Bank Trading Revenues, VaR, and Market Risk

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1. Introduction

The measurement of market risk in financial portfolios using Value at Risk (VaR) has become widely accepted and a large literature exists on VaR measurement. More recently, the literature has been extended to the effects of VaR constraints on risk taking and market volatility. A number of papers have been critical of VaR constraints (e.g., Basak and Shapiro (2001), Danielsson, Shin, and Zigrand (2001), Morris and Shin (1999), Leippold, Trojani, and Vanini (2003), Persaud (2000)). One argument is that management will take more extreme risks under VaR-based constraints. This will lead to larger losses by firms that use VaR. Portfolio constraints based on expected losses are said to have better incentive properties.

A second argument is that changes in market volatility will affect the measured VaRs of different market participants. In response, financial firms will simultaneously adjust their portfolios to satisfy the VaR-constraints. This will produce market herding and thus can cause wider swings in market prices. As a result, the wide-spread use of VaR could increase market volatility.

Taking a different approach from others, Cuoco and Liu (2003) model risk taking effects of a VaR capital constraint coupled with penalties based on the frequency and size of return breaches of VaR. This approach is intended to be more consistent with regulatory VaR-based capital requirements. In their model with attendant penalties, a VaR capital constraint is effective in controlling risk.

Despite the large literature, only a few papers have looked at VaR performance in practice (Berkowitz and O'Brien (2002) and Jaschke, Stahl, and Stehle (2003), using daily revenues and VaRs for U.S. and German banks respectively; Jorion (2002) and Hirtle (2003), using quarterly U.S. bank trading return and VaR data). We are not aware of any empirical evidence on the effects of VaR on risk management or market volatility. The lack of empirical study owes to the limited availability of high-frequency data on portfolio positions, returns, and VaRs.

In this paper, we provide evidence on the relation between bank dealer trading revenue and VaR and their relation to market factors. Bank dealers are subject to a VaR constraint in the form of minimum market risk capital requirements based on internal daily VaRs intended to have a 99-percentile coverage. Our data consists of proprietary daily trading revenue and VaR for 7 large U.S. trading banks. The market factors include currency exchange rates, interest rates, equity returns, and credit spreads. Relationships between both the level and volatility of daily trading revenues and the market factors are examined; as is the relation between VaRs and market factor volatility. The first part of the analysis looks at characteristics of the banks' daily trading returns and VaRs. Several of these characteristics and the relationship of VaR to market volatility do not fit well with some of the paradigms about VaR-based risk management and market volatility.

As with Berkowitz and O'Brien (2002) and Jaschke, Stahl, and Stehle (2003), we find with our expanded data that bank VaRs are conservative relative to prescribed VaR levels. In standard models of a VaR-constrained portfolio, conservativeness would imply the VaR constraint is not binding. However, banks are also subject to penalties related to the frequency of losses in excess of their VaRs. As a result, the bank's optimal coverage level may be both higher than and increasing in the regulatory prescribed VaR coverage level (see Cuoco and Liu (2003)).

While conservative, bank VaRs might still contain forecast information about the bank's trading risk. Using quarterly data, Jorion (2002) and Hirtle (2003) reported that bank VaRs had power in forecasting future trading return volatility. Berkowitz and O'Brien (2002) found that daily GARCH-based VaR forecasts tend to be better forecasts for 1-day ahead volatility than bank VaRs. They did not test whether bank VaRs had any forecast power. In testing the hypothesis here using our daily data, we also find daily VaRs have power in forecasting 1-day ahead trading return volatility.

Even though VaRs are conservative and have forecast power, the issue of whether a VaR constraint increases extreme losses remains. This possibility cannot be formally tested with our data without knowing the return distribution absent a VaR constraint. Nonetheless, Basak and Shapiro (2002) predict highly distinctive characteristics of portfolio return distributions under VaR-constrained risk management. However, kernel density plots of the banks' trading return distributions conditioned on their VaRs do not appear to have these characteristics.

In relating trading revenues to market risks, we first use a linear market factor model for trading returns. The factor regression approach has been employed to estimate market risks for financial institution portfolios and shareholder market equity. The factors cover exchange rate, (default-free) interest rate, equity, and credit market risk categories. Regression results show trading returns are negatively related to interest rate factors, suggesting positive interest rate durations. While other market factors exhibit significant coefficients, signs vary across banks and individual factors, indicating no consistent pattern of directional market risk exposures. We interpret these results as suggesting that trading portfolios are different from investment-oriented financial portfolios and that standard factor regression models may not be adequate to measure trading risk exposures.

The factor regression results do not necessarily mean that trading returns are not subject to a broad spectrum of market risks. In a second set of tests, we look at the trading revenue volatility and the volatility of the market factors. Using absolute value as a measure of volatility, we find that on days of high (low) market volatility, bank trading return volatility also is high (low). The positive relation between trading revenue volatility and market factor volatility holds across banks and for the different market risk categories. These results imply that bank trading returns are related to market risk, although they do not identify direction of the exposures. They also indicate a commonality in market risk across the banks, although not necessarily common directional exposures. Nonetheless, cross-bank trading revenue correlations are positive, as are cross-bank correlations for absolute trading revenues.

