CVA "*Demystified*"

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Abstract

Credit Value Adjustment (CVA) has been one of the "hot topics" in the financial industry since 2009. There have been several papers on the subject and the topic has been widely discussed in all banking conferences around the world. However, often, the fundamentals of this topic have been misunderstood or misinterpreted. Arguably, this is the result of a typical problem within quants (I am a quant): we have a tendency to explain things in unnecessarily complicated ways. This paper aims to bridge that gap. It will explain using simple examples how CVA has been priced into banking products for centuries and how it is, in fact, the root of the banking industry since its origin. It will show how CVA is nothing more than the application to modern financial derivatives of very simple and old concepts, and how its misinterpretation can lead to accounting mismanagement. The mathematical formulation for it will not be included in this text as it can be found in several publications[1].

Introduction

As most readers will know, CVA is an adjustment that can be made to the price of a financial derivative in order to account for the counterparty risk embedded in it. At the end of the day, the true price of a risk is given by how much it costs to hedge it out. For that reason, CVA should be defined as the price of hedging out counterparty credit risk in a given trade or portfolio of trades. Given that the available instruments to hedge

[1] For example:

- Jon Gregory, "Counterparty Credit Risk: The New Challenge for Global Financial Markets", Wiley Finance Series.
- C Burgard, M Kjaer, "PDE Representations of Options with Bilateral Counterparty Risk and Funding Costs", November 2010.
- S Alavian, J Ding, P Whitehead, L Laudicina ,"Credit Valuation Adjustment (CVA)", October 2010.

out credit risk are CDSs, that CVA should be highly related to the credit spread of the counterparties at stake.

CVA illustrated

A good way to explain the fundamental concept of CVA is with a couple of simple examples.

Let's say that we have two institutions, A and B. For some reason, they decide to enter into a trade by which someone is going to toss a coin in one year and, at the end, A will pay B $1 if the coin toss is heads, and B will pay A $1 if it is tails. The quants of both institutions put all their thinking into this problem, and decide that the price of this trade, apart from counterparty risk, is zero[2].

Now they want to price in the counterparty risk. There are two components here: how much can each counterparty owe each other, and how much it will cost to hedge it out. To tackle the first problem, initially quants establish that the potential exposure that each institution has is $0.5, as the coin is fair[3]. To tackle the second problem, they look at the CDS market and they see that, let's say, the credit spread of counterparty A is 100 bps, and that of counterparty B is 900 bps[4]. So, if counterparty A wants to hedge out the credit risk of this trade, they need to enter into a CDS contract paying $0.5 times 900 bps, and, on the other side, B will have to pay $0.5 times 100 bps. So, the trading desks of both institutions talk to each other and they agree to a $0.5 times 800 bps cash flow in favour or counterparty A, at trade inception, to compensate for the price of hedging out the credit risk. That is, the price of the trade accounting for counterparty risk is $0.5*800bps in favour of counterparty A.

Let's summarise this trade cash flows, including the cost of hedging out the counterparty risk. Calling "X" the result of the coin toss event:

	Counterparty A	Counterparty B
Price excluding credit risk	0	0
Price of credit risk	$ 1/2 800bps	-$ 1/2 800bps
Spent on credit risk hedge	-$ 1/2 900bps	-$ 1/2 100bps
Trade pay off	X	$-X$
Total	$X-$ $ 1/2 100bps	$-X-$ $ 1/2 900bps

[2]For simplicity, we are going to assume zero risk-free interest rates for any tenor in time, as the conclusions do not change by this and things are more clear.

[3]Most readers will know that this is calculated by multiplying the potential positive cash flow ($1) by the probability of it happening (0.5). Importantly, this is the average positive exposure. An average does not make much sense when there is only one trade with only one event driving it, but this argument can be extended if this game is played lots of times, or if this trade is in a large book of trades.

[4]The terms structure of credit spreads is assumed to be flat, for simplicity.

That is, apart from the coin tossing result "X", each counterparty seems to be paying its own funding cost! In other words, after netting out all payments, each company is, in addition to X, paying the expected funding cost of the trade[5]. Interesting...

The numbers in that trade worked out very well because the coin toss (the underlying market risk) was done on a fair coin (that is, it had a symmetric distribution of returns). To be a bit more realistic in terms of what usually happens in financial trades, let's say that the distribution of returns of the underlying risk factor is not symmetric; that is, the coin is not fair and it has a 1/3 chances of giving heads, and a 2/3 chance of giving tails. In that case, the exposure that A has to B is $2/3, and the exposure that B has to A is $1/3, and the trade price excluding credit risk is $1/3. Now both counterparties need to agree how to price the counterparty risk. In order to hedge out counterparty risk, A needs to enter into a CDS and pay $2/3 * 900 bps, and counterparty B needs to pay $1/3 * 100 bps. So, the net cash flow that is necessary to make this trade fair is $2/3 * 900 bps - $1/3 * 100 bps = $ 17/3 * 100 bps. Plugging these numbers into the calculation sketched previously, we get

