Banks' Non-Interest Income and Systemic Risk

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Abstract

Which bank activities contribute more to systemic risk? This paper documents that banks with higher non-interest income to interest income ratio have a higher contribution to systemic risk. This suggests that noncore banking activities (outside the roam of traditional deposit taking and lending) are associated with a larger contribution to systemic risk. After decomposing total non-interest income into two components, trading income and investment banking and venture income, we find that both components are roughly equally related to systemic risk. We also find that banks with higher trading income one-year prior to a recession earned lower returns during the recession period. No such significant effect was found for investment banking and venture capital income.

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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 was a showcase of large risk spillovers from one bank to another heightening systemic risk. 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.[1]

However, prior the crisis, banks have increasingly earned a higher proportion of their profits from non-interest income compared to interest income.[2] 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. These activities are different from the traditional deposit taking and lending functions of banks. 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. Table I shows 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). Figure 1 shows big increases in the average non-interest income to interest income ratio starting around 2000 and lasting to 2008. This effect is more pronounced when we use a value-weighted portfolio than an equally-weighted portfolio.

*** Table I and Figure 1 ***

[1] Bernanke 1983, Fama 1985, Diamond 1984, James 1987, Gorton and Pennachi 1990, Calomiris and Kahn 1991, and Kashyap, Rajan, and Stein 2002 as well as the bank lending channel for the transmission of monetary policy studied in Bernanke and Blinder 1988, Stein 1988 and Kashyap, Stein and Wilcox 1993 focus on this role of banking.

[2] When we refer to interest income we are using *net* interest income, which is defined as total interest income less total interest expense (both of which are disclosed on a bank's Income Statement).

This paper examines the contribution of such non-interest income to *systemic* bank risk. In order to capture systemic risk in the banking sector we use two prominent measures of systemic risk. The first is the $\Delta CoVaR$ measure of Adrian and Brunnermeier (2008; from now on referred to as AB). AB defines *CoVaR* as the value at risk of the banking system conditional on an individual bank being in distress. More formally, $\Delta CoVaR$ 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. The second measure of systemic risk is *SES* or the Systemic Expected Shortfall measure of Acharya, Pedersen, Philippon, and Richardson (2010; from now on defined as APPR). APPR define *SES* to be the expected amount a bank is undercapitalized in a systemic event in which the entire financial system is undercapitalized.

In this paper, we begin by estimating these two measures of systemic risk for all commercial banks for the period 1986 to 2008. We examine three primary issues: (1) Is there a relationship between systemic risk 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 two sub-groups, namely, trading income, and investment banking/venture capital income, respectively. We examine if any sub-group has a significant effect on systemic risk. (3) Finally, we examine if there is a relationship in the levels of *pre-crisis* non-interest income and the bank's stock returns earned *during the crisis*.

Our results are the following:

1. 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 11.6% in $\Delta CoVaR$ and 5.4% in SES. This suggests that activities that are *not* traditionally linked with banks (such as deposit taking and lending) are associated with a larger contribution to systemic risk.
2. Glamor banks (those with a high market-to-book ratio) and more highly levered banks contributed more to systemic risk. Generally, larger banks contributed more than proportionally to systemic risk, which is consistent with the findings in AB.
3. After decomposing total non-interest income into two components, trading income and and investment banking and venture income, we find that both components are roughly equally related to ex ante systemic risk. A one standard deviation shock to a bank's trading income

increases its systemic risk contribution by 5% in $\Delta CoVaR$ and 3.5% in *SES,* whereas a one standard deviation shock to its investment banking and venture capital income increases its systemic risk contribution by 4.5% in $\Delta CoVaR$ and 2.5% in *SES*.

4. When we examine realized ex post risk, we find that banks with higher trading income one-year before the recession earned lower returns during the recession period. No such significant effect was found for investment banking and venture capital income. We also find that larger banks earned lower stock returns during the recession. Interestingly, banks who were doing well one-year before the recession continued to do well during the recession.

Our finding that procyclical non-traditional activities (such as investment banking, venture capital and private equity income) can increase systemic risk is consistent with the model of Shleifer and Vishny (2010). In this model, activities where bankers have less 'skin in the game' are overfunded when asset values are high which leads to higher systemic risk.[3] It is also consistent with Fang, Ivashina and Lerner (2010) who find private equity investments by banks to be highly procyclical, and to perform worse than those of nonbank-affiliated private equity investments.

The above results are subject to a caveat that what we only document correlations between non-interest income and systemic risk. Consistent with the entire previous literature cited in this paper, we do not provide a clear-cut causal interpretation as this would require a structural empirical model with an exogenous shock.

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 $\Delta CoVaR$ and *SES.* Allen, Bali and Tang (2010) propose the *CATFIN* measure which is the 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. Brownlees and Engle (2010) define marginal expected shortfall (*MES*) as the expected loss of a bank's equity value if the overall market declined substantially. Tarashev, Borio, and

[3] Our non-traditional banking activities are similar to banking activities such as loan securitization or syndication wherein the banker does not own the entire loan (d < 1 in their model).

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. Billio, et. al (2010) use principal components analysis and linear and nonlinear Granger causality tests and find interconnectedness between the returns of hedge funds, brokers, banks, and insurance companies. 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. Acharya, Hassan and Saunders (2006) find diseconomies of scope when a risky Italian bank expands into additional sectors.

A number of papers have used the $\Delta CoVaR$ measure in other contexts. Wong and Fong (2010) examine $\Delta CoVaR$ 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

3.1 Data

We focus on all publicly traded bank holding companies in the U.S., namely, with SIC codes 60 to 67 (financial institutions) and filing Federal Reserve FR Y-9C report in each quarter. This report collects basic financial data from a domestic bank holding company (BHC) on a consolidated basis in the form of a balance sheet, an income statement, and detailed supporting schedules, including a schedule of off balance-sheet items. 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 ***

3.2 Systemic Risk using ΔCoVaR

We describe below how we calculate the $\Delta CoVaR$ measure of Adrian and Brunnermeier (2008). 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 $\Delta CoVaR$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.