In contrast to bank trading revenue volatility, VaR levels on high market volatility days are not are not consistently higher than levels on low market volatility days. This result generally holds across banks and across market risk categories. Thus, the observed VaR forecast power for trading revenue volatility does not appear due to forecasts of market volatility. The results also run counter to arguments that VaR usage creates herding behavior. Further, we find no systematic cross-bank VaR correlation—there are as many negative as positive cross-bank correlations.

2. Characteristics of the Bank Trading Returns and VaRs

The 1996 Basel Market Risk Amendment (effective January 1998) sets capital requirements for market risk for banks with large trading operations based on internal 99-percentile VaR estimates. The Market Risk Amendment also requires that banks keep records of daily trading revenues and 99 percentile VaRs with a 1-day horizon. The 1-day VaRs are used in monitoring the frequency of trading losses exceeding VaR ("back-testing"). For U.S. bank dealers, trading revenues used for back-testing include revaluations of mark-to-market positions plus net interest, fee, and spread income incidental to trading activities. However, banks generally calculate VaRs only for mark-to-market position revaluations due to changes in market risk factors. Most or all of the expected return is ignored in the VaR calculation. Different modeling approaches are used by the banks. Some use historical simulation, while others estimate explicit distributions (or a joint distribution) for the market risk factors.

Our bank data includes proprietary daily trading revenues and VaRs for 7 U.S. bank dealers. All 7 banks were subject to the Basel VaR-based capital requirements. Four of the banks were among the largest dealers worldwide and the other three were among the top 10 U.S. bank dealers. The maximum sample period is Jan. 1998 – Dec. 2002. For 4 banks, we have data for most or all of the full period, while the others data is available only for a part of the period.

Kernel densities for the banks' trading revenues are plotted in Figure 1. The benchmark normal distributions have the same mean and standard deviation as the plotted trading revenues. The high peaks and occasional outlier values are indicative of high kurtosis in dealer returns (the minimum excess kurtosis is 4 and the median is 10.7).

In Table 1, some descriptive statistics of our data are presented. First note that all dollar values are divided by the bank's trading revenue standard deviation. Also, mean daily trading revenues includes fee and spread income as well as portfolio revaluations and net interest income. The VaR literature has treated risk and return as portfolio driven but, for bank dealers, fee and spread income are also integral to trading.

Average bank VaRs shown in the fourth column of Table 1 are conservative relative to the 1-percent quantile for trading revenue, with an average violation rate of only about .3 percent. However, as noted above, bank VaRs forecast potential trading losses ignoring most or all of the expected trading return. In a mechanistic sense, this may account for some of the VaR conservativeness but not all. Even if we de-mean daily trading revenues and unrealistically assume that non-trading income has no daily volatility, bank VaRs would still be conservative for 4 of the 7 banks. Jaschke, Stahl, and

Stehle (2003) examined VaRs for German banks in 2001, where trading revenue was "cleaned" of components other than position revaluations. They too found the German bank VaRs to be conservative.

Though conservative, VaRs may still have forecast value for the volatility of trading revenue. Jorion (2002) and Hirtle (2003) reported that bank VaRs had power in forecasting future trading return volatility using quarterly data. Berkowitz and O'Brien (2001) reported that reduced-form daily GARCH-based VaRs tended to be superior to bank VaRs in forecasting 1-day ahead trading return volatility. To test for bank VaR forecast content with daily data, each bank's 1-day ahead absolute trading revenue was regressed on the VaR forecast and a time trend. The VaR regression coefficients, reported in the last column in Table 1, are all positive with 4 banks having significant coefficients at the .01 level. The preponderance of positive coefficients suggests that bank VaRs do contain forecast power. There is still an issue of what explains the forecast power. This is taken up in section 4.

A final exercise concerns the distribution of trading returns under a VaR-based constraint. Because VaR constrains only the probability of a large loss, not the size, it is argued that a VaR constraint will provide incentives to increase extreme risk-taking. Since the distribution of trading revenue absent a VaR constraint is not known, this proposition cannot be directly tested. However, Basak and Shapiro (2001) predict highly distinctive characteristics for a risk-averse agent's terminal wealth under a VaR-constraint on a portfolio that includes risky stocks with normal returns. Under the VaR constraint, the probability of terminal wealth less than some specified $\underline{W}$ cannot exceed α. For a binding constraint, Basak and Shapiro predict that the optimizing agent will insure against moderately low levels of wealth, i.e., $\Pr(\underset{\sim}{W} < W < \underline{W}) = 0$ and increase the probability of very low wealth levels, i.e., $\Pr(W < \underset{\sim}{W}) = \alpha$. Further, the constrained agent will shift the distribution of terminal wealth in the no-violation range such that there is a probability mass build-up at the VaR boundary $\underline{W}$ (pp. 377-380, and Figure 2).

Testing these predictions is difficult, not only because return distributions absent a VaR constraint are not known, but also because return distributions and VaRs change from day-to-day. However, to see if there is any indication of the predictions in the bank VaR and trading revenue data, each bank's daily revenue was divided by the 1-day VaR forecast for that day. Under this scaling, for any bank and on any day, a violation occurs if the scaled return is less than -1 (VaR is positive). Thus, we are looking to see if there is a probability mass build-up at (or slightly right of) -1, a noticeable drop in the density slightly left of -1, and an increase in the density far to the left of -1.

