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美國財務會計準則公報 119 號數量性揭露 VAR 預測美國商業銀行利率風險之有用性

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## **Abstract**

Jorion (2002) documents that the VAR numbers publicly disclosed by 8 major banks are informative to predict subsequent fluctuations in banks' trading revenues. Using a relatively larger sample of U.S. commercial banks, this paper investigates (1) whether the quarterly-average VAR disclosures are associated with the variability of current trading revenues and returns (i.e., validation or assessment of VAR statistical accuracy) and (2) whether the end-quarter VAR disclosures are useful to predict the variability of future trading revenues and returns (i.e., predictive value of VAR). The empirical results support that the quarterly average (end-quarter) VAR disclosures provide incremental information for assessing (predicting) the volatility of current (future) trading revenues and returns. Furthermore, since the models estimating VAR numbers involve many different risk measurement methods and assumptions, we argue that larger banks tend to exhibit greater professional expertise and more resources of money, and banks are able to improve their VAR models through learning over time. In other words, we hypothesize that banks size and time horizons significantly affect the accuracy of predicting and assessing power of VAR disclosures. Consistent with the hypotheses, we find that the predictive and assessing powers of the VAR measures are better in the later period than early years, and the VAR disclosures of bigger banks have better predictive and assessing powers than smaller banks.

**Keywords:** derivatives; market risk disclosures; disclosure regulation; value at risk; volatility; bank size; time horizon; Basel Committee; SEC

**Data available:** The data used in this study are publicly available from the sources indicated in the text.

## **I : Introduction**

Value at Risk (VAR) was developed in 1993 in response to those famous financial disasters such as Metallgesellschaft, Orange County, and Barings Bank. These problems led to a series of reports on good risk management practice. The most significant was a report on derivatives risk management published in July 1993 by the Group of Thirty. This report was followed by a report by the US General Accounting Office in May 1994, a joint report issued by the Bank for International Settlements (BIS) and the International Organization of Securities Commissions (IOSCO) in July 1994, and many other reports by the Derivatives Policy Group, the International Swaps and Derivatives Association (ISDA), Moody's, Standard and Poor's, and other interested parties. These reports made a number of sensible recommendations that have rapidly become benchmarks for modern financial risk management. They tended to focus particularly on derivatives risks. But their recommendations apply not just to derivatives providers and investments, but to other financial institutions and most corporations as well (Kevin 1998).

VAR measures the potential loss that could occur under normal market conditions at a given confident level. It is an effective tool for describing and communicating risk because it assesses different risks in terms of a common loss relative to a standard unit of likelihood. To calculating VAR, we need to choose a time horizon and a probability. For instance, a bank might say that the daily VAR of its trading portfolio is \$1 million at the 99 percent confidence level. In other words, under normal market conditions, only one percent of the time, the daily loss will exceed \$1 million. Besides, VAR models typically depend on the past being a good guide to the future. They tend to build around statistical estimates, using probability distributions for the changes in value of a given portfolio over a specific holding

period. Because VAR has considerable intuitive appeal as a condensed big picture of risk exposure, it has gained significant support primarily from the regulatory sectors and has been touted to senior management as a risk control device.

The Securities and Exchange Commission (SEC) required all large U.S publicly traded corporation to report quantitative and qualitative information about market risk in financial reports (SEC, Financial Report Release No. 48, 1997). Three disclosure formats are suggested:

- 1) Tabular presentation of fair value information and contract terms relevant to determining future cash flows, categorized by expected maturity dates.
- 2) Sensitivity analysis expressing the potential loss in future earnings, fair values, or cash flows from selected hypothetical changes in market rates and prices.
- 3) Value at risk disclosures expressing the potential loss in future earnings, fair values, or cash flows from market movements over a selected period of time and with a selected likelihood of occurrence.

Companies may choose one of three alternatives for all of the required quantitative disclosures about market risk. A company may choose one disclosure alternative for market risk sensitive instruments entered into for trading purposes and another alternative for all other market risk sensitive instruments. Also, a company may choose any of the three disclosure alternatives for each risk exposure category within the trading and other than trading portfolios.

Another use of VAR is in the assessment of regulatory capital for market risk. In the Bank of International Settlements (BIS) internal models approach, regulatory capital for market risk is proportional to the VAR that is calculated with a firm's internal model under certain general parameters, which are specified by regulation.

By making use of VAR, banks can decide how to allocate economic capital and how to trade off risk and return.

Jorion (2002) documents that the VAR numbers publicly disclosed by 8 major banks are informative to predict subsequent fluctuations in banks' trading revenues. Using a relatively larger sample of U.S. commercial banks, this paper investigates (1) whether the quarterly-average VAR disclosures are associated with the variability of current trading revenues and returns (i.e., validation or assessment of VAR statistical accuracy), and (2) whether the end-quarter VAR disclosures are useful to predict the variability of future trading revenues and returns (i.e., predictive value of VAR). The empirical results support that the quarterly-average (end-quarter) VAR disclosures provide incremental information for assessing (predicting) the volatility of current (future) trading revenues and returns. Furthermore, since the models estimating VAR numbers involve many different risk measurement methods and assumptions, we argue that larger banks tend to exhibit greater professional expertise and more resources of money, and banks are able to improve their VAR models through learning over time. In other words, we hypothesize that banks size and time horizons significantly affect the accuracy of predicting and assessing power of VAR disclosures. Consistent with the hypotheses, we find that the predictive and assessing powers of the VAR measures are better in the later period than early years, and the VAR disclosures of bigger banks have better predictive and assessing powers than smaller banks.

The remainder of the paper is organized as follows. Section II presents the prior literatures about market risk disclosures and hypotheses development. Section III presents the models used to evaluate the predictive and assessing powers of VAR disclosures. Section IV defines the data and samples in the models. Section V shows the results of the regressions and hypotheses. A final section provides some general

conclusions.

## **II: Prior Literature and Hypothesis Development**

Jorion (2002) investigates the informativeness of banks' publicly available VAR disclosures for the banks' risk profiles. As in Jorion (2002), we test the informativeness of VAR disclosures to volatility of unexpected trading revenues and holding period returns. In addition, we examine the effect of bank size and learning on assessment and predictive value of VAR numbers.

Schrand (1997) uses regulatory data similar to FFR No. 48 tabular disclosures to examine the association between market interest rate sensitivity and derivatives activities for a sample of S&Ls. The findings suggest that FFR No. 48 disclosures may be useful to investors. Wang (2000) investigates whether the quantitative disclosures about notional amount and fair value of foreign exchange derivatives, required by SFAS No. 119, are associated with the information used by investors to assess the sensitivity of equity returns to currency fluctuations.

Rajgopal (1999) find that disclosures about derivatives presented in a tabular and sensitivity analysis format are associated with firms' oil and gas price sensitivity. Berkowitz and O'Brien (2002) provide a detailed analysis of the performance of VAR models actually in use and analysis the distribution of historical trading P&L and the daily performance of VAR estimates of 6 large U.S. banks. The data used in this paper is available to bank regulators, and not to the public.

Linsmeier et al. (2002) find that firms' 10-K market risk disclosures mandated by FFR No. 48, reduce investors' uncertainty and diversity of opinion about the implications. They use a broad sample of nonfinancial firms and conclude that FFR No.48 market risk disclosures provide useful information to investors.

Most prior research on informativeness of derivatives-related disclosure

primarily examines the relation between share prices and changing in a particular financial risk factor. Jorion (2002) is the first paper to investigate the relation between the trading VAR numbers and the subsequent variability of their trading revenues. He concludes that VAR disclosures are informative in that they predict the variability of trading revenues. It is the one using banks' publicly available data to investigate the informativeness of VAR disclosures. There are only 8 banks in the sample and one model to test the predictive power of VAR measures.

