Wrong-way Risk: Regulatory Aspects and Computational Challenges

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1. Introduction to Counterparty Risk and CVA

On the heels of a major financial crisis that saw the failure of a global bank and near failure of several others, institutions must be able to correctly price and manage counterparty credit risk. Difficult problems like wrong-way-risk (WWR) can no longer be disregarded or improperly valued.

WWR is a crucial component of counterparty credit risk (CCR) management, arising from correlation between the counterparty's default probability and the exposure. After the credit crisis, the ability to price and manage this risk is seen as absolutely critical and ignoring it can significantly misstate exposures. As well as existing accounting and capital rules WWR has also received regulatory focus. The revised version of the Basel III capital rules reflecting the CVA modifications (June 2011) states explicitly that 'the Committee is raising counterparty credit risk management standards in a number of areas, including for the treatment of so-called wrong-way risk…'; where wrong-way risk is defined as a case 'where the exposure increases when the credit quality of the counterparty deteriorates'.

Counterparty credit risk, or the risk that the counterparty defaults while owing money, poses a significant risk in a Bank's business and is expressed by a so-called credit valuation adjustment (CVA). The need to evaluate and manage the CVA arises from three different aspects:

1) Adjustment of trade prices to include unilateral or bilateral CVA
2) Accounting standards requirement to measure and report CCR
3) Financial regulations (Basel II / III) now specifying a counterparty risk capital charge and calculation of expected loss over a period of stressed credit conditions (stressed CVA VaR)

1.1 Unilateral CVA

The possibility of loss arises when a counterparty defaults and the mark-to-market of the trade is positive to the bank, i.e. there is a positive exposure. The expected loss at time '*t*' is proportional to the expected positive exposure, multiplied by the default probability and the Loss-Given-Default for this counterparty. To obtain (unilateral) CVA for a trade, one has to integrate the expected loss over the life of the trade. If we denote the discounted expected positive exposure at time t as EE(t), and the time of default as τ_c, the CVA can be expressed as:

$$\mathbf{CVA = LGD_C \cdot \int_0^T EE(t) \cdot P(\tau_c = t) \cdot dt}$$

If we want to discretize it over the set of time points, we can rewrite as:

$$\mathbf{CVA = LGD_C \cdot \sum_{i=1}^{n} \frac{EE(t_{i-1}) + EE(t_i)}{2} \cdot P(t_{i-1} < \boldsymbol{\tau}_c \leq t_i)}$$

Basel III guidelines recommend the following expression, where S_i the credit spread of the counterparty at tenor t_i:

$$\mathbf{CVA = LGD_C \cdot \sum_{i=1}^{n} \frac{EE(t_{i-1}) + EE(t_i)}{2} \cdot max(e^{-\frac{S_{i-1} \cdot t_{i-1}}{LGD_C}} - e^{-\frac{S_i \cdot t_i}{LGD_C}}, 0)}$$

Compared with the discretized formula above, the probability of default in an interval is expressed as:

$$\mathbf{P(t_{i-1} < \boldsymbol{\tau}_c \leq t_i) = max(e^{-\frac{S_{i-1} \cdot t_{i-1}}{LGD_C}} - e^{-\frac{S_i \cdot t_i}{LGD_C}}, 0)}$$

While the above formula is not exact, especially for non-flat credit curves, it avoids bootstrapping of the credit curves. This is the recommended approach by Basel III for regulatory CVA calculations, including CVA VAR estimations.

Note that even the most effective way of managing counterparty risk – collateralization – does not entirely eliminate the risk. This is because of the different features of a trade's governing document-Credit Support Annex. For example, a non-zero threshold, beyond which the counterparty must post collateral, means that exposure can be as high as the threshold. However, even with zero threshold, counterparty risk is not completely eliminated because of the so-called "margin period", which defines the lag between the last margin call and declaration of default. Consequently, the exposure may continue to increase during this period. In any case, all formulae above presume that exposure is calculated with all aspects of collateral and netting taken into account.

2. Wrong way risk

Similar to Basel III, the International Swaps and Derivatives Association (ISDA) defines WWR as the risk that occurs when "exposure to a counterparty is adversely correlated with the credit quality of that counterparty." A counterparty default typically coincides with increased exposure to that counterparty which subsequently results in increased losses. Put simply, WWR is when the counterparty's probability of default increases with its exposure.

