INTERNATIONAL VALUATION STANDARDS COUNCIL

IVS ANNEX 250.02

CREDIT AND DEBIT VALUATION ADJUSTMENTS

Interim Application Guidance

January 2015

Contents

Introduction

1. This Annex forms part of IVS 250 *Financial Instruments*. It provides guidance to support the principles and Requirements in the International Valuation Standards when undertaking valuations of derivatives. Among the relevant principles and Requirements are:

    a. The principle in IVS 102 that a valuation assignment shall be carried out using appropriate procedures and principles.

    b. Requirement 5l in IVS 103 that the report shall make reference to the approach or approaches adopted, the key inputs used and the principal reasons for the conclusions reached

    c. Requirement 5 of IVS 250 which provides that the valuation report shall contain sufficient information to enable users to understand the primary factors influencing the reported value.

2. The guidance in this Annex identifies and discusses acceptable ways of estimating credit and debit valuation adjustments. However, other approaches may be also acceptable in certain situations. The most appropriate approach needs to be determined by the preparer of the valuation based on the facts and circumstances of each case.

3. The "Current Issues" section of this paper makes reference to funding valuation adjustments (FVAs) and the relationship these have with debit valuation adjustments as discussed in this paper. The IVSC has a separate project on FVA and the outcome of this may impact on some of the guidance in this paper. Accordingly, the IVSC Standards Board has issued this as interim guidance, pending the conclusion of the FVA project.

Scope and Purpose of this Guidance

4. The need to reflect the credit risk of the income derived from any cash generating asset is broadly understood. However, complications arise when valuing derivatives because the liability to make payments can change between the counterparties during the term. This means that when valuing their interest on any given date the holder of a derivative has not only to consider the credit risk of their counterparty but also their own credit risk. This paper examines the valuation challenges this produces and provides guidance on how these may be resolved.

5. In this paper the adjustment required to the value of a derivative to reflect counterparty credit risk is termed a Credit Valuation Adjustment (CVA) and the adjustment to reflect own credit risk is termed a Debit Valuation Adjustment (DVA). Both adjustments need to be made when undertaking valuations for a variety of purposes including financial reporting, the presentation of management and investor information, and determining the regulatory capital of financial entities.

6. This paper provides information and guidance on the:

    - principles of CVA and DVA;

    - practical implications of financial reporting and regulatory requirements;

    - techniques and inputs for making valuation adjustments;

    - key challenges when calculating CVA and DVA;

    - practical application of CVA and DVA given the materiality of an entity's holdings; and

    - link between DVA and the cost of funding.

7. The information and guidance contained within this paper has been produced so as to be relevant to both valuation professionals and users of valuation information alike. The paper achieves this by providing an insight into:

    - the relevant methods, concepts and terminology used in calculating and interpreting CVA and DVA;

    - how complex valuation challenges related to CVA and DVA are tackled in practice, both for entities with material and less material derivative holdings; and

    - developments in international financial reporting and regulatory areas.

8. The guidance offered in this paper is relevant to all types of derivative contract irrespective of the asset class or whether they are collateralised or not. Other financial instruments, such as loans are discussed briefly, however guidance on the valuation of these is outside of the scope of this paper.

9. CVA and DVA are required in valuations prepared for financial reporting and for calculating the capital adequacy of financial institutions. In this paper brief reference is made only to the relevant requirements under Basel III and the International Financial Reporting Standards (IFRSs). It is impractical to make reference to all national regulatory or accounting standards in an international guidance document, but where these have similar provisions to the aforementioned international frameworks and standards this guidance may also be applicable.

Definitions

10. The following definitions apply in the context of this paper. Similar words and terms may have alternative meanings in a different context. The IVSC endeavours wherever possible to minimise differences between definitions used by the IVSC and other organizations; however it is occasionally necessary to use a differing definition in order to be fully relevant to valuation. The IVSC's International Glossary of Valuation Terms provides a comprehensive list of defined words and terms commonly used in valuation, together with any alternative meanings.

Basis Risk	The risk that the value of offsetting investments will not change in equal and opposite amounts.
Close-out Risk	The risk that adverse movements occur between the value of the derivatives and the value of the collateral held during the period that it takes to close-out exposures against a counterparty in a default situation.
Contingent Bilateral CVA	A bilateral CVA that takes into account the order of defaults of both counterparties (including joint default) by modelling the default relationship between both parties and applying this to the expected exposure.
Contingent Credit Default Swap (CCDS)	CDS contracts where the notional amount of protection bought or sold is fixed when a credit event occurs and is equal to the market value of a reference derivative transaction on that date.
Credit Default Swap (CDS)	A derivative contract which transfers credit risk from one party to another.
Credit Risk	The risk that one party to a derivative will cause a financial loss for the other party by failing to discharge an obligation.
Credit Valuation Adjustment (CVA)	An adjustment to the measurement of derivative assets to reflect the credit risk of the counterparty.
Debit Valuation Adjustment (DVA)	An adjustment to the measurement of derivative liabilities to reflect the own credit risk of the entity.
Default Probability (DP)	The likelihood of a counterparty not honouring its obligations.
Expected Positive Exposure (EPE)	The discounted receipts and unrealised gains an entity forecasts to receive from the counterparty.
Expected Negative Exposure (ENE)	The discounted payments and unrealised losses an entity forecasts to pay to the counterparty.

Fair Value (IFRS)	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[1].
Funding Valuation Adjustment (FVA)	An adjustment to the measurement of derivatives to reflect cost of funding.
Gap Risk	The risk that adverse movements occur between the value of the derivatives and the value of the collateral held during the period between two margin calls.
Loss Given Default (LGD)	The percentage amount that a party expects to lose if the counterparty defaults.
Market Value	The estimated amount for which an asset or liability should exchange on the valuation date between a willing buyer and a willing seller in an arm's length transaction, after proper marketing and where the parties had each acted knowledgeably, prudently and without compulsion. (*IVS Framework*)
One-way Collateral Agreements	Transactions covered by a one-way credit support annex (CSA), which means that one party is required to post collateral to its counterparty when the value of the trade is in the counterparty's favour, but the counterparty is not required to post collateral in the reverse situation.
Right-way-risk	When exposure to a counterparty or collateral associated with a transaction is positively correlated with the credit quality of that counterparty.
Wrong-way-risk	Occurs when exposure to a counterparty or collateral associated with a transaction is negatively correlated with the credit quality of that counterparty.

