

**THE IMPLICATIONS FOR SECURITIES
REGULATORS OF THE INCREASED USE OF VALUE
AT RISK MODELS BY SECURITIES FIRMS.**

A report by the Technical Committee of IOSCO

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Executive Summary

The growth in derivatives trading activity in securities businesses has led securities firms to develop methods to analyse, control and report their trading risk in a consistent and reliable way. Firms have increasingly been turning to more sophisticated statistically based risk management methodologies using modern option and portfolio theory, and in particular to the use of risk modelling techniques, commonly referred to as value at risk modelling.

The increased use of these models, which seek to estimate with a specified degree of certainty the maximum loss which the firm would suffer in the face of possible adverse market movements, has led to calls for banking and securities regulators to recognise the output of these models for regulatory purposes. The Basle Committee on Banking Supervision (Basle Committee) has proposed the use of value at risk models for the purpose of calculating capital requirements for market risk, and the six major US derivatives dealers which make up the Derivatives Policy Group (DPG) in the USA are now providing value at risk information to the Securities and Exchange Commission (SEC) and the Commodity Futures Trading Commission (CFTC) as part of their arrangements for voluntary oversight. The output of value at risk models is also recognised within the framework of the European Union's Capital Adequacy Directive, which comes into force on 1 January 1996.

In the light of these developments, this paper outlines the issues for consideration by securities regulators when supervising firms which use such models, and considers in particular some of the implications of setting regulatory capital standards based on the output of internal models.

In **Section 2**, the paper explains how value at risk models are constructed. It explains the difference between the calculation of value at risk, which is based on the assumption that events in the future will be similar to those in the past, and the results of stress tests which assess the potential loss a firm may face in certain extreme cases. The paper points out the role which models should play as an integral part of a firm's risk management procedures, and emphasises the important link which exists between the effective use of value at risk models and a firm's internal organisation and management controls. It also identifies the importance for regulators of analysing the firm's trading results in comparison with its value at risk calculations as a measure of the effectiveness with which the model is being used.

Section 3 considers the implications for securities regulators of recognising the output of value at risk models for the purpose of calculating capital requirements for market risk. It notes the risk that firms could be incentivised to seek out models which are most effective in reducing their capital requirements rather than those which are most effective for the purpose of better risk management. It also notes the problem which regulators face in determining how big a cushion of capital firms should be required to hold, over and above that implied by the model, in order to cover unusually large adverse market events which are not captured by the modelling process. Other issues identified in this section include:

- ◆ the need for regulators to specify certain of the parameters for models which are to be used for the purpose of calculating regulatory capital;
- ◆ the implications for regulators of the fact that models provide more favourable results in larger portfolios; and
- ◆ the resourcing implications for regulators of the need to approve models.

In Section 4, the paper notes that the Basle Committee invited IOSCO to comment on its April 1995 proposals on capital for market risk. It welcomes the work of the Basle Committee on the use of value at risk models and proposes that there should be further joint work between IOSCO and Basle on model testing. It also proposes that further consideration be given to the development of standards of best practice to be adopted by firms which wish to use value at risk models for regulatory purposes. However, in the light of the considerations outlined in the paper, the much greater significance of market risk capital requirements for securities firms, the lack of data regarding the reliability of such models in practice and the need to await the results of current initiatives such as the DPG in the USA, the paper notes that the Technical Committee does not feel that it would be appropriate at the present time to set a timescale for a move to the use of models for setting market risk requirements for securities firms

1 Introduction

The recent growth in derivatives trading activity in securities businesses has meant that it has become more difficult for the senior management of these firms to measure, monitor and manage their trading risk through the use of traditional reporting and limits structures. This problem arises not only because of the size and scale of the trading operations concerned, but also because derivatives trading gives rise to additional risks which are not found in the traditional cash markets. In addition, firms which are active in the derivatives trading business have been coming under increasing pressure to provide to their counterparties and shareholders intelligible and meaningful information about their risk profiles and trading performance.¹

As a result, firms have increasingly been turning to more sophisticated statistically based risk management methodologies based on option and portfolio theory. These techniques have led to the development in some firms in recent years of risk management models, commonly known as value at risk models. These models, which aim to estimate the likely loss which the firm will suffer in the event of particular market movements, have been receiving increasing regulatory interest recently both as a mechanism for improved internal controls within authorised firms, and also as a basis for calculating the capital requirement for the market risk which a firm is assuming.