Conversely, if positive exposure decreases and the probability of default increases then this is referred to as right-way risk. This paper primarily focuses on WWR; however, the same methodologies can be applied to right-way risk.

The crucial point for both cases is that, because of the dependency of exposure on defaults, the discounted expected positive exposure EE(t) introduced in the previous section should be calculated conditionally on a counterparty default happening at time t.

WWR can be caused by trade-specific (idiosyncratic) or market-general (systemic) reasons. These two types of WWR's receive different regulatory treatment. Specific WWR arises through poorly structured transactions i.e. trades collateralized by own or related party shares. General WWR arises where the credit quality of the counterparty may be correlated with a macroeconomic factor that also affects the value of derivatives transactions.

2.1 Trade-specific or idiosyncratic WWR

Basel II defines that "Specific Wrong-Way Risk arises when the exposure to a particular counterpart is positively correlated with the probability of default of the counterparty due to the nature of the transactions with the counterparty", i.e. this type of WWR arises from characteristics specific to individual trades.

For example, a company writing put options on its own stock creates wrong-way exposures for the buyer that is specific to the counterparty. Another example of idiosyncratic wrong way risk would be entering into a credit default swap (CDS) where one buys protection on Bank B from counterparty

Bank A, where Banks A and B have similar profiles. If the credit quality of Bank B deteriorates, the CDS will be in the money, and the exposure to Bank A will increase. If Bank A and Bank B have similar profiles, the likelihood is that the credit quality of Bank A will also be deteriorating, therefore increasing the possibility of default.

In Basel II, regulatory recommendations for specific WWR state that banks must have in place procedures to identify, monitor, and control trades from inception through their entire lifecycle.
Basel III strengthens this with the requirement that trades with specific WWR carry an "explicit Pillar I capital charge" with higher Exposure at Default (EAD). This will increase Risk Weighted Assets which are proportional to EAD, and thus Pillar I credit capital charge. Basel III stipulates that where there is a legal connection between the counterparty and the issuer, trades are treated separately, i.e. outside of the netting set:

1) for CDS, expected loss assumes underlying in liquidation. Accordingly, LGD for Advanced or Foundation IRB banks must be set to 100% for such swap transactions. For banks using the Standardized Approach, the risk weight to use is that of an unsecured transaction.
2) for equity derivatives, bond options, securities financing transactions etc. referencing a single company where there exists a legal connection between the counterparty and the underlying company, and where specific wrong way risk has been identified, EAD equals the value of the transaction under the assumption of a jump-to-default of the underlying security.

It may be possible to mitigate Idiosyncratic WWR by selecting a different counterparty or altering the terms of a trade. Collateralization, as always, is another way of alleviating the risk.

2.2 General or systemic WWR

According to Basel II, "General Wrong-Way Risk arises when the probability of default of counterparties is positively correlated with general market risk factors".

Banks have learnt from experience that WWR has a material impact on the exposures of a portfolio. The area of particular impact is the so-called 'cross gamma' effect, i.e. sensitivity of portfolio PnL to simultaneous movements of market factor and counterparty spread. Many counterparties often carry some degree of WWR, particularly relating to interest rates and exchange rates. Common examples include: 1) bank counterparties sensitivity to interest rate cycles; 2) emerging market counterparties sensitivity to exchange rates.

As an example, consider a cross-currency swap with a large emerging market bank. It is very probable that if the bank defaults, local currency will significantly devalue. Thus, if we receive dollars and pay local currency, around the time of counterparty default the exposure is likely to become larger.

Mitigating systemic WWR may not be as straightforward as selecting a different counterparty or changing the terms of a trade. It is generally done by monitoring and hedging cross-gamma or the effect on CVA from simultaneous movements of market factors and counterparty default probabilities. As interest rates drop and exchange rates depreciate, counterparty exposures increase and hedging costs increase. Measuring and managing this cross gamma exposure is critical for effective exposure management.

