ISDA Research Notes

A Note on the Impossibility of Correctly Calibrating the Current Exposure Method for Large OTC Derivatives Portfolios

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Executive Summary

The capital charges for counterparty credit risk form an important part of the Basel Capital Accords. The Basel Committee permits firms to use a variety of methods to calculate regulatory capital on this risk class, including a simple approach – the constant exposure method or CEM – and a more sophisticated models-based approach known as EPE (for 'expected positive exposure').

Counterparty credit risk capital models estimate the potential future exposure ('PFE') of a portfolio of derivatives with a counterparty based on whatever margining scheme applies. The CEM approximates this PFE using a constant percentage of notional, with the portfolio capital charge being the sum of the percentages which apply to each instrument. The CEM therefore recognizes no diversification benefit. In contrast, EPE approaches model the entire future of the net portfolio and thus provide much more accurate estimates for portfolios with more than a handful of instruments. The inaccuracy of the CEM is hardly surprising as it was intended only for smaller portfolios and less sophisticated firms.

More recently the Basel Committee has proposed that the CEM be used as a method for determining the adequacy of financial resources available to an OTC derivatives central counterparty ('CCP'). Since cleared portfolios are very large and very well-hedged, it might be imagined that the CEM is not well suited to this task. This paper confirms that suspicion. In particular we show that the use of the CEM to estimate the riskiness of CCP default fund contributions leads to a significant overstatement of risk. Further, we show that the CEM cannot be simply recalibrated to provide a more risk sensitive approach. Thus an approach which provides more accurate estimates for typical CCPs is to be preferred.

Introduction

The constant exposure method, or CEM, was introduced as a simple approach for approximating the potential future exposure of OTC derivatives. Crucially, it is the simplest of the approaches permitted for the Basel Committee for this purpose, and thus intended only for:

- Less sophisticated banks, and
- Small portfolios of derivatives containing no more than a handful of instruments.

Latterly the Basel Committee has proposed using the CEM to estimate the riskiness of default fund contributions made to central counterparties ('CCP'). The proposal specifically envisages using the CEM to calculate a 'hypothetical capital' that a CCP would be required to have, and comparing the CCP's prefunded financial resources with that hypothetical capital. If the resources are not more than the hypothetical capital, the Committee proposes a penal capital treatment of default fund contributions.

Cleared OTC derivatives portfolios are very different from those that the CEM was designed to deal with. Clearing member house portfolios are typically very large, and often very well hedged. Thus, given that the CEM was not designed for this type of portfolio, there might be concern that the CEM does not produce a meaningful estimate of hypothetical capital. In this paper we show first that that concern is justified – the CEM indeed dramatically over-estimates hypothetical capital. Our second result is less obvious: we show further that the CEM cannot be recalibrated to calculate hypothetical capital accurately for typical cleared portfolios. This is because it fails to recognise the inherent risk diversification benefit in large portfolios.

I. Methodology

We study the behaviour of the CEM by looking at a large number of OTC derivatives portfolios incorporating a range of interest rate and FX derivatives across multiple currencies and tenors. We calculate capital using the sophisticated approach permitted in Basel 2 – portfolio based expected positive exposure, or EPE – and using the CEM.

A large number of portfolios were generated randomly based on an extensive set of instruments. This provided a wide range of both directional and well-hedged portfolios for the analysis. The methodology for portfolio construction is detailed in Appendix One.

For each portfolio, we examined the relationship between CEM and EPE-based exposure at default in each of three situations:

- Unmargined.
- Daily variation-margined, with a 10-day period of risk.
- Daily variation-margined, with a 10-day period of risk and initial margin required to cover a 1-day, 5-day or a 10-day move at 99% confidence level.

II. Diversification

The CEM capital charge for one transaction is a percentage of notional, with the percentage varying by transaction type and maturity. The CEM charge for a portfolio of more than one transaction is the sum of the CEMs for each individual transaction.

In contrast, the EPE of portfolio of transactions is not the sum of the EPEs of individual transactions, but rather a property of the net risk of portfolio. Diversification works to reduce EPE, but not to reduce CEM.

