THE EFFECTIVENESS OF GRAPHICS IN DISCLOSING QUANTITATIVE INFORMATION ON MARKET RISK: AN EXPERIMENTAL INVESTIGATION

Peter Casson*
Sofri Yahya**

ABSTRACT

The effectiveness of graphics in disclosing quantitative information on market risk is examined using an experimental study. Two groups of postgraduate students are presented with an extract of a firm's annual report containing information on market risk. One group of subjects are presented with purely narrative disclosure, the other with a narrative disclosure supplemented with a graphical display.

The results from the experiment demonstrate the superiority of graphical supplemented market risk disclosure format over purely narrative on four factors; predictive accuracy, confidence level of the prediction, task easiness and report comprehensibility.

INTRODUCTION

Bank regulators, accounting standards setters and researchers have recommended that financial firms involved in derivatives activities should improve the transparency of their market risk[1] exposure through public disclosures.[2] The disclosure of more meaningful and useful information is thought necessary to enable market participants to interpret the past performance of a bank in managing risk exposures, to predict its future market risk profiles and to estimate the effect on the bank's cash flows and earnings.

Graphical presentation of quantitative information on market risk is an effective format to convey this type of information. The Basle Committee (1994) recognises that graphs are effective modes of

---

* *Peter Casson is with the Accounting and Finance Division, School of Management, University of Southampton.*
***Sofri Yahya is with the School of Management, Universiti Sains Malaysia.*
[1] *The market risk arises from changes in interest rates, exchange rates and prices of underlying instruments (for example bonds, equities, precious metals) and their derivatives (futures, swaps, options and FRAs) (USGAO 1994). Lately, many have shown their concern with market risk and wanted to be well informed about how the financial institutions manage and control this type of risk (USGAO, 1994 and Young 1996). This is because some of the world's largest financial entities have lost billions of dollars mostly due to this type of risk (Jorion, 1997).*
[2] *For example, Basle Committee (1994), Boudoukh et. al (1995), Bullen and Porterfield (1992), Group of Thirty (1993, 1994), Reed (1995), USGAO (1994), etc.*

presentation and recommends financial institutions to use this technique to improve the disclosure of market risk exposures. This is supported by Goodman et al. (1996) who report that graphical displays facilitate the measurement, analysis and management of market risk. Beckstrom and McDonald (1993) acknowledge that precise graphical representation of risk profiles enables market participants to analyse risk more effectively.

The assumed superiority of graphical disclosure of quantitative information on market risk, however, remains untested by any form of systematic study. This study explores this claim by using an experimental design to investigate the effects of graphic presentation on decision making. Experimental methodology has been used in previous studies to investigate the effects of graphical disclosure of accounting and financial information on decision making (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 Sulivan, 1988). However, not only are the results from the experiments mixed, being contigent upon the task, but above all the studies compare graphics with tabular format (table-versus-graphs controversy). The findings of these studies cannot therefore be assumed to apply to the problem of quantitative information communication in general nor to that of this market risk in particular.

The aim of this study is to determine whether there is a performance advantage when financial firms include graphical displays to disclose market risk profiles in their annual reports. In addition, the study explores the underlying cognitive processes associated with inclusion of graphical, as opposed to purely narrative disclosure. The experiment compares the two formats for their effects on decision quality (predictive accuracy) and perceptions (confidence level, task easiness and report comprehensibility) of users. The choice of these dependents is influenced by DeSanctis (1984), DeSanctis and Jarvenpaa (1989), Dickson et al. (1986), Holstedt (1972) and Sulivan (1988).

The remainder of the paper is divided into three sections. The research methodology is considered in section two and the results described in section three. Finally, the results are discussed in section four.

RESEARCH METHODOLOGY

Two identified formats of presentation of quantitative information on the market are compared: (1) a textual narrative with some quantitative information on the Value-at-Risk and (2) narrative with some

quantitative information on the Value-at-Risk and supplemented with graphic displays of market risk profiles. These formats are chosen on the basis of a survey of the formats by eighty financial firms in communicating quantitative information on market risk.

Subjects

Sixty MBA students from two universities in Malaysia are used as the subjects of this experiment. Students are required by these universities to be proficient in English as the lectures are conducted in the English language. The students have an average of 2.6 years of work experience and, at the time of the experiment, had taken courses in accounting and finance. The average age of the students is 29 and approximately seventy per cent of the sample are male. There is general consensus that students are appropriate for this type of research. Dickson et al. (1986) suggest that it is appropriate to use student subjects for this kind of exploratory, "theory building". Ashton and Kramer (1980) report that the decisions and underlying information-processing behaviour of students and primary decision makers are very similar. Biehal and Chakravarti, (1982) also support the use of students on the basis of cost considerations. In addition, it is possible to obtain large numbers of student subjects. Finally, it is important to note that this kind of study is not concerned with the performance of decision makers in professional context, but with the interrelationships between task, information display, and decision making performance (Amer, 1991).