The VaR-scaled daily revenues were pooled for all 7 banks (7,125 observations) and a kernel density for the pooled observations is plotted in Figure 2. Looking at Figure 2, especially the enlargement of the lower tail, there does not appear to be any probability mass build-up at (or just right of) -1. Nor is there a noticeable drop in the density just to the left of -1. There is some variation in the density in the lower tail but there is no clear indication that banks are limiting violations mainly to extreme losses. The same plotting exercises were done for each individual bank and the individual bank plots give the same pictures. The informal nature of this exercise however limits its conclusiveness.

3. Trading Revenues and Market Factors

a. Trading Revenues in Market Factor Regressions

We first study the relation between bank trading returns and market risk using a market factor regression model. The market factors are the type commonly used in bank VaR models. The market factor regression model is a standard approach to estimating financial institution portfolio or market equity exposures to market risk. The purpose here is to identify trading return market risk exposures and whether there are common exposures across banks.

Daily time series were constructed for 11 market factors in 4 broad market risk categories between 1998 and 2002: exchange rates, (default-free) interest rates, equity returns, and credit spreads. The individual market factors in each market risk category are listed in Table 2a. Exchange rate factors are by region, with regional rates equal to a weighted average of selected individual country weights (Table 2b). The country weights are based on world-wide dealer FX spot and derivatives turnover reported in BIS Central Bank Surveys in 1998 and 2001.

The market factors are expressed as daily log differences (exchange rates and equity returns) and first differences (interest rates and credit spreads). Days were deleted for all market factors for which data was missing for any single factor. Where days were deleted, the differences or log differences uses the two adjacent days on which observations are available. A total of 63 days were deleted, leaving 1,238 difference or log difference observations for each market factor.

Regression results are reported in Table 3a and F-statistics for market risk categories in Table 3b. For the market factors combined, F values indicate significance for all banks but bank 7. Also, F-values for individual market risk categories are frequently significant. For the two interest rate factors, coefficients are consistently negative across the banks. Interpreting the interest rate variables as yield curve factors, the negative coefficients are consistent with positive durations for bank trading portfolios. Bank trading portfolios (including the banks here) maintain consistently high net assets to gross assets, with substantial long positions in government, agency and corporate debt securities. This may explain positive trading portfolio durations. However, maturity information for trading portfolios is not reported and liabilities are only summarily reported as short positions and derivatives revaluation losses.

In contrast to the consistency of the interest rate coefficients, for the other market factors, signs vary across banks and individual factors and significance tends to be weaker. The results indicate no consistent directional exposures to non-interest rate factors. This, however, may not mean that trading portfolios are not consistently exposed to market risks or even that exposures are not common across banks. Trading income includes more than a return to the portfolio. But even at the portfolio level, trading exposures to different market factors often vary, including not only the size of the exposures but also the direction. This variation, particularly between short and long exposures, limits the linear factor model in measuring trading market risk exposures. These results may be indicative of a significant difference between investment-oriented portfolios, such as institutional funds, and trading portfolios.

b. Trading Revenue Volatility and Market Volatility

In a second exercise, we consider market risk exposure in terms of volatility, rather than in terms of directional exposures. For this purpose, days in which absolute changes in each market factor are in the lower and upper 20 percentiles are identified. For each market risk category (e.g., exchange rates), low volatility days are defined as days when an absolute change for at least one factor in that category is in the low 20 percentile, i.e., the union of low volatility days for factors belonging to a market risk category. Analogously, high volatility days are those days when an absolute change for at least one factor in the category is in the high 20 percentile. For all market risk categories combined, a low (high) market volatility day is defined as the intersection of low (high) volatility days for the 4 market risk categories.

Table 4 reports mean and median absolute values for each market factor for low volatility and high volatility days for the different market risk categories. For factors that belong to the designated category, the factor means and medians are consistently lower on low volatility days than the mean and median values on high volatility days. Thus, defining low and high volatility for a market risk category based on the procedure used here seems appropriate. Regarding factors that do not belong to the category (non-category factors), there is a weaker but still pervasive tendency for the non-category factors to be lower on the category's low volatility days than on its high volatility days. Thus there is some positive correlation in volatility across market risk categories.

To determine if trading risk, i.e., trading return volatility, is related to market volatility, mean and median absolute values for each bank's trading revenues are calculated for low and high volatility days for each market risk category and for the intersection of all categories. Since market factors are correlated across categories, the mean and median trading revenue volatilities cannot reliably be determined for a specific market risk category. However, calculating trading revenue volatilities by category breakdown is still beneficial in that it makes a more complete use of the market volatility samples. The bank's trading revenue observations are limited to days on which the bank reported trading revenue. Generally, this is the bank's historical sample period.

Mean and median absolute trading revenue calculations are reported in Table 5. While there are some exceptions, means and medians are mostly higher on the days of high market volatility than on days of low market volatility. This holds for all banks, although it is weaker for bank 7. It also holds for each individual market risk category, although it is weaker for exchange rates. The results in Table 5 provide strong evidence that bank trading risk is related to market risk in terms of volatility.

