A Decentralized Collateral Payment Solution

Christiaan le Roux

Elenjical Solutions
Christiaan le Roux
08 June 2021

Introduction

Any derivative transaction has inherent counterparty credit risk. The payoff of a derivative transaction depends on the prices of the underlying market variables. Hence, if a price moves too far in an unfavorable direction, one of the counterparties involved in the transaction cannot afford to make the settlement and will default on the payment [1].

Counterparty credit risk is trivial when dealing with listed securities, since the counterparty is an exchange (which is generally well regulated and hedged) [1]. All securities listed on a particular exchange need to be standardized and the traded price is public information. Hence, there are situations in which it is beneficial to negotiate the terms of a derivative contract privately. The market for unlisted securities is called the Over the Counter (OTC) market.

The following plot taken from [1] shows how the OTC market has grown since 1998:

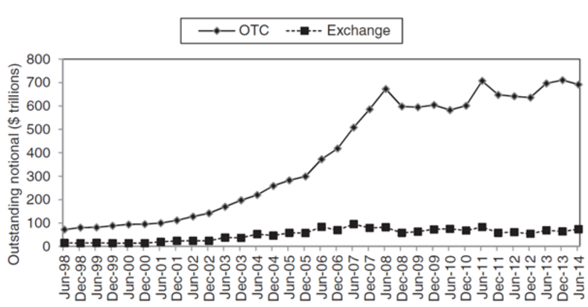

Figure 1: Growth In OTC Contract Since 1998

Since the OTC market involves financial institutions dealing with each other directly, counterparty credit risk cannot be considered trivial. To reduce credit risk, a two way collateral agreement is often included in the contract. The purpose of the collateral agreement is to stipulate how the contract will be marked to market and under what conditions collateral payments are exchanged [1].

The Theoretical Collateral Model

This section briefly introduces the concept of collateral as discussed in [2].

We will denote the two parties involved in the transaction as A and B. Then we will denote the time t present value of the contract's future cashflows, from the perspective of A, as $\Pi_t^{(A)}$. Further, we will denote the time t present value of the contract's future cashflows, from B's perspective, as $\Pi_t^{(B)}$.

A's exposure to B defaulting is $\left(\Pi_t^{(A)}\right)^+ = \max\left(\Pi_t^{(A)}, 0\right)$. Likewise B's exposure to A defaulting is $\left(\Pi_t^{(B)}\right)^+ = \max\left(\Pi_t^{(B)}, 0\right)$.

Variation margin is a form of collateral which mitigates counterparty credit risk when prices fluctuate. The variation margin that party $i \in \{A, B\}$ is required to maintain is:

$$V_t^{(i)} = \left(\Pi_t^{(j)}\right)^+, \text{ where } j \neq i.$$

In the event that party B defaults at time t, $V_t^{(B)}$ is transferred to A and vice versa.

Hence, if the variation margin is continuously maintained, party A's exposure to B defaulting is:

$$-\left(\Pi_t^{(A)}\right)^+ + V_t^{(B)} = -\left(\Pi_t^{(A)}\right)^+ + \left(\Pi_t^{(A)}\right)^+ = 0,$$

and vice versa.

Note that the variation margin B is required to post is A's exposure to B and vice versa. It is therefore very important that the collateral agreement clearly stipulates how the product will be marked to market so that both parties end up with the same values for $\left(\Pi_t^{(A)}\right)^+$ and $\left(\Pi_t^{(B)}\right)^+$.

In reality, financial transactions can take long to settle and involve transaction fees. Hence, it is unrealistic to assume that the variation margin can be maintained on a continuous basis. A variation margin that is maintained periodically still works well to mitigate the majority of counterparty credit risk. However, if there is a large, unfavourable, move in the price of the underlying market variable, one party may not be able to make the necessary payment into their variation margin (which leads yet again to significant credit exposures to the parties involved in the transaction). A solution to this is initial margin, which is a form of collateral posted at the inception of the contract, to mitigate credit exposures due to large movements in the underlying market variables during the margin period of risk (see below). It is difficult, however, to determine what this initial margin should be [1].

Another difficulty when dealing with collateral is determining when a counterparty is in default. We would not want to classify a counterparty as being in default if they missed a payment due to a system error. Further, we would want to classify a counterpart as being in default if there has been no need for them to make any payment, yet they have defaulted on other contracts or are bankrupt. Due to it being difficult to classify a counterparty as having defaulted, it takes time to make the call [1].

Margin Period of Risk

When one of our counterparties defaults, the underlying transactions need to be closed out and then most likely replaced (especially if they were hedging transactions). The average time it takes from when the counterparty stops posting collateral and the underlying transactions are closed out and replaced is called the margin period of risk [1]. The margin period of risk includes the time it takes from when the counterparty actually defaults (there is usually a grace period if a collateral payment is missed to allow for system errors), to when they are classified as defaulting plus the time it takes to close out and replace the transaction.

