

Back-to-basics

Two potentials, one result

In his final paper, Algorithmics' Paul Smetanin shows how a market risk framework based on scenario simulation can assist traders in identifying and managing the portfolio's counterparty exposure

A complete market risk framework should provide a vision and a strategy that endure the tests of time and change. Certain criteria must be satisfied before a market risk approach can be said to represent a complete market risk framework. As outlined in *AsiaRisk* October 2000 (pages 32-35), a market risk framework that is predicated on a robust scenario simulation process will satisfy all the necessary framework criteria.

"Extensibility" is a key criterion. This requires a market risk approach that anticipates a contribution to enterprise-wide risk management, specifically the integration of market, credit and liquidity risk. To exhibit the extensibility of a market risk framework, which is predicated upon scenario simulation, this paper examines the ability of such a scenario framework to provide information that assists in the management of counterparty exposures. This is partly achieved by investigating the counterparty contributions to the market risk probability density function (MRPDF), or achieved completely by using the same scenario simulation capability to measure potential counterparty exposure (PCE) over time. By using a scenario framework, traders are able to manage their PCEs as they trade.

Nature of credit risk

Credit risk is the possibility of incurring the cost of replacing the effects of a financial instrument at the time of a counterparty's default. An instrument's credit risk is generally a function of:

- Current credit exposure:** the current positive market value that the instrument represents to the obligee;
- Potential counterparty exposure (PCE):** the potential changes in the exposure over the instrument's life;
- Probability of default:** a measure of likelihood of the counterparty defaulting over the instrument's remaining life; and
- Asset recovery rates:** the expected value recouped after a counterparty has defaulted, expressed as a percentage of instrument value.

The correlations between PCE, probabilities of default and asset recovery rates are then

modelled with credit-based scenarios to determine a portfolio's credit risk profile.

When a portfolio contains derivatives, it is particularly important to account for PCE, the change in credit exposure resulting from market fluctuations over the remaining life of the instrument (Duffee, 1996; Aziz and Charupat, 1998). This paper is concerned with the management of PCE when making a market risk decision.

Credit and market risk

Market risk can be defined as the potential loss from changes in market risk factors, such as interest rates, foreign exchange rates, equity prices, implied volatilities, etc. Market risk is intrinsically related to credit risk and vice-versa. However, there are caveats that must be addressed in the way the relationship is described. Certain common risk factors are used as inputs into the measurement of both credit and market risk, but each of these risks also have other risk factors and characteristics that

are not interrelated. Factors such as business cycles, international economic events, firm-specific fundamentals, tax effects, firm value and the book value of debt and bankruptcy laws can affect credit risk, but not necessarily market risk.

Furthermore, a primary distinguishing feature between market and credit risk is that most market risks, in liquid markets, can be closed out relatively quickly, whereas the close out of credit risk is a far more difficult proposition.

Given these issues that afflict the management of credit risk, and the scarcity of data available to support credit risk measurement (see below), any technique that allows credit risk to be closed out whenever economically feasible is valuable. It follows that while executing a market risk decision, the simultaneous reduction of PCE would be keenly sought.

Market risk-taking

As a trader pursues profit based on market risk decisions, credit risk is created or reduced. Think of a trader that trades every day of the year with the exception of the last. With profit recognised, the trader decides to close down the market risk in the book, but for some residual basis and spread risks. Realised and unrealised profit and loss and a portfolio of financial instruments is left to show for the activities of the trader. That is, the trader has left PCE, which must be managed for the remainder of the life of the financial instruments in the portfolio. The PCE of a 10-year swap will need to be managed for 10 years.

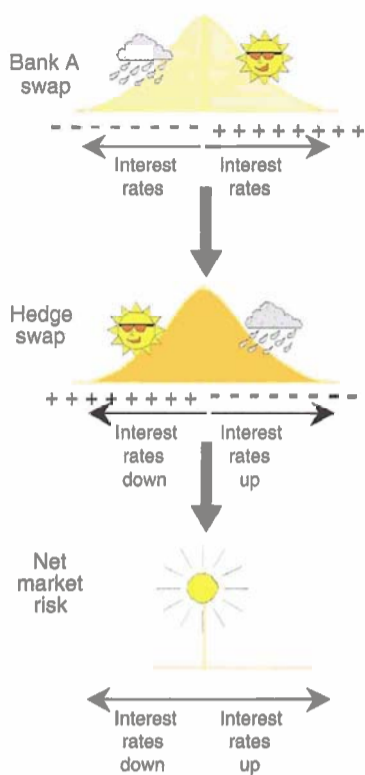
The PCE associated with a market risk trader pursuing profit over time is not represented by risk factor sensitivities simulated over short time horizons, such as typical market risk value-at-risk (VAR) measures. Usually, organisations will adjust the trader's recognised profit for the cost of both market and credit risk capital. However, implementing a complete credit risk measurement framework can be complicated by lack of data, processing and technology issues, for which the organisation may not have evolved a cost-effective, intellectual or practicable solution. The natural organisational goal is for traders to manage the build-up of PCEs as they pursue market risk