Results in earlier research show that VAR measures are informative for future unexpected trading revenue in predictive model. Since VAR measures the risk of a portfolio, we expect that VAR numbers are also associated with the risk of equity. Therefore, we predict that VAR measures are informative to the volatility of unexpected trading revenues and holding period returns:

**H1a:** The VAR measures reported by banks are informative to predict future unexpected trading revenues. That is, the end-quarter VAR numbers are positively associated with the subsequent unexpected quarterly trading revenues.

**H1b:** The VAR measures reported by banks are informative to assess current unexpected trading revenues. That is, the quarter-average VAR numbers are positively associated with the current unexpected quarterly trading revenues.

**H1c:** The VAR measures reported by banks are informative to predict the volatility of future holding period returns. That is, the end-quarter VAR numbers are positively associated with the subsequent variability of quarterly daily returns.

**H1d:** The VAR measures reported by banks are informative to assess the volatility of current holding period returns. That is, the quarterly average VAR numbers are

positively associated with the current variability of quarterly daily returns.

As a statistical estimate, VAR is derived from the probability distribution of the portfolio's potential change in economic value. That probability will be based on some assumptions about and method of simulating the joint probability distribution of changes in market rates and some method for transforming simulated changes in market rates into simulated changes of the portfolio's value. Models for calculating VAR can and do differ in their broad method, in their assumptions and in the details of their implementation.

We argue that larger banks tend to exhibit greater professional expertise or more resources of money and banks are able to improve their VAR models through learning over time. Therefore, we expect the bank size and time horizon will significantly affect the predictive and assessing power of VAR disclosures. We extend the research by providing empirical evidence about whether the predictive and assessing powers of banks' VAR disclosures affected by the size and time horizon. As time passing, VAR measures reported by banks should be more informative by the amendment of models and experience accumulation, and many research about VAR increasingly enhance the accuracy of VAR disclosures of banks. We characterize VAR numbers as comprising a "noise" component, which may be introduced by different VAR methods and assumptions. The quality of bank VAR numbers depends on the magnitude of the variability of the "noise" component. We hypothesize that larger banks have better VAR models and learning over time (i.e., experience) increase the quality of earnings. It is well known that the measurement errors in independent variables (e.g., Collins et al. 1994) will underestimate the association of the variables<sup>1</sup>.

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<sup>1</sup> Measurement errors in an independent variable  $X$  tends to lower coefficient  $b$  toward zero, and also to raise its standard error.

**H2a:** The predictive and assessing powers of the VAR measures for unexpected trading revenues are better in the later period than early years. That is, the end-quarter (quarterly-average) VAR numbers for the later period are more positively associated with the subsequent (current) unexpected quarterly trading revenues.

**H2b:** The predictive and assessing powers of the VAR measures for the volatility of holding period returns are better in the later period than early years. That is, the end-quarter (quarterly-average) VAR numbers for the latter period are more positively associated with the subsequent (current) variability of quarterly daily returns.

**H3a:** The VAR disclosures of experienced and bigger banks have better predictive and assessing powers for unexpected trading revenues. That is, the end-quarter (quarterly-average) VAR numbers for the bigger banks are more positively associated with the subsequent (current) unexpected quarterly trading revenues.

**H3b:** The VAR disclosures of experienced and bigger banks have better predictive and assessing powers for the volatility of holding period returns. That is, the end-quarter (quarterly-average) VAR numbers for the bigger banks are more positively associated with the subsequent (current) variability of quarterly daily returns.

### **III : Research Design**

#### **Model I: Predictive Power of End-Quarter VAR**

For a given portfolio, if the portfolio return is normally distributed with mean  $\mu$  and standard deviation  $s_t$ , the VAR number can be obtained as follows. Denote the initial portfolio value as  $W_0$ , the cut-off returns as  $R^*$ , and the cut-off revenue as  $r^*$ .

Thus, the VAR in absolute dollar terms is<sup>2</sup>

$$VAR(absolute) = -r^* = -R^*W_0 \quad (1)$$

The negative sign arises because we can assume that the extreme tail revenues and returns with which we are dealing are losses, but the VAR is positive. Similarly, if the mean revenue is  $\bar{r}$  and the mean return is  $\mu$ , the VAR relative to the mean is<sup>3</sup>

$$VAR(relative) = -r^* + \bar{r} = -R^*W_0 + \mu W_0 \quad (2)$$

By standard normal table, there is a number  $\alpha$  corresponding to the confidence level  $c$ . For example, if  $c$  is chosen to be 95 percent, the corresponding  $\alpha$  is 1.65, and if  $c$  is 99 percent,  $\alpha$  is 2.33. If  $R$  is normally distributed, we can always describe the confidence level in terms of a single parameter  $\alpha$ , which tell us how far away the cut-loss values of the two tails are from the mean  $\mu$ , in terms of units of the standard deviation  $\sigma$ .

$$R^* = -\alpha\sigma + \mu \quad (3)$$

Hence, we have:

$$VAR(absolute) = -\mu W_0 + \alpha\sigma W_0 \quad (4)$$

$$VAR(relative) = \alpha\sigma W_0 \quad (5)$$

In practice, instead of working with two different types of VAR, we would usually work with only one, the relative VAR.<sup>4</sup> Thus

$$VAR_t = \alpha s_t \quad (6)$$

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<sup>2</sup> Jorion, P. (2001) describes the VAR in absolute dollar terms as  $VAR(zero)$

<sup>3</sup> Jorion, P. (2001) describes the VAR in relative dollar terms as  $VAR(mean)$

<sup>4</sup> The relative VAR is easier to handle because it does not require that we know the mean return  $\mu$ , which could otherwise a problem. In any case, if we are dealing with a short time period, the difference between absolute and relative VARs will be fairly small anyway. So we may as well use whichever VAR is more convenient.

With normally distributed market risk factors, the expectation of the absolute value  $|r_{t+1}|$  is<sup>5</sup>

$$E(|r_{t+1}|) = \sqrt{\frac{2}{\pi}} \times s_t = 0.8 \times s_t \quad (7)$$

Thus, the expected absolute value of the trading revenue is linearly increasing in the forecasted volatility of trading revenue,  $s_t$ , which is proportional to VAR. This setup is valid not only for the normal distribution but also for the conditional distribution, which is fixed and symmetrical.

VAR increases with the time horizon over which VAR is calculated because volatility grows approximately in proportion to the square root of time. The time horizon of VAR public-disclosures by banks corresponds to a horizon of one day, which must be extended to match the quarterly horizon of banks' reported trading revenues. To calculate VAR, the time horizon can be of any length, but it is assumed that the portfolio composition does not change during the holding period. Hence, we can estimate the volatility in quarterly trading revenues from the daily volatility using the square root of time rule

$$\sigma_t = s_t \sqrt{N} \quad (8)$$

where  $N$  is the number of trading days in a quarter, taken as  $N = 63$ , which is the number of average trading days in a quarter from 1995 to 2001.

With distributions other than the normal, the coefficient will in general differ from  $\sqrt{2/\pi}$ , but the VAR measures should still be linearly related to the expected absolute value of trading revenues (Jorion, 2002). Thus, we can test the predictive power of bank's quarterly VAR disclosures by estimating the following equation:

$$|R_{t+1}| = a + b\sigma_t + \varepsilon_{t+1} \quad (9)$$

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<sup>5</sup> Let  $X$  be  $N(\mu, \sigma^2)$ , the expectation of absolute value  $X$  is  $\sqrt{(2\sigma^2)/\pi}$  or  $0.79788456\sigma$

where  $R_{t+1}$  is the trading revenue for quarter  $t+1$ ,  $\sigma_t$  is the forecasted volatility of quarterly trading revenue inferred from the bank's public disclosure of its trading VAR as of the end of quarter  $t$ , and  $\varepsilon_{t+1}$  is random error. The value of  $b$  will equal its theoretical value of 0.80 only if  $\sigma_t$  and  $R_{t+1}$  are measured without error.