Value-at-Risk (*VaR*)[4] measures the worst expected loss 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:

$$Probability(R^i \leq VaR_q^i) = q \quad (1)$$

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%

[4] See Philippe (2006, 2009) for a detailed 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.

quantile and weekly asset return/loss R^i in this paper, and the VaR of bank i is $Probability(R^i \le VaR^i_{1\%}) = 1\%$.

Let $CoVaR_q^{system|i}$ denote the Value at Risk of the entire financial system (portfolio) 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, $CoVaR_q^{system|i}$ which essentially is a measure of systemic risk is the q% quantile of this conditional probability distribution:

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

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:

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

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 ($CoVaR_q^{system|i,median}$):

$$\Delta CoVaR_q^i = CoVaR_q^{system|i} - CoVaR_q^{system|i,median} \qquad (4)$$

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 VaRs 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 $\gamma^{system|i}$:

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

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

[6] See Appendix A for a detailed explanation of quantile regressions.

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

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

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

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

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:

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

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 obtain the value-weighted market returns from the database of S&P 500 Index CRSP Indices Daily. 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 market returns. Liquidity risk is the difference between the three-month LIBOR rate and the three-month T-bill rate. For the next three interest rate variables we calculate the changes from this week *t* to *t-1*. Interest rate risk is the change in the three-month T-bill rate. Term structure is the change in the slope of the yield curve (yield spread between the 10-year T-bond rate and the three-month T-bill rate. Default risk is the change in the credit spread between the 10-year BAA corporate bonds and the 10-year T-bond rate. All interest rate data is obtained from the U.S. Federal Reserve website and Compustat Daily Treasury database. Real estate return is proxied by the Federal Housing Finance Agency's FHFA House Price Index for all 50 U.S. states.

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):

$$VaR^{i}_{q,t} = \hat{R}^{i}_{t} = \hat{\alpha}^{i} + \hat{\beta}^{i} Z_{t-1} \qquad (10)$$

$$R^{i,median}_{t} = \hat{R}^{i}_{t} = \hat{\alpha}^{i,median} + \hat{\beta}^{i,median} Z_{t-1} \qquad (11)$$

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,

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

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

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

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:

$$\Delta CoVaR^{i}_{q,t} = CoVaR^{system|i}_{q,t} - CoVaR^{system|i,median}_{q,t} \qquad (14)$$

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:

$$\Delta CoVaR^{i}_{1\%,t} = CoVaR^{system|i}_{1\%,t} - CoVaR^{system|i,median}_{1\%,t} \qquad (15)$$

3.3 Systemic Risk using SES

Acharya, Pedersen, Phillppon and Richardson (2010) propose the systemic expected shortfall (*SES*) measure to capture 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. Note that the *SES* reverses the conditioning. Instead of focusing on the return distribution of the banking system conditional on the distress of a particular bank, SES focuses on the bank i's return distribution given that the whole system is in distress. AB's *CoVaR* framework refers to this form of conditioning as "exposure *CoVaR*", as it measures which financial institution is most exposed to a systemic crisis and not which financial institution contributes most to a systemic crisis.

We define below the *SES* measure and discuss its implementation.[7] Let s_1^i be bank *i*'s equity capital at time 1, then the bank's expected shortfall (*ES*) in default is:

$$ES^i = E[s_1^i \mid s_1^i \leq 0] \qquad (16)$$

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^i 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*:

$$SES^i = E[s_1^i - k^i a^i \mid S_1 \leq kA] \qquad (17)$$

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:

$$SES^i(\%) = \frac{SES^i}{s_0^i} = E\left[\frac{s_1^i}{s_0^i} - k^i \frac{a^i}{s_0^i} \middle| \frac{S_1}{S_0} \leq k \frac{A}{S_0}\right] \qquad (18)$$

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:

$$SES^i(\%) = E\left[r^i - k^i \times lev^i \middle| R \leq k \times LEV\right] \qquad (19)$$

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 the leverage of bank *i*, and $LEV = \frac{A}{S_0}$ is the aggregate leverage of all banks.

[7] Our estimation of *SES* is slightly different from APPR (2010). APPR calculates *annual* realized *SES* using equity return data during the 2007-08 crisis, whereas we calculate *quarterly* realized *SES* with equity return data from 1986 to 2008.

Following the empirical analysis of APPR (2010), the systemic crisis event (when aggregate banking capital at time t is less than k_t times the aggregate bank leverage) is the five-percent worst days for the aggregate equity return of the entire banking system:

$$R_t \le k_t \times LEV_t \tag{20}$$

However, the problem is that we do not have ex-ante knowledge about bank *i*'s target fraction or threshold of capital (k_t^i). There are two ways to circumvent this problem to estimate the *SES* measure for individual banks. We can set the target fraction of bank *i*'s capital (k_t^i) equal to the target fraction of the entire banking sector (k_t), then the capital threshold of bank *i* at calendar quarter *t* can be estimated by $k_t^i = k_t = \frac{R_t}{LEV_t}$ using the weighted-average equity return and leverage of all banks during the worst 5% market return days at calendar quarter *t*. The target equity level of bank *i* over the same quarter *t* is $k_t \times lev_t^i$, where the leverage of bank *i* is lev_t^i, and the *SES* of bank *i* in percentage term is the difference between its average equity return r_t^i and its target equity level during these five-percent worst days of the entire banking system's equity returns:

$$SES_t^i(\%) = E\left[r_t^i - k_t \cdot lev_t^i \middle| R_t < k_t \cdot LEV_t \right] \tag{21}$$

The problem is whether setting the target fraction of an individual bank's capital equal to the target fraction of the entire banking sector is a reasonable assumption. APPR (2010) propose an easier way to estimate *SES*: realized *SES*. It is the stock return of bank *i* during the systemic crisis event (the worst 5% market return days at calendar quarter *t*). We will follow this measure of realized *SES* in the rest of the paper.