Principles of CVA and DVA

11. The purpose of a CVA is to reflect the credit risk of a counterparty within the value of an entity's derivative holdings. Issuers of derivatives routinely do this in order to ensure they are adequately compensated for the credit risk that they bear. For a DVA an entity incorporates its own credit risk into its derivative valuation. This is done to reflect the fact that an informed counterparty would be expected to adjust for the entity's credit risk when valuing a derivative. The DVA therefore represents the CVA that a counterparty would be expected to calculate when dealing with that entity.

Differences between loans and derivatives

12. The calculation and analysis of credit risk in the loan market is well established and on the whole these same principles can be applied to derivatives. However, there are some important differences between the two types of instrument.

13. When a lender grants a loan they are exposed to the credit risk of the borrower as principal is drawn down. This credit risk exists for the life of the loan and is predominantly driven by the size of the outstanding loan principal, ie credit risk tends to decrease as loan principal is repaid and increase as additional amounts are drawn down. The credit risk exposure is generally in one direction (unilateral) with the lender being exposed to the borrower. The lender's credit risk exposure to the borrower will vary over the life of the loan and will depend on the three factors below:

   - The Expected Positive Exposure (EPE) which is usually equivalent to the principal or drawdown plus unused firm commitments, as listed under the contractual terms of the loan, discounted to valuation date.

   - The likelihood of the borrower not being able to repay amounts required by the contract is the Default Probability (DP).

   - In the event that a borrower fails to repay their debt, the sum that is not recovered by the creditor as a percentage of the loan amount is the Loss Given Default (LGD).

14. For a loan, each of these potential future events can be estimated in order to calculate the fair value of the credit risk. This calculation can be performed at inception and updated at any point over the life of the loan. The integral below represents the product of DP and EPE between time 0 and time T, multiplied by LGD.

$$\text{Credit Risk} = \text{LGD} \int_0^T \text{DP}_t \cdot \text{EPE}_t \ dt$$

   The values of DP are multiplied by EPE from now (time = 0) until the expected maturity of the loan (time = T) to give the expected positive exposures to the counterparty adjusted for the likelihood of default over time. Each value is then summed through integration "with respect to time (t)" (dt) and multiplied by the loss given default to equal the credit risk of the loan.

15. Derivative contracts, unlike loans, will typically only involve the exchange of small cash flows at inception; in fact some require no upfront cash flows at all. Therefore, at the inception of a derivative contract the credit risk will often be very small, particularly when compared to a loan of the same principal amount. Much like a loan the credit risk will vary over the life of the

derivative contract and depend upon similar factors such as EPE, DP and LGD, however there are two important differences:

- the credit risk exposure can switch between counterparties over the life of the derivative, ie, no one party is necessarily the borrower or the lender; and

- derivative cash flows can be more volatile than those of a loan as they are usually based on a large notional amount and an underlying which can be volatile, eg, equity prices for an equity option.

16. It can also be more complicated to establish the credit risk of a derivative relative to a loan. For a loan the credit risk can often be determined on the basis of principal repayments and drawdowns which are contractually determined at inception. For a derivative, the size and direction of future payments between counterparties are often unknown at inception and therefore valuing credit risk can be more complicated.

17. There can also be subtle differences between the treatment of loans and derivatives in the event of default. In the event of default a loan may be offset against any other outstanding obligations between parties, however if they are not, then each loan will be considered individually alongside those of other creditors. Derivatives are almost always transacted under a netting agreement[2] or with a central counterparty (CCP) whereby all contracts with the counterparty are offset in the event of default resulting in a singular claim by one of the parties. Netting agreements are discussed in more detail later in this paper.

CVA in market prices

18. It is now common to see a range of prices quoted in the market place for identical derivative products. This is caused, in part, by the inclusion of a CVA in market prices. This dispersion can arise in some of the following ways:

- The CVA that a bank calculates will vary depending on that bank's existing portfolio of trades with the counterparty. As such the CVA is not specific to the derivative instrument and will vary from bank to bank.

- Entities may be calculating the same CVA, but then not applying a representative CVA to their quotes and hence charging a lower price than their valuation would indicate is fair. There could be many reasons for this such as undercharging for competitive advantage or because they lack the ability to allocate the CVA on a product by product basis.

- If the CVA is negative (reduces exposure to counterparty) this may not be passed on.

- If responsibility for valuing CVAs resides in multiple areas of an entity it is possible that a variety of approaches could be used, potentially resulting in a different CVA being calculated under identical circumstances.

19. For liquid markets, the CVA can be implied from market prices. If this implied CVA is materially different from that produced by an entity's own valuation model the assumptions used in the valuation should be reviewed. In practice, given the wide range of assumptions and parameters used within CVA models, calibrating these valuations to market levels can be

---

[2] The ISDA master agreement, developed by the International Swaps and Derivatives Association is the most commonly used master contract for derivative transactions.

complex. Moreover CVA may not be wholly included by entities that are seeking a competitive advantage and this will make the review mentioned above more difficult.

20. The inclusion of CVAs into market prices is an effective tool for counterparty risk management, however it should not be seen as a replacement for other sound credit risk management techniques. CVA is modelled based on an expected loss, although sound credit risk management should also consider scenarios where unlikely and potentially large losses may occur.