As the correlation with market volatility holds for most if not all 7 banks, the results further imply that there is commonality in the bank dealer's market risk exposures in terms of volatility. Also, as shown in Table 6, unconditional cross-bank correlations for absolute trading revenue are mostly positive (cross-bank VaR correlations in the lower diagonal are discussed below). Whether the direction of market exposures also is common cannot be determined from the test. However, Berkowitz and O'Brien (2001) reported positive cross-bank unconditional correlations for daily trading returns and the positive correlations remain using our expanded data set.

4. VaR and Market Volatility

In a final set of tests, we look at the relation between bank daily VaRs and 1-day ahead market volatility using the same approach used for trading revenue volatility. Specifically, mean and median daily VaRs are calculated for (1-day ahead) low and high volatility days for each market risk category and for the intersection of all categories.

Results are presented in Table 7. In a simple count across the 7 banks and across the 5 market risk categories, 55 percent of the mean and 57 percent of the median VaR calculations are higher on high volatility days than on low volatility days. Thus, for little more than half of the means and medians are VaRs higher on high volatility days. The differences between low and high volatility sample means and medians also are typically small. The results do not support the hypothesis that VaRs for the banks studied here are predicting changes in market volatility.

The results also can be compared to Berkowitz and O'Brien (2002), who found that reduced-form GARCH-based VaR forecasts tended to be superior to bank VaRs in predicting both mean and trading revenue volatility. The GARCH-based VaR forecasts would capture persistence in trading return volatility that comes from multiple sources, one of which would be persistence in market volatility.

A was reported in Table 1, bank VaRs have forecast power for market volatility. The daily VaRs are based on current-day positions and historical information on market risk factors and their volatility. Both sets of conditioning information may have predictive content for future trading return volatility, which depends on future positions and future market volatility. The results here on bank VaRs and in Berkowitz and O'Brien (2002) suggest that the bank VaR predictive power may not be coming from forecasting future market volatility.

Finally, if bank VaRs have little power in forecasting market volatility, this would remove an important source of common variation in bank VaRs that has been said to create herding behavior in market trading. A lack of common variation in bank VaRs can also be seen in cross-bank correlations presented in Table 6, lower diagonal. While many of the correlation coefficients have significance, 10 are positive and 11 are negative.

5. Conclusions

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Table 1. Descriptive Statistics for Daily Trading Revenue and 1-day VaR
(dollar variables are divided by trading revenue sample standard deviation)

			trading revenue		VaR		
bank	dates	sample size	mean	1% quantile	mean	violation rate (%)	|revenue|[1] on VaR
bank 1	1/98-12/00	762	1.05	-1.74	1.94	0.39[a]	0.09
bank 2	1/98-9/00	711	0.79	-1.95	1.70	0.84	0.26**
bank 3	1/98-1/02	1274	0.72	-2.21	4.42	0.31**	0.06**
bank 4	1/98-12/02	1285	0.89	-1.54	7.10	0**	0.06**
bank 5	1/98-12/02	1301	0.53	-2.63	4.35	0.31**	0.06**
bank 6	1/98-6/02	1166	0.72	-1.38	2.08	0.26**	0.02
bank 7	10/98-3/01	626	0.39	-1.24	2.74	0.16**	0.03

1. Coefficients from a regression of day t+1 absolute trading revenue on VaR and the VaR forecast made on day t and a time trend.
[a] p-value < .06; *p-value < .05; **p-value < .01. For the violation rate, the null is 1 percent..

Table 2a. Market Factors[1]

Exchange Rates	Interest Rates	Equity Returns	Credit Spreads[2]
Western Europe (we)	6-mo T-bill (6mo)	NYSE	10- Baa (Baa spd)
Eastern Europe (ee)	10-yr T-bond (10yr)	NASDAQ	5-yr high yield (hi yld spd)
Asian Pacific (ap)			10-yr swap (swp spd)
South America (sa)			

1 Market factors are calculated at a daily frequency for 1998-2002. Observations for all factors are omitted on any day a single factor is missing. There were 63 missing days and a total of 1238 observations. Factors are expressed as 1-day log differences (exchange rate and equity prices) and first differences (interest rates and credit spreads). On missing days, changes are based on the two observed adjacent days.

2 Credit spreads are with respect to Treasury rates of the same maturity.

Table 2b. Exchange Rates (with U.S. dollar)[1]

Western Europe (1998)		Western Europe (1999 – 2002)		Asian Pacific		South America		Eastern Europe	
country	weight	country	weight	country	weight	country	weight	country	weight
Germany	.540	Euro	.633	Japan	.727	Mexico	.658	Russia	1.00
UK	.198	UK	.222	Austral	.136	Brazil	.342		
France	.092	Switzer	.102	HK	.075				
Switzer	.127	Sweden	.043	Sing	.035				
Sweden	.043			Korea	.027				

1. Region exchange rates are weighted log differences. Weights are based on world-wide dealer FX Spot and derivatives turnover volume reported for different currencies. Turnover volume is taken mostly from the 2002 BIS Central Bank Survey. The survey date is June April 2001. However, June 1998 turnover volume, from the 1999 Central bank Survey, is used to determine weights for Western Europe currencies for pre-Euro 1998 (country coverage in the 1998 survey is limited).