3.4 Independent Variables

To investigate the relationship between the bank characteristics and lagged bank's contribution to systemic risk, we run OLS regressions with quarterly fixed-effects of the individual bank's systemic risk contribution ($\Delta CoVaR$ or *SES*) on the following bank-specific variables: market to book (*M2B*), financial leverage (*LEV*), total asset (*AT*), and our main variable of analysis namely non-interest income to interest income (*N2I*).

$$SystemicRisk_t = \phi_0 + \phi_1 M2B_{t-1} + \phi_2 LEV_{t-1} + \phi_3 AT_{t-1} + \phi_4 AT_{t-1}{}^2 + \phi_5 N2I_{t-1} + \varepsilon_t \tag{22}$$

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 *N2I* into two components, namely, trading income to interest income (*T2I*), and investment banking/venture capital income to interest income (*IBVC2I*).[8] We regress the individual bank's systemic risk contribution ($\Delta CoVaR$ or *SES*) on its *T2I* and *IBVC2I* ratios along with other control variables and include quarterly fixed-effects.

$$SystemicRisk_t = \phi_0 + \phi_1 M2B_{t-1} + \phi_2 LEV_{t-1} + \phi_3 AT_{t-1} + \phi_4 AT_{t-1}^{\ 2} + \phi_5 T2I_{t-1} + \phi_6 IBVC2I_{t-1} + \varepsilon_t \qquad (23)$$

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 income includes investment banking and advisory fees, brokerage commissions and venture capital revenue. The detailed definitions and sources of the accounting ratios are listed in Table II.

*** Table II ***

Table III presents the summary statistics. When we compare our results to those found in AB, we find that the average $\Delta CoVaR$ of individual banks to be lower (mean=-1.58% and median=-1.39%) than the average portfolio's $\Delta CoVaR$ found in AB (mean=-1.615% and median not reported). Comparing our results to APPR, we find an average (median) quarterly *SES* of -3.35% (-2.72%) for the years 1986-2008, whereas AAPR find a average (median) annual *SES* of -47% (-46%) for the crisis years 2007-08. As in the previous literature, we also find that banks are highly levered with an average debt-to-capital ratio of 12.6%. The average asset size of the banks is $ 15.7 billion and the median asset size is $ 1.86 billion. We find that the average ratio of non-interest income to interest income to be 0.23, and the median ratio is 0.19.

*** Table III ***

[8] We also included a component that included all other non-interest income items such as fiduciary income, deposit 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 . This component was not significant in any of the regressions so we dropped it from all our regressions.

In Table IV we find that the correlation between the two systemic risk measures Δ*CoVaR* and *SES* is 0.15, suggesting that these two measures capture some similar patterns in systemic risk. The correlation matrix reports no large correlation between the various independent variables. We find that higher leverage and size leads to higher systemic risk and the impact of market-to-book is much smaller. Finally we find that banks with a higher ratio of non-interest income to interest income are correlated with higher systemic risk.

*** Table IV ***

4. Empirical Results

Whereas the above correlations were suggestive, we hence run a multivariate regression, the results of which are given in Table V. The dependent variables are the two measures of systemic risk Δ*CoVaR* and *SES*. Columns 1-2 are the Δ*CoVaR* regressions, and columns 3-4 are the *SES* regressions. All independent variables are estimated with a one quarter lag, and also include quarter fixed-effects which are not reported. The *t*-statistics are calculated using Newey-West standard errors which rectifies for heteroskedasticity.

*** Table V ***

We first examine columns 1 and 3 where we only include our main variable of analysis, namely, the ratio of non-interest income to interest income. In doing so, we ensure that our results are not due to some spurious correlation between the various independent variables. We find that the ratio of non-interest income to interest income is significantly negative to both Δ*CoVaR* and *SES*, suggesting that it contributes adversely to systemic risk. In columns 2 and 4 we include the other four independent variables to check if our results change. We still find that non-interest income to interest income ratio is significantly negative to both Δ*CoVaR* and *SES*, although their economic magnitude is smaller. Specifically, a one standard deviation shock to a bank's non-interest income to interest income ratio increases systemic risk defined as Δ*CoVaR* by 11.6%, and by 5.4% when systemic risk is defined as *SES*. Examining the bank-specific control variables we find that glamour banks, more highly levered banks, and larger banks were associated with higher systemic risk.

From 2001 onwards, we can decompose the ratio of non-interest income to interest income into trading income to interest income (*T2I*) and investment banking and venture capital income to interest income (*IBVC2I*), 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. Investment banking and venture capital includes investment banking and advisory fees, brokerage commission and venture capital revenue. We find in Table VI that both trading and investment banking and venture capital income are statistically negative and of equal magnitude. A one standard deviation shock to a bank's trading income increases systemic risk contribution defined as Δ*CoVaR* (as *SES*) by 5% (by 3.5%), whereas a one standard deviation shock to its investment banking and venture capital income increases its systemic risk contribution by 4.5%. (by 2.5%).

*** Table VI ***

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. To do so, we exploit the fact that venture capital investments activities are very illiquid and cannot be easily marked to market. Hence, if fair-value accounting were the driving force behind our results, one would expect that income from venture capital activity would be less systemic than investment banking income. However, this is not the case. This allows us to conclude that our results are not purely driven by accounting issues. Our finding is generally consistent with the results in Laux and Leuz (2010) and references therein.

We now examine if there is a relationship in the levels of *pre-crisis* non-interest income and the bank's stock returns earned *during the crisis*. Doing so, allows us to predict (using the different components of non-interest income) bank performance during the crisis period. Given that the existing literature has yet to define a well-accepted explicit empirical proxy for ex ante systemic risk, doing so also mitigates the criticism that measures of systemic risk are prone to severe measurement issues.