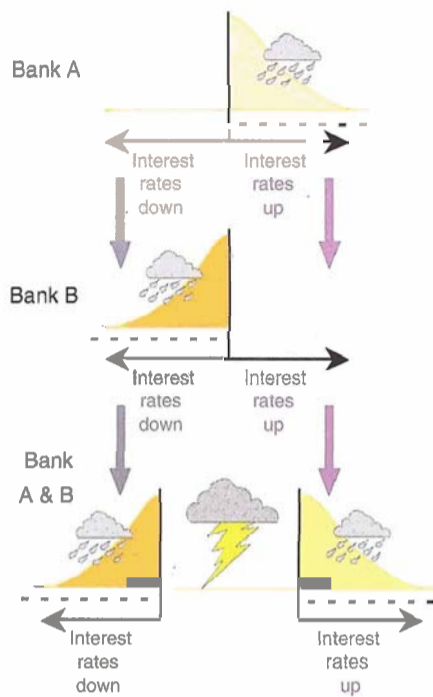
Paul Smetanin, Algorithmics

Back-to-basics

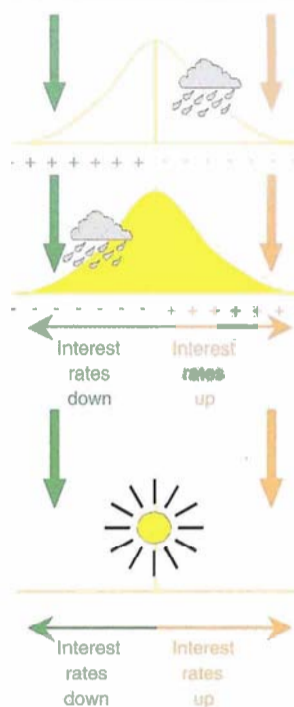
1. Market risk



2. Counterparty exposure



3. Bank A potential counterparty exposure



profits through time. Can a market risk framework that simulates over a short time horizon assist with such a challenge?

A market risk framework that generates a rich source of potential future profit and loss outcomes across instruments allows an appreciation of instrument value drivers. Such information can be used to generate a market risk VAR. If, however, those instruments are mapped to counterparties, the result is an appreciation of a one-day PCE derived from market risk variables. With the goal of managing the growth of the credit counterparty risk profile of the portfolio, under certain circumstances a market risk framework can assist traders in managing PCEs.

A simple case

Consider a simple interest rate case. A trader has a single swap that is paying fixed and receiving floating with the counterparty Bank A. The market risk profile would typically be represented by a one-day scenario simulated MRPDF. If the trader wished to hedge the market risks embedded in such an instrument, a choice of instruments such as futures, bonds, forward rate agreements (FRAs) or swaps could be traded, with the most efficient hedge being a swap of the same terms (maturity, coupon, etc.). By reducing the market risk represented by the negative side of the MRPDF, the trader will forfeit the profitable profile of the swap as represented by the positive side of the MRPDF.

As shown in figure 1, by using a swap contract to hedge the trader is matching the negative side of the MRPDF with a market risk

profile of equal weight (ignoring credit spread effects). In this way, the market risk of the trader's book is neutralised.

However, what has been the impact on the PCEs of the portfolio? Assuming that the swap hedge was dealt with the counterparty Bank B, the potential one-day PCE profile of that swap incorporates the positive side of the MRPDF: as interest rates fall, the swap increases in value. The one-day PCE profile of the Bank A swap incorporates the positive side of the MRPDF: as interest rates rise, the swap increases in value. These effects are illustrated in figure 2.

The one-day PCE contributions of the portfolio show that, regardless of which way interest rates move, the portfolio will have a counterparty credit exposure to either Bank A (interest rates up), or Bank B (interest rates down). Given that the one-day PCE profile provides an indication of how the portfolio's PCE will increase over time, by growing the size of the portfolio through a market risk decision to hedge, the trader has created PCEs that must be managed over the life of the portfolio.¹

How could this situation have been avoided? The hedging decision based only on market risk considerations failed to take into account the symmetrical (in this case) market risk profile of the original swap, the negative side of the MRPDF representing market risk and the positive side of the MRPDF representing one-day PCE.