Table 3a. Trading Revenue on Market Factors with Lagged P&L and Time Trend (Including 3 Spreads)

$$PL_t = b_0 + b_1 (x_{we}) + b_2 (x_{ee}) + b_3 (x_{ap}) + b_4 (x_{sa}) + b_5 (\text{NYSE}) + b_6 (\text{NASDAQ}) + b_7 (r_{6mo}) + b_8 (r_{10yr}) + b_9 (r_{Baa\ spd}) + b_{10} (r_{hi\ yld\ spd}) + b_{11} (r_{swap\ spd}) + b_{12} (TrRev_{t-1}) + b_{13} (\text{Trend})$$

	Parameter	b_0	b_1	b_2	b_3	b_4	b_5	b_6	b_7	b_8	b_9	b_{10}	b_{11}	b_{12}	b_{13}
bank 1	Coeff Est	7.859	61.800	30.307	-293.082	-60.670	-167.860	45.919	-25.268	-20.024	-5.179	-1.078	-3.162	0.156	0.011
	Stand Err	0.962	86.998	14.155	68.209	76.375	56.205	26.891	11.196	12.924	19.492	8.838	14.330	0.036	0.002
	t-statistic	8.171	0.710	2.141	-4.297	-0.794	-2.987	1.708	-2.257	-1.549	-0.266	-0.122	-0.221	4.328	4.922
	F-statistic	8.588													
	R-Squared	0.135													
bank 2	Coeff Est	10.309	196.621	12.954	-265.262	-340.627	-310.378	125.935	-8.670	-1.961	58.575	13.053	14.140	0.235	0.013
	standard err	1.868	174.829	27.134	132.205	147.595	112.360	58.615	22.712	27.293	38.937	20.976	28.686	0.038	0.005
	t-statistic	5.520	1.125	0.477	-2.007	-2.308	-2.762	2.149	-0.382	-0.072	1.504	0.622	0.493	6.239	2.847
	F-statistic	6.715													
	R-Squared	0.116													
bank 3	Coeff Est	2.202	34.289	72.773	-58.127	78.169	27.969	24.063	-19.457	-17.318	-25.785	-17.095	6.565	0.299	0.008
	Stand Err	0.662	64.278	13.254	55.814	53.858	40.895	20.566	8.105	7.854	13.665	5.129	10.925	0.027	0.001
	t-statistic	3.329	0.534	5.491	-1.041	1.451	0.684	1.170	-2.401	-2.205	-1.887	-3.333	0.601	11.174	7.809
	F-statistic	30.030													
	R-Squared	0.242													
bank 4	Coeff Est	1.013	22.953	3.011	11.297	35.926	53.302	-3.762	-2.026	-0.396	4.315	-0.752	0.916	0.344	0.002
	Stand Err	0.186	17.743	3.646	15.414	14.970	11.303	5.667	2.241	2.162	3.767	1.405	3.017	0.026	0.000
	t-statistic	5.439	1.294	0.826	0.733	2.400	4.716	-0.664	-0.904	-0.183	1.145	-0.536	0.304	12.988	6.916
	F-statistic	27.874													
	R-Squared	0.229													
bank 5	Coeff Est	0.279	-11.753	2.540	-6.708	-13.963	-11.732	2.156	-1.801	-2.498	-1.324	-1.015	1.324	-0.044	0.001
	Stand Err	0.099	9.622	1.976	8.350	8.067	6.132	3.071	1.215	1.172	2.041	0.761	1.636	0.028	0.000
	t-statistic	2.825	-1.222	1.286	-0.803	-1.731	-1.913	0.702	-1.482	-2.132	-0.649	-1.334	0.810	-1.571	8.385
	F-statistic	7.518													
	R-Squared	0.074													
bank 6	Coeff Est	6.572	41.159	6.336	32.784	115.735	-41.036	-6.968	-37.840	-3.534	19.878	-18.486	-2.319	-0.003	0.004
	Stand Err	0.764	71.417	14.090	61.056	63.895	49.118	22.597	8.880	8.968	15.243	5.852	12.454	0.030	0.001
	t-statistic	8.603	0.576	0.450	0.537	1.811	-0.836	-0.308	-4.261	-0.394	1.304	-3.159	-0.186	-0.100	3.765
	F-statistic	4.000													
	R-Squared	0.045													
bank 7	Coeff Est	1.763	-20.968	-41.980	-13.997	-9.553	-6.840	8.228	-1.223	-7.135	-4.650	-3.543	8.277	0.131	-0.001
	Stand Err	0.369	32.058	14.338	29.547	29.234	22.131	9.224	3.986	4.677	6.840	3.090	5.193	0.040	0.001
	t-statistic	4.778	-0.654	-2.928	-0.474	-0.327	-0.309	0.892	-0.307	-1.526	-0.680	-1.147	1.594	3.241	-0.781
	F-statistic	2.477													
	R-Squared	0.051													