We specifically examine if banks with higher trading and/or investment banking income in the one-year before the crisis had more negative returns during the crisis. Accordingly, we categorize banks by their trading income (or investment banking/venture capital income) into four quartiles in the year before the latest recession (2006Q3-2007Q3). We use two dummy variables for each component of non-interest income, namely, one dummy variable for the top quartile,[9] and one dummy variable for the lowest quartile. We run a regression with the bank's stock return during the latest recession period (defined by NBER as December 2007 to June 2009) as the dependent variable. In columns 1-3 of Table VII we present the regression when we exclude the prior year's (2006Q3-2007Q3) stock returns, and in columns 4-6 when we include the prior year's stock returns. In all six specifications we find that banks with higher trading income one-year before the recession earned lower returns during the recession period. No such significant effect was found for investment banking and venture income. We also find that larger banks earned lower stock returns during the recession. Interestingly, banks who were doing well one-year before the recession continued to do well during the recession.[10]

*** Table VII ***

Robustness Tests: We run a number of robustness tests. First, we examine if our result is driven by the numerator (non-interest income) and not the denominator (net interest income). In Table VIII, we re-estimate our regressions using the ratio of non-interest income to assets instead of non-interest income to interest income. We find that non-interest income is once again negatively related suggesting that it contributes adversely to systemic risk. Similar relationships are found for trading income and for investment banking and venture capital income in Table IX. These results suggest that it is non-traditional income (namely, non-interest income) that contributes adversely to systemic risk, and not traditional income (namely, interest income).

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[9] See Appendix B for a list of such banks.

[10] We also examined the 18 firms that were analyzed by the Federal Reserve for capital adequacy in late February 2009 under the Supervisory Capital Assessment Program (SCAP). Our sample size was reduced to 15 as three firms were not commercial banks (Goldman Sachs, Morgan Stanley, and American Express). Given the small sample size of 15 we did not find any significant results (results not reported but available from the authors).

*** Tables VIII and IX ***

Second, we examine if our results hold if we use CRSP equity returns (by calculating the value-weighted return of all stocks listed in CRSP monthly database for each calendar quarter) as our proxy for market risk rather than the value-weighted bank stock portfolio. In Table X, we reestimate our regressions using the ratio of non-interest income to interest income. We find that non-interest income is once again negatively related suggesting that it contributes adversely to systemic risk, and the economic significance is slightly larger. Similar relationships are found for trading income and for investment banking and venture capital income in Table XI. These results suggest that it is non-traditional income (namely, non-interest income) that contributes adversely to systemic risk, and not traditional income (namely, interest income).

*** Tables X and XI ***

Third, 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 XII 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 XII ***

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 two prominent measures of systemic risk (namely, ΔCoVaR measure of Adrian and Brunnermeier 2010, and the Systemic Expected Shortfall measure of Acharya, Pedersen, Philipon and Richardson 2010), we find banks with a higher non-interest income to interest income ratio to 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 banks with a higher market-to-book ratio, higher leverage, and larger asset size, contributed more to systemic risk. When we decompose the total non-interest income into two components, we find trading income and investment banking/venture capital income to be significantly and equally related to systemic risk. We find that banks with higher trading income one-year before the recession earned lower returns during the recession period. No such significant effect was found for investment banking and venture capital income. We also find that larger banks earned lower stock returns during the recession. Interestingly, banks who were doing well one-year before the recession continued to do well during the recession.

Our finding that nontraditional activities can increase systemic risk is consistent with the model of Shleifer and Vishny (2010). Nontraditional banking activities are similar to loan securitization or syndication wherein the banker does not own the entire loan. Shleifer and Vishny (2010) suggest that activities where bankers have less 'skin in the game' are overfunded when asset values are high which leads to higher systemic risk. Our results are also consistent with those of Fang, Ivashina and Lerner (2010) who find private equity investments by banks to be highly procyclical, and to perform worse than those of nonbank-affiliated private equity investments.

Appendix A: Quantile regression

OLS regression models the relationship between the independent variable *X* and the conditional mean of a dependent variable *Y* given $X = X_1, X_2, \ldots X_n$. In contrast, quantile regression[11] 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.

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, the mean can be challenging to interpret while the median remains highly informative.[12] 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

[11] 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.

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

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).

Appendix B: Names of banks in the top quartile of trading income and investment banking/venture capital income

This table lists alphabetically the banks in the top quartile of trading income to interest income (T2I) and investment banking/venture capital income to interest income (IBVC2I) ratios in the year before the latest recession (2006Q3-2007Q3).

NAME	Top 25% T2I	Top 25% IBVC2I
ACCESS NATIONAL CORPORATION	Yes	
ALABAMA NATIONAL BANCORPORATION	Yes	Yes
ALLIANCE BANKSHARES CORPORATION	Yes	
AMERICANWEST BANCORPORATION	Yes	
AMERISERV FINANCIAL, INC		Yes
AUBURN NATIONAL BANCORPORATION, INC.	Yes	
BANCFIRST CORPORATION		Yes
BANCTRUST FINANCIAL GROUP, INC.	Yes	
BANK OF AMERICA CORPORATION	Yes	Yes
BANK OF NEW YORK COMPANY, INC., THE	Yes	Yes
BANNER CORPORATION	Yes	
BB&T CORPORATION		Yes
BOK FINANCIAL CORPORATION	Yes	
BOSTON PRIVATE FINANCIAL HOLDINGS, INC.		Yes
BRIDGE CAPITAL HOLDINGS	Yes	
BRYN MAWR BANK CORPORATION	Yes	
C&F FINANCIAL CORPORATION	Yes	
CAPITAL BANK CORPORATION	Yes	
CAPITAL ONE FINANCIAL CORPORATION	Yes	
CARDINAL FINANCIAL CORPORATION	Yes	
CENTRUE FINANCIAL CORPORATION	Yes	
CHARLES SCHWAB CORPORATION, THE	Yes	Yes
CITIGROUP INC.	Yes	Yes
CITY NATIONAL CORPORATION		Yes
COAST FINANCIAL HOLDINGS, INC	Yes	
COBIZ FINANCIAL INC.		Yes
COBIZ INC.		Yes
COLUMBIA BANCORP	Yes	
COMERICA INCORPORATED	Yes	Yes
COMMERCE BANCORP, INC.		Yes
COMMERCE BANCSHARES, INC.		Yes
COMMUNITY BANKS, INC.		Yes
COMMUNITY BANKSHARES, INC.	Yes	
COMMUNITY CENTRAL BANK CORPORATION	Yes	
COMMUNITY TRUST BANCORP, INC.		Yes
COMPASS BANCSHARES, INC.		Yes
COOPERATIVE BANKSHARES, INC.	Yes	
COUNTRYWIDE FINANCIAL CORPORATION	Yes	
CULLEN/FROST BANKERS, INC.		Yes
EAGLE BANCORP, INC.	Yes	
FIDELITY SOUTHERN CORPORATION	Yes	
FIFTH THIRD BANCORP	Yes	Yes
FINANCIAL INSTITUTIONS, INC.		Yes
FIRST BUSEY CORPORATION		Yes
FIRST CHARTER CORPORATION		Yes

