Banks' Non-Interest Income and Systemic Risk

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Abstract

This paper examines the contribution of non-interest income to *systemic* bank risk. Using the $\Delta CoVaR$ measure of Adrian and Brunnermeier (2010) as our proxy for systemic risk, we find banks with a higher non-interest income to interest income ratio have a higher contribution to systemic risk. This suggests that activities that are not traditionally associated with banks (such as deposit taking and lending) are associated with a larger contribution to systemic risk. When we decompose total non-interest income into three components, we find trading income and investment banking and venture capital income to be significantly related to systemic risk. The economic impact on systemic risk of investment banking and venture capital income is higher than that of trading income. Finally we find the impact of non-interest income on systemic risk to be prevalent in the 1990 and 2007 financial crises (which were bank based) and not in the case before the 2001 high tech bubble bust. These effects occur one-year before each crisis and not during the recession, showing their countercyclical contribution to systemic risk build-up.

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"These banks have become trading operations. … It is the centre of their business."
Phillip Angelides, Chairman, Financial Crisis Inquiry Commission

"The basic point is that there has been, and remains, a strong public interest in providing a "safety net" – in particular, deposit insurance and the provision of liquidity in emergencies – for commercial banks carrying out essential services (emphasis added). There is not, however, a similar rationale for public funds – taxpayer funds – protecting and supporting essentially proprietary and speculative activities (emphasis added)"
Paul Volcker, Statement before the US Senate's Committee on Banking, Housing, & Urban Affairs

1. Introduction

The recent financial crisis of 2007-2009 has powerfully shown that risk spillovers from one bank to another created significant systemic risk which was largely ignored by bankers, investors and regulators. The infusion of taxpayer funds to commercial and investment banks under the various programs of the government (Treasury and the Federal Reserve) have come under increasing scrutiny (see for example the quotes above). But all banking activities are not necessarily the same. One group of banking activities, namely, deposit taking and lending make banks special to information-intensive borrowers and crucial for capital allocation in the economy (for example, Bernanke 1983, Fama 1985, Diamond 1984, James 1987, Gorton and Pennachi 1990, Calomiris and Kahn 1991, and Kashyap, Rajan, and Stein 2002). Such a view is also articulated in the bank lending channel for the transmission of monetary policy (Bernanke and Blinder 1988, Stein 1988, Kashyap, Stein and Wilcox 1993).

But banks have increasingly earned a higher proportion of their profits from non-interest income when compared to interest income (see Table I). For example, the mean non-interest income to interest income ratio has increased from 0.18 in 1989 to 0.59 in 2007 for the 10-largest banks (by market capitalization in 2000, the middle of our sample). Non-interest income includes activities such as income from trading and securitization, investment banking and advisory fees, brokerage commissions, venture capital, and fiduciary income, and gains on non-hedging derivatives. This paper examines the contribution of such non-interest income to *systemic* bank risk. In these activities banks are competing with other capital market intermediaries such as hedge funds, mutual funds, investment banks, insurance companies and private equity funds, all of whom do not have federal deposit insurance. The existence of insured deposits to commercial banks could lead to significant moral hazard resulting in higher systemic risk.

*** Table I ***

In order to capture systemic risk in the banking sector we use the *CoVaR* measure of Adrian and Brunnermier (2010; from now on referred to as AB).[1] AB define *CoVaR* as the Value at Risk (*VaR*) of the banking system, conditional on an individual bank being in distress. More formally, it is the difference between the *CoVaR* conditional on a bank being in distress and the *CoVaR* conditional on a bank operating in its median state (which AB refer to as Δ*CoVaR*). Such a measure is calculated one period forward and captures the marginal contribution of a bank to overall systemic risk. AB suggests that prudential capital regulation should not just be based on *VaR*s of a bank but also on their Δ*CoVaR*s, which by their predictive power alert regulators (in our regressions by one-quarter ahead) who can use them as a basis for a preemptive countercyclical capital regulation such as a capital surcharge or Pigovian tax.[2]

In this paper, we begin by estimating the Δ*CoVaR*s of all commercial banks (SIC codes 60 and 61) for the period 1986 to 2008. We examine three primary issues: (1) Is there a relationship between systemic risk (or Δ*CoVaR*) and a bank's non-interest income? (2) From 2001 onwards, banks were required to report detailed breakdowns of their non-interest income. We categorize such items into three sub-groups, namely, trading income, investment banking and venture capital income, and others. We examine if any sub-group has a significant effect on systemic risk? (3) Finally, we examine if there were differential impacts of non-interest income on systemic risk prior to and during the past three economic contractions (1990-91, 2000-01, and 2007-08).

We find the following results:

1. We first find that systemic risk is higher for banks with a higher non-interest income to interest income ratio. Specifically, a one standard deviation shock to a bank's non-interest income to interest income ratio increases its systemic risk contribution by 5.2%. This suggests that activities that are *not* traditionally associated with banks (such as deposit taking

[1] See Section 3 of this paper for more details.

[2] AB calculates this measure for a portfolio of banks whereas we calculate it for individual banks. AB's focus was on showing that the Δ*CoVaR* measure is valid as a measure of a bank's contribution to systemic risk and therefore can be used as a countercyclical capital charge measure. But our focus is on the marginal contribution of non-interest income of individual banks on systemic risk. Given that a capital charge would be levied on an individual bank, our paper also allows regulators to implement how the capital charge can be assessed.

and lending) are associated with a larger contribution to systemic risk. These results hold when we use the systemic expected shortfall measure of Acharya, Pedersen, Philippon and Richardson (2010).

2. We also find that larger banks (measured by asset size) and those with a higher ratio of commercial & industrial loans to total loans contributed more to systemic risk. The result on size is consistent with those found in AB and with the general idea that larger firms contribute more to systemic risk.
3. When we can decompose total non-interest income into three components, we find trading income and investment banking and venture income to be significantly related to systemic risk. The economic impact on systemic risk of trading income is lower than that of investment banking and venture capital income. A one standard deviation shock to a bank's trading income increases its systemic risk contribution by 2.9%, whereas a one standard deviation shock to its investment banking and venture capital income increases its systemic risk contribution by 5.4%.
4. During the previous three economic contractions, banks with a higher non-interest income to interest income ratio contributed more to systemic risk in the 1990 and 2007 bank-based crises; however this is not the case before the 2001 high tech bubble bust. Interestingly, these results show up in end of the boom period (one-year before each crisis) and not during the recession, showing their *countercyclical* contribution to systemic risk build-up.

In section 2 of this paper we describe the related literature and Section 3 explains our data and methodology. Section 4 presents or empirical results and in Section 5 we conclude.

2. Related Literature

Recent papers have proposed complementary measures of systemic risk other than $\Delta CoVaR$.[3] We describe below some of the prominent measures. Acharya, Pedersen, Philippon and Richardson (2010) propose the systemic expected shortfall (*SES*) which is the expected amount a bank is undercapitalized in a systemic event in which the entire financial system is undercapitalized. Allen, Bali and Tang (2010) propose the *CATFIN* measure which is the

[3] See Billio, Getmansky Lo, and Pelizzon (2010) for a good survey.

principal components of the 1% *VaR* and expected shortfall, using estimates of the generalized Pareto distribution, skewed generalized error distribution, and a non-parametric distribution. Tarashev, Borio, and Tsatsaronis (2010) suggest Shapley values based on a bank's of default probabilities, size, and exposure to common risks could be used to assess regulatory taxes on each bank. Chan-Lau (2010) proposes the *CoRisk* measure which captures the extent to which the risk of one institution changes in response to changes in the risk of another institution while controlling for common risk factors. Huang, Zhou, and Zhu (2009, 2010) propose the deposit insurance premium (*DIP*) measure which is a bank's expected loss conditional on the financial system being in distress exceeding a threshold level.

Prior papers have also shown that non-interest income has generally increased the risk of an *individual bank* but have not focused on a bank's contribution to systemic risk. For example, Stiroh (2004) and Fraser, Madura, and Weigand (2002) finds that non-interest income is associated with more volatile bank returns. DeYoung and Roland (2001) find fee-based activities are associated with increased revenue and earnings variability. Stiroh (2006) finds that non-interest income has a larger effect on individual bank risk in the post-2000 period. In a study of Italian banks, Acharya, Hassan and Saunders (2006) find diseconomies of scope when a risky bank expands into additional sectors.

A number of papers have used the *CoVaR* measure in other contexts. Wong and Fong (2010) examine Δ*CoVaR* for credit default swaps of Asia-Pacific banks, whereas Gauthier, Lehar and Souissi (2010) use it for Canadian institutions. Adams, Fuss and Gropp (2010) study risk spillovers among financial institutions including hedge funds, and Zhou (2009) uses extreme value theory rather than quantile regressions to get a measure of *CoVaR*.

3. Data, Methodology, and Variables Used

We focus on all publicly traded bank holding companies in the U.S., namely, with SIC codes 60 or 61 (for commercial banks) and using the Fama-French SIC code classification for banks, namely, "portfolio 44." By focusing on commercial banks we do not include insurance companies, investment banks, investment management companies, and brokers. Our sample is from 1986 to 2008, and consists of an unbalanced panel of 538 unique banks. Four of these banks have zero non-interest income. We obtain a bank's daily equity returns from CRSP which

we use to convert into weekly returns. Financial statement data is from Compustat and from Federal Reserve form FR Y-9C filed by a bank with the Federal Reserve. T-bill and LIBOR rates are from the Federal Reserve Bank of New York and real estate market returns are from the Federal Housing Finance Agency. The dates of recessions are obtained from the NBER (http://www.nber.org/cycles/cyclesmain.html). Detailed sources for each specific variable used in our estimation are given in Table II.

*** Table II ***

We describe below how we calculate the $\Delta CoVaR$ measure of Adrian and Brunnermeier (2010).