	Counterparty A	Counterparty B
Price excluding credit risk	-$ 1/3	$ 1/3
Price of credit risk	$ 17/3 100bps	-$ 17/3 100bps
Spent on credit risk hedge	-$ 2/3 900bps	-$ 1/3 100bps
Trade pay off	X	$-X$
Total	-$ 1/3 $+ X-$ $ 1/3 100bps	$ 1/3 $- X-$ $ 2/3 900bps

So, again, each counterparty is paying its expected funding cost! That is, in expectation, Institution A will have to pay $1/3 to B, which is Institution A's Expected Negative Exposure (ENE), and the cost of this trade for A ($1/3 x 100bps) is the average cost of borrowing (the funding rate) that A needs to pay in order to meet its expected payments. And a mirror argument applies to Institution B.

With these two examples, we have illustrated the following general law: let's say that counterparty A has a potential positive exposure to B of EPE_A and a potential negative exposure to B of ENE_A, and that counterparty B has potential positive and negative exposures to A given by EPE_B and ENE_B. Also, let's say that the credit spread of counterparty A is c_A, and that of counterparty B is c_B. Also, the reader should realise that, if PV is the trade price without considering counterparty risk, then

$$PV = EPE_A + ENE_A = EPE_B + ENE_B \tag{1}$$

$$EPE_A = -ENE_B \tag{2}$$

$$ENE_A = -EPE_B \tag{3}$$

[5] It is being assumed that there is no credit spread basis risk.

With this in mind, then

	Counterparty A	Counterparty B
Price excluding credit risk	PV	$-PV$
Price of credit risk	$EPE_A \cdot c_B - EPE_B \cdot c_A$	$-(EPE_A \cdot c_B - EPE_B \cdot c_A)$
Spent on credit risk hedge	$-EPE_A \cdot c_B$	$-EPE_B \cdot c_A$
Trade pay off	X	$-X$
Total	$PV + X + ENE_A \cdot c_A$	$-PV - X + ENE_B \cdot c_B$

Thereby, if CVA is accounted into this trade on this way and each counterparty hedges out the credit risk, then each counterparty has a trade that is, in average, credit-risk-free, and its P&L is going to be, in addition to "PV" and "X", its own expected funding cost.

In this way, if things are correctly understood and managed, all institutions have an incentive to strengthen their credit quality; their own credit spread gets smaller and funding cost goes down.

Finally, to add some jargon, let's say that the cost of hedging the credit risk is the so-called one-way CVA, that the price of the credit risk is the two-way CVA and that, the negative term in the one-way calculation, that is, the expected funding cost, is called DVA[6] (for Debit Value Adjustment).

CVA has been in the banking industry since their beginnings!

Now that CVA has been formulated in a way that is somewhat intuitive and it is clear how it accounts for credit risk, we should relate it all to what banks have been doing since their beginnings: borrow and lend money.

Let's say that the trade at stake now is a loan; that is, most of the risk in the trade is credit risk.

Counterparty B will by paying counterparty A 900 bps, and counterparty A will be financing the loan by paying 100 bps; in this way, counterparty A will be making 800 bps as profit, which is the two-way CVA of this trade. If counterparty A wants to offload the credit risk of this loan without getting rid of the loan, it can enter into a 900 bps CDS transaction with counterparty B as obligor. By doing so, counterparty A will only be paying 100 bps (the funding cost) net. This is just a simple case of what we have discussed before.

However, if it is not necessary for counterparty A to fund this loan as the money is already available in his vaults, he will not be paying those 100 bps and therefore will not be making any 100bps loss. Hence, the DVA is "hedged out" too.

[6] It is being assumed that there is no credit spread basis risk.

These examples illustrate CVA as no more than the centuries old credit risk pricing system in application to modern financial derivatives. It isn't new to banks[7].

CVA monetization

As previously explained, CVA accounts for the counterparty credit risk that a trade has embedded within it. Until now banks have assumed default risk as negligible in derivative pricing, and a such an unnecessary adjustment. However, default risk is far from negligible these days.

CVA is a price to a credit risk. So, if I take that risk I should be making that money somewhere (as long as the risk does not materialize into a default). How does this happen?

As already illustrated, there are two factors that contribute to CVA: credit risk and funding.

There are two common different uses of the word "monetization", that the author is going to call "cash" monetization and "P&L" monetization. The first one is achieved when all the risk is monetized, and the second one only with respect to P&L accounting. Let's clarify this further.

Cash monetization of the CVA can be achieved by hedging or not hedging the trade credit risk. If the bank decides to hedge the credit risk, he can do so by buying protection against its counteparites via the CDS market. However, it he decides not to do so, the trades are exposed to default risk and the bank will have a credit-related profit (from the lack of payments that it would have to make for the CDS) as long as defaults do not occur. On this way, the one-way CVA can be monetized.