(Continued next page)

NAME	Top 25% T2I	Top 25% IBVC2I
FIRST COMMUNITY BANCORP	Yes	
FIRST FINANCIAL BANCORP		Yes
FIRST FINANCIAL BANKSHARES, INC.	Yes	
FIRST HORIZON NATIONAL CORPORATION	Yes	Yes
FIRST INDIANA CORPORATION	Yes	
FIRST MARINER BANCORP	Yes	
FIRST STATE BANCORPORATION	Yes	
FNB UNITED CORP.	Yes	
FRANKLIN RESOURCES, INC.	Yes	Yes
FREMONT BANCORPORATION	Yes	Yes
FULTON FINANCIAL CORPORATION	Yes	Yes
GLACIER BANCORP, INC.	Yes	
GREATER COMMUNITY BANCORP		Yes
HABERSHAM BANCORP	Yes	
HANCOCK HOLDING COMPANY		Yes
HANMI FINANCIAL CORPORATION	Yes	
HARLEYSVILLE NATIONAL CORPORATION		Yes
HERITAGE COMMERCE CORP	Yes	
HOME FEDERAL BANCORP	Yes	
HORIZON BANCORP	Yes	
HUNTINGTON BANCSHARES INCORPORATED	Yes	Yes
IBERIABANK CORPORATION	Yes	Yes
INDEPENDENT BANK CORPORATION	Yes	
INTERNATIONAL BANCSHARES CORPORATION		Yes
JPMORGAN CHASE & CO.	Yes	Yes
KEYCORP	Yes	Yes
LAKELAND BANCORP, INC.		Yes
LANDMARK BANCORP, INC.	Yes	
LEESPORT FINANCIAL CORP.	Yes	
M&T BANK CORPORATION		Yes
MELLON FINANCIAL CORPORATION	Yes	Yes
MERCANTILE BANKSHARES CORPORATION		Yes
MIDDLEBURG FINANCIAL CORPORATION		Yes
MIDWESTONE FINANCIAL GROUP, INC		Yes
MONROE BANCORP	Yes	
NARA BANCORP, INC.	Yes	
NATIONAL CITY CORPORATION	Yes	Yes
NATIONAL PENN BANCSHARES, INC.		Yes
NB&T FINANCIAL GROUP, INC.		Yes
NEW YORK COMMUNITY BANCORP, INC.		Yes
NORTHERN TRUST CORPORATION	Yes	
OAK HILL FINANCIAL, INC.		Yes
OLD NATIONAL BANCORP		Yes
OLD SECOND BANCORP, INC.	Yes	
ORIENTAL FINANCIAL GROUP INC.		Yes
PACIFIC CAPITAL BANCORP	Yes	Yes
PENNS WOODS BANCORP, INC.	Yes	
PEOPLES BANCTRUST COMPANY, INC., THE		Yes
PLACER SIERRA BANCSHARES		Yes
PNC FINANCIAL SERVICES GROUP, INC., THE	Yes	Yes
POPULAR, INC.	Yes	Yes
PREMIERWEST BANCORP		Yes
REGIONS FINANCIAL CORPORATION		Yes
RENASANT CORPORATION	Yes	
ROYAL BANCSHARES OF PENNSYLVANIA, INC.	Yes	

(Continued next page)

NAME	Top 25% T2I	Top 25% IBVC2I
RURBAN FINANCIAL CORP.	Yes	
SANDY SPRING BANCORP, INC.		Yes
SANTANDER BANCORP		Yes
SEACOAST BANKING CORPORATION OF FLORIDA	Yes	
SIMMONS FIRST NATIONAL CORPORATION		Yes
SKY FINANCIAL GROUP, INC.	Yes	Yes
SOUTH FINANCIAL GROUP, INC., THE		Yes
SOUTH FINANCIAL GROUP, THE		Yes
SOUTHERN COMMUNITY FINANCIAL CORPORATION		Yes
SOUTHWEST BANCORP, INC.	Yes	
STATE STREET CORPORATION	Yes	Yes
STERLING BANCSHARES, INC.		Yes
STERLING FINANCIAL CORPORATION		Yes
SUNTRUST BANKS, INC.		Yes
SUSQUEHANNA BANCSHARES, INC.	Yes	Yes
SVB FINANCIAL GROUP	Yes	Yes
SYNOVUS FINANCIAL CORP.		Yes
TAYLOR CAPITAL GROUP, INC.		Yes
TIB FINANCIAL CORP.	Yes	
TOMPKINS FINANCIAL CORPORATION		Yes
TOMPKINS TRUSTCO, INC.		Yes
TRUSTMARK CORPORATION		Yes
U.S. BANCORP		Yes
UCBH HOLDINGS, INC.	Yes	
UMB FINANCIAL CORPORATION	Yes	Yes
UMPQUA HOLDINGS CORPORATION	Yes	
UNION BANKSHARES CORPORATION	Yes	
UNIONBANCAL CORPORATION	Yes	Yes
UNITY BANCORP, INC.	Yes	
VALLEY NATIONAL BANCORP	Yes	Yes
VIRGINIA COMMERCE BANCORP, INC.	Yes	
VIRGINIA FINANCIAL GROUP, INC.	Yes	
WACHOVIA CORPORATION		Yes
WASHINGTON TRUST BANCORP, INC.		Yes
WELLS FARGO & COMPANY	Yes	Yes
WESBANCO, INC.		Yes
WEST BANCORPORATION, INC.		Yes
WEST COAST BANCORP	Yes	
WILMINGTON TRUST CORPORATION		Yes
WILSHIRE BANCORP, INC.	Yes	
WINTRUST FINANCIAL CORPORATION	Yes	Yes
ZIONS BANCORPORATION		Yes