Value-at-Risk (VaR)[4] measures the worst expected loss under normal market conditions over a specific time interval at a given confidence level. In the context of this paper, VaR_q^i is defined as the percentage R^i of asset value that bank i might lose with q% probability over a pre-set horizon T:

$$Probability(R^i \le VaR_q^i) = q \qquad (1)$$

Thus by definition the value of VaR is negative in general.[5] Another way of expressing this is that VaR_q^i is the q% quantile of the potential asset return in percentage term (R^i) that can occur to bank i during a specified time period T. The confidence level (quantile) q and the time period T are the two major parameters in a traditional risk measure using VaR. We consider 1% quantile and weekly asset return/loss R^i in this paper, and the VaR of bank i is $Probability(R^i \le VaR_{1\%}^i) = 1\%$.

Let $CoVaR_q^{system|i}$ denote the Value at Risk of the entire financial system conditional upon bank i being in distress (in other words, the loss of bank i is at its level of VaR_q^i). That is,

[4] See Philippe (2006, 2009) for detail definition, discussion and application of VaR.
[5] Empirically the value of VaR can also be positive. For example, VaR is used to measure the investment risk in a AAA coupon bond. Assume that the bond was sold at discount and the market interest rate is continuously falling, but never below the coupon rate during the life the investment. Then the q% quantile of the potential bond return is positive, because the bond price increases when the market interest rate is falling.

$CoVaR_q^{system|i}$ which essentially is a measure of systemic risk is the q% quantile of this conditional probability distribution:

$$Probability(R^{system} \le CoVaR_q^{system|i} \mid R^i = VaR_q^i) = q \tag{2}$$

Similarly, let $CoVaR_q^{system|i,median}$ denote the financial system's *VaR* conditional on bank i operating in its median state (in other words, the return of bank i is at its median level). That is, $CoVaR_q^{system|i,median}$ measures the systemic risk when business is normal for bank i:

$$Probability(R^{system} \le CoVaR_q^{system|i,median} \mid R^i = median^i) = q \tag{3}$$

Bank i's contribution to systemic risk can be defined as the difference between the financial system's *VaR* conditional on bank i in distress ($CoVaR_q^{system|i}$), and the financial system's *VaR* conditional on bank i functioning in its median state ($CoVaR_q^{system|i,median}$):

$$\Delta CoVaR_q^i = CoVaR_q^{system|i} - CoVaR_q^{system|i,median} \tag{4}$$

In the above equation, the first term on the right hand side measures the systemic risk when bank i's return is in its q% quantile (distress state), and the second term measures the systemic risk when bank i's return is at its median level (normal state).

To estimate this measure of individual bank's systemic risk contribution $\Delta CoVaR_q^i$, we need to calculate two conditional *VaR*s for each bank, namely $CoVaR_q^{system|i}$ and $CoVaR_q^{system|i,median}$. For the systemic risk conditional on bank i in distress ($CoVaR_q^{system|i}$), run a 1% quantile regression[6] using the weekly data to estimate the coefficients α^i, β^i, $\alpha^{system|i}$, $\beta^{system|i}$ and $\gamma^{system|i}$:

[6] See Appendix A for detail explanation of our quantile regressions.

$$R_t^i = \alpha^i + \beta^i Z_{t-1} + \varepsilon^i \tag{5}$$

$$R_t^{system} = \alpha^{system|i} + \beta^{system|i} Z_{t-1} + \gamma^{system|i} R_{t-1}^i + \varepsilon^{system|i} \tag{6}$$

and run a 50% quantile (median) regression to estimate the coefficients $\alpha^{i,median}$ and $\beta^{i,median}$:

$$R_t^i = \alpha^{i,median} + \beta^{i,median} Z_{t-1} + \varepsilon^{i,median} \tag{7}$$

where R_t^i is the weekly growth rate of the market-valued assets of bank i at time t:

$$R_t^i = \frac{MV_t^i \times Leverage_t^i}{MV_{t-1}^i \times Leverage_{t-1}^i} - 1 \tag{8}$$

and R_t^{system} is the weekly growth rate of the market-valued total assets of all banks ($i = j = 1, 2, 3..., N$) in the financial system at time t:

$$R_t^{system} = \sum_{i=1}^{N} \frac{MV_{t-1}^i \times Leverage_{t-1}^i \times R_t^i}{\sum_j^N MV_{t-1}^j \times Leverage_{t-1}^j} \tag{9}$$

In equation (8) and (9), MV_t^i is the market value of bank i's equity at time t, and $Leverage_t^i$ is bank i's leverage defined as the ratio of total asset and equity market value: $Leverage_t^i = Asset_t^i / MV_t^i$.

Z_{t-1} in equation (7) is the vector of macroeconomic and finance factors in the previous week, including market return, equity volatility, liquidity risk, interest rate risk, term structure, default risk and real-estate return.

We use the weekly value weighted equity returns (excluding ADRs) with all distributions to proxy for the market return. Volatility is the standard deviation of log stock returns during three month prior to time t. Short-term liquidity risk is the difference between the 3-month

LIBOR rate and the 3-month T-bill rate. Interest rate risk is the change in the 3-month T-bill rate. We use the change in the slope of the yield curve (yield spread between the 10-year T-bond rate and the 3-month T-bill rate) to proxy for the term structure. Default risk is the change in the credit spread between the 10-year BAA corporate bonds and the 10-year T-bond rate. Real estate return is based on the FHFA house price index. See Table II for details of our data sources.

*** Table II ***

Hence we predict an individual bank's *VaR* and median asset return using the coefficients $\hat{\alpha}^i$, $\hat{\beta}^i$, $\hat{\alpha}^{i,median}$ and $\hat{\beta}^{i,median}$ estimated from the quantile regressions of equation (5) and (7):

$$VaR^i_{q,t} = \hat{R}^i_t = \hat{\alpha}^i + \hat{\beta}^i Z_{t-1} \tag{10}$$

$$R^{i,median}_t = \hat{R}^i_t = \hat{\alpha}^{i,median} + \hat{\beta}^{i,median} Z_{t-1} \tag{11}$$

The vector of state (macroeconomic and finance) variables Z_{t-1} is the same as in equation (5) and (7). After obtaining the unconditional *VaR*s of an individual bank i ($VaR^i_{q,t}$) and that bank's asset return in its median state ($R^{i,median}_t$) from equation (10) and (11), we predict the systemic risk conditional on bank i in distress ($CoVaR^{system|i}_q$) using the coefficients $\hat{\alpha}^{system|i}$, $\hat{\beta}^{system|i}$, $\hat{\gamma}^{system|i}$ estimated from the quantile regression of equation (6) . Specifically,

$$CoVaR^{system|i}_{q,t} = \hat{R}^{system}_t = \hat{\alpha}^{system|i} + \hat{\beta}^{system|i} Z_{t-1} + \hat{\gamma}^{system|i} VaR^i_{q,t} \tag{12}$$

Similarly, we can calculate the systemic risk conditional on bank i functioning in its median state ($CoVaR^{system|i,median}_q$) as :

$$CoVaR^{system|i,median}_{q,t} = \hat{\alpha}^{system|i} + \hat{\beta}^{system|i} Z_{t-1} + \hat{\gamma}^{system|i} R^{i,median}_t \tag{13}$$

Bank i's contribution to systemic risk is the difference between the financial system's *VaR* if bank i is at risk and the financial system's *VaR* if bank i is in its median state:

$$\Delta CoVaR_{q,t}^{i} = CoVaR_{q,t}^{system|i} - CoVaR_{q,t}^{system|i,median} \tag{14}$$

Note that this is same as equation (4) with an additional subscript t to denote the time-varying nature of the systemic risk in the banking system. As shown in the quantile regressions of equation (5) and (7), we are interested in the VaR at the 1% confident level, therefore the systemic risk of individual bank at q=1% can be written as:

$$\Delta CoVaR_{1\%,t}^{i} = CoVaR_{1\%,t}^{system|i} - CoVaR_{1\%,t}^{system|i,median} \tag{15}$$

To investigate the relationship between the bank characteristics and lagged bank's contribution to systemic risk, we run OLS regressions with quarterly fixed effects and the following bank-specific variables: maturity mismatch (MM), market to book (M2B), financial leverage (LEV), total asset (AT), loan to asset (L2A), C&I loan to total loan (C2A), and non-interest income to interest income (N2I).

$$\begin{aligned}\Delta CoVaR_t = {} & \phi_0 + \phi_1 VaR_{t-1} + \phi_2 MM_{t-1} + \phi_3 M2B_{t-1} + \phi_4 LEV_{t-1} + \phi_5 VOL_{t-1} + \phi_6 AT_{t-1} + \phi_7 AT_{t-1}^{2} \\ & + \phi_8 L2A_{t-1} + \phi_9 CI2L_{t-1} + \phi_{10} N2I_{t-1} + FE(quarterly) + \varepsilon_t \end{aligned} \tag{16}$$

We focus on the impact of bank's N2I ratio (non-interest income to interest income ratio) on its systemic risk contribution.

From 2001 onwards, we can decompose this N2I ratio into its three components, namely, trading income to interest income (T2I), investment banking and venture income to interest income (V2I), and other non-interest income to non-interest income (NT2I). We regress the individual bank's systemic risk contribution ($\Delta CoVaR$) on its T2I, V2I and NT2I ratios along with other control variables and include quarterly fixed effects.

$$\Delta CoVaR_t = \phi_0 + \phi_1 VaR_{t-1} + \phi_2 MM_{t-1} + \phi_3 M2B_{t-1} + \phi_4 LEV_{t-1} + \phi_5 VOL_{t-1} + \phi_6 AT_{t-1} + \phi_7 AT_{t-1}^2$$
$$+\phi_8 L2A_{t-1} + \phi_9 CI2L_{t-1} + \phi_{10} T2I_{t-1} + \phi_{11} V2I_{t-1} + \phi_{12} NT2I_{t-1} + FE(quarterly) + \varepsilon_t \quad (17)$$

Trading income includes trading revenue, net securitization income, gain (loss) of loan sales and gain (loss) of real estate sales. Investment banking and venture capital (IBVC) income includes investment banking and advisory fees, brokerage commissions and venture capital revenue. Other non-interest income includes fiduciary income, deposits service charges, net servicing fees, service charges for safe deposit box and sales of money orders, rental income, credit card fees, gains on non-hedging derivatives, and etc. The detail definitions of all accounting ratios are listed in Table I.