Procedure

Subjects are presented with a short case, based on annual reports of two banks, which describe the market risk profiles and how the risk is managed. In the experimental task, subjects are asked to play the role of banking analysts. They are asked to read the extract, and make a prediction on market risk for the next year. The subjects are also asked to give opinions on the confidence level, task easiness and report comprehensibility on 5-point Likert scales, and answer several general questions. The experiment was conducted in a classroom at scheduled meeting times. Except for the extract, the instructions and the questions are the same for the every subject.

Subject are randomly assigned to one or other of the experimental groups. One group receives a pure narrative disclosure, the other a narrative disclosure supplemented with graphics (See Appendices).

The data are transferred to SPSS for statistical analysis. Following Coll and Coll (1993), with regard to matching the level of measurement of the data to the appropriate statistical test, independent t-test and Mann-Whitney are used to examine differences between the two groups.

RESULTS ANALYSIS

Predictive accuracy

Following Brandon and Jarett (1977, 1979), DeSanctis and Jarvenpaa (1989) and Pratt (1982), the percentage forecast error was used as a measure of the subject's predictive accuracy. This is determined as follows:

$$\text{Percentage Forecast Error} = \frac{(\text{Forecast of Market Risk-Accurate Market Risk})}{\text{Accurate Market Risk}} \times 100$$

The mean percentage forecast error for graphical and purely narratives are 14.7 and 29.8 respectively (lower scores indicate better performance) The difference between the predictive accuracy error for the two groups is significant at p<0.001 (t=9.48 with 58 d.f.) and predictive accuracy is superior for the graphics group compared to the narrative only group.

Effect of graphics on confidence in forecasting

The confidence in forecasting scores, as measured on a five-point Likert scale, is compared between the two groups. Using a Mann-Whitney test the results show that the Z-statistics (5.3428) is significant at p<0.001[3]. Subjects using market risk narrative which includes graphics tend to have higher confidence in their prediction.

Graphics display effects on task easiness

The perceived difficulty in performing the prediction task, as measured using a five point Likert scale, is compared between the groups. Using the Mann-Whitney test, the results show that the Z-statistics (4.4481) is significant at p<0.001[4]. Subjects using the market risk narrative with graphics find the prediction task easier than the other group.

Graphics display effects on report comprehensibility

The perceived comprehensibility of the report extract, as measured using a five point Likert scale is compared between the groups at (Z-statistics = 5.0011, p<0.001)[5]. The group using the extract which includes graphics expressed greater comprehensibility than the other group.

---

[3] *The independent t-test was applied to examine the difference, and the confidence level scores were significantly different for the two groups, at (t=7.22 with 58 d.f.), p<0.001.*
[4]*Independent t-test shows the task easiness is significantly different for the two groups at (t=5.41, with 58 d.f.), p<0.001.*
[5]*Independent t-test also show the comprehensibility of the two groups are significantly different, t(58)=6.45, at p<0.001*

SUMMARY AND DISCUSSION

The purpose of this study is to examine alternative methods of presenting information on market risk. The results from the experiment demonstrate the superiority of graphical market risk disclosure format over purely narrative on four factors, predictive accuracy, confidence level of the prediction, task easiness and report comprehensibility. These results point to the value of graphics presentation on market risk disclosures.

The results of this study are subject to certain limitations, one of which is that the research methodology is straight forward and simplistic. Future research may look into 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 the postgraduate finance students as surrogates for the banking analysts. Although most previous research employs students, there is some concern about the knowledge and experience of this group, especially in the area of market risk and derivatives. Future research should consider the use of banking analysts. Their experience and knowledge may have some influence on the results. To generalise the conclusion, the experiment must be repeated on larger audiences.

Future research should attempt to compare the performance and perception of subjects from other countries. This will extend our knowledge of cross-national differences in the quality of judgement accuracy and perception of the effectiveness of graphics display.

In Fisher's Report, published by Basle Committee (1994), there are several types of graphics recommended for market risk disclosures, i.e., histogram, line chart, scatter-plot, 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 bar type of graph, for example? In addition, researchers may also look into the impact of other graphical features on decision making, such as colour, design, size, labelling etc. The issue of the effects of display type on accuracy of prediction is of importance and may help to explain.