The other side of CVA monetization comes from the funding cost, the DVA, which acts in the opposite way to one-way CVA. Hedging out DVA means ensuring that I do not default. The only way I can ensure that is by having my expected potential liabilities already in my vaults, so I know I will be able to meet those liabilities in the future. However, modern banks are all leveraged; none of them have the expected funding costs in their vaults already[8] and, as a result, DVA cannot be cash-monetized in practice.

However, we are using the word "monetization" in cash-flow sense. But often this word is used in a P&L accounting sense. In that context, "monetization" usually means marking the bank assets and liabilities to market (or to model). Given that modern banks are

[7]In practice, things are more complicated than the perfect examples we are using. However, I encourage the reader to always try to simplify any problem to a simple case like this, as it helps to understand the details of it.

[8]In fact, leveraging is at the core of modern economic system, as the money multiplier mechanism created by banks is what makes the credit cycle function.

highly driven by P&L accounting[9], we should understand what CVA monetization means in that context.

Banks want stable P&L, which means that the CVA volatility needs to be neutralized. In order to do that, banks will trade financial derivatives (CDS, IR swaps, FX forwards, EQ forwards, etc) to delta-hedge the P&L fluctuations coming from CVA. This can be done more or less easily with one-way CVA (except when the counterparty does not have a liquid CDS market, in which case proxy CDSs must used instead), but not that easily with DVA, as in order to neutralize that side of the P&L volatility the bank will need to sell protection on itself, which cannot be done. However, banks can partially neutralize this DVA component of the P&L volatility by selling protection on other banks whose credit quality moves similarly to himself, or on credit indices or baskets of CDSs that also move closely his own CDSs. On this way, a bank can hedge out the systemic component of the DVA P&L volatility.

Finally, the reader should note that with this P&L hedging, P&L volatility is neutralized, but default events may not be fully hedged because the bank may still be carrying counterparty risk; that counterparty risk hedging is achieved via the cash-monetization procedure explained before.

Monetizing via my own downgrade: the "perversity" of accounting rules?

Further to our previous discussion, a paradox appears around CVA: if my own rating gets downgraded, then the DVA of my trades increases and, as a result, the value of my trades increases!! This can be clearly seen in the following formula, where c_{cpty} and c_{myself} are the credit spread of my counterparty and of myself:

$$PV = PV_{CreditRiskFree} - \mathrm{CVA} \sim PV_{CreditRiskFree} - (EPE \cdot c_{cpty} - ENE \cdot c_{myself}) \quad (4)$$

That is, if c_{myself} increases, then the trade PV increases too!! This is paradoxical, and can lead to easy misunderstanding of accounting and potential financial mismanagement.

In fact, in a conversation I recently had with a current leading figure in this topic, this paradox was called "the perversity of accounting rules", given its dangers. A bank CVA P&L is very sensitive to the correlation between his own credit spread and his counterparties: as long as they move in parallel, CVA change will be small; however, if

[9] In my view, this is a good way of doing things as long as treasury can ensure that cash-flow liabilities will always be met. This is because what makes a company default is, at the end of the day, lack of cash. There are lots of example in the past of companies that were profitable but that went bust because they could not meet their cash liabilities.

that correlation breaks CVA moves can be very important. That is because CVA profit and loss is usually highly driven by the *spread* between my credit spread and that of my counterparties.

The paradox comes from a wrong interpretation of the Profit&Loss statements. A company can have a very strong balance sheet, be a profitable company, but default, because what makes you default is not profitability, but lack of cash.

The lesson from this is that P&L is an indication of the performance of a company, but the analyst needs to look into it and understand its details in order to assess the credit quality of a company.

Negative CVA? What does it mean?

Another confusing result of this new Credit Value Adjustment is that a trade can have, in theory, negative CVA. All this means is that a institution with poorer credit quality is likely to be lending money to another with a better credit quality through that trade, and it is an indicator that something may be wrong in a book of trades.

In the Credit Summit that I attended in 2009 in London, a participant talked to us about a piece of work that he had done with a given bank, regarding negative CVA in the books. That bank run into major difficulties in the hype of the 2008 crisis; I am not surprised, as it seems they were not understanding the actual credit risk they were carrying in their books!

Conclusions

I have illustrated how CVA is the adaptation to modern derivatives of what banks have been doing since their beginnings: making money through the spread of their lending and borrowing costs. In particular, this is applied to modern derivatives by considering the cost of hedging out the credit risk of derivatives (one-way CVA) and the cost of funding the expected liabilities (DVA). The difference between both is the CVA price, that represents a financial compensation that the counterparty carrying more credit risk should receive.

One-way CVA can be cash-monetized by not hedging the counterparty risk embedded in a trade; that is, by assuming credit risk. But this monetization is only crystallized if the counterparty does not default. In practice, since all banks leverage, DVA cannot be cash-monetized.

Banks are often interested in P&L-monetization. This can be achieved via delta hedging so that the CVA volatility can be neutralized.

Also I have shown how a profit in the CVA charge does not necessarily mean good news for a bank, and how the main driver of CVA profit and loss can be the spread between the credit spread of the institution under consideration and his counterparties.