In addition, we assume that  $R_{t+1}$  has mean zero and is normally distributed. Thus,  $R_{t+1}$  must be the unexpected component of trading revenues. To amend for the expected component of the trading revenue, unexpected component is measured as the difference between the quarterly trading revenue and its moving average over the previous four quarters. The unexpected trading revenue is defined as

$$R_{t+1} - E[R_{t+1}] = R_{t+1} - (1/4) \sum_{i=1}^4 R_{t+1-i} \quad (10)$$

This transformation implies that  $|R_{t+1} - E[R_{t+1}]|$  should have an expected value of zero. These estimates of unexpected revenues are statistically indistinguishable from zero for our sample of banks. The trading revenue is replaced by its unexpected component. Besides, in order to know whether quantitative VAR disclosures contain useful information for predicting the volatility of unexpected trading revenues, after controlling for traditional derivative notional amounts. Hence, Equation (9) is amended as the following regression:

$$|R_{t+1} - E[R_{t+1}]| = a + b\sigma_t + cNOT_t + \varepsilon_{t+1} \quad (11)$$

where  $NOT_t$  is the outstanding notional value of a bank's derivatives contracts at the end of the previous quarter. If VAR provides incremental information for predicting the volatility of unexpected trading revenues, then we would expect the coefficient  $b$  to remain significantly positive. Ideally, the regression  $R^2$  should be high, implying that the regression model has the significant fitness and  $\sigma_t$  captures much of the variation in  $|R_{t+1} - E[R_{t+1}]|$ .

## Model II : Assessment of Quarterly-Average VAR

Quarterly average VAR is reported as a summary of daily VARs in a quarter. Following the Model I, we expect that quarterly average VARs are also correlated with the current unexpected quarterly trading revenues and coefficient  $b$  would remain significantly positive after controlling for the derivative notional amount. Thus, we can test the assessing power of bank's quarterly VAR disclosures by estimating the following equation:

$$|R_t - E[R_t]| = a + b\sigma_t + cNOT_t + \varepsilon_t \quad (12)$$

where  $|R_t - E[R_t]|$  is unexpected trading revenue for quarter  $t$ ,  $\sigma_t$  is the volatility in unexpected quarterly trading revenue inferred from the bank's public disclosure of its trading VAR as of the average of quarter  $t$ , and  $NOT_t$  is the average of outstanding notional value of a bank's derivatives contracts for quarter  $t$ .

## Model III : End-Quarter VAR and Variability of Daily Returns

Denote market value of common stock equity for a bank in quarter  $t$  as  $MV_t$ , market value of trading assets in quarter  $t$  as  $TAMV_t$ , and market value of non-trading assets in quarter  $t$  as  $OTAMV_t$ . Thus we have

$$MV_t = TAMV_t + OTAMV_t \quad (13)$$

The equation below is used to find the variance of market value of common stock equity for a bank in quarter  $t$ :

$$Var(MV)_t = Var(TAMV)_t + Var(OTAMV)_t + 2\rho_{TAMV,OTAMV}\sigma_{TAMV}\sigma_{OTAMV} \quad (14)$$

where  $Var(TAMV)_t$  is the variance of market value for trading assets in quarter  $t$ ,  $Var(OTAMV)_t$  is the variance of market value for non-trading assets in quarter  $t$ , and  $2\rho_{TAMV,OTAMV}\sigma_{TAMV}\sigma_{OTAMV}$  is the covariance between  $TAMV_t$  and  $OTAMV_t$ .

We evaluate  $Var(OTAMV)_t$  by a proxy which is variance of market returns, and  $2\rho_{TAMV,OTAMV}\sigma_{TAMV}\sigma_{OTAMV}$  is view as noise to  $Var(MV)_t$  estimates. Denote  $Var(Daily\ Return)_{t+1}$  and  $Var(Market\ Return)_{t+1}$  as the variability of daily returns and market returns for the quarter  $t + 1$ .

Our H1c states that we expect to observe the positive association between VAR and quarterly volatility in returns if VAR measures are useful indicators of the risk of equity. Since VAR measures the risk of a portfolio, we consider that VAR numbers are also associated with the risk of equity and should be related to the variability the variability of daily return after controlling for variability of value-weight returns, capturing the effect of systematic risks. In order to test the predictive power of VAR disclosures for the volatility of holding period return, we have the following equation:

$$Var(Daily\ Return)_{t+1} = a + bVar(Market\ Return)_{t+1} + c\sigma_t + dNot_t + \varepsilon_{t+1} \quad (15)$$

where  $\sigma_t$  is the bank's public VAR disclosure of its trading portfolio as of the end of quarter  $t$ , and  $NOT_t$  is the outstanding notional value of bank's derivatives contracts at the end of the quarter  $t$ .

The above equation shows that there is a potential link between VAR and future change in returns after controlling for changes in value-weight returns and notional amounts. Coefficients  $b, c$  and  $d$  are predicted to be positive. VAR is informative about the risks of next quarter's returns, if the regression yields a significant estimate for  $c$ .

#### **Model IV : Quarterly Average VAR and Variability of Daily Returns**

Given that variability of returns is the total risk of a bank, we argue quarterly average VAR disclosures provide incremental information for assessing the volatility of daily return, and coefficient  $c$  would remain significantly positive. Similar to the

concept in Model III, Model IV of quarterly average VAR incorporates control variables that capture the impact of systematic risks and changes in notional amount on derivatives. Thus, we have the following equation:

$$\text{Var}(\text{Daily Return})_t = a + b\text{Var}(\text{Market Return})_t + c\sigma_t + d\text{Not}_t + \varepsilon_t \quad (16)$$

where  $\text{Var}(\text{Daily Return})_t$  is the variability of daily return for quarter  $t$ ,  $\text{Var}(\text{Market Return})_t$  is the variability of value-weight returns for quarter  $t$ ,  $\sigma_t$  is the bank's public quarterly average VAR disclosure of its trading portfolio in quarter  $t$ , and  $\text{NOT}_t$  is the average notional value of bank's derivatives contracts in quarter  $t$ . We predict that coefficients of the control variables,  $\text{NOT}_t$  and  $\text{Var}(\text{Market Return})_t$ , are significantly positive.

### **Subgroups of Time and Bank Size**

To evaluate the effects of learning on assessment and predictive power of VAR numbers, the sample is divided into two subgroups. One is all banks' data in the last 12 quarters (later period) ended in 1<sup>st</sup> quarter 2002, and the other is the data prior to 12 quarters (early years).

For testing the effect of banks size, we divide the sample into two subgroups according to the paper "Public disclosures by banks: results of the 2000 disclosure survey" (May 2002) of Basel Committee on Banking Supervision. Bank of America, Bank of New York, Bank One, Citigroup, First Union, Fleet Boston and J. P. Morgan Chase in the survey are big-sized and experienced. We choose them in one group except First Union merged with Wachovia in 2001, and the remaining banks are in another group.