If the trader had not limited the hedging decision to dealing with only the negative effects of the MRPDF, but had instead incorporated an understanding of the whole market risk

distribution and its implications for one-day PCE, the search for a hedge would have led to matching the whole risk profile of the Bank A swap, as the market risk side of the MRPDF and the one-day PCE side of the MRPDF.

Rather than entering into a Bank B swap, the trader could put the portfolio in a much better PCE profile by dealing with the counterparty that generates the same but opposite PCE profile, namely Bank A.² This is the basis of using a pre-selected counterparty in which to effect a market risk hedging decision, the effect of which is illustrated in figure 3. Shimko (1998) makes a similar point by arguing that the solution to the risk displacement problem is to quantify market, counterparty and operational risks. The benefits of any risk-mitigation decision can only then be evaluated after simultaneously considering the three risk impacts on the entire risk profile of the portfolio.

The portfolio context

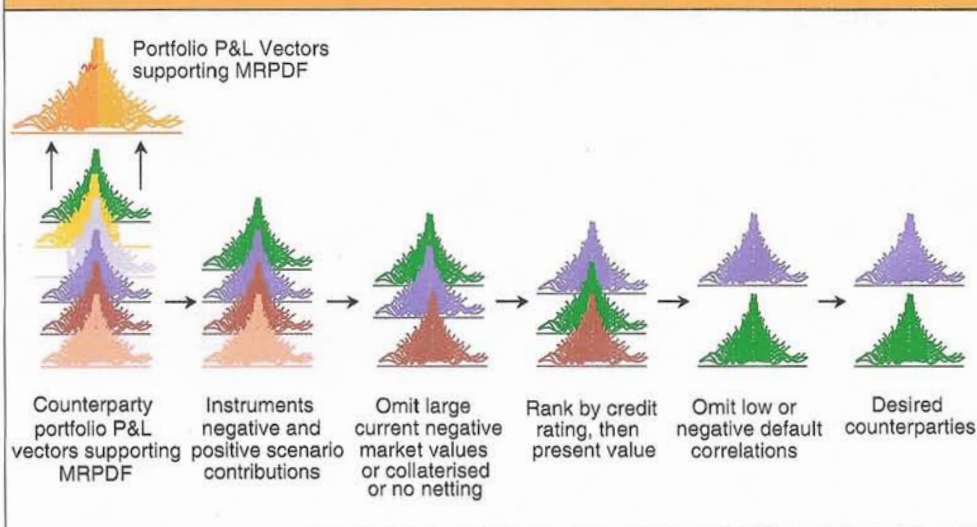
Under certain circumstances, the single swap example can be applied to the portfolio context on the same basis. By using scenario-based representations of the MRPDF, the trader is able to investigate an instrument's contribution to a portfolio's MRPDF. By grouping the instruments that belong to the same counterparty and netting agreements, a counterparty's

¹Note that in this portfolio, a credit risk loss is mutually exclusive in that a short and long position cannot have peak credit exposures at the same time

²Banks are usually in the business of running swap books. It is assumed that Bank B is happy to provide a quote and deal the required swap

Back-to-basics

4. Counterparty pre-selection approach



contribution to the negative and positive side of a portfolio's MRPDF can be determined.

A scenario that falls in the negative side of a portfolio's MRPDF represents a potential market risk loss to the trader. Given that the one-day potential loss is mapped to instruments, it can be decomposed across instruments (eg, type, maturity, terms, etc.) and grouped by their respective counterparties. As a result, when a trader needs to change the shape of the negative side of a portfolio's MRPDF, the decision can incorporate both the instruments that contribute most to market risk (negative side of the portfolio's MRPDF), and the instruments – and therefore the counterparties – that contribute most to counterparty credit exposure. The trader then has information that may determine the likely counterparties with which to effect the desired market risk decision. The trader can now better understand the counterparty contributions to the MRPDF, rather than naively choosing a counterparty when effecting a market risk decision.

MRPDFs based upon one-day scenario simulations do not appropriately measure PCE, as the credit exposure profile of a group of instruments for a given counterparty are not understood over the various lives of that counterparty's instruments. Furthermore, certain key credit risk drivers are not naturally incorporated in short time-horizon scenarios.

