

Communication of Quantitative Information on Market Risk: An Experimental Investigation into the Effectiveness of Alternative Methods of Disclosure

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Abstract

This is an experimental study designed to test the claim that graphical presentation of quantitative information on market risk is superior to tabular display. Significant differences are found between the estimates of subjects presented with graphical information and those where the information is presented in a tabular form. Differences are also found in the perceived level of confidence about the estimates and the perceived level of difficulty of the task.

1. Introduction

The increase in the derivatives activities of financial firms has led to concern that these activities may lead to an increase in systemic risk. One approach that has been suggested to contain this threat is through greater transparency, achieved in particular through disclosures in the annual reports of financial firms that issue or hold derivative instruments. The Financial Accounting Standards Board (FASB) (1994), the Securities and Exchange Commission (SEC) (1997), the International Accounting Standards Committee (IASC) (1995) and Basle Committee on Banking Supervision (Basle Committee) (1994) have responded to the perceived need for greater transparency by requiring financial firms to disclose information about their derivatives activities.

Financial regulators are concerned in particular with the market risk associated with derivatives activities. Market risk is the risk of a fall in the value of derivative instruments held by financial firms due to adverse changes in interest rates, exchange rates and prices. Improved transparency in this area is regarded as especially important. Consequently, financial firms are being encouraged or required to disclose information on the market risk of their derivatives portfolios in their annual reports. There is a consensus that such disclosures should be based on firms' internal risk measures. Measures developed within financial firms for internal risk management purposes, such as Value-at-Risk (VaR), are therefore being used as the basis for the disclosure of quantitative information on market risk in the annual reports.

There has been concern about the way in which quantitative information on market risk is presented in the annual reports of financial firms as well as about what information should be presented. The

Basle Committee (1994) recommends that financial firms use graphics in the disclosure of quantitative information on market risk. Beckstrom and McDonald (1993) suggest that information graphic presentation of market risk enables market participants to analyse risk more effectively and Goodman *et al.* (1996) propose that graphic presentation facilitates the assessment of market risk. The superiority of the use of graphics over other forms of presentation in disclosing quantitative information on market risk, however, remains untested.

Although there have not been studies to assess the effectiveness of graphic as compared with an alternative methods of presenting quantitative information on market risk, there are a number of studies on the effectiveness of graphical presentation of other accounting and financial information (Amer, 1991; Blocher *et al.* 1986; Carey and White, 1991; DeSanctis and Jarvenpaa, 1989; Dickson *et al.* 1986; Hard and Vanecek, 1991; Harvey and Bolger, 1996 and Sullivan, 1988). These studies have focused on the relationship between different ways of presenting information and decision making. Results from the studies are, however, mixed. In particular the results are found to be contingent upon the experimental task. While these studies provide a useful context within which to investigate the effectiveness of graphical modes of presentation, in themselves they cannot be called upon to justify the use of graphics in the presentation of quantitative information on market risk.

The experimental study is designed to test the claim that graphical presentation of quantitative information on market risk is superior to tabular display. Experimental subjects are divided into two groups. Each group of subjects is presented with an extract from the annual report of a hypothetical financial firms disclosing information on market risk. One group receives an extract where the quantitative information on market risk is presented in a graphical form; the other group is presented with an otherwise identical extract but with the quantitative information on market risk is in a tabular form. Subjects are then asked to estimate the level of market risk for the period immediately after the end of the financial year from which the extract is taken. Specifically, subjects are required to indicate the range in which market risk is likely to be for the following period and to estimate the probability distribution of the value of market risk within this range. In addition, Likert

scales are used to elicit subjects' perceived level of confidence in their prediction and perceived difficulty of the task. Significant differences are found between the estimates of subjects presented with graphical information and those where the information is presented in a tabular form. Differences are also found in the perceived level of confidence about the estimates and the perceived level of difficulty of the task.

The remainder of this paper is divided into four sections. The relationship between graphics and decision making is explored in section 2. This is followed by consideration of the research design in section 3. The results of the study are presented in section 4, and discussed in the final section.

2. Graphics and Decision Making

The chapter tests the claimed superiority of graphic over tabular presentation of quantitative information on market risk. Graphic presentation, it is argued, enables market participants to analyse information more effectively and provides for superior decision making. These claims can be examined by looking at the decision making processes and the opinions of market participants.