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Figure 1. Average non-interest income to interest income ratio over the sample period

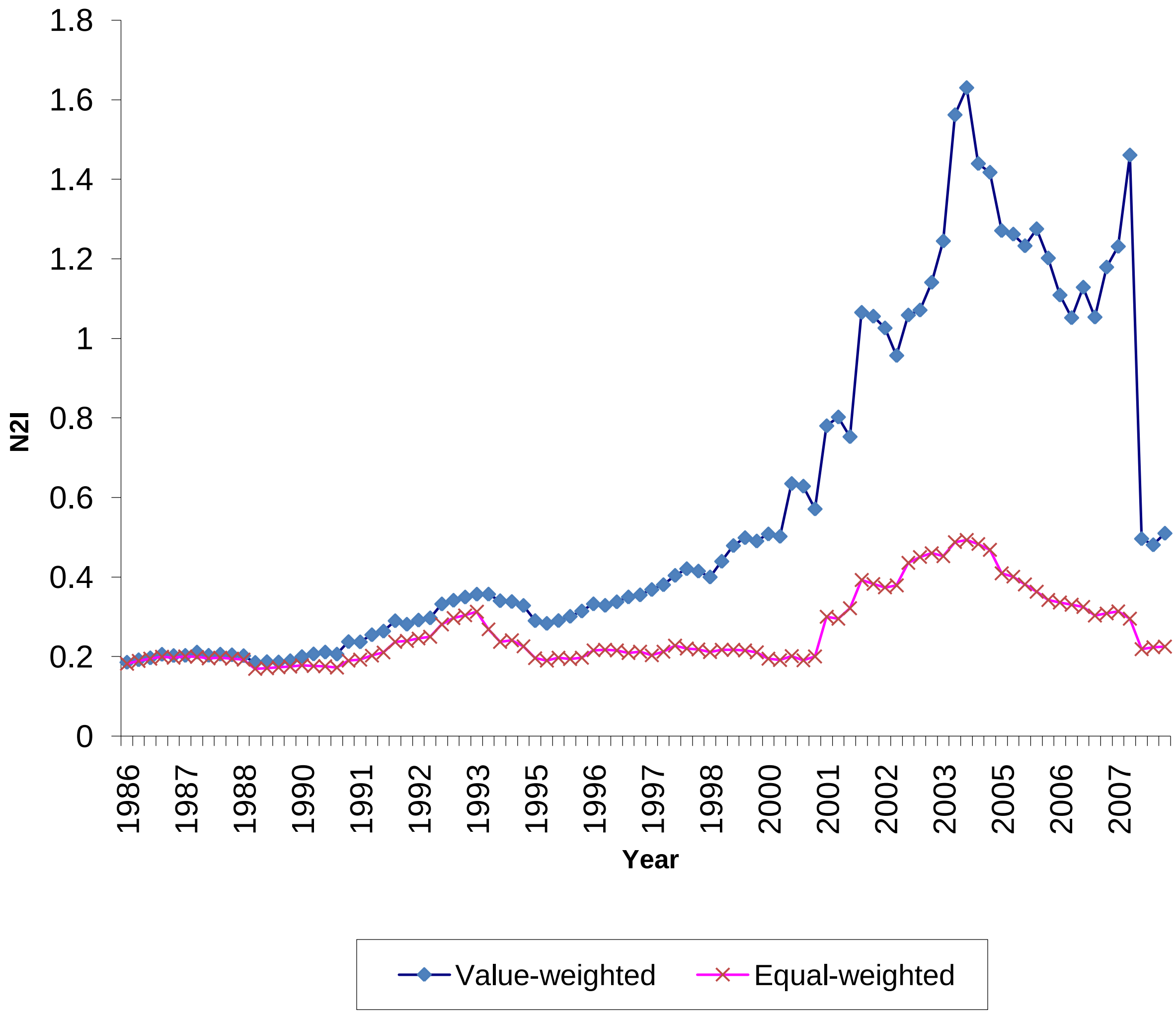

Table I. Non-interest income to interest income ratio of the 10 largest commercial banks

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
ΔCoVaR	Financial institution's contribution to systemic risk	From equation (15)	
SES	Systemic expected shortfall	From equation (21)	
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
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
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
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. (2001 onwards)	U.S. Federal Reserve FRY-9C Report
IBVC2I	IBVC income to interest income	IBVC income includes investment banking/advisory fee, brokerage commission and venture capital revenue. (2001 onwards)	U.S. Federal Reserve FRY-9C Report

Table III. Summary statistics

Variable	Mean	Median	Standard Deviation
$\Delta CoVaR$	-1.58%	-1.39%	1.93%
SES	-3.35%	-2.72%	3.20%
Market to Book	1.80	1.62	1.21
Leverage	12.57	12.15	3.66
Log (Total Assets)	14.73	14.43	1.61
Non-interest Income to Interest Income	0.23	0.19	0.35

See Table 1 for data definition and Section 3 of the paper and for further details.