Table III presents the summary statistics. When we comparing our results to those found in AB, we find that the average Δ*CoVaR* of individual banks is lower (mean=-1.202 and median=-1.043) than the average portfolio's Δ*CoVaR* found in AB (mean=-1.615 and median not reported). In addition, the risks of individual banks (*VaR*) are higher than the average portfolio's risks in AB. We also find that the average ratio of non-interest income to interest income to be 0.29, whereas the median ratio is 0.175. This is similar in magnitude to the proportion of all loans that are commercial and industrial loans.

*** Table III***

The correlation matrix in Table IV reports no large correlation between the various variables. We also find that the correlation between Δ*CoVaR* and lagged *VaR* is 0.20, and the correlation between Δ*CoVaR* and the ratio of non-interest income to interest income is -0.10.

*** Table IV ***

In Table V, we compare the average t-statistics of state variable exposures in our sample with those results in AB. We focus on the Δ*CoVaR* results. We find similar significant results in market return volatility, liquidity and asset returns. We find significant results for the short-term

rate change, term structure, default credit spread, and changes in house prices, whereas AB finds statistically insignificant results on these factors. AB find market returns to be statistically significant whereas we find it to be insignificant.

*** Table V ***

4. Empirical Results

We begin by examining the Table VI. The dependent variable is $\Delta CoVaR$. All independent variables are estimated with a one quarter lag, and we also include quarter fixed-effects which are not reported. The t-statistics are calculated using Newey-West standard errors which rectifies for heteroskedasticity. The independent variables are individual bank's maturity mismatch (MM), market to book ratio (M2B), financial leverage ratio (LEV), total assets (AT), loan to asset ratio (L2A), the ratio of commercial and industrial loans to total loans (C2L), and non-interest income to interest income (N2I). Given that $\Delta CoVaR$ is defined as systemic risk contribution when the bank is in distress compared to its contribution when the bank operates in its median state, a negative (positive) coefficient implies higher (lower) systemic risk next quarter. We find that glamour banks, and banks with a higher proportion of their loans in commercial and industrial loans contribute more to systemic risk. The effect of bank size is nonmonotonic, whereas a higher proportion of loans to assets help reduce systemic risk. Importantly, we find that the ratio of non-interest income to interest income is significantly negative suggesting that it contributes adversely to systemic risk. Specifically, a one standard deviation shock to a bank's non-interest income to interest income ratio increases its systemic risk contribution by 5.2%.

*** Table VI ***

From 2001 onwards, we can decompose the ratio of non-interest income to interest income into trading income to interest income (T2I), investment banking and venture capital income to interest income (V2I), and other non-interest income to interest income (NT2I), respectively. Federal Reserve form FR Y-9C only gives these detailed data after 2001.

Trading income includes trading revenue, net securitization income, gain (loss) of loan sales and gain (loss) of real estate sales. IBVC income includes investment banking & advisory fee, brokerage commission and venture capital revenue. Other non-interest income includes fiduciary income, deposits service charge, net servicing fee, service charges for safe deposit box and sales of money orders, rental income, credit card fees, gains on non-hedging derivatives, etc.. We find in Table VII that both trading (T2I) and investment banking and venture capital income (V2I) are statistically negative. The economic impact on systemic risk of trading income is lower than that of investment banking and venture capital income. A one standard deviation shock to a bank's trading income increases its systemic risk contribution by 2.9%, whereas a one standard deviation shock to its investment banking and venture capital income increases its systemic risk contribution by 5.4%.

*** Table VII ***

The crisis that began with Lehman Brothers allows us to examine how our bank-specific determinants of systemic risk performed during the pre-crisis (2006Q4 to 2007Q3) and the crisis (2007Q4 to 2008Q3) periods. In Table VIII, we use a one-year lagged firm characteristic. As before, we find glamour banks to have a high negative effect on systemic risk and bank size to have a nonmonotonic effect. Trading income remains negatively related in both the pre- and post-crisis periods. However, investment banking and venture capital income (V2I) is negatively related only in the pre-crisis period.

*** Table VIII ***

We then examine how our bank-specific determinants of systemic risk performed during the past three economic contractions. The results in Table IX bank's non-interest income to income ratio is correlated with the bank's $\Delta CoVaR$ only during the boom times preceding the bank-based crises of 1990-91 and 2007-08, and not in the high-technology bubble of 2001.

*** Table IX ***

We now examine if our results are driven by characteristics of Δ*CoVaR* that might not capture real systemic risk. We use the systemic expected shortfall (*SES*) measure of Acharya, Pedersen, Philippon and Richardson (2010) as our definition of systemic risk. In Appendix B we explain how we calculate *SES* using cross-sectional quarterly data. The results of such a regression are given in Table X. Once again we find that the ratio of non-interest income to interest income is significantly negative suggesting that it contributes adversely to systemic risk. Specifically, a one standard deviation shock to a bank's non-interest income to interest income ratio increases the mean SES measure of -6.98% by -2.47%, an increase of 35%. This suggests that the relationship between non-interest income and systemic risk does not depend on our proxy for systemic risk.

*** Table X ***

Robustness Tests: We run a number of robustness tests. First, we address the concern that the bank's non-interest income to income ratio is also correlated with the bank's *VaR*. In columns (1) and (2) of Table XI we find no evidence of this. Second, in columns (3)-(5) of Table XI we find different lags of the bank's non-interest income to income ratio is correlated with the bank's Δ*CoVaR*. This suggests our results are robust to various lagged quarters.

*** Table XI ***

Third, we examine if our result is driven by the numerator (non-interest income) and not the denominator (net interest income). In Table XII, we reestimate our regressions using the ratio of non-interest income to assets instead of non-interest income to interest. We find that non-interest income is once again negatively related suggesting that it contributes adversely to systemic risk.[7] Similar relationships are found for trading income and for investment banking and venture capital income. These results suggest that it is non-traditional income (namely, non-

[7] We also reestimated the *SES* measure of systemic risk while including the ratio of non-interest income to assets. We find similar results (results not reported but available from the authors).

interest income) that contributes adversely to systemic risk, and not traditional income (namely, interest income).

*** Table XII ***

Fourth, we examine if changes in the state variables (Z_t) are the primary force driving our results. To do so, we use as our dependent variable, the bank's $\Delta CoVaR$ in the same quarter instead of one-quarter ahead. In Table XIII we find that banks' with a higher non-interest income to income ratio is correlated with $\Delta CoVaR$ in the same quarter. We also find that investment banking, venture capital and trading income contributed more to systemic risk. These results are consistent with those found before, and suggest that changes in the state variables are not driving our results.

*** Table XIII ***

Fifth, we examine if our results can be explained by fair-value accounting issues. Given that non-interest income consists generally of items which are marked to market, and interest income includes items such as interest on loans and deposits which are at historical cost, we examine if our results are driven by fair-value accounting issues. In order do so, we split investment banking and venture capital to interest income ratio (V2I) into two ratios: investment banking to interest income ratio, and venture capital to interest income ratio, respectively. Investment banking consists of advisory fees and underwriting commissions which are not marked to market, whereas venture capital includes revenues from holdings in companies in which banks have taken to market and which are generally marked to market. If our results are driven by marked to market issues, the regression coefficient of venture capital should be negative and larger (in absolute terms) than the regression coefficient of investment banking. In fact, we find the opposite (results not reported but available from the authors). We find the regression coefficient of venture capital to be positive but not statistically significant and the regression coefficient of investment banking to be positive. These results suggest that mark to market accounting does not explain the contribution of non-interest income to systemic risk, and is generally consistent with the results in Laux and Leunz (2010) and studies cited therein.

Sixth, we address the concern that our results are driven by volatile non-interest income (i.e., in time-series) or by cross-sectional bank characteristics. We break down the ratio of non-interest to interest income (N2I) ratio into three terciles, and count the numbers of banks shifting between terciles. Table XIV provides the number of banks whose N2I ratios changed between different terciles in each calendar quarter. Both the mean and median percentage of banks drifting from one tercile to another during a quarter are only 4% of the total number of the banks, implying that it is indeed the cross-sectional bank characteristics driving our results and not the time-series effect.

*** Table XIV ***

5. Conclusions

The recent financial crisis showed that negative externalities from one bank to another created significant systemic risk. This resulted in significant infusions of funds from the Federal Reserve and the Treasury given that deposit taking and lending make banks special to information-intensive borrowers and for the bank lending channel transmission mechanism of monetary policy. But banks have increasingly earned a higher proportion of their profits from non-interest income from activities such as trading, investment banking, venture capital and advisory fees. This paper examines the contribution of such non-interest income to *systemic* bank risk.

Using the $\Delta CoVaR$ measure of Adrian and Brunnermeier (2010) as our proxy for systemic risk, we find banks with a higher non-interest income to interest income ratio have a higher contribution to systemic risk. This suggests that activities that are *not* traditionally associated with banks (such as deposit taking and lending) are associated with a larger systemic risk. We also find that larger banks (measured by asset size) and those with a higher ratio of commercial and industrial loans to total loans contributed more to systemic risk. When we decompose the total non-interest income into three components, we find trading income and investment banking and venture capital income to be significantly related to systemic risk. The economic impact on systemic risk of trading income is lower than that of investment banking

and venture capital income. Finally we find the impact of non-interest income on systemic risk to be prevalent in 1990 and 2007 financial crises (which were bank based) and not in the case before the 2001 high tech bubble bust. Interestingly, these results show up in end of the boom period (one-year before each crisis) and not during the recession, showing their countercyclical contribution to systemic risk build-up.