To assist the identification of likely counterparties to effect a market risk decision, certain credit risk driver criteria should be used. Criteria for instrument elimination might include:

- Group contributions to the profit and loss vectors that support the calculation of the portfolio's MRPDF by instruments and their counterparties;
- Ignore those instruments that do not have netting agreements;
- Rank counterparties by contribution to the profit and loss vectors;
- Ignore those counterparties with large

current negative values. Those counterparties that are deep out-of-the-money to the obligee represent significantly less PCE than instruments that are slightly out-of-the-money or those that are in-the-money;

- Ignore those counterparties that are known to be collateralised;
- Rank counterparties by credit ratings as a proxy for default risk. See Lula (1993) and Carty (2000);
- Rank counterparties by expected recovery rates (although it is arguable that such a factor is dominated by the importance of other credit risk drivers); and
- Avoid selecting counterparties that have low or negative default correlations to the rest of the counterparties in the portfolio, as it is these counterparties that contribute most to the positive effects of portfolio diversification (Markowitz, 1952).

This process of elimination is shown in figure 4.

Once desired counterparties are determined, the trader then needs to explore the instrument positions and instrument maturities of the identified counterparty portfolios.

Where counterparty portfolios exist in which positions in instruments are predominantly one-way (ie, either short or long), then an opportunity may exist for a pre-selected counterparty to support the desired market risk decision. This requires a double coincidence of terms (eg, maturities) between the instrument position required to support the market risk decision and the counterparty instrument positions. That is, the counterparty portfolio needs to represent an opposite market risk profile to that of the desired market risk decision. For example, if the market risk decision requires a long exposure in 10-year interest rates to meet the selection criteria, a counterparty portfolio will need to have the interest rate profile of a short 10-year position.

The counterparty selection criteria is further complicated when the counterparty portfolio

has a combination of short and long instrument positions of varying maturities. For example, if a counterparty portfolio is made up of a short five-year swap and a long 10-year swap, the one-day PCE does not provide any indication that the counterparty should be pre-selected. This problem arises as the PCE over the life of the instruments in the counterparty's portfolio is not understood. PCE is likely to increase if a desired short 10-year swap was dealt with by the counterparty, as the new swap would negate much of the PCE offset that the original long 10-year swap was providing against the short five-year swap.

If the PCE for that counterparty portfolio was measured using simulated market risk scenarios over the life of the instrument positions, then the PCE profile of the counterparty would be understood and the trader would be in a better position to understand what part of the market risk decision could be dealt with by the counterparty.

The notion of matching market risk decisions with pre-selected counterparty portfolios may be solved by optimisation methods similar to those used in Mausser and Rosen (1999). Optimisation techniques that determine which trades would achieve both the market risk decision and an optimal reduction of portfolio PCE profiles would be valuable, as traders could effect market risk decisions on a PCE-efficient basis. Current literature does not address this problem and any research in this area would be welcome.

Measuring PCEs

Just as MRPDFs can be supported by scenario simulation techniques, so too can the calculation of PCE profiles. This is achieved by simulating market risk factors over time to determine PCEs over the life of instruments. From one simulation-generating source, market risk and PCE profiles can be measured.

By measuring PCE profiles, the portfolio effect is further enhanced by acknowledging that PCE-reducing trades do not have to be the same as the instrument positions in the relevant counterparty portfolio, provided there is a netting agreement in place. For example, the swap PCE of a counterparty could be reduced in another book using FRAs, forex forwards or long-term forex agreements with the same counterparty. This allows such a technique to support the reduction of PCE across a group of traders that trade different markets.

Furthermore, the measurement of PCE profiles can also be used in reverse. Just as a market risk decision can be dealt with to reduce PCE, PCE management can be the genesis of a market risk trade. When the organisation wants to reduce a particular PCE profile (eg, when high exposure concentrations are evident), a group of trades can be determined that reduce the PCE profile while maintaining current levels of market risk. This represents another optimisation problem that could be solved using a scenario-simulation approach.

Arguments against

Two key issues are raised when using single counterparty PCE profiles to pre-select potential counterparties for refining market risk decisions. The first raises the concern that the choice of counterparty could have negative consequences for credit risk diversification, beyond the value of reducing the PCE of a particular counterparty, given that impacts on portfolio diversification in this instance are not measured. The second issue questions why traders might wish to pursue such a PCE reduction strategy when the organisation cannot reflect the true reduction in risk by a reduction in the credit risk cost of capital.

Diversification relies upon the existence of credit exposures and the data issues that plague its measurement. The benefits of credit risk diversification are a function of the correlations across the various credit exposures in the portfolio and the size of those exposures. By reducing the size of PCE, the portfolio moves in a direction of being less dependent on the effects of diversification. That is, if a credit exposure ceases to exist, the requirement for credit risk diversification is reduced.