Master Netting Agreements and Collateral

21. Master Netting Agreements (MNAs) are contracts between two counterparties that enable the aggregation of exposures in the event of bankruptcy. Upon default, the agreement allows a counterparty to collapse all of its offsetting positions into a single receivable or payable claim. However entities should seek legal advice on the enforceability of these agreements in their relevant jurisdictions. Included in the MNA is the netting set, which stipulates which exposures can be netted down and any collateral that can be deducted. Given the extensive use of MNAs across financial markets, most CVA calculations are performed at the counterparty level and not at the deal or contract level.

22. The CVA for a new transaction should be equal to the incremental contribution to the overall CVA for that counterparty, ie, the CVA of a new transaction is equal to the CVA on a portfolio with new transaction minus the CVA on a portfolio without new transaction. It is possible for the new transaction CVA to be negative where the new transaction reduces the net expected exposure to the counterparty.

23. The CSA to a MNA reduces credit risk by setting terms for the provision of collateral between counterparties. The key terms reflect the:

- direction of any collateral provided, ie, whether one or both counterparties are required to provide collateral,

- type and quality of acceptable collateral, eg, particular currencies or securities with certain levels of haircut,

- conditions for what can be done with the collateral, eg, whether it can be rehypothecated or not, and

- frequency and trigger events for collateral to be provided, eg, collateral may be provided daily, but only when the size of the balance to be covered exceeds a minimum threshold amount.

24. Where collateral is posted on a daily basis and the minimum threshold amount is sufficiently small, an agreement is generally described as being "strongly collateralised". However this does not wholly eliminate credit risk, as an entity is exposed to various kinds of "gap" risk on default, eg, that collateral may fluctuate in value. As a major default event might be expected to be concurrent with a period of market turmoil or contagion, the effect of "gap" risk could be significant. This is dealt with in more detail in para 46.

Purpose of Valuation

25. It is important that due consideration is given to the purpose of the CVA or DVA being calculated as it may be necessary to alter the intended methodology in order to produce a practical and meaningful result.

CVA and DVA in Financial Reporting

26. This section focuses only on requirements of the IFRS that are of particular relevance to the measurement of CVA and DVA, but other accounting standards may be applicable. IVS 300 *Valuations for Financial Reporting* contains requirements for valuations produced for financial reporting and guidance on common valuation requirements under the IFRSs.

27. IFRS 9 Financial Instruments requires derivative contracts to be measured at fair value through profit or loss. IFRS 13 Fair Value Measurement provides a framework for measuring fair value and is the result of a joint project undertaken by the International Accounting Standards Board (IASB) and the USA national accounting standard-setter, the Financial Accounting Standards Board (FASB)[3]. IFRS 13 does not require fair value measurements in addition to those already required or permitted by other IFRSs and is not a valuation standard nor does it apply to valuation practices outside of financial reporting.

28. IFRS 13 states that the fair value of a liability reflects the effect of non-performance risk, which includes an entity's own credit risk. Although IFRS 13 does not use the term DVA, the requirement to consider the entity's own credit risk when measuring the fair value of any liability means that the fair value measurement of a liability derivative must include a DVA. This is consistent with the requirement for entities holding those obligations as assets to consider the effect of the entity's credit risks and other risk factors when valuing those assets.

29. Fair value as defined in IFRS 13 is based on the assumption of a market transaction and therefore is generally consistent with the definition of market value in the IVSs. It is intended as an accounting measure that can be applied consistently across IFRSs when those require or permit such a measurement basis. IFRS 13 fair value does therefore require some assumptions and hypotheses that might not be applicable when estimating market value for a purpose other than financial reporting.[4]

CVA and DVA in Regulatory Capital

30. This paper only references the requirements in the Third Basel Accord (Basel III) agreed by the Basel Committee on Banking Supervision, any additional requirements that have been implemented by a particular jurisdiction are not referenced in this paper.

31. Basel III introduced a specific requirement for a capital charge for potential losses due to risks associated with deterioration in the credit worthiness of a counterparty ie, a CVA. The methods for calculating this charge are set out in the Accord and differ depending on whether a bank has regulatory approval for using the internal model method for risk management or not.

---

[3] Converged equivalent accounting standard for US GAAP is Fair Value Measurement (Topic 820)
[4] See also IVS 300 G3

32. The Basel Committee does not consider it appropriate that own credit adjustments (DVA) be reflected in calculating a bank's common equity as part of its required capital. If a bank's credit rating has declined, the application of a DVA to its liabilities would reduce the value of those liabilities and therefore increase its equity. However, as the creditors' claims have not reduced in size the increase in common equity has not improved the bank's solvency or created a capital buffer that protects the creditors.

33. Basel III requires banks to "de-recognise in the calculation of Common Equity Tier 1 all unrealised gains and losses that have resulted from changes in the fair value of liabilities that are due to changes in the bank's own credit risk"[5]. This means that any DVA reflected in the fair value of liabilities included on the bank's balance sheet must be disregarded when valuing those instruments for regulatory capital purposes under Basel III.

Methodology

34. In many ways CVA can be regarded as a hypothetical derivative in its own right. It is contingent on the default of the counterparty and the payoff is a function of the expected value and the recovery rate of the impacted underlying derivatives at the time of default. There are many ways in which this can be calculated in practice and this section considers some of the commonly used methods.

Key Inputs

Default Probability

35. In the past it was common to use a historical approach when calculating DP. A historical approach uses past realised default data, such as experience with certain counterparty types or regions and peer analyses, in order to calculate an internal credit rating and DP for a counterparty.

36. Given the fair value requirements in various accounting standards, it is now generally accepted practice to calculate DP whilst maximising the use of market observable inputs. These approaches imply the DP from market prices and can be estimated using various techniques, dependant on the counterparty:

- Market observable CDS spreads. This method requires an observable and liquid CDS market for the counterparty. It is worth noting that a recovery assumption has to be used along with the CDS spread in order to imply the DP, this is discussed further in para 40 – 42.