Appendix A: Quantile Regression

OLS regression models the relationship between the independent variable *X* and the conditional mean of a dependent variable *Y* given $X = X_1, X_2, \ldots X_n$, as shown in Figure 1. In contrast, quantile regression[8] models the relationship between X and the conditional quantiles of *Y* given $X = X_1, X_2, \ldots X_n$, thus it provides a more complete picture of the conditional distribution of Y given X when the lower or upper quantile is of interest. It is especially useful in applications of Value at Risk (*VaR*), where the lowest 1% quantile is an important measure of risk.

*** Figure 1 ***

Consider the quantile regression in equation (5): $R_t^i = \alpha^i + \beta^i Z_{t-1} + \varepsilon^i$, the dependent variable *Y* is bank *i* 's weekly asset return (R_t^i) and the independent variable *X* is the exogenous state (macroeconomic and finance) variables (Z_{t-1}) of the previous period. The predicted value ($\hat{R}_t^i$) using the coefficient estimates ($\hat{\alpha}^i$ and $\hat{\beta}^i$) from the 1%-quantile regression and the lagged state variable (Z_{t-1}) is bank *i* 's *VaR* at 1% confident level in that week: $VaR_{1\%,t}^i = \hat{R}_t^i = \hat{\alpha}^i + \hat{\beta}^i Z_{t-1}$. Similarly the predicted value ($\hat{R}_t^{system}$) in equation (12) using the coefficient estimates ($\hat{\alpha}^{system|i}$, $\hat{\beta}^{system|i}$ and $\hat{\gamma}^{system|i}$) from equation (6), the lagged state variable (Z_{t-1}), and the $VaR_{1\%,t}^i$ calculated above is the financial system's *VaR* ($CoVaR_{q,t}^{system|i}$) conditional on bank *i* 's return being at its lowest 1% quantile (VaR_t^i): $CoVaR_{1\%,t}^{system|i} = \hat{R}_t^{system} = \hat{\alpha}^{system|i} + \hat{\beta}^{system|i} Z_{t-1} + \hat{\gamma}^{system|i} VaR_{1\%,t}^i$.

Note that the 50% quantile regression is also called median regression. Like the conditional mean regression (OLS), the conditional median regression can represent the relationship between the central location of the dependent variable *Y* and the independent variable *X*. However, when the distribution of *Y* is skewed as shown in Figure 1, the mean can be

[8] Koenker and Hallock (2001) provide a general introduction of quantile regression. Bassett and Koenker (1978) and Koenker and Bassett (1978) discuss the finite sample and asymptotic properties of quantile regression. Koenker (2005) is a comprehensive reference of the subject with applications in economics and finance.

challenging to interpret while the median remains highly informative.[9] As a consequence, it is appropriate in our study to use median regression to estimate the financial system's risk ($CoVaR_{1\%}^{system|i,median}$) when an individual bank is operating in its median state. The predicted value ($\hat{R}_t^i$) using the coefficient estimates ($\hat{\alpha}^{i,median}$ and $\hat{\beta}^{i,median}$) from the 1%-quantile regression in equation (7) and the lagged state variable (Z_{t-1}) is bank i 's median return: $R_t^{i,median} = \hat{\alpha}^{i,median} + \hat{\beta}^{i,median} Z_{t-1}$.

Following the same method, the financial system's risk conditional on bank i operating in its median state ($CoVaR_{1\%}^{system|i,median}$) is calculated using the coefficient estimates $\hat{\alpha}^{system|i}$, $\hat{\beta}^{system|i}$, $\hat{\gamma}^{system|i}$ from equation (6), the state variable (Z_{t-1}), and the median return of bank i ($R_t^{i,median}$): $CoVaR_{q,t}^{system|i,median} = \hat{\alpha}^{system|i} + \hat{\beta}^{system|i} Z_{t-1} + \hat{\gamma}^{system|i} R_t^{i,median}$.

Finally, the measure of bank i 's contribution of systemic risk ($\Delta CoVaR$) is the difference between $CoVaR_{q,t}^{system|i}$ and $CoVaR_{1\%}^{system|i,median}$: $\Delta CoVaR_{1\%,t}^{i} = CoVaR_{1\%,t}^{system|i} - CoVaR_{1\%,t}^{system|i,median}$. It is obvious that the calculation can be simplified to: $\Delta CoVaR_{1\%,t}^{i} = \beta^{system|i}(VaR_{1\%,t}^{i} - R_t^{i,median})$ as shown in Adrian and Brunnermeier (2010).

[9] The asymmetric properties of stock return distributions have been studied in Fama (1965), Officer (1972), and Praetz (1972).

Appendix B: Realized *SES* (Systemic Expected Shortfall)

Acharya, Pedersen, Phillppon and Richardson (2010) propose the *SES* (Systemic Expected Shortfall) to measure a bank's contribution to a systemic crisis due to its expected default loss. *SES* is defined as the expected amount that a bank is undercapitalized in a future systemic event in which the overall financial system is undercapitalized. In general, *SES* increases in the bank's expected losses during a crisis.

Two standard firm level risk measures are *VaR* and *ES* (Expected Shortfall). We have explained *VaR* and its extension *CoVaR* before. The purpose of this appendix is to define the ES measure and to discuss its implementation in our context.[10] Let s_1^i be bank *i*'s equity capital at time 1, then the bank's expected shortfall (*ES*) in default is $ES^i = E[s_1^i \mid s_1^i < 0]$.

The bank *i*'s systemic expected shortfall (*SES*) is the amount of bank *i*'s equity capital s_1^i drops below its target level, which is a fraction *k* of its asset a^i, in case of a systemic crisis when aggregate banking capital S_1 at time 1 is less than *k* times the aggregate bank asset *A*:

$SES^i = E[s_1^i - ka^i \mid S_1 < kA]$, where $S_1 = \sum_{j=1}^{N} s_1^j$ and $A = \sum_{j=1}^{N} a^j$ for *N* banks in the entire financial system. To control for each bank's size, SES^i is scaled by bank *i*'s initial equity capital s_0^i at time 0 and the banking system's equity capital is scaled by the banking system's initial equity capital S_0: $SES^i(\%) = \frac{SES^i}{s_0^i} = E\left[\frac{s_1^i}{s_0^i} - k\frac{a^i}{s_0^i}\middle| \frac{S_1}{S_0} < k\frac{A}{S_0}\right]$, where $S_0 = \sum_{j=1}^{N} s_0^j$ for *N* banks in the entire financial system. This percentage return measure of the systemic expected shortfall can be estimated as: $SES^i(\%) = E\left[r^i - k \cdot lev^i \middle| R < k \cdot LEV\right]$, where $r^i = \frac{s_1^i}{s_0^i}$ is the stock return of bank *i*, $R = \frac{S_1}{S_0}$ is the portfolio return of all banks, $lev^i = \frac{a^i}{s_0^i}$ is bank *i*'s leverage, and $LEV = \frac{A}{S_0}$ is the aggregate leverage of all banks.

We are interested in calculating the realized *SES*, because we need to use bank *i*'s non-interest income at time 0 to predict its systemic expected shortfall at time 1. Following the

[10] This estimation of *SES* is slightly different to Acharya, Pedersen, Phillppon and Richardson (2010) that calculate the *annual* realized *SES* using only the equity return data during the 2007-08 crisis. The empirical method described in this section estimates the *quarterly* realized *SES* with equity return data from 1986 to 2008.

empirical analysis of Acharya, Pedersen, Phillppon and Richardson (2010), the systemic crisis event ($R_t < k_t \cdot LEV_t$, or when aggregate banking capital at time t is less than k_t times the aggregate bank leverage) is the 5% worst days for the aggregate equity return of the entire banking system. The threshold k_t of calendar quarter *t* then can be estimated by $k_t = \frac{LEV_t}{R_t}$ at a standard risk level of 5% using the weighted-average equity return of all banks at the day of its 5-percentile equity return. The target equity level of bank *i* over the same quarter *t* is $k_t \cdot lev_t^i$ where bank *i*'s leverage is lev_t^i , and its *SES* in the percentage term is the difference between its average equity return r_t^i and its target equity level during these 5% worst days of the entire banking system's equity returns: $SES_t^i(\%) = E\left[r_t^i - k_t \cdot lev_t^i \middle| R_t < k_t \cdot LEV_t \right]$.

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Table I. Non-interest income to interest income ratio of the 10 largest commercial banks

Bank Name	1989	2000	2007
Citigroup	0.21	0.89	0.50
Bank of America	0.21	0.38	0.48
Chase	0.16	0.67	0.76
Wachovia	0.14	0.35	0.38
Wells Fargo	0.19	0.57	0.53
Suntrust	0.18	0.27	0.35
US Bank	0.18	0.50	0.55
National City	0.19	0.38	0.31
Bank of New York Mellon	0.21	0.67	1.39
PNC Financial	0.13	0.68	0.69
Average	0.18	0.53	0.59

Non-interest income ratio to interest income ratio (N2I) is defined below and the data are taken from the Federal Reserve Bank reporting form FR Y9C:

$$N2I = \frac{Noninterest\ Income}{Net\ interest\ Income} = \frac{BHCK4079}{BHCK4107}$$

Citigroup was Citibank in 1989 before the merger with Travelers Group. Bank of America was called BankAmerica in 1989 before the merger with NationsBank. US Bank was First Bank System in 1989 before the combination with Colorado National Bank and West One Bank. Bank of New York Mellon was called Bank of New York in 1989 before the merger with Mellon Financial.