Table IV. Correlations between the various variables

	$\Delta CoVaR$	*SES*	Market to Book	Leverage	Log(Total Assets)
SES	0.15				
Market to Book	-0.02	0.01			
Leverage	-0.14	-0.09	-0.02		
Log(Total Assets)	-0.25	-0.14	0.09	0.13	
Non-interest Income to Interest Income	-0.07	-0.04	0.17	-0.05	0.26

Table V. Regression of a bank's systemic risk on firm characteristics

In regression model (1) and (2) the dependent variable is $\Delta CoVaR$, which is the difference between *CoVaR* conditional on the bank being under distress and the *CoVaR* in the median state of the bank. In model (3) and (4) the dependent variable is Realized *SES*, systemic expected shortfall. The independent variables include one quarter lagged firm characteristics such as market to book, leverage, total asset, and non-interest income to interest income ratio.

Dependent Variable:	$\Delta CoVaR_t$		Realized SES_t	
	(1)	(2)	(3)	(4)
Market to Book $_{t-1}$		-0.0296***		-0.0632***
		(-3.25)		(-3.77)
Leverage $_{t-1}$		-0.0411***		-0.0704***
		(-2.76)		(-7.12)
Log (Total Asset) $_{t-1}$		0.0354		-0.209***
		(1.14)		(-5.54)
Log (Total Asset) squared $_{t-1}$		-0.00953***		0.0032
		(-9.21)		(0.23)
Non-interest Income to Interest Income $_{t-1}$	-0.525***	-0.168***	-0.514***	-0.216***
	(-5.07)	(-4.08)	(-4.71)	(-5.18)
Quarterly fixed-effects	Yes	Yes	Yes	Yes
N	23,085	23,085	23,085	23,085
Adjusted R-square	0.06	0.12	0.34	0.35
F-test	207.09	233.40	426.14	474.24

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 VI. Regression of a bank's systemic risk on different components of non-interest income

In regression model (1) and (2) the dependent variable is $\Delta CoVaR$, which is the difference between *CoVaR* conditional on the bank being under distress and the *CoVaR* in the median state of the bank. In model (3) and (4) the dependent variable is Realized *SES*, systemic expected shortfall. The independent variables include one quarter lagged firm characteristics such as market to book, leverage, total asset, trading income to interest income, and IBVC 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. All these detail accounting items are reported in FR Y-9C since 2001.

Dependent Variable:	$\Delta CoVaR_t$		Realized SES_t	
	(1)	(2)	(3)	(4)
Market to Book $_{t-1}$		-0.0827***		-0.0455
		(-3.61)		(-1.40)
Leverage $_{t-1}$		-0.0229***		-0.00314
		(-2.64)		(-0.27)
Log (Total Asset) $_{t-1}$		-1.191***		-3.116***
		(-6.55)		(-11.02)
Log (Total Asset) squared $_{t-1}$		0.0303***		0.0886***
		(5.05)		(9.74)
Trading Income to Interest Income $_{t-1}$	-0.751***	-0.258**	-1.106***	-0.631**
	(-4.93)	(-2.28)	(-3.99)	(-2.37)
IBVC Income to Interest Income $_{t-1}$	-0.186***	-0.122**	-0.218***	-0.12***
	(-2.73)	(-2.00)	(-3.55)	(-2.95)
Quarterly fixed-effects	Yes	Yes	Yes	Yes
N	9,603	9,603	9,603	9,603
Adjusted R-square	0.14	0.25	0.48	0.51
F-test	246.44	270.20	545.15	573.46

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 return *during* the crisis on its pre-crisis firm characteristics

The dependent variable is the bank's equity return from December 2007 to June 2009, the recession period defined by the NBER's Business Cycle Dating Committee. The independent variables include the bank's prior 1-year equity return (from December 2006 to November 2007), log total asset, log asset squared, dummy variables for firms in top and bottom 25%tile of trading income to interest income ratio and IBVC (investment banking and venture capital) income to interest income ratio (averaged from 2006Q3 to 2007Q3).

Dependent Variable: $Return_t$	(1)	(2)	(3)	(4)	(5)	(6)
Prior Year's Equity $Return_{t-1}$				0.721***	0.722***	0.722***
				(7.48)	(7.39)	(7.46)
Log (Total $Asset)_{t-1}$	-0.0368**	-0.203	-0.0376**	-0.0423***	-0.0313	-0.0423***
	(-2.47)	(-1.21)	(-2.48)	(-3.11)	(-0.20)	(-3.06)
Log (Total Asset) $squared_{t-1}$		0.00516			-0.000344	
		(1.00)			(-0.07)	
Dummy of top 25%tile Trading Income to Interest $Income_{t-1}$	-0.0933**	-0.0988**	-0.0892*	-0.0779*	-0.0775*	-0.0699*
	(-2.05)	(-2.15)	(-1.85)	(-1.87)	(-1.84)	(-1.68)
Dummy of bottom 25%tile Trading Income to Interest $Income_{t-1}$			0.00927			0.0231
			(0.19)			(0.51)
Dummy of top 25%tile IBVC Income to Interest $Income_{t-1}$	0.0755	0.0774	0.0686	0.0333	0.0331	0.0289
	(1.38)	(1.41)	(1.22)	(0.66)	(0.66)	(0.56)
Dummy of bottom 25%tile IBVC Income to Interest $Income_{t-1}$			-0.0293			-0.0231
			(-0.61)			(-0.52)
Intercept	0.120	1.437	0.138	0.344*	0.256	0.343*
	(0.56)	(1.07)	(0.62)	(1.73)	(0.21)	(1.66)
N	284	284	284	284	284	284
Adjusted R-square	0.04	0.04	0.03	0.20	0.19	0.19
F-test	4.16	3.37	2.56	17.72	14.13	11.83

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

Table VIII. Robustness test: Non-interest income to total assets

In regression model (1) and (2) 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. In model (3) and (4) the dependent variable is Realized *SES*, systemic expected shortfall. The independent variables include one quarter lagged firm characteristics such as market to book, leverage, total asset, and non-interest income to total asset.