To deal with this type of WWR, as Basel III stipulates: "Banks must identify exposures that give rise to a greater degree of general wrong-way risk. Stress testing and scenario analyses must be designed to identify risk factors that are positively correlated with counterparty credit worthiness." These stress and scenario analyses need to include the possibility of severe shocks occurring when relationships between risk factors change. Banks should monitor general WWR by product, region, industry, or other relevant categories. On a regular basis, reports should be provided to senior management and the appropriate committee of the Board that highlight the wrong way risks, as well as define the steps being taken to manage that risk.

Basel III makes a special case for banks which have the permission to use the internal models method (IMM) to calculate counterparty credit risk regulatory capital. Now, to calculate Effective EPE, which is one of the multipliers in EAD expression, banks must use the greater of the portfolio-level capital using current market data and the portfolio-level capital charge based on stress calibration. When the Effective EPE model is calibrated using historic market data, the bank must employ current market data to compute current exposures and at least three years of historical data to estimate parameters of the model. Alternatively, market implied data may be used to estimate parameters of the model. To calculate the Effective EPE using a stress calibration, the bank must also calibrate Effective EPE using three years of data that include a period of stress to the credit default spreads of a bank's counterparties or calibrate Effective EPE using market implied data from a suitable period of stress.

3. Bilateral CVA and WWR

In many trades both parties can incur losses as a consequence of respective counterparty default, in which case the CVA should be treated as bilateral. In this scenario, we have to calculate the debt valuation adjustment (DVA), which is a CVA from the point of view of the counterparty; and then subtract DVA from CVA.

3.1. Bilateral CVA in the case of WWR

Compared to unilateral CVA, calculating and subtracting DVA is not the only change. CVA itself should be adjusted to reflect the fact that the Bank's loss at time '*t*' is incurred only if the Bank survived until that time. Consequently, we now have joint probability of counterparty default and Bank's survival:

$$\mathbf{CVA}_{bil} = \mathbf{LGD_C} \cdot \int_0^{\mathbf{T}} \mathbf{EE(t)} \cdot \mathbf{P}(\boldsymbol{\tau}_\mathbf{c} = \mathbf{t}, \boldsymbol{\tau}_\mathbf{B} > \boldsymbol{t})$$

As in the case of unilateral CVA, in the presence of WWR, Expected Exposure (EE) is discounted Expected Positive Exposure <u>conditional on a counterparty default happening at time '*t*' and the Bank's survival until time '*t*'.</u>

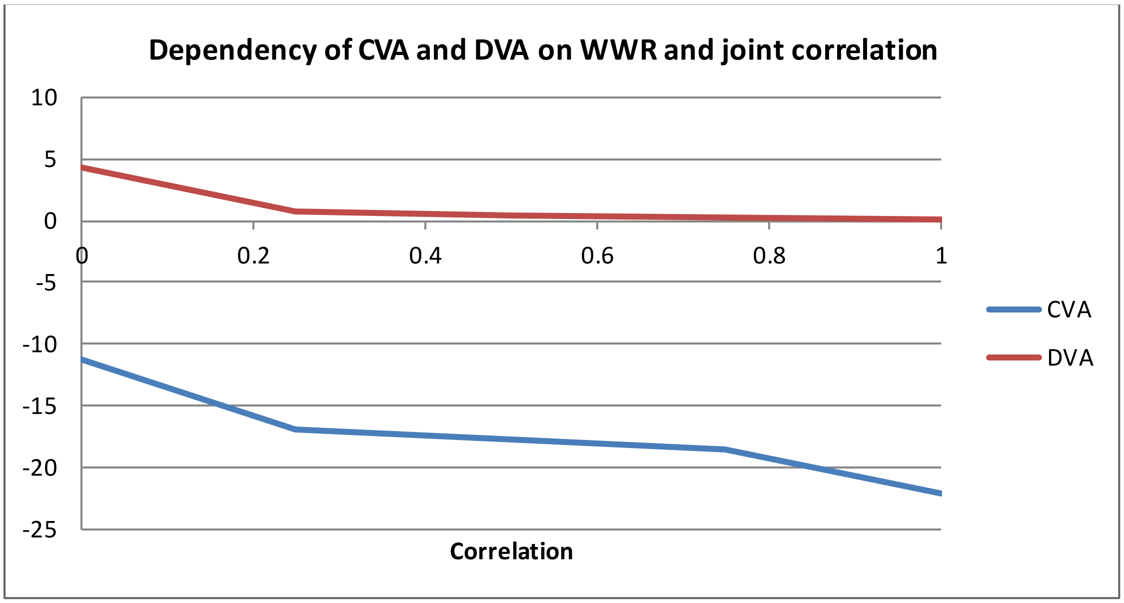
Finally, since Debt Value Adjustment (DVA) is an expected discounted gain due to the Bank's default over the life of the transaction, it is calculated as:

$$\mathbf{DVA} = \mathbf{LGD_B} \cdot \int_0^{\mathbf{T}} \mathbf{NEE(t)} \cdot \mathbf{P}(\boldsymbol{\tau}_\mathbf{c} > \boldsymbol{t}, \boldsymbol{\tau}_\mathbf{B} = \mathbf{t})$$

Where in the case of WWR, NEE is a discounted Expected Negative Exposure <u>conditional on a Bank's default at time t and counterparty survival until time '*t*'.</u>

3.2 Test case

As a test case, consider 5-year USD at-the-money payer interest rate (IR) swap, and assume that the Bank has a flat spread of 100 bps and the counterparty 200 bps, both with 40% recovery. Assume that the correlation between the IR and counterparty default is the same as the correlation between the IR and the Bank default and 'joint default' correlation (which controls joint probabilities described in the previous section). With this positive correlation, when a counterparty is close to default, the IR is more likely to increase than decrease. As a result, expected positive exposure increases and CVA increases in absolute value and this is a case of WWR. For the same reason, DVA decreases when correlation increases. However, as Graph 1 demonstrates, an increase in joint default correlation has the effect of DVA decreasing to '0' due to the counterparty having a higher spread than the Bank.



Graph 1 CVA and DVA for IR swap in a case when WWR and joint default correlations are the same. Note that the copula-like WWR model used for these calculations allows correlation between IR and counterparty default to be calibrated to a historical correlation between IR and counterparty credit spreads.

4. Modeling WWR

Evaluating wrong-way risk is very challenging, as one has to model the correlation between market factors, e.g., IR or FX and default of counterparty. Even in the case of specific risk, one has to account for the dependency of reference credit or equity on counterparty default.

Merely specifying the correlation between market factors and counterparty spreads is not sufficient to explain the whole WWR as this would not capture the large market factor movements at time of default. Also, in this case, cross-gamma hedging can become inefficient when market factors jump near default. This is particularly relevant for EM currencies, which can rapidly devalue if large local counterparties default. This is a known effect for quanto CDS traders who separate 'slippage' and 'devaluation' contributions to quanto CDS basis. One possible solution is to add a separate jump-at-default process for FX. Nevertheless, this process also requires separate assumptions to be made on the size of the jump and separate calibration for FX drift and volatility.

The best solution, perhaps, is to correlate time of counterparty default with market factors, similar to copula, therefore unifying modeling for both systemic and specific risks. This is achieved by using the same set of independent market drivers for market factor dynamics and distribution of default times. A key advantage of this approach is that it calculates conditional expected exposures from unconditional, without re-running Monte Carlo paths, by changing the probability measure and therefore reweighting the paths that are already calculated. As a result, one can estimate all credit metrics with and without WWR in a single run and therefore quantify the effect of WWR by taking the difference.

5. Conclusion

This paper highlights the importance of WWR as a feature of counterparty credit risk. The Basel III document specifically mentions WWR as one of the key areas where the standard of credit risk management needs enhancing. There are two types of WWR, specific and general, each receiving different regulatory treatment. In terms of valuation, WWR creates additional challenges, as one has to calculate expected exposures conditional on counterparty default and in the case of bilateral CVA also on the probability of its own survival. This requires modeling correlations between defaults and also correlation between defaults and market factors. In all likelihood, the best models for this type of calculation are copula-like set-ups, as they evaluate WWR by reweighting Monte Carlo paths without the need to recalculate exposures. They also allow calibrating WWR correlations to historical correlations between movements of market observables and counterparty credit spreads. In today's environment, WWR will possibly grow to become more significant and modeling WWR will remain a challenge.