Table II. Variable definitions

Variable	Name	Calculation	Sources
VaR	Value at Risk of financial institution	From equation (10)	
ΔCoVaR	Financial institution's contribution to systemic risk	From equation (14)	
R^i	Weekly asset return of individual bank	$\frac{MV_t^i \times LEV_t^i}{MV_{t-1}^i \times LEV_{t-1}^i} - 1$	CRSP Daily Stocks, Compustat Fundamentals Quarterly
R^s	Weekly asset return of all banks	$\sum_i \frac{MV_{t-1}^i \times LEV_{t-1}^i}{\sum_j MV_{t-1}^j \times LEV_{t-1}^j} R^i$	CRSP Daily Stocks, Compustat Fundamentals Quarterly
V	Market return volatility	Standard deviation of S&P 500 index	CRSP Indices Daily
L	Market liquidity spread	3mth LIBOR rate – 3mth Treasury bill rate	U.S. Federal Reserve, Compustat Daily Treasury
ΔRF	Risk-free rate change	3mth Treasury bill $rate_t$ – 3mth Treasury bill $rate_{t-1}$	U.S. Federal Reserve
ΔYC	Change in yield curve slope	(10yr $Treasury_t$ – 3mth $Treasury_t$) – (10yr $Treasury_{t-1}$ – 3mth $Treasury_{t-1}$)	Compustat Daily Treasury
ΔCS	Change in credit spread	(10yr BAA $bond_t$ – 10yr $Treasury_t$) – (10yr BAA $bond_{t-1}$ – 10yr $Treasury_{t-1}$)	Compustat Daily Treasury
MR	Weekly equity market return	Value weight equity market return including all distributions	CRSP Indices Daily
RE	Real estate market return	Average 50 U.S. states real estate price appreciation	Federal Housing Finance Agency
MM	Maturity mismatch	Short term debt / total asset	Compustat Fundamentals Quarterly
M2B	Market to book	MV / equity book value	CRSP Daily Stocks, Compustat Fundamentals Quarterly
MV	Market value of equity	Price × Shares outstanding	CRSP Daily Stocks
LEV	Leverage	Total asset / equity book value	Compustat Fundamentals Quarterly
VOL	Equity return volatility	Standard deviation(Stock Returns)	CRSP Daily Stocks
AT	Logarithm of total book asset	Log(Total Asset)	U.S. Federal Reserve FRY-9C Report
AT^2	Square term of AT	$[\text{Log(Total Asset)}]^2$	U.S. Federal Reserve FRY-9C Report
L2A	Loan to total asset	(Loan + Lease) / Total Asset	U.S. Federal Reserve FRY-9C Report
C2L	C&I loans to total loan	(Commercial Loan + Industrial Loan) / Total Loan	U.S. Federal Reserve FRY-9C Report
N2I	Non-interest income to interest income	Non-interest income) / Interest Income	U.S. Federal Reserve FRY-9C Report
T2I	Trading income to interest income	Trading income includes trading revenue, net securitization income, gain(loss) of loan sales and gain(loss) of real estate sales.	U.S. Federal Reserve FRY-9C Report
V2I	IBVC income to interest income	IBVC income includes investment banking/advisory fee, brokerage commission and venture capital revenue.	U.S. Federal Reserve FRY-9C Report
NT2I	Other non-trading non-interest income to interest income	Non-trading income includes fiduciary income, deposits service charge, net servicing fee, service charges for safe deposit box and sales of money orders, rental income, credit card fees, gains on non-hedging derivatives, and etc.	U.S. Federal Reserve FRY-9C Report

Table III. Summary statistics

Variable	Mean	Median	Standard Deviation
$\Delta CoVaR$	-1.202	-1.043	1.013
VaR	-10.64	-9.699	4.613
Maturity Mismatch	0.076	0.056	0.076
Market to Book	1.844	1.711	0.794
Market Value	2545	313	10258
Leverage	12.3	14.59	3.012
Log (Total Assets)	14.88	14.58	1.606
Equity Return Volatility	0.022	0.02	0.011
Non-interest Income to Interest Income	0.244	0.175	0.286
Loans to Total Assets	0.647	0.664	0.126
C&I Loans to Total Loans	0.197	0.172	0.122

Table IV. Correlations between the various variables

	$\Delta CoVaR$	VaR	Maturity Mismatch	Market to Book	Leverage	Equity Return Volatility	Log(Total Assets)	Loans to Total Assets	C&I Loans to Total Loans
VaR	0.20								
Maturity Mismatch	-0.16	-0.06							
Market to Book	-0.13	0.08	0.04						
Leverage	-0.01	-0.11	0.27	-0.02					
Equity Return Volatility	0.02	-0.38	-0.10	-0.18	0.08				
Log(Total Assets)	-0.29	0.04	0.37	0.17	0.18	-0.31			
Loans to Total Assets	0.10	-0.02	-0.32	-0.13	-0.14	0.00	-0.16		
C&I Loans to Total Loans	-0.13	-0.02	0.15	-0.05	0.11	-0.02	0.23	-0.09	
Non-interest Income to Interest Income	-0.10	-0.02	0.01	0.13	-0.14	-0.04	0.11	-0.26	-0.02

Table V. Average t-statistics of state variable exposures

	Financial System's VaR		Bank (portfolio)'s VaR		Bank (portfolio)'s CoVaR	
	our estimate	Adrian & Brunnermeier (2010)	our estimate	Adrian & Brunnermeier (2010)	our estimate	Adrian & Brunnermeier (2010)
Market Return Volatility $_{t-1}$	(-3.75)	(-13.97)	(-3.78)	(-4.26)	(-14.47)	(-7.45)
LIBOR (Repo) to T-bill Spread $_{t-1}$	(-6.27)	(-2.86)	(-5.23)	(-1.07)	(-13.37)	(-2.04)
3-month Yield Change $_{t-1}$	(1.03)	(-1.18)	(-1.83)	(-0.44)	(-7.03)	(-0.74)
Term Spread Change $_{t-1}$	(-0.64)	(-0.09)	(-0.76)	(-0.47)	(-10.01)	(0.13)
Credit Spread Change $_{t-1}$	(-0.03)	(-0.66)	(-4.41)	(-0.87)	(-12.52)	(-0.56)
Market Return $_{t-1}$	(2.09)	(5.72)	(3.86)	(3.25)	(0.35)	(4.26)
House Price Change $_{t-1}$	(1.11)	(2.14)	(1.48)	(0.93)	(4.32)	(1.61)
Bank (portfolio)'s Asset Return $_{t-1}$					(18.32)	(4.07)

Our estimate uses individual bank's asset return, whereas Adrian & Brunnermeier (2010) uses bank portfolio's asset return.

Table VI. Regression of a bank's Δ*CoVaR* on firm characteristics

The dependent variable is Δ*CoVaR*, which is the difference between *CoVaR* conditional on the bank being under distress and the *CoVaR* in the median state of the bank. The independent variables include one quarter lagged *VaR* of the bank and other firm characteristics such as maturity mismatch, market to book, leverage, return volatility, total asset, loan to asset, commercial & industrial loan to total loan and non-interest income to interest income ratio.

Dependent Variable: $\Delta CoVaR_t$	(1)	(2)	(3)	(4)	(5)	(6)
VaR_{t-1}	0.0373***	0.0366***	0.0370***	0.0363***	0.0358***	0.0350***
	(9.80)	(9.68)	(9.79)	(9.67)	(9.44)	(9.32)
Maturity Mismatch $_{t-1}$	-0.474***	-0.400***	-0.234	-0.138	-0.302**	-0.204
	(-3.18)	(-2.64)	(-1.53)	(-0.89)	(-1.99)	(-1.33)
Market to Book $_{t-1}$	-0.225***	-0.200***	-0.216***	-0.189***	-0.208***	-0.181***
	(-11.90)	(-10.50)	(-11.65)	(-10.19)	(-11.27)	(-9.81)
Leverage $_{t-1}$	-0.00247	-0.000887	-0.00226	-0.000692	-0.00632	-0.00465
	(-0.64)	(-0.23)	(-0.59)	(-0.18)	(-1.64)	(-1.21)
Equity Return Volatility $_{t-1}$	4.077***	1.402	4.395***	1.657	4.453***	1.726
	(3.73)	(1.26)	(4.03)	(1.50)	(4.09)	(1.56)
Log (Total Asset) $_{t-1}$	-0.130***	-1.360***	-0.124***	-1.393***	-0.120***	-1.383***
	(-17.59)	(-15.44)	(-16.72)	(-16.14)	(-16.11)	(-16.07)
Log (Total Asset) squared $_{t-1}$		0.0393***		0.0405***		0.0403***
		(13.89)		(14.66)		(14.83)
Loan to Total Asset $_{t-1}$			0.450***	0.481***	0.315***	0.349***
			(4.66)	(4.91)	(3.18)	(3.45)
C&I Loan to Total Loan $_{t-1}$			-0.316***	-0.376***	-0.336***	-0.395***
			(-3.96)	(-4.633)	(-4.20)	(-4.87)
Non-interest Income to Interest Income $_{t-1}$					-0.0498***	-0.0485***
					(-12.53)	(-11.16)
Intercept	1.186***	10.74***	0.880***	10.73***	0.958***	10.76***
	(6.89)	(15.57)	(4.85)	(15.41)	(5.29)	(15.46)
N	15,838	15,838	15,817	15,817	15,817	15,817
Adjusted R-square	0.21	0.23	0.22	0.23	0.22	0.23
F-test	17.32	22.34	17.77	22.48	21.93	26.05

t-test based on Newey-West standard error is shown in the parenthesis with ***, ** and * indicating its statistical significant level of 1%, 5% and 10% respectively.

Table VII. Regression of a bank's Δ*CoVaR* on different components of non-interest income

The dependent variable is $\Delta CoVaR_t$, which is the difference between *CoVaR* conditional on the bank being under distress and the *CoVaR* in the median state of the bank. The independent variables include one quarter lagged *VaR* of the bank and other firm characteristics such as maturity mismatch, market to book, leverage, return volatility, total asset, loan to asset, commercial & industrial loan to total loan, trading income to interest income, IBVC income to interest income, and other non-trading non-interest to non-interest income ratio. Trading Income includes trading revenue, net securitization income, gain(loss) of loan sales and gain(loss) of real estate sales. IBVC Income includes investment banking/advisory fee, brokerage commission and venture capital revenue. Other Non-trading Income includes fiduciary income, deposits service charge, net servicing fee, service charges for safe deposit box and sales of money orders, rental income, credit card fees, gains on non-hedging derivatives, and etc. All these detail accounting items are reported in FR Y-9C since 2001.