The regulatory specified margin period of risk is 10 days. Since a lot can happen in the market over a 10 day period (think meme stocks or Steinhoff) this leads to a large initial margin requirement. Which is expensive in terms of liquidity and opportunity cost to the parties posting the initial margin [1].

Central Clearing Parties (CCP)

A CCP acts as something of an exchange for OTC transactions. The CCP is a central counterparty to all members making trades through it. Using a central counterparty can significantly reduce credit risk, and should therefore also reduce initial margin requirements. CCP's use two key techniques to mitigate the overall credit risk in the market: netting and loss waterfalls [1].

There are advantages and disadvantages to CCP's discussed in [1].

Advantages:

- Transparency
- Netting
- Loss mutualization (losses are shared by the members of the CCP and not only the exposed parties)
- Legal and operational efficiency
- Liquidity
- Default Management (transactions can be replaced faster)

Disadvantages:

- Moral Hazard
- Adverse Selection
- Bifurcations (Only standard products can be cleared through a CCP)
- Procyclicality

CCP's are very effective at reducing the credit exposure for each member on an individual level. However, they all now have one central counterparty and a failing CCP would be devastating to the overall market. Systemic risk is thus significantly increased.

Smart Contract Collateral

A smart contract is a set of instructions given to a computer to automatically execute the terms of the legal contract [3].

Historically, a financial transaction needs to be cleared by a financial intermediary which is expensive and can take multiple days. However, in 2008, a revolutionary white paper was published by an unknown author using a the pseudonym Satoshi Nakamoto titled Bitcoin: A Peer-to-Peer Electronic Cash System. This paper introduced the notion of the blockchain, which has subsequently revolutionized the way many people make financial transactions.

The blockchain technology can significantly reduce the cost and time it takes to complete financial transactions. Most crucially, however, it does not require a financial institution to facilitate the transfer of crypto-currency from one party to another [4].

Through tokenization (a digital representation of assets on a blockchain), smart contracts and blockchain technology can be leveraged to improve the efficiency of the collateral mechanism.

Leveraging a smart contract would require the mark to market calculation methodology and the definition of default be clearly and fully defined in the initial contract. The clear definition of default and calculation methodology implies that there is less room for any form of legal dispute about collateral payments or default conditions. Further, margin period of risk is reduced since the condition for default is clearly defined. Blockchain tokens can be transferred in far less time than historical methods. This can facilitate intraday collateral payments, further reducing the margin period of risk. Hence, a key benefit of smart contract collateral is a reduction in the initial margin requirement. Beyond that, smart contract collateral reduces the overall cost of posting collateral and does not create significant amounts of systematic risk as in the case of a CCP [2].

Smart contract collateral is not a perfect solution, however:

Firstly, both parties are required to keep enough of the crypto tokens in their respective wallets to make collateral payments. Since the crypto tokens cannot be used for anything else, it is effectively another form of initial margin.

Secondly, the use of smart contracts effectively adds an american option to the contract, since either party can empty their wallet at any time to trigger the closeout procedure [5].

Finally, it will be difficult to replace transactions that are closed out early if not enough capital market participants adopt this methodology [5].

Implementation

A possible implementation of smart contract collateral, adapted from [2], would be to build some form of OTC exchange or trading platform on top of a blockchain network. The idea is that the exchange would allow participants to communicate with each other and make OTC trades. The system would act as a decentralized version of a CCP, potentially offering netting and loss waterfall features. The key difference would be that instead of acting as a central counterparty, it would rather act as a facilitator for the transactions to take place.

Implementing smart contract collateral in this manner would effectively remove the American option issue, since now if a member empties their wallet, they will default on all their contracts rather than just one.

Furthermore, if enough parties use the system, they can use their cryptocurrency wallet to facilitate all OTC transactions. This makes it far more feasible to keep money in a crypto wallet. Many parties utilizing the system would also allow transactions to be replaced easily.

Conclusion

A significant amount of trust would be required from market participants before enough institutions would utilize the system to make it worthwhile. It would also be difficult to gain trust, since the world of cryptocurry is complex and thus not many people fully understand the potential of blockchain technology.

However, systems like the one outlined above could prove incredibly beneficial to the world of finance by lowering the operational and credit risk, lowering the cost, and improving the accessibility of dealing with OTC derivatives [2].

References

[1] Jon Gregory. *The xVA Challenge: counterparty credit risk, funding, collateral and capital*. John Wiley & Sons, 2015.

[2] Massimo Morini. “Managing Derivatives on a Blockchain. A Financial Market Professional Implementation”. In: *A Financial Market Professional Implementation (May 5, 2017)* (2017).

[3] Nick Szabo. “Smart contracts”. In: *Unpublished manuscript* (1994).

[4] Michael Nofer et al. “Blockchain”. In: *Business & Information Systems Engineering* 59.3 (2017), pp. 183–187.

[5] Christian P Fries and Peter Kohl-Landgraf. “Smart Derivative Contracts (Detaching Transactions from Counterparty Credit Risk: Specification, Parametrisation, Valuation)”. In: *Available at SSRN 3163074* (2018).