Counterparty credit risk management: estimating extreme quantiles for a bank

Counterparty credit risk (CCR) is a complex risk to assess and banks lacked scientifically robust methods for calculating their level of potential exposure. ***Qiwei Yao,*** *together with his collaborators, developed an innovative methodology for estimating counterparty credit risk, which can help banks meet regulatory requirements and calculate appropriate capital reserves.*

Impact Case -- Research Excellence Framework (REF)

The Basel III framework is an internationally agreed set of measures designed to strengthen the regulation, supervision, and risk management of banks, in response to weaknesses exposed by the Global Financial Crisis of 2007 to 2009. One of its requirements is enhanced management of counterparty credit risk (CCR) – the risk of suffering a loss because another party to a contract fails to meet its side of the deal. Under Basel III, investment banks such as Barclays are required to apply backtesting procedures for estimating their levels of counterparty credit risk and to ensure they hold adequate capital and liquidity to cover worst-case scenarios for potential losses. This strong emphasis on banks' proper management of CCR is important to the stability not only of individual banks but also, in light of their interconnections, to the financial system as a whole.

However, CCR is a complex risk to assess; as a hybrid of credit and market risk, it is contingent both on changes in the counterparty's creditworthiness and on movements in underlying market risk factors. Banks such as Barclays have previously lacked scientifically robust methods for calculating their level of potential exposure, and instead taken ad hoc approaches to calculating the level of financial buffer they require.

What did we do?

Between 2012 and 2014, I worked with the Director of Quantitative Exposure at Barclays to develop a more reliable and robust backtesting methodology for the bank to estimate potential future exposure to counterparty credit risk. I was invited to join the project because of my expertise in statistical analysis, especially in time series and dependent data. Backtesting is an analytical tool used by banks and their regulators to monitor the performance of their risk factor valuation methods. It uses historical price data to test the efficacy of existing risk factor models. In particular, it tests whether the models' extreme quantiles of potential future exposure – that is, the maximum expected lifetime credit exposure under pre-determined probabilities – are correctly quantified.

The first step is typically to simulate various future market risk factors such as interest rates, equities, and foreign exchange rates. Next, all the derivative positions of the bank are computed at each time horizon of each of these simulated market scenarios, to determine the bank's potential future exposure to counterparty default. The amount of holding capital required to cover counterparty credit risk is then calculated, in line with the relevant regulation. For example, a backtesting setup can create a price model for an asset which can be traded with different time maturities at different prices. Two complicating factors are: (i) the interdependency of prices at different time horizons; and (ii) the explicit unavailability of price distributions.

Although the distributions are not available, banks store 1,000 *simulated* price paths as a proxy for them, allowing backtesting based on these. (Various constraints mean most banks, including Barclays, can *only* store 1,000 simulated price paths.) Yao's work tackled the challenge of estimating extreme potential future exposure which would occur with odds of between 1:5,000 and 1:10,000 based on the small available samples of 1,000 simulated price paths. His method takes advantage of the fact that the extreme quantiles required are determined by multiple random variables. The key idea here is that it is not necessary to go to extremes along any component variable in order to observe the joint extreme events. This seemingly counter-intuitive observation is central to the success of the new approach, which, despite being readily demonstrable, had never previously been explored in the literature or in practice. The resulting method developed by Yao and colleagues provides a satisfactory solution to quantifying the extreme quantiles of potential future exposure accurately and reliably. The method is conceptually simple, theoretically sound, and easy to implement – and it provides robust performance in practice.

What happened?

Barclays holds counterparty credit risk-weighted assets worth tens of billions of US dollars. The methodology was applied across this portfolio, allowing the bank to calculate an appropriate capital buffer to protect both its own and its customers' interests. For the bank, underestimating potential losses leads to their exposure to potential uncovered financial losses. Overly conservative estimation creates additional unnecessary overheads and, consequently, increases in the costs of borrowing and decreases in investment. Since its first use by Barclays in late 2013, the new method has withstood rigorous backtesting under the Basel III framework. This has helped to ensure that Barclays and its customers have avoided exposure to highly risky positions. Had its backtesting failed, the bank would have been required to increase its estimates of potential future exposure and so hold additional capital, which would be extremely costly. By avoiding this, the direct saving for the Bank from using this new scientifically calculated buffer is substantial. This, in turn, reduces the cost of borrowing, and potentially increases investment and economic growth, with substantial indirect benefits to society.

Introducing this new methodology improves the overall stability of Barclays. Both the bank's and its customers' interests are protected by alleviating exposure to uncovered high risky positions within a small probability (such as 0.05 per cent or 0.01 per cent). This in turn contributes to the stability of the global financial system by mitigating the potential impact of the failure of one bank on others. As such, the research has contributed indirectly to assuring greater financial system security at lower cost, with wider economic benefits.

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