A simple measure of diversification is therefore as the ratio of the maximum unmargined EPE of the portfolio over the 1st year to the sum of the EPEs of each instrument in the portfolio. The smaller this number is, the more diverse the portfolio is. Figure One shows the distribution of diversification amongst the generated portfolios, with 95% of the chosen portfolios have a diversification ratio of less than 10%. This is typical of cleared dealer portfolios.

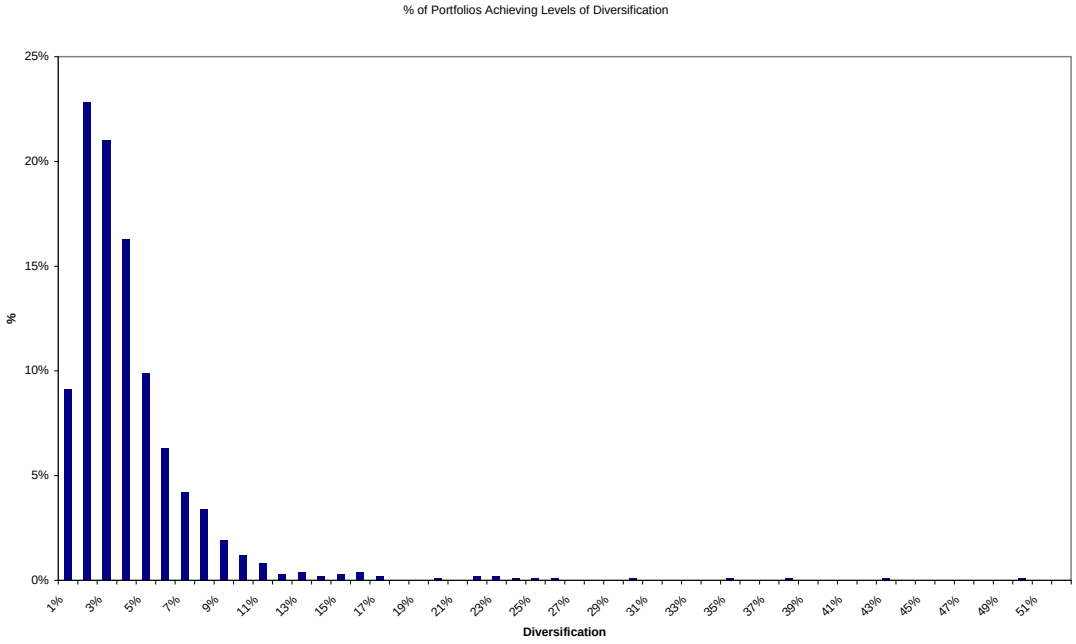

Figure One: Distribution of Diversification

To give some insight into this diversification measure, we also plot it (in Figure Two) against number of trades. As might be expected, smaller portfolios are less diverse. Once a portfolio reaches 1,000 trades, it is likely to have a diversification ratio of less than 10% even if it is rather directional. The average diversification level for large portfolios in our analysis is 4%.

Note that typical clearing member portfolios at interest rate derivatives CCPs are currently tens or hundreds of thousands of transactions, so they are likely to have diversification ratios close to the 4% average.

