign.

The Black-Scholes-Merton price of the option based on the bank's assumed "risk-free" rate is $26.79.[4] If the trader sells the option for this price and is charged 2% on the net after-hedging funding cost, the trader's net profit on the trade will be zero. (As mentioned, we are making the idealized assumption that delta-hedging is implemented in such a way that it works perfectly. We are also assuming that the 30% volatility is the actual stock price volatility, not an implied volatility.) If the sale price is higher, the trader's net profit will be positive. However, if the trader sells the option for $26.79 and is charged 4% on the net after-hedging funding cost, there will be a loss of $1.34. This is because the value of the transaction when the "risk-free" rate is increased to 4% is $28.13. A natural response to this on the part of the trader is to demand that the "risk-free" discount rate in the bank's systems be changed from 2% to 4%. If this is done the

[3] All interest rates are quoted with annual compounding.

[4] In this example and all subsequent option pricing examples we are assuming that all the assumptions underlying the Black-Scholes-Merton model are correct. This ensures that all our hedging arguments work. In reality none of these assumptions is true. However, if the hedging arguments underlying FVA do not work in our idealized setting it does not seem possible that they can work in a more realistic setting.

model price correctly reveals to the trader the threshold price at which the deal will be profitable if funded at 4%.

These examples illustrate that FVA can be seen as nothing more than a rational response by traders to the incentives provided by their employers. But it leads to a situation where the valuation of a transaction calculated by the dealer's systems is in general different from the fair value required by accounting standards. We now explore this point.

2. Fair Value

SFAS 157 and IFRS 13 define the fair value as "the price that would be received to sell an asset or paid to transfer a liability in an orderly transaction between market participants at the measurement date."[5] Should two entities with different funding costs have different fair value estimates for the same asset? The answer is no. Consider two individuals, A and B. A can borrow money at 2% to buy IBM shares and B can borrow money at 6% to do the same thing. It is quite possible that borrowing costs will influence their decisions on whether to buy the shares. But A and B should agree that the fair value of the shares is their market price. This fair value may be different from the private values of A or B for the shares either because of their funding costs or for other reasons.

Accounting standards distinguish between Level 1, Level 2, and Level 3 estimates of fair value. Level 1 estimates are based on quoted prices for identical assets or liabilities in active markets. Level 2 estimates are usually based on quoted prices for similar assets or liabilities in active markets. Level 3 estimates usually involve situations where no similar assets or liabilities trade. Level 1 valuations do not require a model. Level 2 valuations require a model to interpolate between the prices of actively traded instruments to determine the value of an instrument that is not actively traded. Level 3 valuations require a model to incorporate the underlying assumptions on which the valuation is based.

[5] See Financial Accounting Standards Board (2006) and International Accounting Standards Board (2011)

Use of Models

In addition to being used by traders to determine the breakeven price at which a hedged derivative trade will earn a particular rate of return (a private valuation), models are also used to estimate the fair value for accounting and reporting.

Nearly all derivatives valuations are Level 2. For example JPMorgan Chase reported that about 98% of its derivatives valuations were Level 2 in 2011. Derivative pricing models are therefore normally used to determine a price for a derivative that is consistent with other instruments that trade actively. Suppose the Black-Scholes-Merton model is used to price a particular option on an asset. The procedure is as follows. The model is used to calculate implied volatilities from other similar options that trade actively on the same asset. Interpolation procedures are then used to estimate the implied volatility corresponding to the strike price and maturity of the option under consideration. The Black-Scholes-Merton model is then used to price this option using the interpolated volatilities.

The model is really nothing more than a sophisticated interpolation tool. It is used first to calculate implied volatilities and again to value the option. In implementing the model it is necessary to assume some interest rate. If we change the assumed interest rate (e.g., from LIBOR to OIS), the implied volatilities will change but the fair values calculated for the derivatives will not change appreciably. This is because the role of the model as an interpolation tool has not changed. We have merely switched from one interpolation method to another very similar interpolation method.

From the perspective of fair value calculation, it does not matter very much whether the interest rate is OIS or LIBOR or LIBOR plus a spread. However, if different interest rates are used in different situations there is scope for confusion. For example, suppose that the bank uses LIBOR for non-collateralized transactions and OIS for collateralized transactions when estimating fair market values for options. In this case there will be two sets of implied volatilities, one for each type of transaction. In fact, two options which are exactly the same may be valued using two different volatilities if one is collateralized and one is not.

In addition, if implied volatilities are used to communicate pricing information within the bank or between dealers and brokers, it is likely that there will be further confusion. Without knowing the interest rate that is used the implied volatility conveys only limited information about the option value.