The Z tests associated with the regression coefficients of variables allow us to test the significance of the effect of being in the designated categories. If  $b_1$  and  $b_2$

are denoted as VAR measures of slope coefficients for later period (bigger banks) and early years (smaller banks), we test the hypothesis  $H_0 : b1 = b2$  against  $H1 : b1 < b2$ , which is equivalent to  $b1 - b2 = 0$ , as both  $b1$  and  $b2$  follow a normal distribution (OSL),  $Z = \frac{b2 - b1}{\sqrt{\text{var}(b2 - b1)}}$  should follow the t-distribution of student with  $(n_1 + n_2 - 3)$  degrees of freedom, where  $n_1$  and  $n_2$  are numbers of observations in two subgroups. As the subgroups are independent, we have  $Z = \frac{b2 - b1}{\sqrt{\text{var}(b1) + \text{var}(b2)}}$ . As the alternative hypothesis is one side inequality, we use one tailed t-test and  $Z_{crit} = t_{0.025} = 2.00$ . If  $Z_{obs} > Z_{crit}$  and we can conclude that  $b2 > b1$  with probability of 2.5% of type 1 error.

#### **IV : Data and Descriptive Statistics**

##### **The bank samples**

The criterion for banks in this sample is the availability of publicly disclosed VAR data of bank holding companies in U.S. We collect annual (10-K) and quarterly (10-Q) reports of top 200 bank holding companies from the Internet, and find only a few companies have disclosed their market risks for VAR measures. Most banks disclose their market risk positions using the cash flow or sensitivity measures, based on static or deterministic interest rate scenarios. Eventually the sample includes 17 banks in top 60 bank holding companies. Because large banks' investment portfolios become more complex, with holdings of instruments that are in some cases longer-dated or have more options, than smaller bank investments. They have greater incentives to establish risks control system for effective identification, monitoring, and reporting risks. Of these 17 banks in the sample, each one issued VAR disclosures in different ways and began to disclose in different time. We collect all the VAR measures from the quarter in which the banks began to disclose to 1<sup>st</sup> quarter in 2002.

Table 1 shows the disclosures of VAR for 17 U.S. banks. The description of

methods used for VAR measurements are shown in column 2. As is well known, there are three primary VAR calculation methodologies: (1) Historical simulation (2) Variance/Covariance approach (3) Monte Carlo simulation. More than half banks didn't disclose the methods they used. Some banks even used vague descriptions.

The columns 3 and 4 show the confidence level banks used to calculate VAR and where they IPO. The columns 5 to 8 represent the beginnings of the public reporting VAR measures for the 17 banks.

In "The New Basel Capital Accord" the quantitative disclosures for banks using the standardized approach include interest rate risk, equity position risk, foreign exchange risk and commodity risk. It allows a comparison between different types of risks and between different institutions. The column 9 shows the period since which banks began to disclose the VAR for specific risks. Not all the banks disclose their risks by the same taxonomy.

Table 2 shows the details of each bank's VAR disclosures in each year. Table 3 represents the taxonomy banks use for specific risks. Most banks adopt consistent methods to report VARs over time. But it is hard to find two banks disclose market risks by VAR measures in the same formats, with the same horizons and confidence levels.

### **Value at Risk**

VAR data for trading activities were collected from the banks' annual (10-K) and quarterly (10-Q) reports. According to the SEC's market risk disclosure rule FFR No.48, banks must disclose market risk in one of the three methods, that is, tabular presentation, sensitivity analysis and value at risk. It is not effective until January 1,1998. Few banks chose to disclose market risks by VAR after 1998, and fewer banks had disclosed market risks by VAR before 1998. Besides, many banks report VAR

only as an average or an end-of-period value, and the period of the average values are different from 3 months. Hence, we use the following decision rule in collecting VAR measures:

VAR (quarterly-average):

1. Average VAR for the current quarter.
2. Average of the beginning and ending quarterly VAR data.

If quarterly data are not available, we turn to annual data.

3. Average VAR for the year
4. Average of the beginning and ending annual VAR data.
5. VAR reported at the end of the year.

VAR (end-quarter):

1. End-of-quarter VAR data for the previous quarter
2. Average VAR for the quarter.

If quarterly data are not available, we turn to annual data.

3. Average VAR for the year.
4. VAR reported at the end of the year.

Using annual VAR data instead of quarter data should reduce the accuracy of the risk forecast and assessment in the regressions (Equations 11, 12, 15 and 16), because four quarterly trading revenue, returns and notional amount observations correspond to the same value of the VAR-based independent variable.

Banks report VAR data in different forms, with different confidence levels and different reporting horizons. We transferred these into a quarterly standard deviation assuming normal distributions and identically and independently distributed returns using Equations (6) and (8).

Summary statistics are reported in Table 4 for quarterly average and end-quarter

VAR numbers. For these and other statistics reported below, all numbers are measured in million dollars besides notional amount, measured in billion of dollars.

### **Trading revenues, trading assets and notional amount**

We collect the trading revenues, trading assets and notional amounts of these banks from the database of the Federal Reserve Bank of Chicago named “Commercial Bank and Bank Holding Company Database”. Bank holding companies conform to certain criterion must file the report (FR Y-9C<sup>6</sup>) required by law. The advantage of using this database is that it covers all bank holding companies. However, not all bank holding companies are publicly traded. Therefore, there is no data for Allfirst, which is a wholly owned subsidiary of Allied Irish Banks (AIB). Trading revenues include revenues from interest rate, foreign exchange, equity security and index, and commodity and other exposures but not include fees and interest revenues earned on assets and liabilities. The notional amount is the sum of interest rate, foreign exchange, equity derivatives and other commodity contracts. Table 5 and 7 shows the summary statistics of the trading revenue, trading assets and notional amount for the 17 banks from 1996 through 1<sup>st</sup> quarter 2002.

### **Other data**

The data employed in this study about total assets, book value, returns and value-weight returns are taken from Bank Compustat and CRSP. The definition of return is the change in the total value of an investment in a common stock a day per dollar of initial investment. Value-weight return indices contain the daily returns, including all distributions, on a value-weighted market portfolio (excluding American Depository Receipts). Summary statistics are reported in Table 6 for the total assets

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<sup>6</sup> This report collects basic financial data from a domestic bank holding company on a consolidated basis in the form of a balance sheet, an income statement, and detailed supporting schedules, including a schedule of off-balance-sheet items.

and book value of the 17 banks.

## V : Results

We test the usefulness and informativeness of VAR measures by estimating the assessing (predicting) power of the volatility of current (future) trading revenues and returns. We adopt White's [1980] test and reject homoscedasticity for all regressions, so White's adjusted t statistics are reported. Observations with any variable in the extreme 1% of either tail of the pooled sample distribution of that variable are deleted.

For controlling the scale effect, all variables in Equation (11) and (12) are deflated by previous quarter's trading assets and current quarter's trading assets, respectively. Similarly variables ( $\sigma_t, NOT_t$ ) in Equation (15) and (16) are deflated by previous quarter's book value and current quarter's book value, respectively.

### Results for H1: Hypotheses for the informativeness of VAR disclosures

Table 8 reports the regression results of absolute value of quarter t+1 unexpected trading revenue on quarter t end-quarter VAR-based volatility and notional derivatives amount. It reports the results of a "pooled sample-OLS" regression with 263 observations. Consistent with H1a, we find that the coefficients on the VAR-based volatility and notional derivatives are positive and statistically significant  $t = 3.64$  and  $t = 2.98$ .

Table 9 presents the results of the regression of quarter t absolute value of unexpected trading revenue on quarter t quarterly average VAR-based volatility and notional derivatives amount. The results, consistent with H1b, shows t-test statistics 4.42 at 0.05 significant level with 262 observations, and the slope coefficient  $b$  is 0.6410. The adjusted R-square is 23.22%.