The dependent variables used and the results of the present experiment may provide some directions for future research.

Appendix 1.

Example of Extract from the Annual Report (Purely Narrative)

Imagine that you are the banking analyst at J.P. Stanley. A director has asked you to evaluate the market risk management of the Universal Bank. You are expected to make comments on the performance of the bank in controlling its market risk exposures and forecast the market risk profile for the following year. Below is an extract from the bank's annual report (a section on Market Risk Management).

Extract from the annual report of Universal Bank, 1996.

MARKET RISK MANAGEMENT

Accompanying deregulation and internationalisation of financial activities, money and capital, foreign exchange, securities and other markets have become linked globally and now fluctuate dynamically from day to day. In parallel with these developments, swaps, options, futures and other derivative products have rapidly become more sophisticated and specialised.

To respond appropriately to changes in the market environment and actively expand derivative operations, the bank has established the Global Market Risk Management Group with the objectives of strengthening risk management capabilities. Specifically, the bank has established position limits for its money market, foreign exchange and securities transactions, including such limits for both trading and investment securities. Through the setting of these limits and establishment of risk management guidelines, including loss-cutting rules, the bank is engaged in research related to the measurement of risk and with the objective of complying with BIS market risk guidelines, has put in place systems for monitoring market risk through the use of the Value-at-Risk (VAR) Method. During the latter half of the fiscal year under review, for example, the Bank's VAR (measured in accordance with BIS guidelines, which call for a holding period of 10 business days and a 99% confidence interval) ranged from ¥7.5 billion to ¥15.5 billion and averaged ¥11.5 billion (based on weekly estimates).

Glossary:

Market risk is the uncertainty to which future earnings are exposed as a results of changes in the value of portfolios of financial instruments. This risk is a consequence of our trading and assets and liability management activities in the interest rate, foreign exchange, equity and commodity markets.

Value-at-risk (VAR) is a method of assessing risk that uses standard statistical techniques. It measures the worst expected loss over a given time interval under normal market conditions at a given confidence level. For instance, a bank might say that the daily VAR of its trading portfolio is $35 million at the 99% confidence level. In other words, there is only 1 chance in a 100, under normal conditions, for loss greater than $35 million to occur.

Appendix 2.

Example of Extract from the Annual Report (with Graphics)

Imagine that you are the banking analyst at J.P. Stanley. A director has asked you to evaluate the market risk management of the Universal Bank. You are expected to make comments on the performance of the bank in controlling its market risk exposures and forecast the market risk profile for the following year. Below is an extract from the bank's annual report (a section on Market Risk Management).

Extract from the annual report of the International Bank plc.
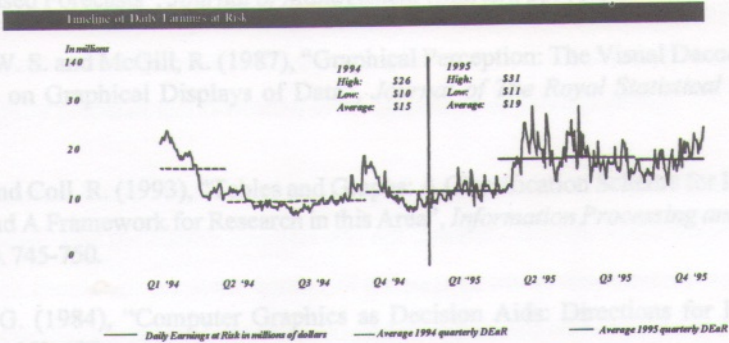
MARKET RISK MANAGEMENT

Market risk is the uncertainty to which future earnings are exposed as a result of changes in the value of portfolios of financial instruments. This risk is a consequence of our trading and asset and liability management activities in the interest rate, foreign exchange, equity and commodity markets.

The bank utilises Daily Earnings at Risk (DEaR) as one tool to estimate potential market risk related to all of our trading and asset and liability management activities. DEaR measures potential losses that are expected to occur within a 95% confidence level, implying that actual daily revenue might exceed DEaR approximately 5% of the time. In estimating DEaR, it is necessary to make assumption about market behaviour. The standard deviation used assumes normal market behaviour and an adverse market movement of 1.65 standard deviations.

The Corporate Risk Management Group sets DEaR limits for each trading activity. The level of risk to be assumed by a business is based on our overall objectives, business manager experience, client requirements, market liquidity and volatility. Within these limits, business managers set regional, local, product, currency and trader limits as appropriate.