Can We Match Funding Costs and Market Prices?

As we have discussed, models are used for two purposes: determining the price at which a hedged derivative transaction will earn a particular rate of return, a private valuation, and estimating the fair market value. Is it possible to calibrate the trader's model to market prices so the private value agrees with the fair market values and yet earns the funding cost?

Let us return to the example considered earlier where a client wants to enter a forward contract to buy a non-dividend paying stock in one years' time. The stock price is currently $100. Suppose that the one-year forward price of the stock in the market is 102. If the trader's cost of funding is 4%, the trader's breakeven delivery price, the price at which the contract has a private value of zero, is 104. However, at this delivery price the contract has a fair market value that is different from zero. In this case there is no way the fair market value of the contract can be brought into line with the private value determined using a model that incorporates the trader's funding cost.

For more complicated transactions it sometimes appears that a private model price based on the funding cost can be made to agree with market prices. Consider the previous example in which a one-year call option with a strike price of 100 is being sold on a stock currently trading at $120. Suppose that the market price is $26.79. This is consistent with an interest rate of 2% and a volatility of 30%.

Suppose the trader makes a funding value adjustment by setting the interest rate equal to the average funding cost, 4%. If she calibrates the model to the market price she finds that an implied volatility is 25.66% matches the market price. Using this volatility it appears that the trader's model matches the market price and yet allows her to earn her funding cost on the hedged transaction.

Of course this is only an illusion. If a trader always matches market prices, the trader is in effect using the market model and, since the market model uses a 2% interest rate, this is what the trader can expect to earn. Furthermore, the hedging argument that underlies the determination of the rate of return earned depends on using the true volatility. In this example, we assumed that the true volatility is 30%. Since the trader is using the wrong volatility, the hedges will not work as expected. The only way the trader can earn a return that is higher than 2% is by selling the option at a higher price than the market price. Profits cannot be manufactured by changing the model.

The option example highlights the fact that if the trader is using a model that is different from the market's (in this case using a different assumed interest rate) and she calibrates her model to market prices (in this case estimating the volatility from market prices), she will not achieve the desired outcome. If the model involves unobservable parameters such as volatility the trader must make the best estimate of these parameter values. If the trader is inferring the values from market prices she must use her best estimate of the model that the market is using rather than her own model when inferring the values.

We conclude that it is not possible for the trader to match her private price to the market price and yet earn a rate of return equal to her funding cost unless the interest rate that is consistent with market prices equals the trader's funding cost.

Determinants of Fair Value

The market price for an actively traded derivative (or anything else) is ultimately determined by supply and demand. The market price is the price that balances supply and demand. Those market participants who want to buy at the market price presumably have a private value for the derivative that is higher than the market price. Those who want to sell at the market price presumably have a private value that is lower than the market price. Does the resulting price reflect funding costs?

There are many reasons why different market participants might value the same derivative transaction differently.[6] One possible reason is that different market participants are subject to different funding costs. In their private valuations they might (rationally or irrationally) use discount rates that reflect their funding costs. In this case, the resulting market price will reflect the funding costs of the market participants but in a very complicated way. If funding costs are

[6] We should be pleased that different market participants value the same transaction differently. If this were not the case, there would be no trading!

the only reason for variation in the private values, the market price will reflect the funding cost of the buyer that has the lowest private value greater than the market clearing price, the marginal buyer, and the funding cost of the seller that has the highest private value less than the market clearing price, the marginal seller.

It should be clear from this discussion that there is only one fair value for any asset. This is the price that balances supply and demand. Two different market participants that use the same models and the same market prices to calibrate the models should agree about the no-default fair value of derivative transactions.

This result is also true of derivative valuations that reflect CVA, DVA and CRA. Dealers who have the same information and same models should agree on the NDV, CVA, DVA and CRA in equation (1). In particular, this is true of the two parties to the transaction since a) the no-default value of the portfolio to one party is the negative of its no-default value to the other, b) the counterparty's CVA is the dealer's DVA and vice versa, and c) the collateral interest paid by the dealer is the interest received by the counterparty so that the counterparty's CRA is equal in magnitude and opposite in sign to the dealer's CRA.

In this case, although everyone agrees on the valuation, the valuation is specific to the pair of entities involved in the transaction because different entities have different CVAs and DVAs. It is tempting to say that this is a violation of the accounting standards' definition of fair value since, if one party novates a transaction to a new counterparty, the price at which the transaction is done will reflect the credit risk of the new counterparty. However, this is not so when all costs and benefits are taken into account.