Value at risk measures have recently been proposed for regulatory purposes in some jurisdictions. The recent proposal from the Basle Committee on Banking Supervision, if approved, will allow banks to calculate their market risk requirement based on their internal value at risk models with effect from 1 January 1998. The European Union's Capital Adequacy Directive which comes into effect on 1 January 1996 recognises value at risk models for the purposes of calculating the capital requirements for foreign exchange, and a recent decision will now allow banks and securities firms within the EU which have operational value at risk models to use a 'benchmarking' approach when calculating the capital requirement for other elements of their market risk. In addition, the recent report of the

¹ This paper is concerned solely with the use of value at risk models for regulatory purposes, and does not address disclosure requirements.

DPG in the United States uses value at risk models as the basis for reporting to the SEC and CFTC on the activities of the affiliated swap vehicles of authorised broker dealers.

Consequently, value at risk models will play an increasingly important role within the securities industry, and some securities regulators will increasingly rely on the outputs of these models for regulatory purposes. This will have significant implications for both the management of the firms and for the regulators of those firms. The purpose of this paper is to identify the principal issues for consideration by securities regulators when supervising firms which use such models, and to outline some of the implications of setting regulatory capital standards based on the output of internal value at risk models.

2 Value at risk models in securities firms

2.1 What are value at risk models?

Securities firms which have been active in the derivatives markets have for a number of years used statistical models for the purpose of pricing options, valuing their option portfolios and managing their option risk. These models typically have been based on variants of certain standard option pricing formulae. The requirement for tools of this sort arises from the fact that option risk is non-linear with respect to the price of the underlying instrument. Depending on the strategy being employed, it is possible to suffer losses on an option portfolio under a whole range of different scenarios, including a scenario where the price of the underlying stock does not move at all. It is therefore essential for firms involved in this business to be able to identify and monitor their risk in an effective manner.

More recently, however, some firms have developed models which extend beyond their options activities, and incorporate the risks in the rest of their trading portfolio. These models which are referred to as 'whole portfolio' or 'value at risk' models integrate the properties of

confidence (normally 95% or 99%). In other words, if the future is like the past, the amount estimated by the model to be at risk would be lost once in every twenty days or once in every hundred depending on the confidence level chosen², and then only if the firm was unable to take any action to mitigate its loss.

In addition to estimation of the value at risk as predicted by the models, firms will often complement these results by conducting their own 'stress tests' on their portfolios. Stress tests apply particular worst case assumptions to the portfolio to assess the effect of certain severe adverse market movements on the institution. This might include, for example, a sudden sharp increase in interest rates or a sharp fall in the equity markets. Stress tests therefore override some of the estimated relationships in the model and aim to identify what particular market event or combination of events would most severely impact an institution's potential losses if they were to occur. The range of possible stress tests is extremely wide, but by establishing a standard set of such tests, institutions are able to give some indication of the events to which their trading portfolios would be particularly vulnerable.

It is important to note however that value at risk, even if it is based on a statistical model, is to a significant extent a judgmental concept. The models are based on observed statistical relationships which are of varying levels of reliability. They are also heavily dependent on the assumptions which the model builders make about the relationships between different financial instruments, the observation periods over which the relationships are estimated. In this sense, there is as yet no basis for defining any one 'correct' value at risk model. While it is important for regulators to understand the overall characteristics and properties of the model that a firm is using, it is also very important to understand how the firm uses the outputs of its particular model and stress testing as an aid to effective risk management. Properly used, value at risk models form an increasingly important part of firms' overall risk control environment. It is in this context that they assume a particular significance for securities regulators, who recognise that models are an important element of a good system of management controls. Consequently it will become increasingly important in the future for securities regulators to be conversant with the nature of these models and the issues associated with their use by regulated firms.

² These examples assume that the models are based on a one day holding period for the portfolio.

The relationship between models and management controls

In assessing the use of value at risk models by securities firms, the regulator needs to understand how the model fits into the overall operational and control structure of the firm. A model, however well constructed theoretically, cannot on its own provide assurance about a firm's ability to control its risks. In particular, it is important to note that value at risk models primarily address market risk, which is only one of the risk factors which a securities firm faces. Other factors include credit risk, operational risk, liquidity risk and legal risk, all of which need to be managed in an effective manner.