Table 10 reports the relation between end-quarter VAR numbers and the subsequent variability of quarterly daily returns. The slope coefficient on the

VAR-based volatility are 0.2756, which is significant  $t = 2.74$  with 218 observations. The results are consistent with H1c that VAR disclosures are useful in predicting volatility in banks' holding period return.

Table 11 reports the results of the regression of regressions of variability of quarter  $t$  return on variability of quarter  $t$  market return, quarter  $t$  VAR-based volatility and notional derivatives amounts. The slope coefficient  $c$  is 0.2978 ( $t$  value=2.97) with 226 observations. The results are consistent with H1d.

From the results of Table 8, 9, 10 and 11, VAR disclosures provide incremental information for assessing (predicting) the volatility of current (future) trading revenues and returns, after controlling for systematic risk, derivatives notional amounts and scale effects.

### **Results for H2: Hypotheses for the difference of informativeness of VAR disclosures in the later period and early years.**

To obtain additional evidence we run univariate regressions for all banks sample divided according to the time horizon. Table 8 and table 9 indicate that (1) the coefficients of slope  $b$  for the earlier stage and later stage in Equation (11) are 0.4383 and 1.0645, with significant  $t = 3.88$  and  $t = 3.43$ , (2) In Equation (12) the coefficients are 0.4964 and 1.1248, which are significant  $t = 4.93$  and  $t = 3.32$ . The Z tests for the difference in coefficients  $b$  of these two equations are 1.90 and 1.78. The results are consistent with to the prediction ( $b_2 > b_1$ ), significantly at 0.1 confidence level.

As table 10 and table 11 shows, the coefficients of slope  $c$  for the earlier stage and later stage in Equation (15) and (16) are 0.1358 and 0.8237, 0.1500 and 0.7926. The Z tests for the difference in coefficients  $c$  are 2.60 and 2.54 significantly at 5% confidence level. Results from Z test reveals that the coefficients on earlier stage and later stage are statistically different from each other. The results are consistent with

H2b.

**Results for H3: Hypotheses for the difference of informativeness of VAR disclosures in big banks and small banks.**

We divide the sample into two subgroups by banks size. The coefficients  $b$  in Equation (11) and (12) are 0.2383 and 0.9004, 0.2701 and 0.8232 respectively. In this case  $Z = 1.94$  and  $2.26$ , we use one tailed t-test that  $Z_{crit} = t_{0.05} = 1.65$ . Thus we can conclude that  $b_2 > b_1$  with probability of 5% of type 1 error. The results are consistent with H3a.

The results of Z test for coefficients  $c$  in Equation (15) and (16) are 0.88 and 0.55. The insignificant difference between  $c_1$  and  $c_2$  is not consistent with H3b.

Overall, the results indicate that the end-quarter (quarterly-average) VAR numbers for the later period are more positively associated with the subsequent (current) unexpected quarterly trading revenues and returns. Besides, the end-quarter (quarterly-average) VAR numbers for the bigger banks are more positively associated with the subsequent (current) unexpected quarterly trading revenues and returns.

## **VI: Conclusion**

Using a sample of bank holding companies in U.S., the paper provides evidence that (1) whether the quarterly-average VAR disclosures are associated with the variability of current trading revenues and returns (i.e., validation or assessment of VAR statistical accuracy) and (2) whether the end-quarter VAR disclosures are useful to predict the variability of future trading revenues and returns (i.e., predictive value of VAR). The results suggest that the quarterly-average (end-quarter) VAR disclosures provide incremental information for assessing (predicting) the volatility of current (future) trading revenues and returns.

As time passing, VAR measures reported by banks should be more informative

by the amendment of models and experience accumulation, and many research about VAR increasingly enhance the accuracy of VAR disclosures of banks. Hence, we hypothesize that bank size and time horizons significantly affect the predictive and assessing power of VAR disclosures. Consistent with the hypotheses, we find that the predictive and assessing powers of the VAR measures are better in the later period than early years, and the VAR disclosures of bigger banks have better predictive and assessing powers than smaller banks.

We believe that sufficient information to assess banks' overall market risk exposure is critical to banks, regulator, and financial statement users, and understandability and transparency will only be accomplished with strong disclosure requirements. Thus we expect banks would be forced to disclose market risks in more complete and detailed way.

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**TABLE 1**  
**Description of VAR disclosures for the 17 U.S. Banks**

<b>Bank</b>	<b>Description of method</b>	<b>Confidence level</b>	<b>IPO</b>	<b>First VAR disclosure (10K)</b>	<b>First VAR disclosure (10Q)</b>	<b>Reported Average VAR since</b>	<b>Reported End-quarter VAR since</b>	<b>Disclosed Specific Risks since</b>
BANK ONE	various statistical models and techniques numerous assumptions and estimates	99% since 1997-Q1	NYSE	1996	1997-Q1	1998-Q4	1996-Q4	1997-Q4
POPULAR		95% since 1999-Q4	Nasdaq	1999	NA	NA	1999-Q4	NA(only total amount)
PACIFIC CENTURY	variance/covariance	95% since 1997-Q4	NYSE	1997	1998-Q1	NA	1997-Q4	NA(only foreign exchange)
BANK OF NEW YORK	monte carlo simulation	99% since 1997-Q4	NYSE	1998	1998-Q1	1997-Q4	1997-Q4	1997-Q4
J P MORGAN CHASE	historical simulation	97.5% since 1994-Q4, 99% since 1997-Q4	NYSE	1994	1995-Q1	1994-Q4	1997-Q4	1997-Q4
CITICORP	assumptions are based on historical experience.	97.7% since 1997, 99% since 1997-Q4	NYSE	1997	1998-Q1	1997-Q4	1997-Q4	1997-Q4
ALLFIRST	variance/covariance	99% since 1997-Q4	NA	1997	NA	NA	1997-Q4	NA(only total amount)
FLEETBOSTON	industry-standard risk measurement techniques	99% since 1998-Q4	NYSE	1999	2000-Q1	1998-Q4	1999-Q4	1999-Q4
MELLON	Corporation's methodology	95% since 1996-Q1	NYSE	1996	1996-Q1	1998-Q4	1996-Q1	NA(only total amount)
BANK OF AMERICA	sophisticated modeling techniques	99% since 1998-Q3	NYSE	1998	1998-Q3	1998-Q3	NA	1999-Q4(1998-Q4~1999-Q3 no total)
NATIONAL CITY	historical simulation	97.5% since 1997-Q4	NYSE	1997	NA	1998-Q4	NA	NA(only total amount)
NORTHERN TRUST	variance/co-variance methodology	95% since 1997-Q4	Nasdaq	1997	NA	1998-Q4	1997-Q4	NA(only total amount)
PNC	NA	NA	NYSE	1997	1998-Q1	2000-Q4	1997-Q4	NA(only total amount)
KEYCORP	statistical methods	95% since 1997-Q3	NYSE	1997	1998-Q1	1997-Q4	1997Q4	NA(only total amount)
STATE STREET	simulation approach	99% since 1997-Q4	NYSE	1997	1998-Q1	1997-Q4	NA	NA(no total amount)
WACHOVIA	variance/covariance	97.5% since 1997-Q4	NYSE	1997	1998-Q1	1998-Q4	1997-Q4	1998-Q1
BOK	variance/covariance	99% since 1998-Q4	Nasdaq	1998	1998-Q1	NA	1998-Q4	NA(only total amount)