- Market implied CDS spreads (proxy spreads). This method derives implied CDS spreads for unobservable issuers through the interpolation or extrapolation of observable CDSs. A common method is to use a factor model that constructs a CDS spread surface as a function of credit rating and maturity. These grids can be formulated by industry sector, geography or other criteria provided that sufficient data is available. Counterparties can then be mapped to the appropriate proxy CDS curve, based on the criteria used so that the DP can be calculated.

---

[5] © Basel Committee on Banking Supervision

- Market implied risky bond or debt spreads. This method derives a credit spread from the debt instruments of an entity that does not have an active CDS market. This is often used in conjunction with observable and implied CDS to formulate a proxy spread surface. It can be complex and introduces uncertainty in the form of basis risk which can be significant and must be taken into account when assessing the reliability of the inputs.

Exposures

37. In the past, expected exposures were sometimes assumed to be equal to the current market value of a derivative plus an amount that was determined by an entity to take into account the circumstances of the transaction, the type of derivative and the time horizon of the contract. This is now generally viewed as an insufficiently sophisticated and either a semi-analytical or simulation based method is used instead.

38. A semi-analytical method utilises specific risk factors that impact the expected exposures over the life of the contract. The expected distribution of those risk factors is then characterised using a semi-analytic expression. An example would be to model the impact of forward prices using a normal distribution and then characterising the distribution in terms of mean and standard deviation, instead of randomly selecting values from the distribution as is required for simulation based approaches. While generally viewed as being more sophisticated and useful for quick calculations, semi-analytic methods cannot typically incorporate important credit risk mitigants such as netting and collateral or factor in path dependent features such as "after the event" or exercise decisions.

39. A simulation based method repeatedly generates the expected exposures over the life of the contract and is generally viewed as a standard requirement for entities with material derivative holdings. Monte Carlo simulation is the most commonly used method. Exposure profiles can be simulated and split into a term structure of positive (used in CVA) and negative (used in DVA) exposures. The EPE term structure for each simulated exposure time can be calculated using the formula below and is repeated many thousands of times.

$$EPE(t) = \frac{1}{N} \sum_{1}^{N} Max \left(\sum_{s \in NettingSet} MV_{1,t}^{s} \cdot d_t , 0 \right)$$

Where: N = number of simulations;
t = time;
$MV_{1,t}$ = collateral adjusted market value of each trade within netting set s at t;
d_t = discount factor

The calculation above is a two stage process. Firstly market values (MV) are randomly generated (simulated) and then discounted (by a factor of d) to todays value, whilst taking into consideration the effects of netting, ie the setting off of exposures between counterparties. Secondly this process is repeated thousands of times (N) and then averaged to give the EPE. The reciprocal process is performed to calculate ENE.

40. Collateralisation of exposures represents an additional level of complexity that is best supported by simulation based methods where the market value of collateral can be offset

against the calculated net exposure over the life of the trade or the netting set. To the extent that collateralisation eliminates counterparty exposure, some entities will exclude the trade population from the calculation of CVA altogether. Even under these circumstances, however, it is imperative to understand the impacts of the re-margining period and potential lack of liquidity as this may give rise to residual exposure in the close-out period. In addition, the impact of threshold levels and minimum transfer amounts need to be addressed within the expected exposure modelling framework.

41.   The choice of discounting method will affect the exposures. This is done using "risk free" rates, ie, excluding any counterparty risk. Typically this was done using a LIBOR-based discounting assumption, however many have since moved to OIS (overnight index swap) as a better approximation to the risk free rate. Moreover, FVA (the funding cost of the derivative) may be considered and could impact the exposure calculation; typically by reducing the exposures as the term funding spread is now positive above LIBOR. This would mean that not only the market value of the trades change (a cost for assets and a gain for liabilities), but also the exposures feeding a CVA (and any DVA) would reduce also. There is debate about the interpretation of regulatory rules in light of FVA, given that term funding is not strictly risk free and it can be implicitly dependent on liquidity and/or credit depending on how the FVA is calculated. The relationship between CVA, DVA and FVA will be discussed in more detail later in this paper.

Loss Given Default

42.   There are two types of LGD involved in the calculation of CVA and DVA, the implied recovery assumption used to generate the DP term structure and that used to calculate the amount recovered in default within the CVA calculation.

43.   In the first instance, this assumption is critical to the calibration of the DP term structure and due to a strong negative correlation between recovery rates and default probability, can have a significant impact on the resulting CVA. It is very difficult to view LGD on an implied basis and given the relationship between credit spreads, DP and LGD, it is typically based on an assumed level that is commonly used in the industry in order to isolate the DP. These are available from credit rating agencies and an example assumption would be a 60% LGD, ie, a 40% recovery rate for senior unsecured corporate bonds.

44.   In the second instance, this assumption is generally set equal to that used to determine the DP term structure, unless the observable market data used to calibrate DP is meaningfully different to the exposure to the counterparty. The LGD may also take into account the type of industry of the counterparty, legally enforceable terms such as seniority and break clauses/termination triggers, as well as any collateral held. Further judgment may need to be used in order to reflect additional factors that could affect the LGD, eg, that recoveries may not be equal for bonds and OTC derivatives contracted under ISDA terms. Such judgements should be based on observable market data where available.

Modelling

45. There are a number of methods to model CVA, but they principally fall into three categories in the following order of sophistication:

    a) Unilateral method. CVA is modelled on the positive exposures to calculate the value of the portfolio of derivatives after adjusting it for potential counterparty default. This valuation is always a charge relative to a counterparty risk free valuation as a corresponding DVA calculation (ie, application to the negative exposures) is not performed. An extension to this approach is to weight the positive exposures using an entity's own DP.

    b) Non-contingent bilateral method. CVA is modelled as described in the unilateral case and a symmetrical unilateral-style DVA is computed in an analogous manner. In essence the CVA and DVA are calculated independently of each other (ie, there is no implicit relationship) and then added together at the end to arrive at a net impact.

    c) Contingent bilateral method. CVA and DVA are measured simultaneously as the net figure of the positive and negative exposures. Both the entity's CVA to its counterparty and the counterparty's CVA (DVA) to the entity are netted within time buckets, resulting in a series of net CVA or DVA, which are summed (integrated) to yield the total net CVA/DVA. The net amount can be positive or negative depending on whether the counterparty or the entity is most likely to default and may take into account the order of default and the relative exposures entities have to one another.