Decision making in a world of uncertainty requires an individual to form expectations about future states of that world. Such expectations are necessarily based upon an individual's model of the world and upon information. It is claimed that graphical and tabular methods of presenting information results in different decisions then implicit in this claim is the view that expectations about future states of the world formed from these alternative methods are different. One way to test the effect of different methods of presentation on decision making is to look at the expectations individuals form about the future state of the world. This approach is adopted in the literature by requiring subjects to make predictions, given past information about a variable, about the future value of that variable. In a world of uncertainty, however, individuals are more likely to have in mind a range of future states of the world with probabilities attached to each of the possible states. It is therefore necessary to identify the effects of different modes of presentation on the subjective probability distributions individuals form of the future expected values of the variable. In the case of this study, the variable being examined is the expected future value of the market risk of a financial firm's portfolio of derivative instruments.

The proposition that the method of presentation of quantitative information on market risk affects decision making implies:

- (1) Individuals receiving information in a graphical form different expectations of the mean level of future market risk than individuals receiving information in a tabular form.

- (2) Individuals receiving information in a graphical form different subjective probability distributions of future market risk than individuals receiving information in a tabular form.

Further, if graphical is superior to tabular presentation, individuals receiving information in a graphical form should be more similar in the expectations they form than individuals receiving the information in a tabular form.

The method of presenting quantitative information on market risk is therefore predicted to be associated with the characteristics of the judgements individuals make about future values of market risk. Individuals' experience of the prediction task itself may also be expected to differ between alternative modes of presentation. If graphical presentation is superior to tabular display then individuals receiving information in a graphical form are expected to find the task of prediction more comprehensible and easier than someone presented with information in a tabular form. They are also expected to be more confident in the predictions they are making.

3. Research Design

An experimental design is used in which subjects are randomly assigned to one of two groups; one group receiving an extract from the annual report of a financial firm in which quantitative information on market risk is presented in a graphical form; the other group receiving otherwise identical information but with the quantitative information being presented in tabular form. A technique, the *method of relative heights*, is used to elicit subjects' subjective probability distributions of the value of market risk in the period immediately after the end of the financial year of the financial firm for which information is provided. Likert scales are used to elicit subjects' perceptions of the experimental task.

Subjects

The subjects for the study are forty-one postgraduate students taking courses either in international banking and financial studies, or in international financial markets. The justification for using students, as opposed to market professionals, in studies of this type has been considered elsewhere. Dickson *et al.* (1986) suggest students are appropriate for exploratory, *theory building* studies. Ashton and Kramer (1980) report similarities between the decisions and underlying information-processing behaviour of students and primary decision makers. Biehal and Chakravart (1982) support the use of students on the basis of cost considerations. Amer (1991) notes that what is being studied is the relationship between task, information display and decision making performance rather than the behaviour of decision makers in practice.

At the time of the study the subjects had undertaken at least a foundation course in financial reporting and

had a general background in finance and banking. Their average age is twenty five years and approximately seventy five per cent are male. The subjects are divided into two groups on a random basis: one group receiving an extracts with graphical presentation of quantitative information on market risk; the other group receiving an otherwise identical extract with the exception that the quantitative information is presented in tabular form. There are no significant difference between the groups in terms of age and gender.

Experimental Task

Subjects are required to predict the level of market risk in the quarter immediately following the end of the reporting period for the financial firm using information contained in an extract from the annual report of a financial firm. The extract used is based on one contained in the 1995 annual report of a large multinational financial firms which used a graphic display of its market risk measures. The measure of market risk used, *Daily Earnings at Risk* (DEaR) is a variation on the VaR measures commonly used by financial firms. For the study, the extract is modified to disguise the name of the firm and two versions created: one with the original graphic presentation, the other in which key components of the graphical displays are presented in tabular form. There is a loss of information in transforming the data from graphic to tabular presentation. In particular, there is a greater frequency of data in the graphical presentation as, in order to avoid presenting subjects with too much data which may hinder effective processing, a longer time interval is used in the tabular presentation. The tabular presentation does, however reflect the type of information contained in the annual reports of financial firms using this method of presentation.

Previous studies comparing the effectiveness of alternative methods of presenting accounting, financial or economic information have required subjects to identify a single value for the expected future value of the variable being studied. The models used to generate measures of market risk assume the factors determining its value level follow stochastic processes. It is therefore more realistic to think in terms of a distribution of possible future values of market risk rather than a single value. This study therefore using a technique to elicit subjects' subjective probability distributions of the value of market risk. Independent of these considerations, Goodwin and Wright (1991) suggest that asking subjects to indicate a single value may lead to unreliable responses, possibly because they are uncomfortable with the task and are tempted to give a response without sufficient thought. Goodwin and Wright indicate that subjective probability techniques may be more effective.