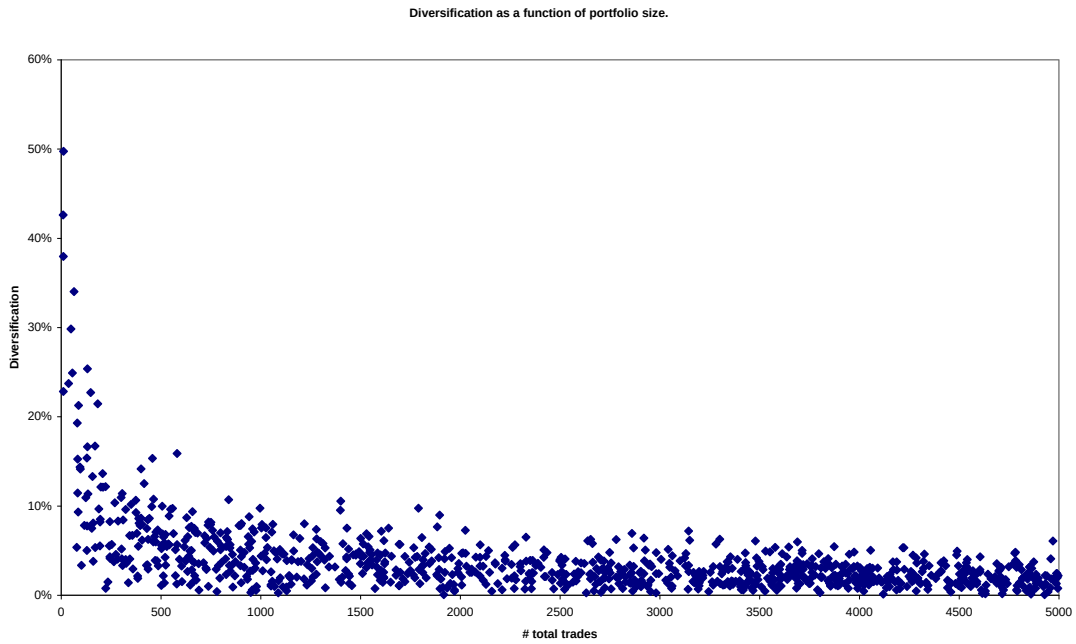

Figure Two : Diversification as a function of total portfolio size.

III. How good an estimate of capital is CEM?

In order to examine the performance of the CEM as a capital measure, we calculate the ratio of the correct EPE-based capital estimate to the CEM capital. Figure Three plots this for unmargined trades as a function of diversification.

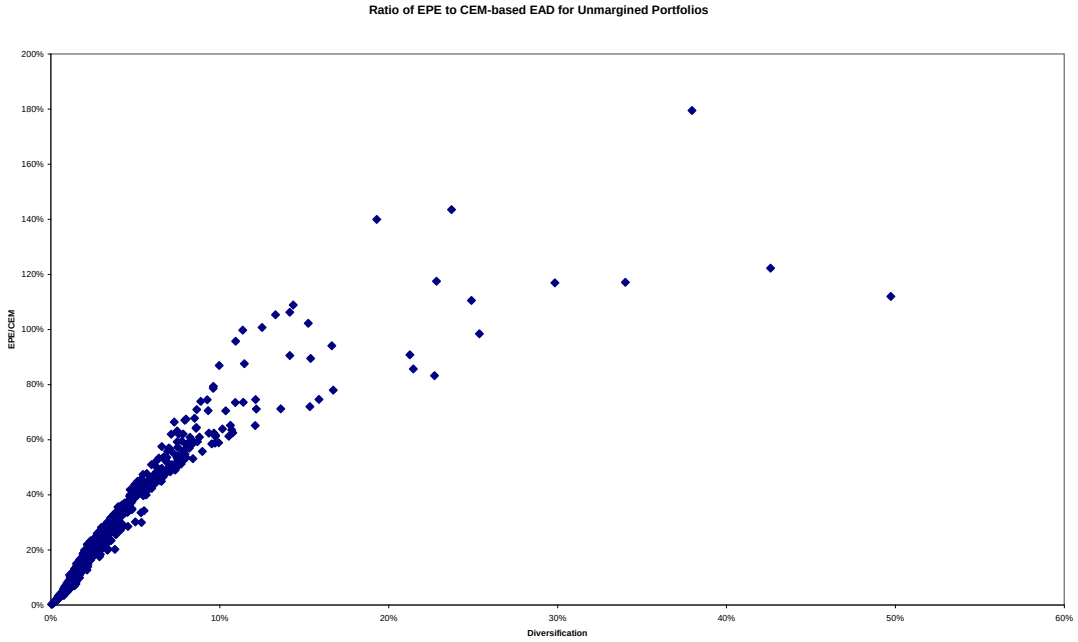

Figure Three: Ratio of EPE to CEM-based EAD for Unmargined Portfolios

Here we see that for less diverse portfolios to the right of the plot, the CEM performs reasonably, but as soon as the portfolio diversification measure is 15% or less:

- The EPE/CEM ratio is less than one, i.e. the CEM over estimates capital; and
- The ratio is a strong function of diversification, i.e. the CEM is more wrong for more diverse portfolios.