**TABLE 2**

<b>Reporting</b>	<b>details</b>	<b>for</b>	<b>the</b>	<b>17</b>	<b>U.S.</b>	<b>Banks</b>
<b>Bank</b>	<b>2001</b>	<b>2000</b>	<b>1999</b>	<b>1998</b>	<b>1997</b>	<b>1996</b>
BANK ONE	Average min max end	Average min max end	Average min max end	Average min max end	Average min max end	end
POPULAR	End	End	End			
PACIFIC CENTURY	End	End	End	End	End	
BANK OF NEW YORK	Average min max end	Average min max end	Average min max end	Average min max end	Average min max end	
J P MORGAN CHASE	Average min max end	Average min max end	Average min max end	Average min max end	Average end	Average
CITICORP	Average min max end	Average min max end	Average min max end	Average min max end	End	
ALLFIRST	End	End	End	End	End	
FLEETBOSTON	Average min max end	Average min max end	Average min max end	Average		
MELLON	Average end	Average end	Average end	Average end	End	End
BANK OF AMERICA	Average min max	Average min max	Average min max	Average min max		
NATIONAL CITY	Average min max	Average min max	Average min max	Average min max	Max	
NORTHERN TRUST	Average min max end	Average min max end	Average min max end	Average min max end	End	
PNC	Average end	Average end	End	End	End	
KEYCORP	Average end	Average end	Average end	Average end	Average end	
STATE STREET	Average min max	Average min max	Average min max	Average min max	Average min max	
WACHOVIA	Average min max end	Average min max end	Average min max end	Average min max end	End	
BOK	Max end	Max end	Max end	Max end		

Note: J P Morgan Chase reported average VAR in 1994 and 1995. We do not present it because of the limitation of the table. Merge information: First Union merged with Wachovia in September 2001. Chase Manhattan merged with J P Morgan in January 2001 to become J P Morgan Chase; data prior to the merge is that of Chase Manhattan. Citicorp merged with SSB to become Citigroup in October 1998; data prior to the merge is Citicorp.

**TABLE 3**  
**Reporting details for the 17 U.S. Banks**

<b>Bank</b>	<b>2001</b>	<b>2000</b>	<b>1999</b>	<b>1998</b>	<b>1997</b>	<b>1996</b>
BANK ONE	I, FX, E, Total	I, FX, E, Total	I, FX, E, Total	I, FX, E, C, Total	I, FX, E, C, Total	Total
POPULAR	Total	Total	Total			
PACIFIC CENTURY	FX	FX	FX	FX	FX	
BANK OF NEW YORK	I, FX, Total	I, FX, Total	I, FX, Total	I, FX, Total	I, FX, Total	
J P MORGAN CHASE	I, FX, E, C, HF, Total	I, FX, E, C, HF, Total	I, FX, E, C, HF, Total	I, FX, E, C, Total	I, FX, E, C, Total	Total
CITICORP	I, FX, E, C, Total	I, FX, E, C, Total	I, FX, E, C, Total	I, FX, E, C, Total	I, FX, E, C, Total	
ALLFIRST	Total	Total	Total	Total	Total	
FLEETBOSTON	I, FX, E, Total	I, FX, E, Total	I, FX, E, C, Total	I, FX, E, C, Total		
MELLON	Total	Total	Total	Total	Total	Total
BANK OF AMERICA	I, FX, E, C, FI, Total	I, FX, E, C, FI, Total	I, FX, E, C, FI, Total	I, FX, E, C, FI, Total		
NATIONAL CITY	Total	Total	Total	Total	Total	
NORTHERN TRUST	Total	Total	Total	Total	Total	
PNC	Total	Total	Total	Total	Total	
KEYCORP	Total	Total	Total	Total	Total	
STATE STREET	I, FX	I, FX	I, FX	I, FX	I, FX	
WACHOVIA	I, FX, E, Total	I, FX, E, Total	I, FX, E, Total	I, Total	I, FX	
BOK	Total	Total	Total	Total		

Note: I = Interest rate, FX = Foreign Exchange, E = Equity, C = Commodity, HF = Hedge Fund, FI = Fix Income.

**TABLE 4****Panel A: Summary Statistics of Banks' Quarterly-Average VAR (\$ Millions)**

	Sample	Mean	Max	Min	Median	1st Qu	3rd Qu
BANK ONE	25	12.04	27.5	4	12.5	6.65	15
POPULAR	13	0.78	1	0.6	0.8	0.6	1
PACIFIC CENTURY	0	NA	NA	NA	NA	NA	NA
BANK OF NEW YORK	21	5.13	6.7	3.4	5.4	3.7	6.3
J P MORGAN CHASE	21	34.11	73.7	19.75	24.5	23	26.8
CITICORP	21	29.29	56	15	24	19	28
ALLFIRST	21	0.46	0.7	0.2765	0.4265	0.3	0.6
FLEETBOSTON	17	40.41	45	32	40	38	44
MELLON	25	2.60	6.5	1	2	1.5	3.5
BANK OF AMERICA	17	41.68	61.3	25.5	40.98	32.2	47.9
NATIONAL CITY	17	0.45	0.5	0.3	0.5	0.5	0.5
NORTHERN TRUST	21	0.20	0.285	0.091	0.209	0.181	0.233
PNC	21	0.57	1.05	0.3	0.55	0.3	0.775
KEYCORP	21	1.04	2	0.4	1	0.6	1.3
STATE STREET	18	2.89	5.4	0.6	2.1	0.9	5.05
WACHOVIA	21	11.90	17.5	7	12	11	12
BOK	17	1.24	3.1	0.101	0.5865	0.3315	2.15
Overall	317	11.32	73.7	0.091	3.1	0.6	17

**Panel B: Summary Statistics of Banks' End-Quarter VAR (\$ Millions)**

	Sample	Mean	Max	Min	Median	1st Qu	3rd Qu
BANK ONE	25	12.14	29	3.9	12	5.1	14
POPULAR	13	0.77	1	0.6	0.8	0.6	1
PACIFIC CENTURY	0	NA	NA	NA	NA	NA	NA
BANK OF NEW YORK	21	5.18	8.6	2.9	5.2	3.6	6.2
J P MORGAN CHASE	21	35.46	93.3	18.8	24.4	23	28.9
CITICORP	21	29.38	56	15	24	20	32
ALLFIRST	21	0.47	0.7	0.253	0.4265	0.3	0.6
FLEETBOSTON	17	43.59	78	31	43	38	44
MELLON	25	2.68	7	1	2	2	3
BANK OF AMERICA	17	40.15	61.3	21	39.6	31.7	47.9
NATIONAL CITY	17	0.45	0.5	0.3	0.5	0.5	0.5
NORTHERN TRUST	21	0.17	0.285	0.052	0.181	0.091	0.233
PNC	21	0.58	1.2	0.3	0.6	0.3	0.7
KEYCORP	21	0.98	1.6	0.3	1	0.6	1.3
STATE STREET	18	2.89	5.4	0.6	2.1	0.9	5.05
WACHOVIA	21	12.05	19	6	12	11	13
BOK	17	1.16	3.1	0.045	0.539	0.227	2.1
Overall	317	11.52	93.3	0.045	3.1	0.6	16

Note: The VAR measures of Pacific Century are only about foreign exchange.