46. There are additional features that can be considered when determining the most appropriate calculation method to use. The inclusion of jump-to-default models enables an entity to consider scenarios where the counterparty suffers a sharp deterioration in creditworthiness rather than a gradual decline that might be implied by other models; however these models can be difficult to calibrate.

47. The model may also incorporate credit simulation and collateral modelling techniques which can be used to calculate the impact of ratings downgrades and collateral thresholds on the CVA. As part of the modelling, or through additional scenarios, the effect of break clauses such as mandatory terminal clauses, mutual termination clauses and automatic termination events are also considered in the CVA calculation.

48. Finally, methods may be incorporated into the relationship model framework and/or gap risk models to consider generic or specific wrong-way-risk and right-way-risk. General wrong or right-way risk is dealt with at the portfolio level by introducing a relationship between the exposure and counterparty risk eg, the exposure to a counterparty whose business is related to export could be deemed to increase due to a change in FX rates. Specific wrong or right-way risk applies to specific derivative contracts and arises from poorly structured transactions eg, where an entity writes put options on its own equity.

Reconciliation

49. Depending on the modelling approach taken, it may be necessary to make additional adjustments to calibrate the CVA, and potentially the DVA, to market value. This is consistent with IVS 102 *Implementation* which encourages the use of more than one valuation approach or method, especially where there are insufficient factual or observable inputs for a single

method to produce a reliable conclusion. Where more than one method is used, the resulting indications of value should be analysed and reconciled."[6]

50.   A common example would be where empirical market data suggests that a unilateral model may overstate the CVA. A bilateral approach may then have a reducing effect on the CVA either by combining the original CVA with a unilateral DVA term, scaling the probability of a counterparty default by the probability of the entity's own default, or truncating (or not taking at all) the CVA where the probability of an entity's own default is higher than that of the counterparty. The need for these types of adjustments may be more apparent for certain classes of counterparty that have a specific type of exposure or restrictions around their treatment, eg sovereigns.

Scenario analysis

51.   Scenario analysis is required in order to calculate expected exposures and involves the use of models to reflect potential future changes to the inputs that drive derivative valuations. The scenarios are typically generated using Monte Carlo simulation which involves performing valuations of a derivative many times. For each of these iterations, valuation inputs are allowed to change randomly, within an appropriate range, in order to provide possible future values for the derivative. The scenarios for each derivative are then aggregated by counterparty, with the average forecast value in each future time period reflecting the expected exposure.

52.   Given the need to compute alternate valuations in an expedient manner, the modelling techniques used for scenario analysis are usually less sophisticated, with less inputs and adjustments, than those used for a standalone valuation. This can potentially result in problems with derivatives whose valuations are sensitive to nuances which cannot be captured by a less sophisticated model. Some examples of modelling approaches and common limitations for different types of derivative and input are provided below.

Interest rates

53.   Interest rate simulation is used both to determine the value of interest rate derivatives and to determine discount factors which are the building blocks for constructing interest rate curves that are fundamental to the valuation of most types of derivative. The most common modelling techniques assume that future interest rates are normally distributed and revert towards the current forward rate curve.

54.   A common limitation is that some models may assume that any changes in interest rates will move in the same direction at all tenors (parallel shifts) ie, if the three month interest rate were to increase, the five year interest rate could not decrease. In practice interest rates of different tenors can move in opposite directions (non-parallel shifts) and this impact on a derivatives value will not be considered under some models. Also, some models have difficulty anticipating negative interest rates, which although rare, are of particular interest for CVA and DVA calculations as these infrequent events can have significant valuation effects.

---

[6] See IVS 102 para 7

Equities

55. Black & Scholes based valuation models are normally used for the purpose of scenario modelling as these are well established and widely understood. Equities will often be split into broad portfolio types and equity returns are simulated by a one factor Brownian Motion assuming normally distributed variables.

56. These variables are subject to "drift" to influence the random variable, taken from various sources including the dividend adjusted risk free rate. The risk free rate is the simulated interest rate in the equity's currency. The volatility input can be based on either historical or implied volatility. The historical volatility input will normally be based upon the historical volatility for the previous corresponding time period; eg, for the next three month period the volatility for the previous three months is used. This is straightforward to compute but less accurate than implied volatility, however due to the expediency in its calculation, historical volatility is often considered sufficient for the purpose of scenario generation for CVA.

57. A potential model limitation is that simulated equity returns are approximately log-normally distributed, but empirical research shows that actual equity returns exhibit more frequent extreme returns; this means that tail events are more prevalent in practice than the statistical data would suggest. Also the mapping of equities to certain broad portfolios eg, by industry or country, is a limiting simplification. Ideally more detailed economic factors would be considered that relate specifically to the entity in question. Lastly, accurate assumptions of the relationship between equities can be difficult to gauge given the many interrelated factors that drive equity values, which can be further complicated by a large portfolio. As a result this relationship is often ignored or very approximately estimated.

Foreign exchange

58. Scenario modelling techniques for spot foreign exchange (FX) rates are usually generated by a Geometric Brownian Motion, which assumes that FX spot returns are normally distributed. The drift factor which influences the distribution is typically driven by the difference between the spot interest rates of the two currencies in question and a constant volatility factor. The volatility input is calibrated in a similar way to an equity, ie, against a historical time series.

59. A potential limitation can arise when volatility calibration is simplified, which can lead to an overestimation of volatility. Also as FX modelling is inherently linked to underlying interest rate models, any short comings in the interest rate models carry over to the FX model. However, the increasingly widespread use of multifactor interest rate models, such as the LIBOR Market Model or Heath-Jarrow-Morton methods addresses many of the shortcomings of the interest rate calculation, which in turn improves upon the FX process.