For very diverse portfolios with a ratio of 1% or less, the EPE/CEM ratio tends to zero; it seems that there is no bound on how wrong the CEM can be for unmargined portfolios.

The dependence of EPE/CEM on diversifications means that the CEM cannot be recalibrated to produce better answers: how wrong it is is itself a function of portfolio diversification.

Figure Five shows the analysis for margined portfolios with no initial margin. Here we see that the CEM always over-estimates capital, and again that how much it over-estimates capital by is a strong function of diversification.

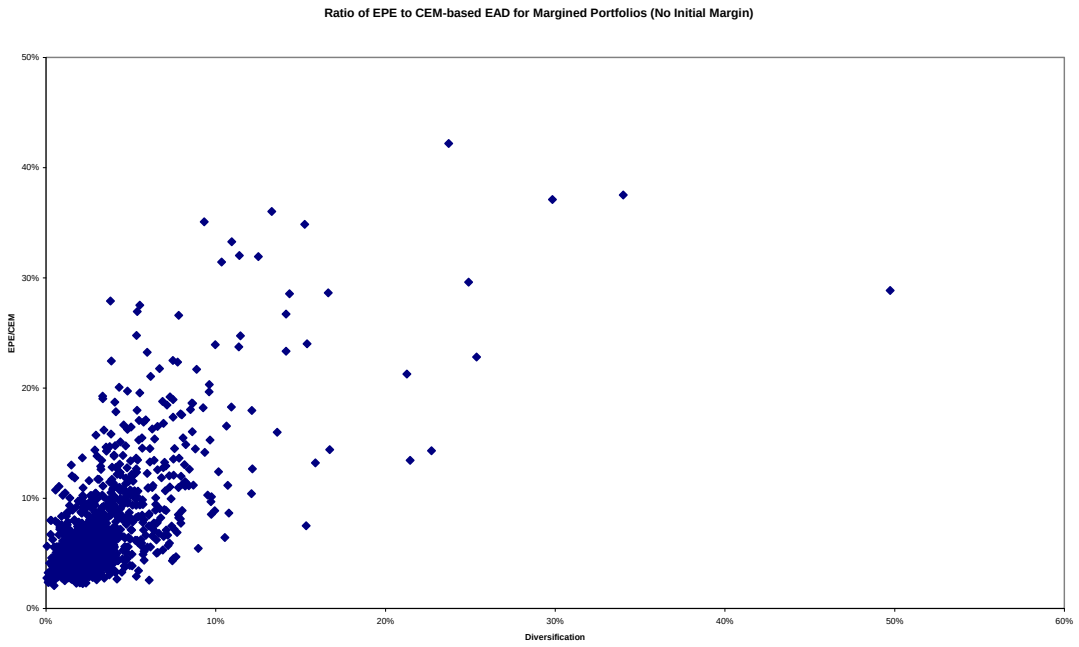

Figure Four : Ratio of EPE to CEM-based EAD for Margined Portfolios (No Initial Margin)

The remaining charts examine the ratio when initial margin is present. We look at initial margin levels calculated from the 1-day, 5-day and 10-day 99% portfolio exposure (calculating this from the same distributions that drive the EPE-based measure).