Consider a transaction between A and B. From A's point of view the no default value is 100, CVA is 5, DVA is 10 and CRA is zero. The value to A is 105 and the value to B is –105. Now suppose that A novates the transaction to C, a firm with no credit risk. C's DVA is zero so the value of the transaction to C is 95. It appears 10 of value has been lost. After novation, the value to A is 95 and B is –95. However, because B makes a gain of 10, it should at least in principle, be willing to pay A 10 when A announces that it is novating the transaction to C. Assuming this payment happens, A receives 95 from C and 10 from B. B pays 10 to A and ends up with a transaction worth –95. The original valuations (105 to A and –105 to B) are preserved.

A troubling aspect of including FVA is that it results in different market participants having different estimates of the fair value. Consider equation (2) which includes FVA. If the dealer and the counterparty have the same funding costs, the dealer's FVA is equal in magnitude and opposite in sign to the counterparty's FVA and both continue to agree on the fair value. However, if the dealer and the counterparty have different funding costs they no longer agree on the fair value.

Theoretical Arguments

The heart of the FVA debate flows from the procedures used to measure the performance of the derivatives desk. We now consider a number of theoretical arguments that show that funding costs should not influence estimates of market value. Technical details are in Hull and White (2012c).

The evaluation of an investment should depend on the risk of the investment, not how it is financed. This can be quite difficult to accept. Suppose a bank is financing itself at an average rate of 4.5% and the risk-free rate is 3%. Should the bank undertake a risk-free investment earning 4%? The answer is that of course it should accept the investment. Because the investment is risk-free, its cash flows should be discounted at the risk-free rate and when this is done the investment has a positive value.

It appears that the bank is earning a negative spread of 50 basis points on the investment. However, the incremental cost of funding the investment should be the risk-free rate of 3%. As the bank enters into projects that are risk-free (or nearly risk-free) its funding costs should come down. Suppose that the bank we are considering doubles in size by undertaking entirely risk-free projects. The bank's funding cost should change to 3.75% (an average of 4.5% for the old projects and 3% for the new projects). This shows that the incremental funding cost associated with the new projects is 3%.

This argument does not usually cut much ice with practitioners because it seems far removed from reality.[7] A bank does not double in size by taking risk-free projects. What usually happens

[7] A related argument is that in the absence of taxes and bankruptcy the amount of capital that a bank has should not matter to the shareholders. Shareholders in a bank with more capital will be happy with a lower rate of return because the risk they bear is also lower. See Admati (2010). This argument also does not seem to cut much ice with practitioners

is that its average cost of funding remains approximately the same through time. This average cost of funding is, in the opinion of its investors, presumably matched by the average risk of the projects it undertakes. Risk-free projects enable riskier-than-average projects to be taken elsewhere in the bank so that the overall risk of the bank's portfolio remains approximately the same.

Why not then use the same discount rate for all projects? The answer is that this is liable to have dysfunctional consequences. It makes riskier-than-average projects seem more attractive than they should do and risk-free (or almost risk-free) projects unattractive.

The argument we have just given seems to be at least partially accepted by financial institutions. Banks and other financial institutions do undertake very-low-risk investments such as those in government securities even though they know the return is less than their average funding costs. For our purpose, the key point about this argument is that it shows that funding costs should in theory be irrelevant in the valuation of any investment, risk-free or otherwise. To make the point that funding costs are irrelevant to the pricing of derivatives, we can use this result in conjunction with the risk-neutral valuation result which states that we can perform the valuation by calculating expected payoffs and discounting at the risk-free rate.

Another theoretical argument is the following. Suppose a derivatives dealer funds itself at 4.5% when the risk-free rate is 3%. We assume that the whole of the 1.5% credit spread is compensation for the risk that the bank will default.[8] What is the expected funding cost to a dealer after the cost of defaults have been considered? Because we are assuming that the whole of the 1.5% spread is an adjustment for the lender's default losses, it is 3%. In other words, the (risk-neutral) expected funding costs of the bank is always the risk-free rate.

The argument in the preceding paragraph can be restated in terms of DVA. Hull and White (2012b) distinguish two sources of DVA. For a portfolio with a counterparty, DVA1 measures the benefit to the dealer of the fact that the dealer might default on the derivatives. DVA2 measure the benefit to the dealer of the fact that the dealer might default on the debt instruments used to fund the hedged derivatives position. The DVA in equations (1) and (2) is DVA1. FVA

[8] In fact, this is a simplification. Part of the credit spread can be attributed to non-credit factors such as liquidity. Some researchers have argued that that the liquidity component of a credit spread can form the basis for a valid model adjustment

is equal in magnitude and opposite in sign to DVA2. It can be argued that either both FVA and DVA2 should be quantified (so that they cancel out) or (more simply) neither should be quantified.