Dependent Variable: $\Delta CoVaR_t$	(1)	(2)	(3)	(4)	(5)	(6)
VaR_{t-1}	0.0389***	0.0376***	0.0387***	0.0381***	0.0375***	0.0364***
	(7.38)	(7.21)	(7.40)	(7.35)	(7.07)	(6.92)
Maturity Mismatch $_{t-1}$	0.137	0.396**	-0.00587	0.242	0.0185	0.282
	(0.69)	(2.01)	(-0.03)	(1.24)	(0.09)	(1.43)
Market to Book $_{t-1}$	-0.221***	-0.180***	-0.214***	-0.176***	-0.206***	-0.163***
	(-9.32)	(-7.59)	(-8.97)	(-7.36)	(-8.54)	(-6.81)
Leverage $_{t-1}$	0.00791	0.00672	0.00279	0.00286	0.00130	0.000613
	(1.47)	(1.27)	(0.51)	(0.52)	(0.24)	(0.11)
Equity Return Volatility $_{t-1}$	0.0282	-1.287	-0.341	-1.665	0.00988	-1.182
	(0.01)	(-0.67)	(-0.18)	(-0.87)	(0.01)	(-0.61)
Log (Total Asset) $_{t-1}$	-0.130***	-1.560***	-0.134***	-1.510***	-0.128***	-1.547***
	(-13.00)	(-13.47)	(-13.33)	(-12.99)	(-12.25)	(-13.65)
Log (Total Asset) squared $_{t-1}$		0.0454***		0.0436***		0.0451***
		(12.44)		(11.92)		(12.75)
Loan to Total Asset $_{t-1}$	0.294**	0.351***	0.130	0.202	0.0991	0.151
	(2.34)	(2.77)	(0.99)	(1.51)	(0.81)	(1.21)
C&I Loan to Total Loan $_{t-1}$	-0.395***	-0.377***	-0.393***	-0.360***	-0.408***	-0.378***
	(-2.96)	(-2.81)	(-2.95)	(-2.69)	(-3.03)	(-2.79)
Trading Income to Interest Income $_{t-1}$	-0.283**	-0.399***			-0.252*	-0.356***
	(-2.13)	(-3.01)			(-1.87)	(-2.68)
IBVC Income to Interest Income $_{t-1}$			-0.0448***	-0.0390***	-0.0414***	-0.0332***
			(-9.08)	(-8.01)	(-6.42)	(-5.11)
Other Non-trading Non-interest Income $_{t-1}$					-0.0971	-0.164*
					(-1.03)	(-1.70)
Intercept	-0.191	10.89***	1.722***	12.31***	-0.0206	12.58***
	(-0.71)	(11.10)	(8.50)	(13.05)	(-0.08)	(13.70)
N	7,982	7,982	7,981	7,981	7,981	7,981
Adjusted R-square	0.22	0.25	0.23	0.25	0.23	0.25
F-test	20.39	27.60	42.78	49.75	38.55	41.95

t-test based on Newey-West standard error is shown in the parenthesis with ***, ** and * indicating its statistical significant level of 1%, 5% and 10% respectively.

Table VIII. Prediction of a bank's Δ*CoVaR* on one-year lagged firm characteristics in the 2007-08 crisis

The dependent variable is $\Delta CoVaR_t$, which is the difference between *CoVaR* conditional on the bank being under distress and the *CoVaR* in the median state of the bank. The independent variables include 1-year lagged firm characteristics such as maturity mismatch, market to book, leverage, return volatility, total asset, loan to asset, commercial & industrial loan to total loan, non-interest income to interest income, trading income to interest income, IBVC income to interest income, and other non-trading non-interest income to interest income ratio.
Trading Income includes trading revenue, net securitization income, gain(loss) of loan sales and gain(loss) of real estate sales. IBVC Income includes investment banking/advisory fee, brokerage commission and venture capital revenue. Other Non-trading Income includes fiduciary income, deposits service charge, net servicing fee, service charges for safe deposit box and sales of money orders, rental income, credit card fees, loan commitment fees, gains on non-hedging derivatives, interest on tax refunds, and etc. The exact dates of current economic crisis (2007Q4 – 2008Q3) are taken from NBER web site.

Dependent Variable: $\Delta CoVaR_t$	2006Q4 – 2007Q3			2007Q4 – 2008Q3		
	(1)	(2)	(3)	(4)	(5)	(6)
VaR_{t-1}			0.00120			0.0436**
			(0.121)			(2.419)
Maturity Mismatch $_{t-1}$	0.269	0.208	0.216	1.019	1.004	1.205
	(0.56)	(0.43)	(0.44)	(1.18)	(1.17)	(1.38)
Market to Book $_{t-1}$	-0.240***	-0.222***	-0.221***	-0.273***	-0.262***	-0.279***
	(-4.22)	(-3.58)	(-3.57)	(-3.30)	(-2.86)	(-3.03)
Leverage $_{t-1}$	0.00412	-0.00121	-0.00129	-0.0337	-0.0327	-0.0322
	(0.29)	(-0.08)	(-0.08)	(-1.58)	(-1.42)	(-1.42)
Equity Return Volatility $_{t-1}$	-9.182	-9.425	-9.327	-11.57	-12.59	-8.308
	(-1.37)	(-1.41)	(-1.38)	(-1.02)	(-1.11)	(-0.71)
Log (Asset Size) $_{t-1}$	-2.135***	-2.115***	-2.118***	-3.145***	-3.167***	-3.046***
	(-7.74)	(-7.68)	(-7.57)	(-6.59)	(-6.51)	(-6.43)
Log (Asset Size) squared $_{t-1}$	0.0632***	0.0625***	0.0626***	0.0899***	0.0911***	0.0874***
	(7.42)	(7.37)	(7.28)	(6.21)	(6.18)	(6.09)
Loan to Total Asset $_{t-1}$	0.147	0.0211	0.0211	0.197	0.108	0.282
	(0.55)	(0.07)	(0.07)	(0.42)	(0.22)	(0.59)
C&I Loan to Total Loan $_{t-1}$	-0.247	-0.280	-0.281	-0.163	-0.123	-0.221
	(-0.62)	(-0.70)	(-0.70)	(-0.30)	(-0.22)	(-0.41)
Trading Income to Interest Income $_{t-1}$	-1.728***	-1.537***	-1.534***	-3.581***	-3.475***	-3.228**
	(-3.05)	(-2.77)	(-2.77)	(-2.68)	(-2.65)	(-2.47)
IBVC Income to Interest Income $_{t-1}$		-0.0292*	-0.0289*		0.0289	0.0380
		(-1.87)	(-1.83)		(0.95)	(1.27)
Other Non-trading Non-interest Income to Interest Income $_{t-1}$		-0.0447	-0.0470		-0.552	-0.671
		(-0.19)	(-0.19)		(-1.15)	(-1.41)
Intercept	16.79***	16.78***	17.25***	26.10***	26.27***	25.58***
	(7.49)	(7.50)	(7.55)	(6.76)	(6.72)	(6.69)
N	971	971	971	895	895	895
Adjusted R-square	0.20	0.20	0.20	0.18	0.18	0.19
F-test	15.60	36.91	34.23	11.77	13.34	13.36

t-test based on Newey-West standard error is shown in the parenthesis with ***, ** and * indicating its statistical significant level of 1%, 5% and 10% respectively.

Time Line of Events at Lehman Brothers

2007Q3: Lehman closes subprime mortgage business and cuts thousands of mortgage-related jobs and. CFO Chris O'Meara steps down to head global risk management division.

2007Q4: Lehman reports $4.2 billion earnings for 2007 fiscal year, a 5% increase from the previous year.

2008Q1: Lehman announces to stop originating mortgages through wholesale channels. Lehman obtains $2 billion 3-year credit line from consortium of 40 banks including JPMorgan Chase and Citigroup. On March 16, JPMorgan announces offer to purchase Bear Sterns.

2008Q2: Lehman shows a $2.8 billion loss admitting the loss coming from both mortgage-related positions and hedges against those positions, and announces plan to raise additional $6 billion in new capital including $4 billion in common stock and $2 billion in convertible preferred stock.

2008Q3: Lehman shares plunge amid rumors that its assets have not been priced to appropriately reflect their true value. On September 15, Lehman officially files bankruptcy after Treasury Secretary refusing to back any takeover. One week later, Lehman U.S. operations re-opened for business under Barclays Capital.

Table IX. Regression of a bank's Δ*CoVaR* on firm characteristics pre- and during crises

The dependent variable is $\Delta CoVaR_t$, which is the difference between *CoVaR* conditional on the bank being under distress and the *CoVaR* in the median state of the bank. The independent variables include 1-year lagged *VaR* of the bank and other firm characteristics such as maturity mismatch, market to book, leverage, return volatility, total asset, loan to asset, commercial & industrial loan to total loan, non-interest income to interest income, non-interest income. The exact dates of economic crisis are taken from NBER web site. I define two time periods for each economic contraction: boom period (1 calendar year) and crisis period (NBER's definition of economic contraction).