Subjective probability techniques have been used in accounting by Chesley (1975) and in financial decision making processes by Bartos (1969), Bolger and Harvey (1995), Harvey (1988), Kabus (1972), Stael von Holstein (1972), Wallsten and Budescu (1983) and Yates *et al.* (1991). The techniques have not, however, been used to examine difference in prediction performance with alternative methods of presentation.

Goodwin and Wright (1992) and Whitcomb *et al.* (1995) identify a number of methods that may be used to elicit estimates of subjective probability. These include direct assessment, use of a probability wheel, the probability method (numerical probability), graph drawing, event trees, fault trees and log-odds scale. The procedure chosen for the present study, the method of relative heights, is designed to elicit a probability density function.

Following Goodwin and Wright, subjects are provided with a diagram with the measure of market risk (DEaR) on the horizontal axis and a likelihood measure, with a range of zero to ten, on the vertical axis. Subjects are required to place themselves in the position of a banking analyst employed by an investment bank are asked to indicate the range in which the average DEaR for the first quarter of 1996 may fall. Having identified the range, they are required to divide it into five equal intervals which are to be recorded on the horizontal axis. Subjects are then required to indicate in which interval the average DEaR for the first quarter of 1996 is *most likely* to fall and to assign a value of ten on the vertical axis to that interval. For each of the other intervals, subjects are required to estimate how likely it is that DEaR will be in that interval as compared with the interval they have identified as *most likely*.

In addition to obtaining subjective probabilities from subjects using the *method of relative height*, subjects are required to provide additional information about themselves (age and gender) and about the task. The information about the task, which is measured on a five-point Likert scale, relates to the level of confidence with which the prediction is made, the difficulty of the task and the comprehensibility of the information provided on market risk.

The experimental was conducted in a class room setting. Extracts from the accounts together with the questionnaire was distributed to subjects who were told to read through the information. An oral explanation of the task was provided and the author was available to deal with any difficulties raised by subjects. It was made clear that subjects did not have to participate in the study and that anonymity would be maintained. There were no refusals. The subjects were given about 30 minutes to complete the questionnaire.

4. Results

The results can be conveniently be divided into two sections. The results from the use of the *method of relative heights* are presented first; followed by the results of the Likert scales.

Estimates of Market Risk

Three measures are divided from the method of relative heights:

- The subjective probability assigned to the most likely value for the average DEaR for the first quarter of 1996. Subjects indicate the likelihood of DEaR falling in each interval, other than the one indicated as being *most likely*, by marking its height relative to the most likely value. The subjective probability of DEaR falling in each interval is then determined as the number of units assigned to that interval divided by the total number of units assigned to all interval. This is illustrated below:

Interval	Height (Units)	Probability
10-14	1	1/19=0.05
15-19	2	2/19=0.11
20-24	10	10/19=0.53
25-29	5	5/19=0.26
30-34	1	1/19=0.05
Total	19	1.00

- The mean value of the average DEaR predicted for the first quarter of 1996. This measure is the sum of the mid-point of each of the five intervals multiplied by the probability assigned to that interval.
- The size of each interval.

These measures are calculated for each subject. The results are shown in Table 1 (below)

Table 1: Comparison of Groups in their Estimates of Market Risk (Mann-Whitney Test)

	Graphics (Mean)	Tabular (Mean)	Z-statistic	Significance
Probability of most likely range	0.463	0.416	-2.05	p<0.05
Predicted DEaR	21.76	23.83	-2.35	p<0.05

The results indicate significant differences between the two groups of subjects in terms of the subjective probability assigned to the most likely interval and the mean expected value of average DEaR. Specifically, subjects receiving an extract from the annual report containing a graphical presentation of quantitative information assigned a higher probability to the most likely value and the expected average DEaR to be closer to the value

for the last quarter before the end of the accounting period than did subjects receiving the information in tabular form. There is no significant difference in the size of the range chosen by the two groups (Mann-Whitney U-test; Z=-1.58 with 39 df, ns).

The variance of predictions of the future level of market risk should be smaller in the group receiving the graphical presentation than in the group where quantitative information is presented in a tabular form. The *squared rank test* for differences in the variance of two groups (Conover, 1980; Sprent, 1989) is used to test this hypothesis. The results indicate that the variance in predicted DEaR is smaller in the group receiving the graphical display (Z=2.10 with 39 df; p<0.05).

Perception Of The Task

A Mann-Whitney U test is used to compare differences between the two groups in their perceptions of the experimental task. The results of the analysis are shown in Table 2 (below):

Table 2: Comparison of Groups in their Perception of the Task (Mann-Whitney Test)

	Z-statistic	Significance
Confidence in predictions.	-2.344	p<0.05
Perceived easiness of the task.	-2.460	p<0.05
Perceived comprehensibility of the task.	-2.612	p<0.01

Subjects who received and extract from the annual report containing a graphical presentation are significantly different from subjects who received the information in tabular form in that they:

1. Had greater confidence in their predictions.
2. Perceived the task as being less difficult.
3. Perceived the information as being more comprehensible.