3. Unintended Consequences of FVA

Market participants with high funding costs will tend to find themselves trading uncollateralized derivatives that provide funding while those with low funding costs will tend to find themselves trading uncollateralized derivatives that require funding. Dealers with high funding costs will short assets and buy forwards on the assets whereas dealers with low funding costs will do the opposite trade. Dealers with low funding costs will find themselves selling (buying) uncollateralized call (put) options whereas those with high funding costs will find themselves doing the reverse. In fact, if regulations and internal controls permitted them to do so, low-funding-cost dealers would sell huge volumes of assets forward to high funding cost dealers on an uncollateralized basis. They would also sell (buy) huge volumes of call (put) options to (from) dealers with high funding costs. Consider again the option example mentioned earlier. If a dealer with funding costs of 2% were able to sell the option to a dealer with funding costs of 4% for 27.46, FVA-adjusted models would indicate both dealers have made a profit of 0.67.

Regulations now require most transactions between dealers to be collateralized whereas those with end users need not be collateralized. Given this, FVA adjustments are likely to lead to the situation where end users when they want to sell assets forward or sell call options or buy put options will get the best pricing from high-funding-cost dealers and, when they want to buy assets forward or buy call options or sell put options, they will get the best pricing from low-funding-cost dealers.

This may be a cause for concern. High-funding-cost dealers will tend to enter into bullish trades (long forwards, long calls, short puts) and attempt to hedge risks. Low-funding cost dealers will tend to enter into bearish trades (short forwards, short calls, long puts) and attempt to hedge risks. In both cases, big hedge positions in the underlying asset will be necessary for delta hedging. It may be more healthy for dealers to have a more balanced book.

Another issue is that a dealer's uncollateralized transactions with end users, whether in options or other derivatives, are sometimes hedged by collateralized transactions with other dealers. If a different model is used to calculate prices for the two sorts of transactions, hedging may be less than optimal. Indeed, computing a different no-default value for a transaction depending on whether it is collateralized or non-collateralized would seem to violate the law of one price.

It is important for management to choose incentives which encourage the derivatives desk to trade in the best interests of their shareholders. Many considerations, including those we have just mentioned, are likely to influence this. A key issue is whether shareholder interests are best met by focussing on the return on capital measure discussed in Section 1 or by focussing on fair value, which is discussed in Section 2. In theory, fair value is what shareholders should be concerned about, but in practice many derivatives dealers would argue that return on capital is what matters most to their shareholders.

4. Conclusions

Regardless of the models used by banks for their trading decisions there is only one fair value for a derivative. This is the value of the derivative that balances supply and demand. The purpose of a model when it is used to calculate fair value is nearly always to price a derivative that is not actively traded consistently with other derivatives that are actively traded. Calibrating variables such as implied forward prices, implied volatilities, and implied correlations play a key role in the calculation of fair values. But they can only perform this role accurately if the organization using the calibrating variables has implemented the same model as the organization producing them. This suggests that, if we are to avoid confusion, all dealers should use the same discount rates when calculating the fair values of derivatives. Consistency between dealers is more important than the discount rate itself.

Problems arise because the performance measures used by dealers push traders into using a different interest rate from that used by the market. One alternative for dealers is to also use this different model to calculate fair values. But accountants are unlikely to accept this approach because model prices will be out of line with those in the market. In the case of options, it is tempting to suggest that dealers can choose a discount rate equal to their funding costs and then match market prices with their implied volatilities. In fact, if they do this they will be disappointed with the results because they will not achieve their objective of ensuring that, if they trade at system prices, they will earn their funding costs on a hedged derivatives portfolio.

Another alternative is to use two models, one to price transactions for the purposes of trading decisions, the other to calculate fair values. This is may be a viable approach, but it has the disadvantage that it is liable to lead to the situation where the internal performance measure is out of line with the results reported in the company's financial statements.

Another way of solving the problem is to change the measure used to assess the performance of the derivatives trading activities so that it is consistent with the market. This means that derivatives desk is charged for funding at the rate used in determining market prices rather than the dealer's average funding cost. This approach would have a number of advantages. It would mean that the prices used for trading are the fair values used by accountants. It would lead to the no-default value of a collateralized derivative being calculated in the same way as the no-default value of the same non-collateralized derivative making hedging easier. The desirability of long or short positions in derivatives would no longer be influenced by funding costs. The treasury department may object that it is losing money by raising funds at one rate and passing them on to the derivatives desk at a lower rate. This can perhaps be dealt with by giving the treasury desk credit for the DVA2 associated with the funding of the derivatives desk.

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