The pursuit of joint market and credit risk-related decisions is a natural response to the increase of market price efficiency

The measurement of diversification specifically, and credit risk more generally, is fraught with data issues, such as:

- Due to limited observable empirical data, the specification of realistic correlations and asset recovery rates is difficult, so data issues should be the focus of future research (Kao, 2000);
- The accuracy of the inputs into many credit risk measurement models cannot be checked (Jarrow and Turnbull, 2000);
- There is a lack of widely available and comprehensible data for default activity. Given the private nature of debt contracts, concealed price and default information, the advance of credit risk research has been limited (Carty, 2000);
- Regulators cite the lack of data as a principal reason that credit risk models have not been used in the way market risk models have in the determination of Basle Committee capital requirements. Germany's Bundesbank committee is said to be sceptical of statistical models, primarily because of a lack of data on corporate defaults and the difficulty of testing such models over the entire economic cycle (*The Economist*, 1999);
- The development of a credit risk system is problematic, given the lack of data, the

importance of extreme values and the relationship between interest rate and credit spread exposures (Munro, 1999); and

- The lack of quality data contributes to the limited application of using credit risk models (Parkinson and Ochs, 1998).

Given the low or negative correlation for which counterparties are excluded from the selection criteria, it is argued that any negative effects on portfolio diversification will be limited. Furthermore, given the paucity of data and the risks of mis-specifying the effects of diversification, it is questionable that the effects of diversification can be thoroughly understood to the level required to negate the value of PCE-efficient market risk decision techniques. As to why traders would want to follow a PCE reduction strategy, their motivation is likely to be a combination of how they are charged currently for the effects of using credit lines and the pressure that organisational credit authorities are applying to reduce certain credit exposure concentrations.

Organisations without complete credit risk measurement systems are likely to pass on the costs of using credit lines on a name-by-name

basis, with perhaps some haircut representing the expected credit portfolio effects. Given the predominant focus on charging credit risk capital on a name basis, the value of the technique increases for traders as the focus is on reducing particular counterparty exposures. In this way, if the PCE of a counterparty is reduced, the market risk factor impact analysis likely to be conducted by the credit authority will be reduced.

If a trader is up against key credit exposure concentrations, the relevant credit authority is also likely to have applied some pressure on the business, which itself is a motivation to reduce credit exposures. This example is particularly applicable in interbank exposures, which are generated as a result of supporting a customer franchise business. There are times in many organisations that traders have built up exposures to particular interbank names, given the attractive margins that those names offer for hedge transactions, or the fact that those names supply liquidity to certain markets.

Conclusion

A market risk framework is required to provide a vision and a strategy that endures the test of time and change. This demands a structure that

allows new developments to be absorbed into processes without impacting upon the structure of the framework or decision-making ability. A scenario-simulation capability is the basis of such a framework. The value and versatility of this framework is displayed when it is applied to combining the mindsets of market risk and PCE measurement and management.

The pursuit of joint market and credit risk-related decisions is a natural response to the increase of market price efficiency, as economies are continually influenced by international market forces and market volatility increases with the ease of capital transfers. The extensibility of such a framework across different types of risk is highly valued as the rules of business change. Not only is such a framework supported by regulators, but more importantly it has now become a business imperative. ■

Paul Smetanin is senior director of product marketing with Algorithmics in Toronto. Previously, he was global head of market risk with ANZ Bank in Melbourne

REFERENCES

- Aziz J and N Charupat, 1998**
Calculating credit exposure and credit loss: a case study
Algo Research Quarterly 1(1), September, pages 31-46
- Carty L, 2000**
Corporate credit risk dynamics
Financial Analysts Journal 56(4), pages 67-81.
- Duffee G, 1996**
On measuring credit risks of derivative instruments
Journal of Banking and Finance 20(5), pages 805-833
- Jarrow R and S Turnbull, 2000**
The Intersection of market and credit risk
Journal of Banking and Finance 24, pages 271-299
- Kao D, 2000**
Estimating and pricing credit risk: An overview
Financial Analysts Journal 56(4), July, pages 40-66
- Lula G, 1993**
Loan portfolio management - post-FDICIA
Journal of Commercial Lending 76(3), November, pages 15-21
- Markowitz H, 1952**
Portfolio selection
The Journal of Finance 7, pages 77-91
- Mausser H and D Rosen, 1999**
Applying scenario optimisation to portfolio credit risk
Algo Research Quarterly 2(2), June, pages 19-33
- Munro J, 1999**
Credit and fixed Income: Can we learn from equity management?
Global Investor 124, July/August, pages 34-38
- Parkinson K and J Ochs, 1998**
Using credit screening to measure risk
Business Credit, 100(3), March, pages 22-27
- Shimko D, 1998**
End user's guide: As if by magic
Risk 11(10) October, page 45
- The Economist, 1999**
How much capital should banks put against their loans?
The Economist, May