Credit derivatives

60. Various techniques are used to model potential future credit spread dynamics. The short credit spread for the forthcoming three months provides the starting point for the simulation. It will often follow a mean reverting model to estimate the spread development in future periods. The volatility can be calibrated, normally to the most liquid point on the credit curve, which tends to be five years. To generate the complete credit curve the simulated short spread is extended

based on the assumption that the general shape of the credit curve will not change over the life of the simulation.

61. A widespread approach is to use a one factor model eg, a Merton model, which indicates that an entity will default when its asset values become too low. These default thresholds are calibrated based on the historical DP of similar counterparties. One factor models are relatively simplistic and cannot reproduce all credit curves shapes. In particular they cannot generate a scenario where some tenors on the curve increase whilst other fall or stay the same. Also, credit spreads and default events are not directly correlated therefore a one-factor model may produce unrealistic scenarios eg, where an entity defaults even though its credit spread is low.

Calculating the adjustment

62. The extent to which the various methods and models discussed are applied in practice will vary according to the materiality of an entity's holding of derivatives. The time and investment in systems to manage and calculate CVA and DVA has to be proportionate to the importance of the entity's derivative portfolio to its overall operations and financial performance. In some instances simplifying assumptions may need to be employed to enable calculations to be made within a reasonable time scale and cost, having regard to the purpose of the valuation and the size of the exposure relative to the total assets of the entity.

63. As discussed in para 37, a Monte Carlo simulation is often used to generate stochastic paths for market variables. The portfolio EPE is calculated at the counterparty level for each generated path, taking into account netting rules and collateral agreements. Finally, in order to reflect the counterparty default the paths are weighted by the DP and interest rate.

64. The EPE to a counterparty is the market value of trades with positive positions at time t as highlighted below.

$$EPE_t = max(MV_t, 0)$$

This expression means that the expected positive exposure to a counterparty is the greater of the market value of trades with positive positions or zero, ie, the EPE cannot be a negative value.

65. Since the expected exposure is conditional upon the counterparty defaulting at time t, it should also account for the relationship between the exposure and the counterparty default time. The exposure is then adjusted for the expected recovery of the reference derivative, and the LGD is obtained.

66. It is worth highlighting that the most appropriate recovery rate for CVA is that obtained on the derivative's market value; however this can be difficult to observe and estimate. As such general practice is to use the more observable CDS or bond implied recovery rate.

67. An example of this algorithmic relationship is shown below in a simplified and discrete form.

$$CVA = \sum_{0}^{T} (1 - R_t) \cdot EPE_t \cdot DP_t$$

Where:　R_t = Recovery rate at time t

This simplified expression allows for the approximation of a CVA by multiplying the LGD by EPE and DP at different times and then summing these values.

68.　Algorithms should also account for mechanisms to reduce counterparty risk including netting, collateral, Special Purpose Vehicles (SPVs) and CCPs. These can be reflected in the valuation adjustment calculation in the following ways.

- Netting. The availability or amount of netting can be modelled for the time of default.

- Collateral. This can be reflected by considering the specific details in the CSA agreements, ie thresholds, unilateral versus bilateral collateral posting, collateral call frequency or gap risk, and rating triggers.

- SPVs. The CVA will be a function of the collateral held by the SPV, how accessible this is upon default and whether the entity holds a junior or a senior claim to SPV collateral.

- CCPs. The credit risk that arises from dealing with a CCP should be considered. However when derivative holdings are less material, given the very small DP of CCPs, the CVA is generally ignored (considered equal to zero).

69.　In addition to the approaches outlined above, for certain derivatives calculated exposures, whether expected or current, can be replaced with a closed-form method that utilises option pricing methodology, such as the Black-Scholes formula. For less material holdings the option pricing approach can also be extended to cover more types of derivative. An example of such an algorithm is displayed below.

$$CVA = (1 - R_t) \cdot BS_{call}(K, S_t, \sigma, t) \cdot DP_t$$

Where:　K = Strike price,
　　　　S_t = Spot price,
　　　　σ = Volatility,
　　　　t = Time.

This calculation allows for the approximation of the EPE by treating it as an option. The Black Scholes model is a simple way of calculating the value of an option and it has four main inputs as listed above. Once the value of the option component (labelled BS above) has been computed, it is multiplied by the LGD and DP to return the CVA.

70.　For less material holdings, CVA calculations can be based on spot levels of exposure. Unlike the approaches described previously, the spot approach utilises the current market value of positions instead of expected values within CVA calculations. This approach effectively takes a snapshot of today's credit risk with the implied assumption that this will not change materially in the future. An example of such an algorithm is displayed below.

$$CVA = (1 - R_t) \cdot MV \cdot DP_t$$

Hedging CVA

71. There are numerous ways that an entity can hedge CVA. One of the most straightforward methods is to use CDS contracts, assuming that there is an active market for the counterparty. The entity seeking to hedge will purchase a CDS referencing the counterparty, which will offset the CVA exposure for the corresponding maturity. In the event of the counterparty's default, the CDS will offset the losses suffered by the entity.

72. The approach above is an example of a risk replication approach where the cost of the hedge is equal to the size of the CVA. This type of hedge needs to be closely monitored so that the maturity and amount of CDS protection required to offset the CVA can be regularly rebalanced as necessary. Implementing the risk replication approach presents a number of challenges:

   - Given that the exposure to a derivative is market dependent, wrong-way-risk can arise when the counterparty's DP is linked to the market level referenced by the derivative. This can make it difficult to maintain an efficient hedge as a complex hybrid risk is being hedged.

   - When there is a default the recovery rate of the CDS will be determined independently of the entity's loss, eg, by the ISDA Credit Derivatives Determinations Committees, and therefore will not necessarily equal the specific loss suffered on the derivative portfolio.