As with any other system, the outputs of a model are dependent on the quality of the data which goes in to the model. Consequently, a model will only be able to accurately reflect the risk in a firm's trading portfolio if it accurately captures all the positions and valuations within that portfolio. This means that careful attention needs to be paid to the way in which a firm approaches its operational controls. In particular, it is important for regulators to understand whether the model is integrated into the firm's trading system, so that the same data which is used by the traders is also used by the model, and by the accounting and management information systems or whether data is input separately into different systems. If, as is often the case, data is input separately into different systems, special attention needs to be paid to the quality of the reconciliation processes which exist to ensure that the data which is being used by the traders is consistent with the data which is used to run the models and to prepare reports to management on both the risk and the profitability of trading operations.

It is also important for the regulator to be reassured that the information which management is receiving about the performance of their trading activities is independently checked and verified. This should include an independent assessment of the valuation of particular positions, including where appropriate a reperformance of the valuation of particular large or complex trades by the risk management or financial control department, as well as an independent check on both the prices and the volatilities which are held in the system.

2.3 Structure of the Firm

In this context, the regulator will wish to pay particular attention to the way in which the firm is structured and its overall management approach towards risk control. In particular, the regulator will want to understand how the firm sets its risk limits, and how these limits fit into the model structure, how they are monitored on an ongoing basis, and what action is taken in the event of breaches of limits. The trading limits or other broad policy constraints should be set by the firm's governing body (board of directors or its equivalent) in terms which are readily comprehensible to members of the governing body, and the limits structure should be reviewed regularly by the governing body in the light of information about the risk profile of the firm and its actual trading performance. A copy of the limits structure should be readily available for review by the regulator as should copies of the reports on the risk profile and trading performance which are prepared for the governing body.

It is also necessary for the regulator to understand how risk is managed and controlled within the firm. The regulators should ensure that they are familiar with the senior management responsible for assuming trading risk, and that they understand the reporting lines within the trading businesses. This is of particular importance where firms assume and manage risk on a functional basis across a number of operating entities.

In addition, the regulator will wish to understand and be satisfied about the adequacy of the reporting structure for the risk control functions. Staff responsible for reporting and control, including risk control, accounting and settlement staff, should have a reporting line to senior management which is independent of the trading function. The reporting lines which ensure the integrity of these functions should be properly documented and endorsed by the governing body. In addition, the operating procedures which ensure that the functions discharge their responsibilities effectively should be properly documented. Regulators will wish to familiarise themselves with these processes and procedures as well as establishing contact with senior management responsible for the control functions in order to satisfy themselves of the commitment of the firm to a proper control environment. They will also need to be reassured that the staff concerned, particularly those involved in reporting and risk control functions, have the appropriate skills and authority to understand and challenge the decisions of the trading staff.

It is only when the regulator is satisfied that the firm has proper policies and procedures in place in relation to its internal controls that the regulator will be in a position to place reliance on the output of value at risk models for regulatory purposes.²

2.4 Integrity of the model environment

In assessing the models which are being used by securities firms, regulators will wish to establish the basis on which the firm has derived its model, and the environment within which the system is operating. Moreover, firms' models are not static, but are subject to continuous change in the light of further experience and research. Regulators will therefore wish to understand the basis on which the firm has selected a particular model and to obtain a measure of reassurance about its properties. One approach which has been adopted by the Basle Committee is to construct a sample portfolio, and to test models against the sample portfolio. This allows the regulators to assess the range of results produced by different models and to identify those models which produce results which fall outside a predetermined range. This approach could also be adopted from time to time with firms which were already using approved models to monitor the effect changes in model parameters since the initial approval took place.

In addition, the regulator will wish to be assured as to the integrity of the operating environment within which the model is run. This includes ensuring that procedures are in place to control access to the system, both in the development and the production environment, so that no unauthorised changes can be made to key model parameters which could affect the output of the model. In addition, there should be an independent review of any new pricing algorithms which are added to the model. The firm should also undertake regular backtesting of their models to establish how well the model predicted actual events, particularly following any significant market movement, and to ensure that the experience is properly factored into the model for the future.