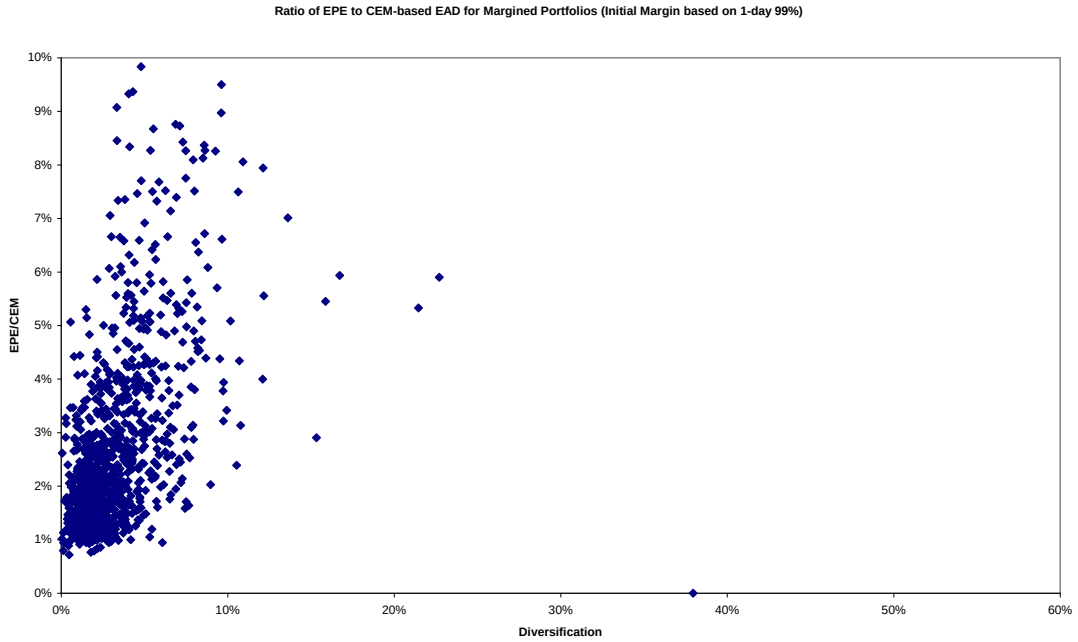

Figure Five : Ratio of EPE to CEM-based EAD for Margined Portfolios (IM based on 1-day 99%)

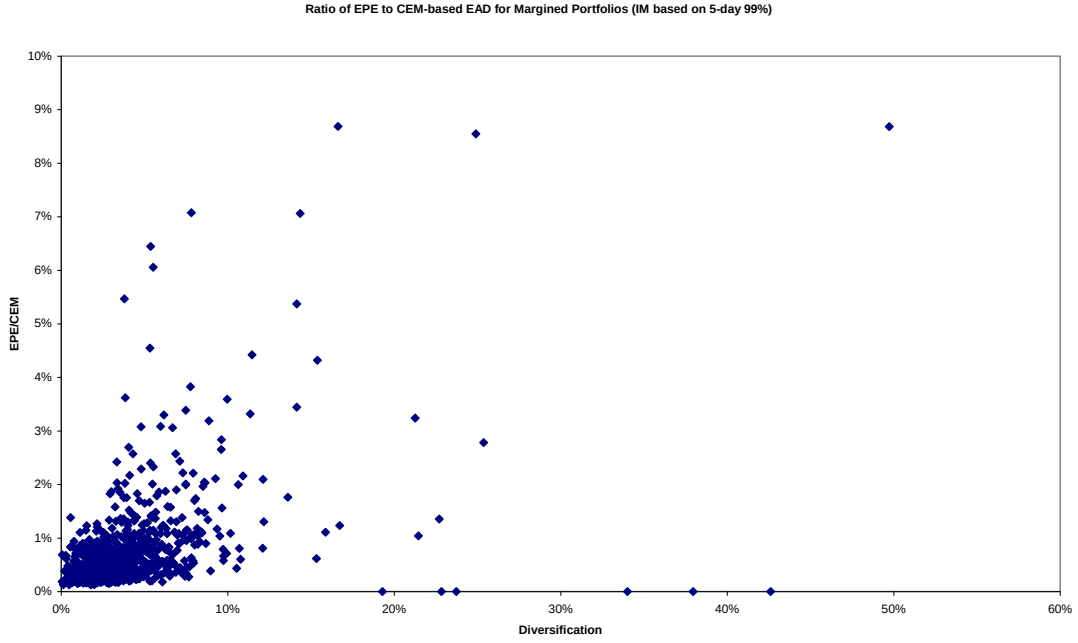

Figure Six : Ratio of EPE to CEM-based EAD for Margined Portfolios (IM based on 5-day 99%)