The following presents the market risk profiles for our trading activities and asset and liability managements activities as of and for the years ended December 31, 1995 and 1994. Overall, market risk levels of the firm in 1995 were in line with 1994 as higher risk levels in trading activities were offset by lower levels in assets and liability management activities.

The graph below presents DEaR related to our combined trading activities for each trading day in 1995 and 1994, as well as the average quarterly DEaR. The level of market risk in our trading portfolios, which is measured on a diversified basis, will vary with market factors, the level of client activity, and our expectations of price and market movements. Risk level in 1994, as depicted in the graph, reflected our responses to difficult market conditions. During 1995, our risk levels increased although still at levels considered to be moderate. Our change in views of market opportunities throughout 1995 was reflected primarily by higher market risk levels in our propriety unit and emerging markets activities.

Timeline of Daily Earnings at Risk

	1994	1995
High:	$26	$31
Low:	$10	$11
Average:	$15	$19

Q1 '94   Q2 '94   Q3 '94   Q4 '94   Q1 '95   Q2 '95   Q3 '95   Q4 '95

Daily Earnings at Risk in millions of dollars ——— *Average 1994 quarterly DEaR* ——— *Average 1995 quarterly DEaR*

Appendix 3:

Questions

Based on the extract, please answer the following questions:

Question 1:   Give your prediction on the average market risk for the next year . _____

Question 2:   On the scale below, could you please indicate your level of confidence in your prediction:

1	2	3	4	5

Not really confident   Very confident

Question 3:   Based on the scale below , how do you rate this analysis task.

1	2	3	4	5

        Difficult

Very easy

Question 4:   Based on the scale below, in general, how do you rate the comprehensibility of the information on market risk provided to you.

1	2	3	4	5

Not really comprehensible   Highly comprehensible

Question 5: Gender: _____

Question 6: Year/s of Working Experience: _____

Question 7: Age: _____

REFERENCES

Amer, T. (1991) "An Experimental Investigation of Multi-Cue Financial Information Display and Decision Making", *Journal Information Systems*, Fall, pp. 18-34.

Ashton, R. H. and Kramer, S. S (1980) "Students As Surrogates in Behaviour Accounting Research: Some Evidence". *Journal of Accounting Research*, Vol. 18 (Spring), pp. 1-15.

Basle Committee on Banking Supervision and the Technical Committee of the International Organisation of Securities Commissions (1994), *Discussion Paper on Public Disclosure of Market and Credit Risks by Financial Intermediaries (Fisher Report)* Basle, September.

Beckstrom, R. and Mcdonald, P. (1993) Visualisation of Derivatives Risk, in Schwartz, R, *Advanced Strategies in Financial Risk Management*, New York Institute of Finance: New Jersey.

Biehal, G. and Chakravarti, D. (1982) "Information-Presentation Format and Learning Goals As Determinants of Consumer's Memory Retrieval and Choice Processes", *Journal of Consumer Research*, Vol. 8, pp. 431-444.

Bettman, J. R and Zins, M. A.(1979) "Information Format and Choice Task Effects in Decision Making '', *Journal of Consumer Research*, Vol. 6, pp. 141-153.

Blocher, E., Moffie, R. and Zmud, R. (1986) "Report Format and Task Complexity: Interaction in Risk Judgements", *Accounting, Organizations and Society*, Vol. 11, No. 6, pp. 457-470.

Boudoukh, J., Richardson, M. and Whitelaw, R. (1995), "Expect the Worst", *Risk*, Vol. 8, September, pp. 100-101.

Brandon, C. H and Jarett, J. E (1977), "Experimenting with Students' Ability to Forecast", *The Accounting Review*, July, pp. 697-704.

Brandon, C. H and Jarett, J. E (1979), "Revising Earnings Per Share Forecasts: An Empirical Test", *Management Science*, No. 3, pp. 211-220.

Bullen, H. and Porterfield, L (1994), "Derivative Financial Instruments: Time for Better Disclosure", *CPA Journal*, July, pp. 18-22.

Carey, J. and White, E. (1991), "The Effects of Graphical Versus Numerical Response on the Accuracy of Graph-Based Forecasts", *Journal of Management* (March), pp. 77-96.

Cleveland, W. S. and McGill, R. (1987), "Graphical Perception: The Visual Decoding of Quantitative Information on Graphical Displays of Data", *Journal of The Royal Statistical Society*, Part 3, pp. 192-229.