Dependent Variable: $\Delta CoVaR_t$	Boom 1989Q4 – 1990Q3	Crisis 1990Q4 – 1991Q3	Boom 2000Q1 – 2000Q4	Crisis 2001Q1 – 2001Q4	Boom 2006Q4 – 2007Q3	Crisis 2007Q4 – 2008Q3
VaR_{t-1}	0.00249	0.0426	-0.00131	0.0241**	0.00140	0.0417**
	(0.11)	(1.36)	(-0.10)	(2.37)	(0.14)	(2.32)
Maturity Mismatch $_{t-1}$	-1.848*	-2.799*	-0.0896	0.316	0.0569	1.157
	(-1.93)	(-1.86)	(-0.14)	(0.61)	(0.12)	(1.29)
Market to Book $_{t-1}$	0.397**	0.0722	-0.211***	-0.121*	-0.222***	-0.320***
	(2.15)	(0.38)	(-3.60)	(-1.95)	(-3.65)	(-3.34)
Leverage $_{t-1}$	-0.00255	-0.0286	-0.0192	0.00296	-0.00253	-0.0319
	(-0.10)	(-0.94)	(-1.28)	(0.30)	(-0.16)	(-1.39)
Equity Return Volatility $_{t-1}$	-0.225	10.20	4.199	4.880	-9.444	-8.326
	(-0.02)	(1.04)	(1.08)	(1.59)	(-1.40)	(-0.70)
Log (Asset Size) $_{t-1}$	-1.327	-0.916	-1.879***	-1.924***	-2.051***	-2.928***
	(-0.88)	(-0.82)	(-6.15)	(-6.69)	(-7.47)	(-6.32)
Log (Asset Size) squared $_{t-1}$	0.0381	0.0302	0.0571***	0.0581***	0.0602***	0.0826***
	(0.81)	(0.82)	(5.79)	(6.24)	(7.16)	(5.90)
Loan to Total Asset $_{t-1}$	0.461	0.765	-0.0418	-0.00501	-0.0118	0.511
	(0.54)	(0.74)	(-0.10)	(-0.01)	(-0.04)	(0.89)
C&I Loan to Total Loan $_{t-1}$	-0.00176	-1.317	-0.300	-0.321	-0.270	-0.188
	(-0.00)	(-1.32)	(-1.13)	(-1.03)	(-0.68)	(-0.35)
Non-interest Income to Interest Income $_{t-1}$	-2.991***	-1.478	-0.305	-0.396	-0.0455***	-0.00167
	(-3.77)	(-1.54)	(-1.11)	(-1.48)	(-3.37)	(-0.06)
Intercept	9.818	6.381	14.60***	14.71***	16.81***	24.62***
	(0.83)	(0.72)	(6.06)	(6.61)	(7.44)	(6.53)
N	216	232	909	976	971	895
Adjusted R-square	0.21	0.19	0.22	0.20	0.19	0.18
F-test	4.97	4.28	14.08	11.75	42.56	11.53

t-test based on Newey-West standard error is shown in the parenthesis with ***, ** and * indicating its statistical significant level of 1%, 5% and 10% respectively.

Table X. *SES* (Systemic Expected Shortfall) and non-interest income

The dependent variable is realized systemic expected shortfall (*SES*), which is the average equity return of the bank below its target level conditional on the average equity return of the entire banking system being below its target level. See Appendix B for technical details of *SES*'s definition and implementation. The independent variables include bank characteristics such as maturity mismatch, market to book, leverage, return volatility, total asset, loan to asset, commercial & industrial loan to total loan, return on asset, non-interest income to interest income, trading income to interest income, IBVC income to interest income, and other non-trading non-interest to interest income. Trading income includes trading revenue, net securitization income, gain (loss) of loan sales and gain (loss) of real estate sales. IBVC income includes investment banking/advisory fee, brokerage commission and venture capital revenue. Other non-trading non-interest income includes fiduciary income, deposits service charge, net servicing fee, service charges for safe deposit box and sales of money orders, rental income, credit card fees, gains on non-hedging derivatives, and etc. All these detail accounting items are reported in FR Y-9C since 2001.

Dependent Variable: SES_t	(1)	(2)	(3)	(4)	(5)
$Maturity\ Mismatch_t$	-0.0739	-0.00605	-0.0672	-0.0371	-0.0417
	(-0.664)	(-0.0416)	(-0.476)	(-0.262)	(-0.288)
$Market\ to\ Book_t$	0.350***	0.432***	0.427***	0.436***	0.429***
	(7.295)	(30.02)	(29.22)	(30.74)	(29.68)
$Leverage_t$	-0.0752***	-0.0802***	-0.0813***	-0.0808***	-0.0816***
	(-5.571)	(-27.68)	(-27.20)	(-27.84)	(-27.21)
$Equity\ Return\ Volatility_t$	-11.98***	-11.92***	-11.77***	-11.88***	-11.56***
	(-6.987)	(-4.770)	(-4.784)	(-4.763)	(-4.652)
$Log\ (Total\ Asset)_t$	-0.0323***	-0.0236***	-0.0239***	-0.0200***	-0.0215***
	(-6.852)	(-4.805)	(-5.032)	(-3.837)	(-4.030)
$Loan\ to\ Total\ Asset_t$	-0.00581	-0.129**	-0.0893	-0.0950	-0.109*
	(-0.111)	(-2.159)	(-1.568)	(-1.621)	(-1.817)
$C\&I\ Loan\ to\ Total\ Loan_t$	0.219***	0.178	0.164	0.189*	0.137
	(2.941)	(1.535)	(1.427)	(1.659)	(1.163)
$Return\ on\ Asset_t$	33.95	1.102	4.986**	1.269	5.388**
	(1.534)	(0.566)	(2.178)	(0.662)	(2.212)
$Non\text{-}interest\ Income\ to\ Interest\ Income_t$	-0.0858**				
	(-2.036)				
$Trading\ Income\ to\ Interest\ Income_t$		-0.0990*			-0.116**
		(-1.822)			(-2.027)
$IBVC\ Income\ to\ Interest\ Income_t$			-0.0288***		-0.0282***
			(-4.112)		(-3.840)
Other Non-trading Non-interest Income to $Interest\ Income_t$				-0.0908***	-0.0297
				(-3.546)	(-1.133)
Intercept	1.684***	0.413***	1.598***	0.370***	1.564***
	(6.652)	(3.001)	(7.965)	(2.643)	(7.575)
N	9,161	4,445	4,444	4,445	4,444
Adjusted R-square	0.65	0.69	0.70	0.70	0.70
F-test	430.07	139.85	142.83	141.09	136.41

t-test based on Newey-West standard error is shown in the parenthesis with ***, ** and * indicating its statistical significant level of 1%, 5% and 10% respectively.

Table XI Robustness test: *VaR* and impact of differential lags

The dependent variable of regression (1) and (2) is individual bank's *VaR*. The independent variables include one quarter lagged *VaR* and other firm characteristics including non-interest income to interest income and its breakdowns. Regression (3) to (5) use the 2-quarter, 3-quarter and 1-year instead of 1-quarter lagged Non-interest/Interest Income ratio as independent variable.

Dependent Variable	VaR_t		$\Delta CoVaR_t$		
	(1)	(2)	(3)	(4)	(5)
VaR_{t-1}	0.865***	0.898***	0.0419***	0.0419***	0.0419***
	(146.70)	(102.20)	(8.95)	(8.94)	(8.95)
Maturity Mismatch $_{t-1}$	-0.360	-0.193	-0.367**	-0.367**	-0.364**
	(-1.24)	(-0.42)	(-2.07)	(-2.07)	(-2.05)
Market to Book $_{t-1}$	0.0283	0.0549	-0.181***	-0.181***	-0.181***
	(1.04)	(1.25)	(-8.70)	(-8.70)	(-8.69)
Leverage $_{t-1}$	-0.0108	-0.00812	-0.00629	-0.00624	-0.00615
	(-1.49)	(-0.71)	(-1.36)	(-1.35)	(-1.33)
Equity Return Volatility $_{t-1}$	-17.18***	-22.26***	-0.00692	-0.0145	-0.0150
	(-6.77)	(-4.90)	(-0.00)	(-0.01)	(-0.01)
Log(Total Asset) $_{t-1}$	-0.0520	-0.0773	-1.348***	-1.349***	-1.350***
	(-0.26)	(-0.27)	(-12.54)	(-12.54)	(-12.55)
Log (Total Asset)-squared $_{t-1}$	0.000417	0.000229	0.0395***	0.0395***	0.0395***
	(0.07)	(0.03)	(11.67)	(11.68)	(11.68)
Loan to Total Asset $_{t-1}$	-0.0508	-0.183	0.476***	0.477***	0.480***
	(-0.31)	(-0.72)	(3.93)	(3.93)	(3.95)
C&I Loan to Total Loan $_{t-1}$	-0.0201	-0.168	-0.494***	-0.495***	-0.495***
	(-0.13)	(-0.61)	(-5.12)	(-5.12)	(-5.12)
Trading Income to Interest Income $_{t-1}$		-0.377			
		(-1.22)			
IBVC Income to Interest Income $_{t-1}$		-0.0255			
		(-1.35)			
Other Non-trading Non-interest Income to Interest Income $_{t-1}$		0.210			
		(1.32)			
Non-interest Income to Interest Income $_{t-1}$	-0.0211				
	(-1.41)				
Non-interest Income to Interest Income $_{t-2}$			-0.0451***		
			(-10.48)		
Non-interest Income to Interest Income $_{t-3}$				-0.0452***	
				(-10.35)	
Non-interest Income to Interest Income $_{t-4}$					-0.0446***
					(-9.96)
Intercept	-2.854*	1.239	10.11***	10.11***	10.12***
	(-1.77)	(0.55)	(11.31)	(11.31)	(11.31)
N	12,176	6,318	12,176	12,176	12,176
Adjusted R-square	0.81	0.82	0.23	0.23	0.23
F-test	527.95	667.89	22.49	22.49	22.35

t-test is shown in the parenthesis with ***, ** and * indicating its statistical significant level of 1%, 5% and 10% respectively.

Table XII Robustness test: Non-interest income to total asset

The dependent variable is $\Delta CoVaR_t$, which is the difference between *CoVaR* conditional on the bank being under distress and the *CoVaR* in the median state of the bank. The independent variables include one quarter lagged *VaR* of the bank and other firm characteristics such as maturity mismatch, market to book, leverage, return volatility, total asset, loan to asset, commercial & industrial loan to total loan, return on asset, non-interest income to total asset, trading income to total asset, IBVC income to total asset, and other non interest to total asset. Trading Income includes trading revenue, net securitization income, gain(loss) of loan sales and gain(loss) of real estate sales. IBVC Income includes investment banking/advisory fee, brokerage commission and venture capital revenue. Other non-trading Income includes fiduciary income, deposits service charge, net servicing fee, service charges for safe deposit box and sales of money orders, rental income, credit card fees, gains on non-hedging derivatives, and etc. All these detail accounting items are reported in FR Y-9C since 2001.