73. An alternative to a CDS hedge portfolio is to enter into a CCDS. A CCDS involves establishing predefined contingencies, which may include a market risk such as a change in interest rates or the occurrence of a corporate event such as a merger or acquisition. If a contingency occurs, the notional credit risk exposure of the instrument is adjusted accordingly. Given the often bespoke nature of contingencies, the CCDS market is not well developed.

74. Hedging CVA is less straightforward for counterparties whose credit risk is not traded in a liquid CDS market and its determination depends upon judgements and estimates to identify the cost associated with the counterparty credit risk. Various approaches are used to estimate the cost of buying protection against illiquid counterparties:

   - Actuarial models; these are run using credit risk models that use an entity's historical loss data (if available) and can be combined with similar data from credit rating agencies. The credit charge will depend on the internal credit rating assigned to the counterparty and will update accordingly should this rating change. Actuarial models are gradually being replaced by the market based approaches on this list.

   - Individual liquid proxies; a substitute CDS is selected to closely match the attributes of a counterparty such as its credit rating, industry, country, and capital structure.

   - Traded credit indices; these indices may be based upon a type of industry, market or credit rating, eg, iTraxx Europe consists of 125 investment grade names, ABX HE consists of 20 US residential mortgage backed securities, and Dow Jones CDX NA HY consists of 100 high yield names.

   - Managed basket; involves the construction of a basket of securities that replicates the underlying risk for a portfolio of counterparty credit risk exposures. This can be done using a collateralised debt obligation type of structure transacted in derivative form or through a structured note.

75. CVA represents a component of a portfolio's market value, the purest measure of which is the cost of assigning a derivative portfolio to another entity, ie, simulating a transfer due to counterparty default. This is rarely an observable price but indications may exist, eg, if a derivative portfolio is deep in the money (similar to a pure asset), the portfolio is similar to a loan and the credit spread should not diverge significantly from the credit spreads of loans with that counterparty. However, situations can arise where the CDS spread is above the spread at which loans are traded with that same counterparty because the CDS spread can contain a speculative element that is unrelated to the credit exposure of a derivative portfolio. It is therefore important to consider these factors when choosing the most appropriate hedging approach.

Monetisation of DVA

76. One of the main practical issues with DVA is the ability to monetise the effect on profit and loss effect. The monetisation of DVA is challenging and three methods are discussed below: termination, default or hedging.

Termination

77. For the case of debt, a bond repurchase allows an issuer to record a capital gain if the price has fallen since issuance. It should be noted that cash will generally have to be raised to fund this repurchase, so the economic benefit may be illusory. For derivative contracts, the closest thing to repurchase is termination, either bilaterally or via novation to a third party. In theory, a sophisticated counterparty would be prepared to consent to the novation of a contract to a less risky counterparty or into a collateralised agreement, at a discount reflecting its CVA to the risky counterparty; though in practice it may be difficult to calculate this rate.

Default

78. Another way to monetise the own credit profit is by defaulting and not repaying the full liability. Although the creditor has made a loss, the defaulted debtor has not made a contractual gain as he still owes money. If the entity has unlimited legal liability, the default would not prevent the repayment of the debt. Limited liability is a specific feature of the shares that embed the right not to repay the liquidation shortfall and the entity does not benefit from the default as it has failed on its contractual obligation.

Hedging

79. An entity can attempt to hedge its credit risk by selling self-referencing CDS, but this is not generally considered practical. As long as the transaction is sufficiently over-collateralised there should be no wrong-way-risk to the buyer, whilst, at the other extreme, the default pay-out of an uncollateralised claim will be reduced by the recovery factor. As long as the recovery is not nil, such a contract can be sold at a non-zero premium. As an alternative, entities may look to hedge the market value profit and loss volatility of DVA as well as they can, without matching cash flows in the event of default. Practically, CDSs can be sold on a set of correlated entities, either individually or via credit indices. However considerable basis risk may exist between these proxies and the entity' own credit spread, leading to reduced hedge effectiveness and significant profit and loss moves.

Governance and Controls

80. The IVS Framework states that it is a fundamental expectation (of applying the standards) that appropriate controls and procedures are in place to ensure the necessary degree of objectivity in the valuation process. The IVSs do not prescribe what constitutes appropriate controls and procedures, recognising that these will vary greatly between different valuation purposes, market structures and jurisdictional requirements.

81. IVS 250 *Financial Instruments* highlights the need for an adequate control environment to minimise threats to the objectivity of valuations where these are to be relied upon by external parties, eg, for inclusion in financial statements or regulatory returns. It expounds the general principle that valuations produced by a particular function of an entity should be subject to scrutiny by other functions of the entity.

82. In addition to the general points raised in the IVSs above, there are some specific considerations for CVA and DVA. Firstly the same methodology should be used for calculating CVA and DVA for different purposes eg, financial reporting and risk management, or within different functions of an entity wherever possible. It is also especially important that there are appropriate systems in place to ensure that the data sources relied upon by an entity are both objective and reliable.

Current Issues

83. There are a number of topics where there is continuing debate between academics and practitioners alike and for which it is not currently possible to identify generally accepted principles or procedures. However due to the significance of the current issues some key aspects of the debate are discussed here.

    a) the cost of funding,

    b) the link between CVA, DVA and FVA,

    c) the bilateral nature of CVA and DVA and the effect of the close-out method, and

    d) CCPs

Cost of Funding

84. There are several distinctions between types of funding cost that need to be considered. FVA[7] may be the pure funding cost or the funding basis, the difference of which is explained below.

    a) Full funding cost (also known as full financing cost or all-in financing cost) is the spread at which an entity can issue debt (it can be vanilla or structured, public or private, so different costs are possible).

    b) Pure funding cost is a generic cost that is not entity specific and excludes any credit risk. It could be approximated by secured funding such as a covered bond, or be the cost of term funding by an entity with no credit risk if the funding instrument was illiquid ie, difficult to sell or a repo (repurchase agreement).