**TABLE 5****Panel A: Summary Statistics of Banks' Quarterly Trading Revenue (\$ Millions)**

	Sample	Mean	Max	Min	Median	1st Qu	3rd Qu
BANK ONE	25	82.2	277.0	5.4	64.0	20.5	130.0
POPULAR	25	0.6	4.0	-2.0	1.0	0.0	2.0
PACIFIC CENTURY	19	1.3	21.2	-18.2	0.5	-0.1	2.6
BANK OF NEW YORK	24	119.7	338.3	10.1	88.3	50.8	172.6
J P MORGAN CHASE	24	#####	#####	62.5	1223.0	789.3	#####
CITICORP	24	#####	#####	295.0	1725.0	#####	#####
ALLFIRST	0	NA	NA	NA	NA	NA	NA
FLEETBOSTON	20	215.0	873.0	7.5	100.5	46.9	259.3
MELLON	24	166.0	859.0	21.2	89.5	50.7	166.0
BANK OF AMERICA	24	386.1	#####	38.9	192.3	132.0	511.2
NATIONAL CITY	24	373.7	#####	-0.2	8.8	0.9	433.5
NORTHERN TRUST	24	90.6	264.0	-38.7	67.1	31.3	129.8
PNC	24	44.2	176.2	-34.3	18.3	-0.3	86.1
KEYCORP	24	36.8	117.4	-37.7	29.1	20.0	50.4
STATE STREET	24	126.8	293.8	35.1	116.5	73.2	166.8
WACHOVIA	24	121.0	386.9	3.4	56.5	16.9	211.5
BOK	24	54.6	345.0	1.0	21.1	3.0	72.6
Overall	377	389.0	#####	-38.7	73.9	12.5	224.8

**Panel B: Summary Statistics of Banks' Quarterly Trading Assets (\$ Millions)**

	Sample	Mean	Max	Min	Median	1st Qu	3rd Qu
BANK ONE	25	9120	92890	196	8397	874	10040
POPULAR	25	265	372	153	270	225	299
PACIFIC CENTURY	19	12	30	2	10	7	14
BANK OF NEW YORK	24	4459	12051	586	2170	1644	8734
J P MORGAN CHASE	24	86634	250550	8357	63343	57567	71532
CITICORP	24	88592	208216	28432	107920	34872	124039
ALLFIRST	0	NA	NA	NA	NA	NA	NA
FLEETBOSTON	20	2080	7819	156	494	230	2097
MELLON	24	1839	7312	300	668	547	971
BANK OF AMERICA	24	28660	66311	773	23714	14318	52366
NATIONAL CITY	24	19730	77287	12	28	19	59378
NORTHERN TRUST	24	227	597	22	204	163	275
PNC	24	199	476	9	191	123	265
KEYCORP	24	525	1521	92	321	188	657
STATE STREET	24	1332	2058	702	1357	949	1559
WACHOVIA	24	1694	3762	665	1420	1055	2148
BOK	24	3810	28227	3	800	6	1038
Overall	377	16910	250550	2	877	220	8680

Note: Allfirst is a bank holding company but not publicly traded.

**TABLE 6****Panel A: Summary Statistics of Banks' Quarterly Total Assets (\$ Millions)**

	Sample	Mean	Max	Min	Median	1st Qu	3rd Qu
BANK ONE	25	2E+05	3E+05	95708	3E+05	1E+05	269425
POPULAR	25	22974	30745	15805	23174	19301	27230
PACIFIC CENTURY	21	14295	15017	12905	14295	13987	14731
BANK OF NEW YORK	24	66664	89677	51499	63658	59823	75567
J P MORGAN CHASE	24	4E+05	8E+05	79607	4E+05	3E+05	398560
CITICORP	23	4E+05	7E+05	3E+05	3E+05	3E+05	411939
ALLFIRST	21	15782	18551	9799	17507	11246	17991
FLEETBOSTON	24	99219	2E+05	17713	92708	82974	107311
MELLON	24	78418	2E+05	41582	47398	43703	49732
BANK OF AMERICA	24	3E+05	7E+05	32798	2E+05	2E+05	614138
NATIONAL CITY	24	2E+05	7E+05	35110	84058	52510	612297
NORTHERN TRUST	24	48424	1E+05	20302	28394	25050	85918
PNC	24	59615	77207	33219	71895	37683	73662
KEYCORP	24	71940	80889	64764	70762	69149	75494
STATE STREET	24	59124	87270	27229	50179	36366	83733
WACHOVIA	24	59890	73298	45425	64376	48302	66082
BOK	22	37941	76853	4240	35627	5314	70312
Overall	401	#####	#####	4240	69660	31520	113100

**Panel B: Summary Statistics of Banks' Quarterly Book Value (\$ Millions)**

	Sample	Mean	Max	Min	Median	1st Qu	3rd Qu
BANK ONE	25	15300	20870	8185	18630	9916	19900
POPULAR	25	1585	2199	1060	1577	1350	1736
PACIFIC CENTURY	21	1165	1372	1047	1167	1082	1212
BANK OF NEW YORK	24	5354	6467	4804	5137	4964	5609
J P MORGAN CHASE	24	23796	42004	6178	21561	18732	23298
CITICORP	23	25949	47912	17684	22569	19400	28867
ALLFIRST	21	1684	1981	1138	1823	1232	1906
FLEETBOSTON	24	8050	15606	1656	7636	6168	9112
MELLON	24	6898	19454	3332	4059	3565	4507
BANK OF AMERICA	24	24018	47223	3443	20378	10886	45304
NATIONAL CITY	24	17893	50084	2790	6057	4342	46978
NORTHERN TRUST	24	3410	7672	1349	1866	1565	6509
PNC	24	4471	6036	2132	5470	2590	5789
KEYCORP	24	5740	6822	4674	5881	5056	6184
STATE STREET	24	4017	6702	1560	2353	1895	6474
WACHOVIA	24	3780	5376	2441	3690	3219	3882
BOK	22	3159	6865	306	2961	396	5799
Overall	401	9293	50080	306	5338	2046	9665

**TABLE 7****Panel A: Summary Statistics of Banks' Quarterly Notional Amount (\$ Billions)**

	Sample	Mean	Max	Min	Median	1st Qu
BANK ONE	25	490.0	1332.5	0.1	729.6	0.8
POPULAR	25	0.1	1.8	0.0	0.0	0.0
PACIFIC CENTURY	19	0.6	0.9	0.0	0.6	0.4
BANK OF NEW YORK	24	7006.5	162229.3	58.1	295.9	195.9
J P MORGAN CHASE	24	11042.7	24199.1	413.9	9612.6	6711.4
CITICORP	24	6362.8	23520.4	1883.8	5340.6	2566.7
ALLFIRST	0	NA	NA	NA	NA	NA
FLEETBOSTON	20	74.2	308.7	7.8	16.7	11.5
MELLON	24	92.8	287.6	32.4	52.2	40.9
BANK OF AMERICA	24	2274.6	6059.9	41.9	1509.0	829.9
NATIONAL CITY	24	2414.0	9633.7	1.9	10.3	5.8
NORTHERN TRUST	24	18.0	47.5	1.6	14.4	13.2
PNC	24	64.1	1212.8	2.7	15.3	10.1
KEYCORP	24	30.5	56.9	8.2	30.8	21.7
STATE STREET	24	80.9	138.6	42.4	74.8	61.0
WACHOVIA	24	88.8	201.2	7.9	73.0	11.5
BOK	24	310.4	2104.7	0.0	23.2	0.0
Overall	377	1945.0	#####	0.0	41.4	10.6

Note: The period for the summary statistics of Table 5, 6 and 7 is from 1996 through 1<sup>st</sup> quarter

2002. Allfirst is a wholly owned subsidiary of Allied Irish Banks, (AIB), an Irish banking corporation. It is a bank holding company in U.S. but not publicly traded.