Table 3b. F-Tests of Linear Restrictions
(K = parameters, q = restrictions)

	unrestricted model (K = 14)		market factors = 0 (q = 11)		exchange factors = 0 (q = 4)		equity factors = 0 (q = 2)	
bank	observ	RSS_U	RSS_R	F	RSS_R	F	RSS_R	F
bank 1	728	104766	112986	5.09	108682	6.67	106068	4.44
bank 2	681	358482	377439	3.21	364810	2.94	362607	3.84
bank 3	1235	161734	170744	6.18	166240	8.51	162483	2.83
bank 4	1236	12369	12857	4.38	12460	2.24	12723	17.51
bank 5	1236	3634.01	3702	2.07	3657	1.89	3647	2.19
bank 6	1110	164883	169856	3.01	165509	1.04	165206	1.08
bank 7	620	11835.4	12136	1.40	12013	2.27	11853	0.44

	interest rate factors = 0 (q = 2)		credit factors = 0 (q = 3)	
bank	RSS_R	F	RSS_R	F
bank 1	106127	4.64	104790	0.05
bank 2	358570	0.08	360386	1.18
bank 3	163345	6.08	164412	6.74
bank 4	12378.2	0.45	12385	0.54
bank 5	3656.91	3.85	3644	1.16
bank 6	167744	9.51	166390	3.34
bank 7	11888	1.35	11922	1.48

Table 4. Market Factor Mean and Median Absolute Daily Changes Conditioned on Low and Hi Market Volatility*

Exchange Rate Volatility

	mean		median	
	low vol	hi vol	lo vol	hi vol
exchange rate log change				
w. europe	0.35	0.54	0.24	0.46
e. europe	0.43	0.99	0.05	0.15
asia/pacif	0.37	0.59	0.26	0.05
so amer	0.35	0.57	0.22	0.43
non-exchange rate factors				
nyse	0.87	0.95	0.70	0.73
nasdaq	1.72	1.87	1.40	1.47
6-mo treas	0.03	0.03	0.02	0.02
10-yr treas	0.05	0.05	0.04	0.04
Baa spd	0.02	0.03	0.02	0.02
hi yld spd	0.06	0.06	0.04	0.05
swap spd	0.02	0.02	0.02	0.02

Interest Rate Volatility

	Mean		median	
	low vol	hi vol	lo vol	hi vol
interest rate percentage rate change				
6-mo treas	0.01	0.06	0.01	0.05
10-yr treas	0.02	0.08	0.01	0.08
non-interest rate factors				
w. europe	0.37	0.48	0.30	0.38
e. europe	0.48	0.82	0.09	0.09
asia/pacif	0.42	0.49	0.32	0.36
so amer	0.40	0.49	0.27	0.35
nyse	0.76	1.07	0.62	0.81
nasdaq	1.53	2.07	1.19	1.72
Baa spd	0.02	0.04	0.01	0.03
hi yld spd	0.04	0.09	0.03	0.07
swap spd	0.02	0.03	0.02	0.02

Stock Volatility

	mean		median	
	low vol	hi vol	lo vol	hi vol
stock: log change				
nyse	0.34	1.69	0.21	1.62
nasdq	0.77	3.39	0.46	3.15
non-stock factors				
w. europe	0.40	0.48	0.33	0.41
e. europe	0.37	0.80	0.09	0.09
asia/pacif	0.44	0.49	0.33	0.38
so amer	0.39	0.48	0.29	0.36
6-mo treas	0.03	0.04	0.02	0.03
10-yr treas	0.04	0.06	0.03	0.05
Baa spd	0.02	0.03	0.02	0.02
hi yld spd	0.05	0.08	0.04	0.07
swap spd	0.02	0.03	0.02	0.02

Credit Spread Volatility

	Mean		median	
	lo vol	hi vol	lo vol	hi vol
credit spread: percentage rate change				
Baa spd	0.02	0.04	0.01	0.04
hi yld spd	0.04	0.09	0.02	0.09
swap spd	0.01	0.03	0.01	0.03
non-credit spread factors				
w. europe	0.42	0.46	0.34	0.37
e. europe	0.48	0.74	0.08	0.09
asia/pacif	0.45	0.47	0.33	0.34
so amer	0.41	0.48	0.27	0.33
6-mo treas	0.03	0.04	0.02	0.03
10-yr treas	0.03	0.06	0.03	0.05
nyse	0.79	1.06	0.66	0.79
nasdaq	1.66	2.09	1.37	1.79

Intersection of All Market Risk Categories

	mean		median	
	low vol	hi vol	lo vol	hi vol
log change				
w. europe	0.29	0.68	0.19	0.70
e. europe	0.26	1.90	0.07	0.12
asia/pacif	0.37	0.69	0.26	0.51
south amer	0.29	0.72	0.23	0.69
percentage rate change				
6 mo. treas	0.01	0.07	0.01	0.06
10 yr Tr	0.02	0.10	0.01	0.10
log change				
nyse	0.37	2.05	0.25	1.96
nasdaq	0.66	3.97	0.39	3.27
percentage rate spread change				
Baa spd	0.01	0.05	0.01	0.05
hi yld spd	0.02	0.14	0.01	0.12
swap spd	0.01	0.04	0.01	0.03

* Low and High volatility samples for market risk categories: For each market risk category, days in which absolute changes in one or more factors within the category are in the lower (upper) 20 percentile over 1998 -2002 constitute low (high) volatility days for that category. Low and high volatility samples for all market risk categories: This is the intersection of the 4 individual market risk category low and high volatility samples, respectively. Mean and median absolute changes for individual market factors: These are the mean and median values for the respective factors on days of low and high volatility for the designated market risk category. For non-category factors, e.g, non-exchange rate factors, means and medians are for the designated market risk category's respective low and high volatility samples. The units of measurement for the non-category factors are the same as the units indicated for their category.