Coll, J. H. and Coll, R. (1993), "Tables and Graphs: A Classification Scheme for Display Presentation Variables and A Framework for Research in this Area", *Information Processing and Management*, Vol. 29, No. 6, pp. 745-750.

DeSanctis, G. (1984), "Computer Graphics as Decision Aids: Directions for Research", *Decision Sciences*, pp. 463-487.

DeSanctis, G. and Jarvenpaa, S. L. (1989), "Graphical Presentation of Accounting Data for Financial Forecasting: An Experimental Investigation", *Accounting Organizations and Society*, Vol. 14, No. 5/6, pp. 509-525

Dickson, G., DeSantics, G. and McBride, D. (1986), "Understanding The Effectiveness of Computer Graphics for Decision Support: A Cumulative Experimental Approach", *Communications of the ACM*, March, Vol. 29, No.1, pp. 40-47.

Goodman, E., Poplawski, C. and Rosen, J. (1996), Views on Measuring the Risks of a Derivatives Trader, in Klein, R. and Lederman, J. *Derivatives Risk and Responsibility: The Complete Guide to Effective Derivative Management*, Irwin: USA, pp. 85-118.

Group of Thirty (1993), *Derivatives: Practices and Principles*, Group of Thirty: Washington.

Hard, N. and Vanecek, M. (1991), "The Implications of Task and Format on the Use of Financial Information", *Journal of Information Systems*, Fall, pp.35-49.

Harvey, N. and Bolger, F. (1996), "Graphs Versus Tables: Effects of Data Presentation Fomat on Judgemental Forecasting", *International Journal of Forecasting*, Vol. 12, pp. 119-137.

Hofstedt, T. R. (1972), "Some Behaviour Parameters of Financial Analysis", *Accounting Review,* October, pp. 679-692.

Jarvenpaa, S.L. (1989), " The Effect of Task Demands and Graphical Format on Information Processing Strategies", *Management Science,* Vol. 35, No. 3, pp. 285-303.

Jorion, P. (1997) *Value at Risk: The New Benchmark for Controlling Market Risk*. Irwin Professional: U. S. A.

Reed, N. (1995), "Disclosure Deficits:, *Risk*, Vol. 8, October, pp. 25-32.

Sullivan, J. (1988), "Financial Presentation Format and Managerial Decision Making", *Management Communication Quarterly*, November, Vol. 2, No. 2, pp. 194-216.

United States General Accounting Office (USGAO), (1994), *Financial Derivatives-Actions Needed to Protect the Financial System*, USGAO: Washington.

Young, J. (1996) "Institutional Thinking: The case of Financial Instruments". *Accounting Organizations and Society,* Vol. 21, No. 5, pp.487-512.

INFORMATION FOR CONTRIBUTORS

1. Manuscripts covering any aspects of the financial sector, particularly the securities industry, will be considered for possible publication. Manuscripts are examined and refereed for publication on the understanding that they have not been published before and that they are not being simultaneously considered for publication elsewhere.

2. A small honorarium will be paid for each published article, apart from 20 off-prints of the paper. Articles published in the journal become the copyright of Kuala Lumpur Stock Exchange.

3. Manuscripts in duplicate copies should be sent to Ms. Qua Gek Kim, Research/Publication Department, Kuala Lumpur Stock Exchange, P O Box 11023, 50732 Kuala Lumpur, MALAYSIA.

4. The Manuscript should be typed on A4 size paper. The points given below should be taken into consideration in preparing the Manuscript.

5. *Title*: The Manuscript should include the title of the article, author's name, designation and institutional affiliation at the top of the first page of the written text.

   Abstract: An Abstract of not more than 150 words.

6. *Tables*: Tables should be given Arabic numbers, for example "Table 3", and should be numbered consecutively throughout the article. Each table should carry a title inserted at the top of the table. Tables should be located at the relevant places where references to them are made in the main text.

7. *Figures*: Diagrams should be given Arabic numbers, for example "Figure 1", and should be numbered consecutively throughout the Manuscript. Each figure should carry a title inserted above the diagram. Figures should be located in the relevant places where they are referred to in the main text. Figures will be directly photographed for printing, and should therefore be carefully prepared and submitted in the final form of photographing.

8. *Footnotes*: Footnotes should be numbered consecutively throughout the article and not page by page. Use the Arabic numbers and not asterisks or other symbols to identify the footnotes which should appear at the bottom of the page to which they relate. Footnotes should only be used to provide supplementary information, and should be kept to a minimum.