**TABLE 8**

**Regressions of Absolute Value of Q t+1 Unexpected Trading Revenue on Q t  
VAR-Based Volatility and Notionals**

$$|R_{i,t+1} - E[R_{i,t+1}]|/A_{i,t} = a_i + b_i(\sigma_{i,t}/A_{i,t}) + c_i(NOT_{i,t}/A_{i,t}) + \varepsilon_{i,t+1}$$

Samples	Obs	OLS				Z
		Constant	$\sigma_t$ Slope b	$NOT_t$ Slope c	R-square	
Overall	263	0.0339 (3.53)	0.6398* (3.64)	0.2675* (2.98)	16.02%	1.90
Prior to 12 quarters	100	0.0006 (0.06)	0.4383* (3.88)	0.6567* (8.65)	42.30%	
Last 12 quarters	163	0.0474 (4.42)	1.0645* (3.43)	0.0654 (1.08)	15.04%	1.94
Small	156	0.0694 (5.55)	0.2383 (1.29)	0.3249* (3.01)	13.12%	
Big	107	0.0062 (0.78)	0.9004* (3.15)	0.0250 (0.38)	54.39%	

Note:  $R_{i,t+1}$  is the quarterly trading revenue,  $E[R_{i,t+1}]$  is the expected trading revenue in quarter t+1 based on a moving average of the last four quarters,  $\sigma_{i,t}$  is the ending of VAR-based unexpected trading revenue for banks  $i$  in quarter t, and  $NOT_{i,t+1}$  is the ending of notional derivatives amount for banks  $i$  in quarter t. The variables are scaled by the previous quarter's trading assets  $A_{i,t}$ . The Z value is defined as  $\frac{b2 - b1}{\sqrt{Var(b1) + Var(b2)}}$ . Significantly at the 0.01 level denoted by \*.

**TABLE 9**

**Regressions of Absolute Value of Q t Unexpected Trading Revenue on Q t  
VAR-Based Volatility and Notionals**

$$|R_{i,t} - E[R_{i,t}]|/A_{i,t} = a_i + b_i(\sigma_{i,t}/A_{i,t}) + c_i(NOT_{i,t}/A_{i,t}) + \varepsilon_{i,t}$$

Samples	Obs	OLS				Z
		Constant	$\sigma_t$ Slope b (t – statistics)	$NOT_t$ Slope c (t – statistics)	R-square	
Overall	262	0.0251 (2.64)	0.6410* (4.42)	0.3730* (3.86)	23.22%	1.78
Prior to 12 quarters	101	-0.0016 (-0.14)	0.4964* (4.93)	0.6795* (6.03)	54.01%	
Last 12 quarters	161	0.0437 (3.95)	1.1248* (3.32)	0.0696 (0.93)	12.51%	
Small	156	0.0599 (4.98)	0.2701 (1.94)	0.4271* (3.96)	22.29%	2.26
Big	106	0.0084 (1.32)	0.8232* (4.10)	0.0076 (0.13)	57.59%	

Note:  $R_{i,t}$  is the quarterly trading revenue,  $E[R_{i,t}]$  is the expected trading revenue in quarter t based on a moving average of the last four quarters,  $\sigma_{i,t}$  is the average of VAR-based unexpected trading revenue for banks  $i$  in quarter t, and  $NOT_{i,t+1}$  is the average of notional derivatives amount for banks  $i$  in quarter t. The variables are scaled by the quarter's average trading assets  $A_{i,t}$ . The Z value is defined as  $\frac{b2 - b1}{\sqrt{Var(b1) + Var(b2)}}$ . Significantly at the 0.01 level denoted by \*.

**TABLE 10**

**Regressions of Variance of Q t+1 Return on Variance of Q t+1 Market Return, Q t VAR-Based Volatility and Notionals**

$$Var(Daily\ Return)_{i,t+1} = a_i + b_i Var(Market\ Return)_{i,t+1} + c_i (\sigma_{i,t} / A_{i,t}) + d_i (NOT_{i,t} / A_{i,t}) + \varepsilon_{i,t+1}$$

Samples	Obs	OLS					Z
		$Var(MR)_{t+1}$	$\sigma_t / A_t$	$NOT_t / A_t$			
		Constant	Slope b	Slope c	Slope d	R-square	
Overall	218	0.0078 (6.26)	1.2004* (12.09)	0.2756* (2.74)	0.0001* (2.21)	36.03%	
Prior to 12 quarters	106	0.0062 (4.26)	1.3578* (10.26)	0.1358 (1.34)	0.0001* (3.50)	47.88%	2.60*
Last 12 quarters	112	0.0090 (3.94)	0.9981* (6.59)	0.8237* (3.37)	0.0029 (1.72)	25.25%	
Small	130	0.0079 (5.14)	1.1873* (9.23)	0.2783* (2.57)	0.0020 (1.15)	37.13%	0.88
Big	88	0.0063 (2.95)	1.2193* (8.04)	0.5474 (1.91)	0.0001* (2.46)	35.96%	

Note:  $Var(Daily\ Return)_{i,t+1}$  is the variance of daily return of bank  $i$  for the quarter  $t+1$ ,  $Var(MR)_{t+1}$  is the variance of daily return on a value-weighted market portfolio for the quarter  $t+1$ ,  $\sigma_{i,t}$  is the end-quarter VAR-based volatility in unexpected trading revenue for banks  $i$  in quarter  $t$ , and  $NOT_{i,t+1}$  is the notional amount of derivatives for banks  $i$  in quarter  $t+1$ . The variables  $(\sigma_{i,t}, NOT_{i,t+1})$  are scaled by the book value  $A_{i,t}$ . The Z value is defined as

$$\frac{c2 - c1}{\sqrt{Var(c1) + Var(c2)}}. \text{ Significantly at the 0.01 level denoted by *.$$

**TABLE 11**

**Regressions of Variance of Q t Return on Variance of Q t Market Return, Q t VAR-Based Volatility and Notionals**

$$Var(Daily\ Return)_{i,t} = a_i + b_i Var(Market\ Return)_{i,t} + c_i(\sigma_{i,t}/A_{i,t}) + d_i(NOT_{i,t}/A_{i,t}) + \varepsilon_{it}$$

Samples	Obs	OLS					Z
		$Var(MR)_t$	$\sigma_t/A_t$	$NOT_t/A_t$			
		Constant	Slope b	Slope c	Slope d	R-square	
		(t – statistics)					
Overall	226	0.0074 (6.25)	1.2118* (12.71)	0.2978* (2.97)	0.0001* (2.44)	38.14%	
Prior to 12 quarters	103	0.0061 (4.38)	1.3624* (10.69)	0.1500 (1.38)	0.0001* (3.59)	50.52%	2.54*
Last 12 quarters	123	0.0086 (4.09)	1.0196* (6.97)	0.7926* (3.47)	0.0025 (1.62)	27.30%	
Small	135	0.0073 (4.83)	1.2322* (9.77)	0.3309* (2.95)	0.0018 (1.07)	39.35%	0.55
Big	91	0.0067 (3.22)	1.1773* (8.38)	0.4892 (1.85)	0.0001* (3.27)	37.81%	

Note:  $Var(Daily\ Return)_{i,t}$  is the variance of daily return of bank  $i$  for the quarter  $t$ ,  $Var(MR)_t$  is the variance of daily return on a value-weighted market portfolio for the quarter  $t$ ,  $\sigma_{i,t}$  is the average of VAR-based volatility in unexpected trading revenue for banks  $i$  in quarter  $t$ , and  $NOT_{i,t+1}$  is the average notional amounts of derivatives amount for banks  $i$  in quarter  $t$ . The variables  $(\sigma_{i,t}, NOT_{i,t})$  are scaled by the quarter's average book value  $A_{i,t}$ . The Z value is defined as  $\frac{c2 - c1}{\sqrt{Var(c1) + Var(c2)}}$ . Significantly at the 0.01 level denoted by \*.