Table 5. Absolute Bank Trading Revenue Conditioned on Low and High Market Volatility*

Conditioning Market Factors	bank 1		bank 2		bank 3		bank 4		bank 5		bank 6		bank 7	
	rev	obs	rev	obs	rev	obs	rev	obs	rev	obs	rev	obs	rev	obs
Exchange Rate														
low vol: mean	14.68	389	23.63	373	12.83	720	3.67	721	1.47	721	11.02	634	2.41	313
hi vol: mean	15.58	452	24.52	435	12.41	695	3.69	695	1.55	695	11.58	626	3.03	387
low vol: med	12.89		12.54		11.00		3.03		1.18		9.20		1.83	
hi vol: med	14.37		20.88		9.82		2.97		1.15		9.50		2.15	
Interest Rate														
low vol: mean	14.31	297	21.67	283	11.32	427	3.40	428	1.39	428	11.09	392	2.36	212
hi vol: mean	16.77	202	28.07	192	14.18	399	4.00	399	1.71	399	12.53	350	3.10	202
low vol: med	12.89		18.03		9.38		2.82		1.11		8.70		1.96	
hi vol: med	14.83		22.43		12.00		3.45		1.34		9.55		1.77	
Stock														
low vol: mean	14.65	263	22.60	256	11.59	411	3.61	411	1.55	411	10.93	385	2.55	198
hi vol: mean	17.15	195	29.17	166	13.54	367	4.31	368	1.51	368	12.52	306	2.36	198
low vol: med	13.47		19.07		9.65		3.07		1.18		9.50		2.04	
hi vol: med	14.41		23.63		11.00		3.35		1.18		10.00		1.60	
Credit														
low vol: mean	14.32	365	22.48	349	11.54	576	3.69	576	1.42	576	10.75	536	2.61	294
hi vol: mean	17.20	255	26.72	232	13.89	511	4.24	512	1.64	512	11.81	436	2.75	264
low vol: med	12.89		19.05		10.00		2.95		1.15		8.60		1.84	
hi vol: med	15.02		21.91		11.22		3.55		1.27		9.70		1.85	
All Mkt Factors														
low vol: mean	15.19	46	22.50	45	10.42	60	3.08	60	1.26	60	11.41	58	2.26	27
hi vol: mean	18.85	34	37.49	32	17.50	74	4.76	74	1.97	74	12.72	58	2.44	35
low vol: med	13.73		18.97		7.30		2.57		1.13		9.93		1.81	
hi vol: med	16.92		29.33		15.83		3.87		1.48		11.65		1.58	

*Explanation: Means and medians for each broad market category (e.g., exchange rate) are the mean and median P&L values for the category's respective low and high volatility samples (see Table 6. Observations reported are the number of days the bank had a P&L in that market factor/volatility category. Note that for banks' 1, 2, and 7, P&L data cover only part of the 1998 - 2002 market factor observation period.

Table 6. Cross-Bank Absolute Trading Revenue and VaR Correlations[1]
(upper diagonal: absolute trading revenue; lower diagonal: VaR)

	bank 1	bank 2	bank 3	bank 4	bank 5	bank 6	bank 7
bank 1		0.321	0.233*	0.154*	0.089*	0.096*	-0.042
bank 2	0.025		0.156*	0.033	0.168*	0.122*	0.055
bank 3	0.094*	0.017		0.145*	0.112*	0.082*	-0.003
bank 4	0.03	-0.418*	0.229*		-0.034	0.046	0.046
bank 5	-0.163*	-0.098*	-0.472*	-0.199*		0.048	0.115*
bank 6	-0.338*	-0.217*	-0.182*	0.237*	0.467*		0.015
bank 7	-0.165*	0.488*	-0.06	-0.458*	0.257*	0.083*	

1Trading revenue and VaR correlations use residuals from regressions of bank VaR on trend.
* p-value < .05.

Table 7. Bank VaR Conditioned on Low and High Market Volatility*

Conditioning Market Factors	bank 1		bank 2		bank 3		bank 4		bank 5		bank 6		bank 7	
	VaR	obs	VaR	obs	VaR	obs	VaR	obs	VaR	obs	VaR	obs	P&L	obs
<u>Exchange Rate</u>														
low vol: mean	24.59	389	41.11	373	57.76	720	25.94	721	7.74	721	26.14	634	12.29	313
hi vol: mean	25.03	452	42.63	435	57.55	695	24.01	695	8.20	695	24.54	626	12.91	387
low vol: med	24.42		41.94		57.00		25.16		5.98		24.10		11.62	
hi vol: med	24.54		44.20		57.00		23.84		6.91		23.21		11.99	
<u>Interest Rate</u>														
low vol: mean	24.28	297	42.76	283	59.67	427	23.45	428	8.78	428	24.72	392	12.37	212
hi vol: mean	25.81	202	40.42	192	55.73	399	25.79	399	7.26	399	25.67	350	12.90	202
low vol: med	24.26		44.91		58.00		22.98		7.15		23.32		11.84	
hi vol: med	25.53		39.48		56.00		25.47		5.89		24.05		11.89	
<u>Stock</u>														
low vol: mean	24.41	263	42.34	256	59.91	411	24.66	411	8.35	411	25.85	385	12.26	198
hi vol: mean	25.34	195	38.23	166	55.99	367	27.26	368	6.58	368	25.58	306	12.07	198
low vol: med	24.21		44.04		58.00		23.76		6.44		24.11		11.64	
hi vol: med	24.64		35.96		56.94		27.21		5.43		24.25		11.49	
<u>Credit</u>														
low vol: mean	24.91	365	41.71	349	60.08	576	24.92	576	7.96	576	25.31	536	12.08	294
hi vol: mean	25.63	255	38.48	232	55.80	511	26.83	512	6.81	512	26.03	436	12.63	264
low vol: med	24.63		41.55		58.34		24.61		6.37		23.60		11.59	
hi vol: med	24.90		37.03		56.00		26.44		5.68		24.25		11.63	
<u>All Mkt Factors</u>														
low vol: mean	24.38	46	43.18	45	63.75	60	22.49	60	9.53	60	24.74	58	11.28	27
hi vol: mean	26.68	34	43.46	32	54.52	74	27.54	74	6.56	74	25.02	58	13.30	35
low vol: med	24.68		47.12		61.36		21.17		8.36		23.64		11.37	
hi vol: med	25.94		49.15		56.50		27.70		5.50		24.60		11.75	