Confidence in Prediction and Estimates of Market Risk

The level of confidence that subjects have in their predictions of future levels of market risk may be expected to be related to the qualities of the predictions themselves. In particular, it may be expected to be correlated with: (a) the size of the range within which future level of market risk may fall; and (b) the probability assigned to the most likely interval. The correlations between the variable are shown in Table 3 (below):

Table 3: Confidence in Prediction and Judgement Performance
(Pearson Correlation Coefficients)

	Confidence in predictions.	Possible range	Probability of most likely interval
Confidence in predictions.	1.00	-0.38*	0.37*
Possible range	-	1.00	-0.31*
Probability of most likely interval	-	-	1.00

*Significant at $p < 0.05$

The results indicate that subjects who are more confident in their predictions are likely to attach a higher probability to the future value of market risk that they identify as *most likely*, and are likely to expect the possible future values of market risk falling within a smaller range. These findings agree with Teigen (1994) and Yaniv and Foster (1995) who report a close relationship between a subject's judgement interval and confidence level or degree of belief.

5. Concluding Remarks

The importance of disclosure by financial firms of the market risk of their derivatives portfolios has been highlighted in a number of reports. It is not only important to identify what information should be disclosed, it is also necessary to consider how best to present that information. There is a view that quantitative information on market risk should be presented in a graphical form. However, until this study there is no empirical evidence to support the proposition.

The evidence from this study is that subjects predictions about a financial firm's future level of market risk is partly dependent upon the method used to present quantitative information on past levels of market risk. Because of the nature of market risk it is not possible to indicate which group of subjects make the *best* predictions. Subjects presented with information in a graphical form tend to market predictions closer to the most recent level of market risk, and these subjects attached a higher level of probability to market risk being at this level. There is less variance in the predictions of subjects within the group receiving graphical presentation of quantitative information in their predictions of future market risk than with subjects in the other group. This result would support the proposition that graphical presentation results in more consistent predictions than does

tabular presentation. The results of the attitudes of respondents to the different modes of presentation would indicate superiority of graphics. Subjects receiving graphical presentation of market risk information are more confident in their predictions, find the task easier and find the information more comprehensible (Table 4 below).

Table 4: Comparison Of Groups In Their Perception Of The Task
(Means)

	Graphical Group	Tabular Group
Confidence in predictions.	3.33	2.3
Perceived easiness of the task.	3.04	2.5
Perceived comprehensibility of the task.	3.57	2.65

Financial markets are seen as functioning most effectively when participant have sufficient information about risk and returns to enable them to make informed investment and trading decisions. In episodes of market stress, lack of transparency is seen to an increase in the probability of firms failing. In turn this leads to reduced liquidity and to funding problems. This pattern is seen to be at least partly corrected by increased disclosure in annual reports. It is also suggested that if market participant are provided with meaningful information, they can impose market discipline on firms so that they manage their affairs in a prudent manner. If the results of this study can be extended to the decision making of market participants, it is not only what information that is disclosed it is also the way it is disclosed that is important.

The results of this study are subject to certain limitations. One limitation is that the research methodology may be considered to be too straight forward and simplistic. Future research may involve a series of experiments with the purpose of finding out whether the effectiveness of graphical displays varies as a function of the decision task environment in which the user is operating.

This study uses postgraduate finance students as surrogates for professional banking analysts. Although most previous research studies employ students, there is some concern about the appropriateness or "investor like" quality of this group, especially in the area of market risk and derivatives. Thus, future research should consider the use real banking analysts. Their experience and knowledge may have some influence on the results. To generalise from the conclusions, the experiment must be repeated on larger audiences.

In Fisher's Report, published by Basle Committee (1994), several different types of graphics are

recommended for market risk disclosures, i.e., histogram, line chart, scatterplot graph, etc.. Therefore, studies are needed to examine the most effective and efficient format to employ. Would our results have been different if we had used the bar type of graph, for example? In addition, researchers may also look into the impact of other graphic features on the understandability of information, i.e., colour, design, size, labelling, etc. The issue of the effects of display type on accuracy of prediction has some importance in this.

Future research may also look into whether subjects finishing first have better results than subjects finishing last, or how does prior education of the subjects affect the results. The dependant variables used and the results of the present experiment may provide some directions to future research.

6. References

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