---

[7] The Standards Board commenced a project on FVA in 2014

c)	Funding basis is the full funding cost minus pure credit risk. Pure credit risk is the cost of the likelihood that the issuer may default, excluding any general funding cost. The current debate is concerned with whether this is equivalent to the CDS spread or the full funding cost minus the pure funding cost.

85.	On the asset side, the CVA is a pure counterparty credit risk. The question is whether to add to it the pure funding cost or the full funding cost, as full funding cost plus CVA is the minimum spread at which a bank may lend without losing money progressively. It is also worth noting that in the case of liabilities FVA plus DVA is equal to the full funding cost, after eliminating any double counting.

86.	The impact of the funding cost on assets is dependent on whether finance can be secured against the asset itself via the repo market, or through general bank borrowing. In the latter case, the value of the asset will depend upon the cost at which a party can borrow, which may vary among peers. This could lead to different asset values and potentially contradict the definition of fair value.

87.	Derivative assets cannot be the underlying of a repo as a master agreement will likely specify that derivative assets can only serve as collateral for derivative liabilities that arise through the netting agreement. Therefore derivative assets cannot be used as collateral to a counterparty to provide funding.

Link between CVA, DVA and FVA

88.	Derivatives can be both assets and liabilities. A highly out of the money derivative behaves like a liability and as such it is reasonable that it would have a comparable value to that of a debt instrument. In particular, the own credit adjustment and funding cost that are relevant to debt can also apply to derivatives as DVA and FVA. There is currently considerable debate as to how the cost of funding can be taken into account in the valuation of derivatives, and no consensus has yet been reached.

89.	The interaction between DVA and FVA is complex. DVA can be seen as the pure credit component and FVA as a pure funding component that would exist if there was no credit risk. By measuring DVA and FVA separately there is a risk of double-counting the same economic effect.

90.	Although debate is on-going, many entities with material derivative holdings have moved to incorporate FVA into derivative prices as well as valuations prepared for inclusion in financial statements. In so doing, a number of practical decisions need to be made, including:

- Whether to use the entity's own curve for assets and liabilities, a counterparty's curve, or a blended curve that is reflective of the industry cost-of-funds.

- Whether to calibrate that curve to primary issuance, secondary trading, CDS or an internal assessment of funding levels.

- Whether the full contractual maturity of the derivative should be used in any calculation or if an expected holding period should be used instead, and if so, how to calculate the latter.

91. FVA affects both assets and liabilities and therefore when applied to derivatives it will affect both the EPE and ENE. The EPE position may attract both a CVA and FVA. What is debatable is whether the full funding cost is also allocated to EPE/ENE in addition to CVA/DVA. This would make the asset value dependent on both the counterparty credit risk and the entity's own credit risk. This is contrary to the principle that the value of an asset should not depend on the credit quality of the holder of this asset. However, assets that are not easily transferable or cannot be funded using them as collateral (rehypothecable) need to be funded by the liabilities of the holder with its full funding cost. Derivatives are neither freely transferable (this would require the agreement of the counterparty) nor rehypothecable (if derivative assets are encumbered by derivative liabilities through the MNA they cannot be given as collateral to a third party). Therefore the valuation of derivative assets could depend on the total cost of funding including own credit risk component.

Close-out method

92. There is currently no clear consensus as to which close-out method is the most appropriate and this area is the subject of extensive research. Dependant on how a portfolio is valued at the time of default, the choice of close-out method will affect the magnitude of the CVA and DVA. As outlined in the modelling section there are three main close-out methods.

- Unilateral

- Non-contingent bilateral

- Contingent bilateral

93. The unilateral method is the simplest to implement, however it can be difficult for counterparties to agree on the value of a derivative as it is unlikely a counterparty will view the other as credit risk free.

94. The non-contingent bilateral method is also simple to implement but is not economically consistent as CVA and DVA are measured independently, which assumes the successive default of the two counterparties with each having liabilities at the time of default. The problem is that in practice, a claim on default precludes the possibility of any subsequent future claim by the other party as the derivative contract will have been closed-out and no such default is possible.

95. Unlike the other methods, the bilateral contingent method assumes that after the first default, all contracts are valued as if there were no subsequent credit risk. An issue with this method is that it assumes that if a party defaults on an asset, it will be able to transfer it assuming that the other counterparty is credit risk free. As a consequence a pure asset (exposure that has always a positive value) is created and its value increases when the holder's DP increases. Another issue is that this method is very sensitive to the relationship between the defaults of the counterparties, and the order in which they occur. More sophisticated contingent methods take the remaining credit risk after the first default into account and may even consider the credit risk of a new party to which the rights and obligation of the defaulted party have been assigned.

CCPs

96.   The likelihood of a CCP defaulting is very low as they are very well collateralised by contributions from their members. As such, many did not consider it necessary to calculate a CVA when dealing with CCPs. However CCPs are now used to clear a large and growing proportion of OTC derivatives and it is currently being debated amongst practitioners, academics and regulators how best to consider the credit risk that arises. Whilst many agree that by design, at the derivative contract level, CCPs represent a very small credit risk. However given the proportion of the market that is now cleared over CCPs, if a default were to occur the losses could be significant. Such a default would be difficult to model and this is the issue around which the debate centres.

Glossary of Acronyms

CCDS	Contingent Credit Default Swap
CCP	Central Counterparty
CDS	Credit Default Swap
CSA	Credit Support Annex
CVA	Credit Valuation Adjustment
DP	Default Probability
DVA	Debit Valuation Adjustment
ENE	Expected Negative Exposure
EPE	Expected Positive Exposure
FASB	Financial Accounting Standards Board
FVA	Funding Valuation Adjustment
FX	Foreign Exchange
IASB	International Accounting Standards Board
IFRS	International Financial Reporting Standards
ISDA	International Swaps and Derivatives Association
IVS	International Valuation Standards
LGD	Loss Given Default
LIBOR	London Interbank Offered Rate
MNA	Master Netting Agreement
OTC	Over The Counter
SPV	Special Purpose Vehicle
US GAAP	US Generally Accepted Accounting Principles