*Means and median VaRs for low and high volatility samples for each market risk category are for the respective low and high volatility days in the market risk category. Sample observations are the number of days the bank had a VaR in that volatility/market risk category.

Figure 1. Kernel Densities for Bank Trading Revenue

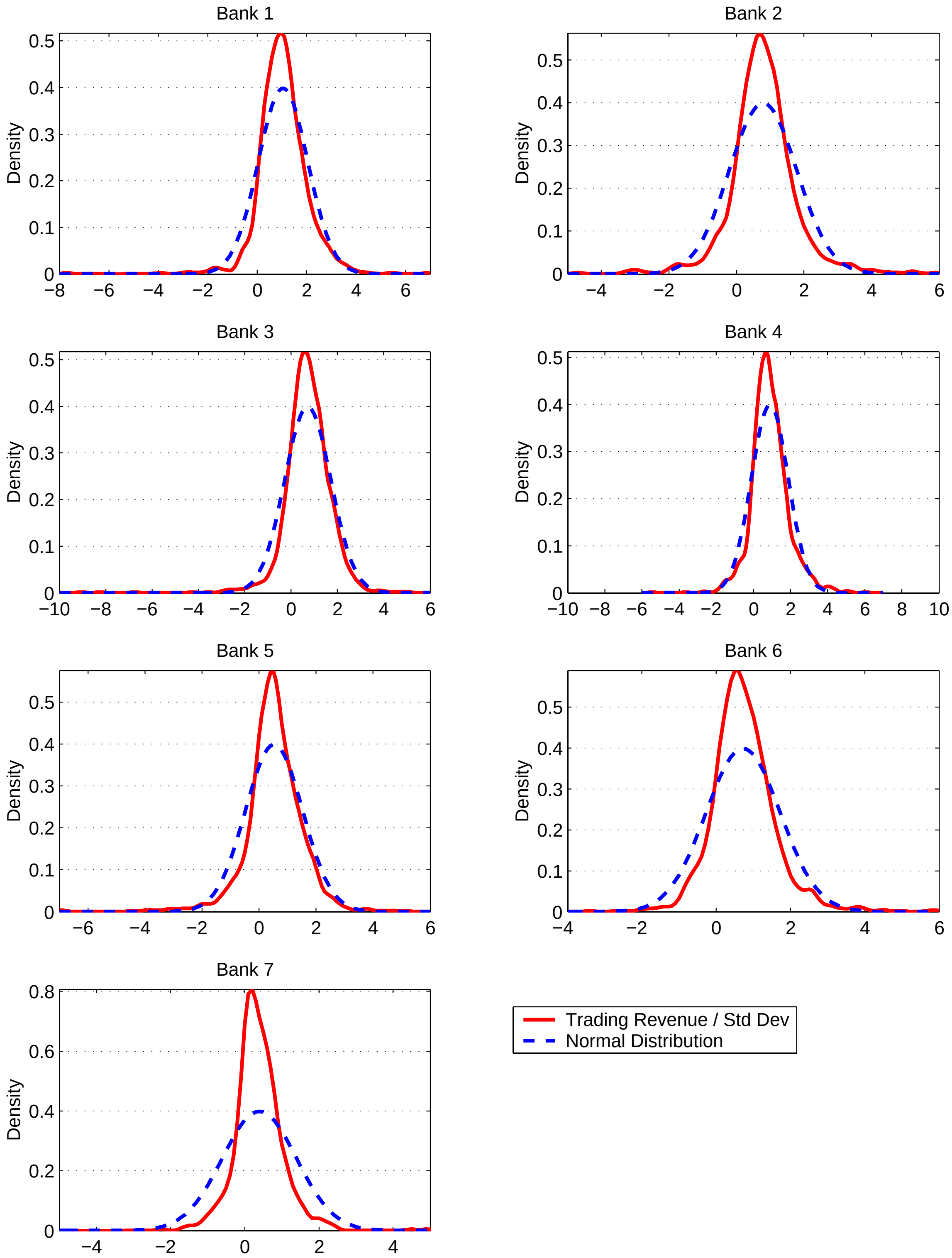

Figure 2. Kernel Density For Trading Revenue / VaR For All Banks