Dependent Variable:	$\Delta CoVaR_t$		Realized SES_t	
	(1)	(2)	(3)	(4)
Market to Book $_{t-1}$		-0.0252***		-0.0559***
		(-2.76)		(-3.32)
Leverage $_{t-1}$		-0.0414***		-0.0709***
		(-2.79)		(-7.20)
Log (Total Asset) $_{t-1}$		0.0346		-0.211***
		(1.12)		(-5.61)
Log (Total Asset) squared $_{t-1}$		-0.0094***		0.00059
		(-9.15)		(0.43)
Non-interest Income to Total Asset $_{t-1}$	-21.66***	-7.512***	-22.74***	-10.73***
	(-11.16)	(-5.61)	(-8.97)	(-5.89)
Quarterly fixed-effects	Yes	Yes	Yes	Yes
N	23,085	23,085	23,085	23,085
Adjusted R-square	0.06	0.12	0.33	0.35
F-test	208.04	234.72	427.75	476.32

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 IX. Robustness test: Different components of non-interest income to total assets

In regression model (1) and (2) the dependent variable is $\Delta CoVaR$, which is the difference between *CoVaR* conditional on the bank being under distress and the *CoVaR* in the median state of the bank. In model (3) and (4) the dependent variable is Realized *SES*, systemic expected shortfall. The independent variables include one quarter lagged firm characteristics such as market to book, leverage, total asset, trading income to total asset, and IBVC income to total asset 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. All these detail accounting items are reported in FR Y-9C since 2001.

Dependent Variable:	$\Delta CoVaR_t$		Realized SES_t	
	(1)	(2)	(3)	(4)
Market to Book $_{t-1}$		-0.0825***		-0.0458
		(-3.61)		(-1.41)
Leverage $_{t-1}$		-0.0231***		-0.00347
		(-2.65)		(-0.29)
Log (Total Asset) $_{t-1}$		-1.193***		-3.116***
		(-6.60)		(-11.06)
Log (Total Asset) squared $_{t-1}$		0.03***		0.0886***
		(5.10)		(9.78)
Trading Income to Total Asset $_{t-1}$	-14.29***	-6.83***	-23.58***	-16.08***
	(-4.09)	(-2.56)	(-3.69)	(-2.71)
IBVC Income to Total Asset $_{t-1}$	-13.37***	-7.584***	-15.14***	-7.446***
	(-3.49)	(-2.82)	(-2.69)	(-2.41)
Quarterly fixed-effects	Yes	Yes	Yes	Yes
N	9,603	9,603	9,603	9,603
Adjusted R-square	0.14	0.25	0.48	0.51
F-test	246.44	270.66	545.15	573.35

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. Robustness test: Regression of a bank's systemic risk estimated using CRSP ***market return*** on a bank's non-interest income

In regression model (1) and (2) 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. In model (3) and (4) the dependent variable is Realized *SES*, systemic expected shortfall. The independent variables include one quarter lagged firm characteristics such as market to book, leverage, total asset, and non-interest income to interest income ratio.

Dependent Variable:	$\Delta CoVaR_t$		Realized SES_t	
	(1)	(2)	(3)	(4)
Market to Book $_{t-1}$		-0.183***		-0.0632***
		(-8.60)		(-3.14)
Leverage $_{t-1}$		-0.0142		-0.0704
		(-0.78)		(-0.61)
Log (Total Asset) $_{t-1}$		0.00528		-0.209***
		(0.15)		(-5.19)
Log (Total Asset) squared $_{t-1}$		0.0064***		0.00629***
		(5.30)		(3.22)
Non-interest Income to Interest Income $_{t-1}$	-0.783***	-0.433***	-0.447***	-0.216***
	(-4.00)	(-3.60)	(-4.92)	(-4.45)
Quarterly fixed-effects	Yes	Yes	Yes	Yes
N	23,168	23,168	23,168	23,168
Adjusted R-square	0.04	0.06	0.31	0.32
F-test	89.93	116.14	417.76	465.74

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: Regression of a bank's systemic risk estimated using CRSP market return on different components of non-interest income

In regression model (1) and (2) 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. In model (3) and (4) the dependent variable is Realized *SES*, systemic expected shortfall. The independent variables include one quarter lagged firm characteristics such as market to book, leverage, total asset, trading income to interest income, and IBVC 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. All these detail accounting items are reported in FR Y-9C since 2001.

Dependent Variable:	$\Delta CoVaR_t$		Realized SES_t	
	(1)	(2)	(3)	(4)
Market to Book $_{t-1}$		-0.184***		-0.0285
		(-4.61)		(-0.93)
Leverage $_{t-1}$		-0.0161		0.0167
		(-1.03)		(0.79)
Log (Total Asset) $_{t-1}$		-0.66**		-2.887***
		(-1.99)		(-10.32)
Log (Total Asset) squared $_{t-1}$		0.0122		0.0833***
		(1.21)		(9.23)
Trading Income to Interest Income $_{t-1}$	-1.531*	-0.887	-1.187***	-0.819***
	(-1.81)	(-1.12)	(-3.77)	(-2.58)
IBVC Income to Interest Income $_{t-1}$	-0.219**	-0.131**	-0.201***	-0.109***
	(-2.07)	(-2.01)	(-4.07)	(-2.89)
Quarterly fixed-effects	Yes	Yes	Yes	Yes
N	9,601	9,601	9,601	9,601
Adjusted R-square	0.03	0.05	0.45	0.48
F-test	27.34	47.03	535.00	552.77

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 XII. 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%