Dependent Variable: $\Delta CoVaR_t$	(1)	(2)	(3)	(4)	(5)
VaR_{t-1}	0.0357***	0.0403***	0.0402***	0.0415***	0.0388***
	(9.351)	(7.570)	(7.592)	(7.909)	(7.205)
Maturity Mismatch $_{t-1}$	-0.368**	0.145	0.0509	0.0828	0.103
	(-2.393)	(0.727)	(0.258)	(0.422)	(0.518)
Market to Book $_{t-1}$	-0.199***	-0.204***	-0.208***	-0.203***	-0.206***
	(-10.10)	(-8.254)	(-8.225)	(-8.009)	(-7.921)
Leverage $_{t-1}$	-0.00756*	0.00436	0.00382	0.00412	0.00306
	(-1.879)	(0.790)	(0.683)	(0.733)	(0.540)
Equity Return Volatility $_{t-1}$	4.352***	-0.616	-0.564	-0.748	-0.186
	(3.973)	(-0.322)	(-0.293)	(-0.387)	(-0.0958)
Log (Total Asset) $_{t-1}$	-0.121***	-0.136***	-0.137***	-0.135***	-0.133***
	(-15.69)	(-13.53)	(-13.48)	(-12.98)	(-12.82)
Loan to Total Asset $_{t-1}$	-0.206**	-0.308**	-0.236*	-0.257**	-0.292**
	(-2.199)	(-2.378)	(-1.863)	(-2.037)	(-2.247)
C&I Loan to Total Loan $_{t-1}$	-0.324**	-0.691***	-0.673***	-0.641***	-0.733***
	(-2.462)	(-3.383)	(-3.294)	(-3.153)	(-3.574)
Return on Asset $_{t-1}$	-1.352	-7.642***	-3.648	-8.024***	-2.302
	(-0.445)	(-3.787)	(-1.026)	(-4.071)	(-0.589)
Non-interest Income to Total Asset $_{t-1}$	-4.027***				
	(-5.396)				
Trading Income to Total Asset $_{t-1}$		-6.125**			-7.082**
		(-2.123)			(-2.381)
IBVC Income to Total Asset $_{t-1}$			-2.296**		-2.582***
			(-2.478)		(-2.645)
Other Non-trading Non-interest Income to Total Asset $_{t-1}$				-2.071	-1.433
				(-0.643)	(-0.448)
Intercept	1.204***	0.247	0.249	1.998***	0.199
	(6.786)	(1.047)	(1.055)	(10.85)	(0.841)
N	15,825	7,982	7,981	7,988	7,981
Adjusted R-square	0.22	0.23	0.23	0.23	0.23
F-test	45.26	58.95	59.06	59.06	56.50

t-test based on Newey-West standard error is shown in the parenthesis with ***, ** and * indicating its statistical significant level of 1%, 5% and 10% respectively.

Table XIII Robustness test: Regression of a bank's Δ*CoVaR* on non-interest income of the same quarter

The dependent variable is $\Delta CoVaR_t$, which is the difference between *CoVaR* conditional on the bank being under distress and the *CoVaR* in the median state of the bank. The independent variables include the current quarter's *VaR* and other firm characteristics such as maturity mismatch, market to book, leverage, return volatility, total asset, loan to asset, commercial & industrial loan to total loan, non-interest to interest income, trading income to interest income, IBVC income to interest income, and other non-trading non-interest income to non-interest income ratios. Trading Income includes trading revenue, net securitization income, gain(loss) of loan sales and gain(loss) of real estate sales. IBVC Income includes investment banking/advisory fee, brokerage commission and venture capital revenue. Other Non-trading Income includes fiduciary income, deposits service charge, net servicing fee, service charges for safe deposit box and sales of money orders, rental income, credit card fees, gains on non-hedging derivatives, and etc.

Dependent Variable: $\Delta CoVaR_t$	(1)	(2)	(3)	(4)	(5)	(6)
VaR_t	0.0501***	0.0493***	0.0485***	0.0477***	0.0461***	0.0449***
	(12.28)	(12.16)	(11.91)	(11.78)	(8.391)	(8.257)
Maturity Mismatch $_t$	-0.359**	-0.320**	-0.382**	-0.343**	0.0953	0.289
	(-2.351)	(-2.068)	(-2.513)	(-2.228)	(0.501)	(1.523)
Market to Book $_t$	-0.197***	-0.172***	-0.199***	-0.174***	-0.207***	-0.165***
	(-10.47)	(-9.146)	(-10.53)	(-9.206)	(-8.421)	(-6.863)
Leverage $_t$	-0.00541	-0.00429	-0.00634	-0.00521	0.00452	0.00346
	(-1.395)	(-1.110)	(-1.629)	(-1.342)	(0.844)	(0.654)
Equity Return Volatility $_t$	5.220***	2.448**	5.593***	2.821**	0.754	-0.643
	(4.815)	(2.228)	(5.148)	(2.561)	(0.417)	(-0.361)
Log (Total Asset) $_t$	-0.123***	-1.375***	-0.118***	-1.369***	-0.126***	-1.547***
	(-17.10)	(-16.83)	(-16.48)	(-16.87)	(-13.45)	(-14.60)
Log (Total Asset) squared $_t$		0.0400***		0.0400***		0.0451***
		(15.33)		(15.43)		(13.64)
Loan to Total Asset $_t$	-0.197**	-0.133	-0.176**	-0.112	-0.284**	-0.202*
	(-2.213)	(-1.468)	(-1.979)	(-1.243)	(-2.387)	(-1.667)
C&I Loan to Total Loan $_t$	-0.248*	-0.318**	-0.300**	-0.369***	-0.722***	-0.663***
	(-1.931)	(-2.477)	(-2.330)	(-2.872)	(-3.657)	(-3.375)
Return on Asset $_t$	-9.272***	-9.657***	-4.160*	-4.595**	-2.171	-2.990
	(-5.061)	(-5.470)	(-1.958)	(-2.159)	(-0.877)	(-1.231)
Non-interest Income to Interest Income $_t$			-0.0472***	-0.0468***		
			(-9.241)	(-8.552)		
Trading Income to Interest Income $_t$					-0.264*	-0.308**
					(-1.698)	(-1.997)
IBVC Income to Interest Income $_t$					-0.0420***	-0.0350***
					(-6.724)	(-5.553)
Other Non-trading Non-interest Income $_t$					-0.0245	-0.521
					(-0.0450)	(-0.884)
Intercept	1.375***	11.11***	1.294***	11.01***	1.217***	12.71***
	(8.170)	(17.23)	(7.703)	(17.17)	(6.177)	(15.31)
N	15,825	15,825	15,825	15,825	7,981	7,981
Adjusted R-square	0.21	0.23	0.21	0.23	0.20	0.22
F-test	17.82	22.31	20.41	24.43	34.16	38.40

t-test based on Newey-West standard error is shown in the parenthesis with ***, ** and * indicating its statistical significant level of 1%, 5% and 10% respectively.

Table XIV Robustness test: Statistics of banks drifting between non-interest income terciles

The number of banks whose Non-interest Income to Interest Income ratios change from one tercile to another tercile in each calendar quarter.

Year	*Quarter*	*# Changes*	*# TotalBanks*	$\frac{\#Changes}{\#TotalBanks}$	*Year*	*Quarter*	*# Changes*	*# TotalBanks*	$\frac{\#Changes}{\#TotalBanks}$
1986	4	1	49	2%	1998	1	5	206	2%
1987	1	2	50	4%	1998	2	13	196	7%
1987	2	2	50	4%	1998	3	6	208	3%
1987	3	1	53	2%	1998	4	2	215	1%
1987	4	2	54	4%	1999	1	7	223	3%
1988	1	1	53	2%	1999	2	11	227	5%
1988	2	4	55	7%	1999	3	5	221	2%
1988	3	2	56	4%	1999	4	9	228	4%
1988	4	1	57	2%	2000	1	9	233	4%
1989	1	1	57	2%	2000	2	21	229	9%
1989	2	0	55	0%	2000	3	11	232	5%
1989	3	0	56	0%	2000	4	9	235	4%
1989	4	0	58	0%	2001	1	8	247	3%
1990	1	0	59	0%	2001	2	26	241	11%
1990	2	3	57	5%	2001	3	8	225	4%
1990	3	3	55	5%	2001	4	8	227	4%
1990	4	2	62	3%	2002	1	9	185	5%
1991	1	3	63	5%	2002	2	14	200	7%
1991	2	4	62	6%	2002	3	6	244	2%
1991	3	2	67	3%	2002	4	4	252	2%
1991	4	1	77	1%	2003	1	11	271	4%
1992	1	0	77	0%	2003	2	14	258	5%
1992	2	8	78	10%	2003	3	8	257	3%
1992	3	4	79	5%	2003	4	3	266	1%
1992	4	3	79	4%	2004	1	2	269	1%
1993	1	0	79	0%	2004	2	21	266	8%
1993	2	4	79	5%	2004	3	8	258	3%
1993	3	4	82	5%	2004	4	4	253	2%
1993	4	0	81	0%	2005	1	6	248	2%
1994	1	6	82	7%	2005	2	10	248	4%
1994	2	4	82	5%	2005	3	12	249	5%
1994	3	7	135	5%	2005	4	4	257	2%
1994	4	4	142	3%	2006	1	7	251	3%
1995	1	3	142	2%	2006	2	23	238	10%
1995	2	13	146	9%	2006	3	8	244	3%
1995	3	5	148	3%	2006	4	6	234	3%
1995	4	7	155	5%	2007	1	5	237	2%
1996	1	6	150	4%	2007	2	13	226	6%
1996	2	6	164	4%	2007	3	8	225	4%
1996	3	4	164	2%	2007	4	7	217	3%
1996	4	4	166	2%	2008	1	7	217	3%
1997	1	2	161	1%	2008	2	14	221	6%
1997	2	12	176	7%	2008	3	12	222	5%
1997	3	8	180	4%	2008	4	10	216	5%
1997	4	6	195	3%				Mean	4%

Figure 1. OLS, median regression and 1% quantile regression