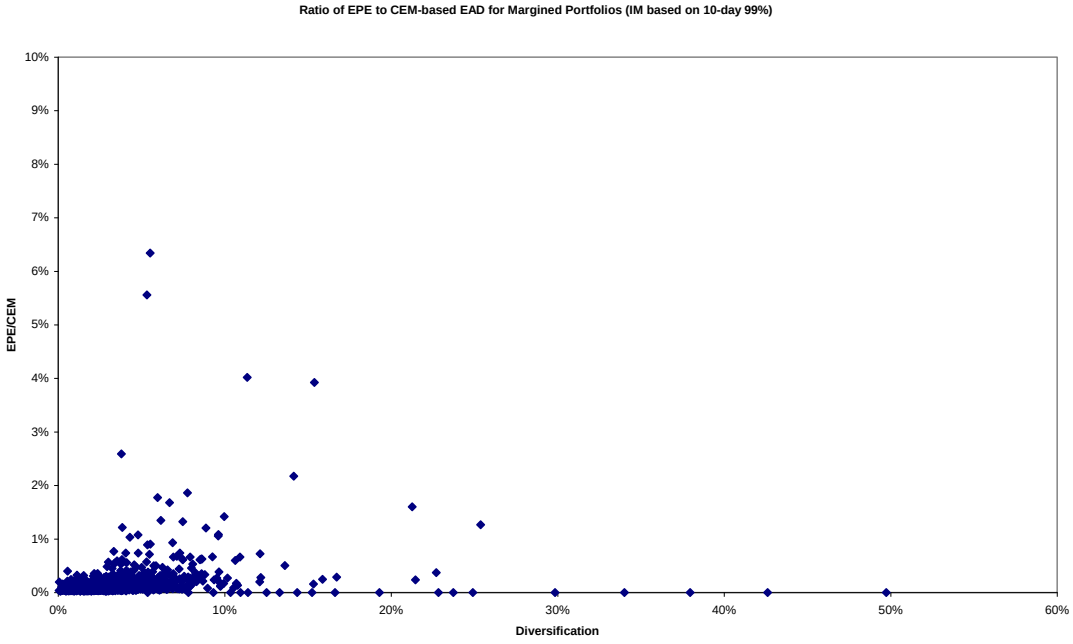

Figure Seven : Ratio of EPE to CEM-based EAD for Margined Portfolios (IM based on 10-day 99%)

A similar picture emerges here.

- The CEM grossly over-estimates capital, sometimes by a factor of a hundred or more;
- How wrong it is depends on portfolio diversification.

IV. Conclusions

Our analysis shows that CEM-based capital estimates are dramatically over-stated for large OTC derivatives portfolios. Moreover no simple recalibration is possible without incorporating an additional dimension of diversification. The CEM is therefore not an appropriate tool for calculating CCP hypothetical capital.

V. Appendix I: Transaction Generation

The following trade types were included in this analysis:

- Interest rate swaps.
  - Notionals: USD 100MM to 1Bn, in 100MM steps converted at spot to relevant currency.
  - Currencies: USD, GBP, EUR, CHF, JPY, NOK, SEK, NZD, AUD and CAD.
  - Tenors: 1y, 2y, 5y, 7y, 10y, 12y, 15y, 20y, 25y, 30y
  - Moneyness: at-the-money with +/-5% and +/-10% relative increments.
  - Frequencies: Semi/Semi.
- Cross-currency swaps.
  - Notionals: USD 100MM to 500MM, in 100MM steps converted at spot to relevant currency.
  - Currencies, in groups with all cross-currencies represented:
  - (CHF, EUR, GBP, JPY, USD), (EUR, BRL), (EUR, RUB), (USD, BRL), (USD, RUB).
  - Tenors: 2y, 5y, 10y
  - Moneyness: at spot, with +/- 5% and +/-10% relative increments.
  - Type: Fixed/Fixed.
- Interest Rate Options
  - Notionals: USD 20, 50 and 100MM converted at spot to relevant currency.
  - Currencies: USD, GBP, EUR, CHF, JPY, NOK, SEK, NZD, AUD and CAD.
  - Tenors: 2y, 5y and 10y.
  - Moneyness: at-the-money with +/-5% and +/-10% relative increments.
  - Type: Cap and Floor

Uniformly distributed weightings achieve combinations of long/short positions. Given the above, there are 2,020 possible combinations, from which we derive 1,000 portfolios of 5,000 transactions. This leads to multiple 'picks' of the same position. From a transaction perspective, this may lead to a reduction in the actual number of different types of transaction and the individual weighting gets some redistribution away from uniform. These combinations then provide a mixture of diverse and directional portfolios.