Regulators will also wish to be satisfied that the assumptions underlying the model are realistic and err on the side of caution. Particular consideration needs to be given to the practice of 'marking to model' or 'marking to theoretical value' in the context of derivative positions. This is particularly relevant if a dealer has significant positions in instruments where the market for the derivative or the underlying instrument lacks liquidity or transparency. In such cases there should be procedures in place to determine the price at which a position could actually be liquidated in the market by reference to quotations received from other dealers. These may at times differ significantly from the theoretical value produced by the firm's own model. Similarly attention needs to be paid to the institutional factors in relation to particular instruments, such as restrictions on the holding of stocks by particular classes of investor or foreign exchange controls which may vitiate the assumption of immediate tradability in the security on which most models are based.

The regulator will also wish to ensure that the risk management processes and procedures are subject to periodic review by both internal and external auditors who are fully conversant with the risk management processes and that any recommendations arising from these audits are acted on promptly. Firm's should also have documented and tested disaster recovery procedures which will allow them to recover key data and manage their trading risk in a timely manner in the event of significant business disruption.

2.5 Assessing the effectiveness of models

Where a firm is using a model as an integral part of its risk management process, the regulator will wish to understand how the output of the model influences the firm's decision making process. In particular, the regulator may wish to discuss with the firm the way in which daily management reports are prepared, and how non model based judgmental factors are incorporated into the risk control process. The regulator will also wish to know whether the risk management function has the authority to instruct traders to reduce their overall level of risk, and if not where such authority lies in the firm. Moreover in assessing the effectiveness of a firm's use of an internal model, particular attention should be paid to a comparison of

observed daily trading results⁴ against the model output. The firm's trading results should fall within the bounds of the value at risk predictions almost all the time. Significant variations, whether positive or negative, would suggest that the regulator should question further the effectiveness of the firm's model as a risk control technique.

3 Using value at risk as a basis for setting capital standards.

Value at risk models have been developed by securities firms as an aid to improved internal risk management. Furthermore, only a very few firms yet have the ability to measure their risk on a consistent basis across their whole trading portfolio using these models. However as the techniques involved in these models become better developed there will be increasing demands on the securities regulators to recognise the output of these models for the purposes of calculating capital requirements for market risk. This development carries significant implications, which require careful consideration.

3.1 Changing the rationale for using models

There is an inevitable risk that, in moving to recognise models for capital calculations, the rationale for using models within firms will change. At present, those firms that have developed value at risk models have done so of their own volition for the purpose of managing their market risk. It is therefore argued by some firms that, in recognition of their superior risk management capabilities, these firms should benefit from a more favourable models based regime for capital calculation. Moreover, it is argued that other firms will be encouraged to develop similar risk management practices by setting more favourable regulatory capital standards based on models. However, if the primary incentive to use models is no longer the internal objective of better risk management, but becomes instead the prospect of lower capital requirements, regulated firms could be incentivised to use models in an inappropriate manner. Regulators could then come under pressure to approve the use of models with the

primary objective of enabling firms to operate with a lower capital requirement. There could also be an incentive for firms to seek out models which delivered a lower capital requirement rather than improved risk management. This underlines the burden of responsibility which a move to a models based capital requirement will place on the regulators to be satisfied that firms are indeed using models for the primary objective of good internal risk management and only secondarily in order to benefit from a more favourable capital standard.

3.2 The purpose of regulatory capital

A further consideration is the difference between the circumstances which models address and those which concern regulators. Value at risk is a statistical measure based on historical observations of the likelihood of a firm's profit or loss falling outside a predetermined range. It therefore addresses what is likely to happen in normal circumstances. It does not seek to measure what might happen in face of an unusual event or when the unexpected happens. Yet it is precisely these very occasional but significant events (sometimes termed outliers) which regulators are most concerned about, and where capital is most required to protect the firm and the wider financial system. Consequently there will always have to be a cushion of capital for regulatory purposes over and above that implied by the model, but the amount of that cushion will be the subject of regulatory judgement. The Basle Committee has decided to establish a cushion of this type by requiring a multiplication factor of 3 to be applied to the value at risk calculation. As yet there is not enough regulatory experience of value at risk models to form a clear view on whether this approach will provide a sufficient cushion to deal with large adverse market movements, or whether an alternative approach, perhaps based on stress testing, would prove more appropriate.

3.3 Internal models or a regulatory model?

The case for recognising firms own value at risk models for the purpose of capital calculation is based on two main justifications. First, since there is no definitive model of market risk, it is argued that it is preferable to have a range of estimates rather than for the regulators to attempt to prescribe one model which firms should use. Secondly it is argued that firms which already have well developed value at risk models should not be required to undertake separate calculations of regulatory capital requirements.

However, for a number of reasons regulators will find that they will have to become involved in specifying a number of the key parameters which should apply to the models which firms will be allowed to use for the purposes of calculating regulatory capital.

At present different firms use a range of different techniques and assumptions in calculating value at risk for their own risk management purposes. Variables which may differ between firms include:

- ◆ the observation period over which model relationships are calculated
- ◆ the confidence level which is applied
- ◆ the minimum holding period which is assumed for the portfolio
- ◆ the acceptability of correlations within product types - e.g. between different equities and different equity markets
- ◆ the acceptability of correlations between product types - e.g. between interest rates and equity markets

In the absence of agreed conventions about these factors it is possible for different firms' models to produce significantly different value at risk numbers for the same portfolio. Clearly this would not be acceptable in the context of regulatory capital where a significant measure of equality of treatment is required as between different regulated firms. Consequently it is necessary for the regulators to require a reasonable measure of commonality between the models which firms use for calculating regulatory capital, and to have a clear view about the acceptable degree of dispersion between the results of different firms' models. Indeed, much of the work which the Basle Committee has undertaken recently has been associated with specifying certain of the key parameters such as the confidence level, the observation period, the holding period and the acceptable cross correlations with which they propose banks' models must comply in order to be recognised for the purposes of capital calculation.

It is therefore unavoidable that a move towards the recognition of value at risk will require regulators to set standards for the acceptable parameters. This will mean that firms may still

3.4 The problem of cross entity risk management

One of the main benefits from the use of value at risk models by securities firms is that it enables them to manage their risk on a portfolio basis across a number of different books and legal entities. Thus firms may, for example, aggregate all their European interest rate risk into a single portfolio with offsetting hedges recognised between different markets and different legal entities within their group. Moreover, since the use of models produces non-aggregative results (i.e. the value at risk in one larger portfolio will always be less than that in two smaller portfolios of similar instruments) regulators will need to consider how to respond to the request by firms to be able to benefit from such portfolio effects within any particular jurisdiction. In addition, this will create an incentive for regulated firms to minimise their regulatory capital requirements by moving their trading activities into regulated entities with larger portfolios where the benefits of the value at risk approach will be greatest. Nevertheless, regulators will need to recognise that each legal entity may be subject to differing regulatory and bankruptcy requirements, which must be accounted for in a regulatory capital regime.

Further consideration will need to be given to this factor, particularly in the context of group supervision.

3.5 Regulatory techniques and regulatory resourcing

The move towards using value at risk models for regulatory purposes will place significant additional pressures on securities regulators. In certain countries which have a tradition of relying extensively on external auditors, the regulatory commission may itself have to assume direct responsibility for oversight of the standards which will have to apply to firms using models, and to the models themselves. To the extent that regulators do not currently have expertise in this area it will have to be developed. Regulators will therefore need to give careful consideration to the implications for their recruitment and remuneration policies of the need to employ staff for this task before deciding to endorse a move in this direction. Some jurisdictions may wish to consider alternative techniques such as the employment of a specialised consulting firm or the development of a standard of best practice with their audit firms in order to perform the requisite independent model and control testing programme.

4 Further action on models

The market risk proposals issued by the Basle Committee in April 1995 expressly invited comment from IOSCO. The Technical Committee welcomes the Basle Committee's invitation to comment on the use of value at risk models for the purposes of calculating capital for market risk. The Committee also recognises the growing importance of value at risk models in the securities industry, and wishes to explore further the possibility of considering the use of such models for the purposes of calculating regulatory capital requirements. However, in light of the considerations outlined in this paper, the much greater significance of market risk capital requirements for securities firms, the lack of data regarding the reliability of such models in practice, and the need to await the results of current initiatives such as the DPG in the US, the Committee does not feel that it is appropriate at this stage for securities regulators to set a timescale for such a development.

The Committee believes that it would be highly desirable that those regulators who have experience of models both in the banking and securities regulatory field should work together on model testing and analysis in order to obtain a better understanding of the issues associated with this development. In particular further consideration should be given to the development of standards of best practice to be adopted by firms which wish to use models for regulatory purposes. The Committee therefore looks forward to the opportunity for the appropriate working parties of IOSCO and the Basle Committee to work jointly in this important area of common interest.