This version: May 30, 2013

# Why Do Banks Use Financial Derivatives?

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## Abstract

In this paper we examine the impact of financial derivatives on risk sensitivities of publicly listed U.S. bank holding companies' (BHCs), controlling for the on-balance sheet activities and bank-specific characteristics between 1997 and 2011. Our results suggest the use of financial derivatives has significant effects on the risk exposures. For BHCs in our sample, we find that the more pronounced use of interest rate derivatives and credit derivatives corresponds to greater interest rate risk exposure and credit risk exposure. However, the increased use of exchange rate derivatives is associated with lower exchange rate risk exposure. We find that the use of financial derivatives *for hedging purposes* is negatively related to risk sensitivities of BHCs (except for exchange rate derivatives for hedging for smaller, end-user BHCs – small BHCs). In the global financial crisis, the relationship between interest rate derivatives and exchange rate derivatives and risk exposures is stronger than in normal time, and the positive relationship between credit derivatives and credit risk exposure became less pronounced.

**Keywords:** Financial Derivatives, Interest Rate Derivatives, Exchange Rate Derivatives, Credit Derivatives, Risk Exposures

**JEL codes:** G20, G21, G28

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## Abstract

In this paper we examine the impact of financial derivatives on risk sensitivities of publicly listed U.S. bank holding companies' (BHCs), controlling for the on-balance sheet activities and bank-specific characteristics between 1997 and 2011. Our results suggest the use of financial derivatives has significant effects on the risk exposures. For BHCs in our sample, we find that the more pronounced use of interest rate derivatives and credit derivatives corresponds to greater interest rate risk exposure and credit risk exposure. However, the increased use of exchange rate derivatives is associated with lower exchange rate risk exposure. We find that the use of financial derivatives *for hedging purposes* is negatively related to risk sensitivities of BHCs (except for exchange rate derivatives for hedging for smaller, end-user BHCs – small BHCs). In the global financial crisis, the relationship between interest rate derivatives and exchange rate derivatives and risk exposures is stronger than in normal time, and the positive relationship between credit derivatives and credit risk exposure became less pronounced.



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# 1. Introduction

Banks have tremendously increased the use of financial derivatives in last decades. The notional principal amount of financial derivatives held by the U.S. bank holding companies (BHCs) rose from $7.34 trillion at the end of December, 1990, to $231 trillion in the fourth quarter of 2011. Not all BHCs are equal users of financial derivatives. The financial derivatives activity in the U.S. banking system is dominated by a small group of large financial institutions. The top 25 BHCs hold 99.8% of the financial derivatives (Office of the Comptroller of the Currency, 2011).

An increased activity in financial derivatives markets was generally looked upon favorably before the global financial crisis 2007-2010. Greenspan (1999) noted that "the value added of derivatives themselves derives from their ability to enhance the process of wealth creation." Trichet (2007) further explained that "price discovery in the credit derivatives market reduces the risk of mispricing loans." Recently, however, the perspective has turned around as the risks of financial derivatives have become more evident. The Financial Stability Board (2010) concluded that "the crisis demonstrated the potential for contagion arising from the interconnectedness of OTC derivatives market participants and the limited transparency of counterparty relationships." The unanswered question then is whether banks use financial derivatives to hedge risk or rather to increase their risk exposures.

This paper analyzes why BHCs use financial derivatives and whether financial derivatives expose BHCs further towards risks. We are interested in whether BHCs employ financial derivatives for hedging or for speculative purposes. In particular, we measure whether the use of financial derivatives is related to the risk exposures of BHCs towards interest rate risk, exchange rate risk and credit risk.

We collect on-balance-sheet, off-balance-sheet financial data and stock price on the publicly traded U.S. BHCs in the period from 1997 to 2011. We divide BHCs into the large BHCs (asset greater than $50 billion) and small BHCs (asset less than $50 billion).[1] Figure 1 and Figure 2 present some perspective on the notional principal amounts of interest rate, exchange rate and credit derivatives held by large BHCs and small BHCs in our sample.

<Insert Figure 1 and Figure 2 here>

Our analysis shows that a BHC's use of financial derivatives is associated with its higher exposure towards interest rate risk and credit risk and lower exposure toward exchange rate risk. Interestingly, the impact of the use of financial derivatives on the risk exposure is more pronounced for large BHCs than it is for small

[1] BHCs with $50 billion or more in consolidated asset are automatically included in the systemically important category. See http://www.federalreserve.gov/newsevents/testimony/gibson20120516a.htm.

BHCs.

These results may indicate that large BHCs with their main operations such as prime brokerage, asset management, proprietary trading and market making primarily use financial derivatives to derive trading related gains and this exposes them further towards the systematic risk. In comparison, the results may indicate that small BHCs (with main operations in deposit taking and commercial lending) to a larger extent employ financial derivatives to hedge against systematic risk.

To further analyze what impact financial derivatives have on risk exposures, we decompose financial derivatives according to their reported purposes. Since March 1995, BHCs are required to report whether their financial derivatives activity is for trading purposes or for purposes other than trading (henceforth, for hedging).[2] We decompose financial derivatives according to their reported (trading vs. hedging) purposes (compare Figure 3 and Figure 4). Our findings show that financial derivatives reportedly held for hedging are negatively and significantly related to BHCs' risks.

<Insert Figure 3 and Figure 4 here>

The above result suggests that the use of financial derivatives is aligned with the reported (hedging vs. trading) purposes. However, when splitting BHCs into large and small BHCs, this observation becomes slightly more nuanced. That is, the reported purpose of financial derivatives is aligned with their impact on risks especially for large BHCs but not for small BHCs. In particular, the use of financial derivatives for hedging is either statistically insignificantly or even positively related to risks (in the case of exchange rate derivatives for small BHCs). Hence, the reported purpose of financial derivatives seems to match their true purposes for large BHCs but not necessarily for small BHCs.

Many recent regulatory attempts aim at separating commercial banking from more riskily banking activities such as engagement in investment banking and trading (see the Volker rule under Dodd–Frank Wall Street Reform and Consumer Protection Act and Independent Commission on Banking (2011)).[3] The problem that may occur is that it is difficult to separate whether banks invest in financial derivatives for trading or for hedging purposes. Our results indicate that the biggest caution may be needed with respect to the small BHCs. For small BHCs, engagement into financial derivatives for hedging is associated with higher exposures towards exchange rate risk and credit risk. Nevertheless, to limit (or even ban) the use of

[2] Bank regulatory reports contain information on financial derivatives (interest rate, foreign exchange, commodity and equity derivatives) held for trading purposes and for purposes other than trading, but do not break credit derivatives in this way. In our analysis, we use notional principal amounts on credit derivatives contracts for which the bank is "beneficiary" (credit protection bought) and for which the bank is "guarantor" (credit protection sold) as the variables to evaluate the use of credit derivatives.

[3] This is understandable in light of huge bank losses in the global financial crisis. Due to the 2007-2009 financial crisis, large U.S. and European banks lost more than $1 trillion on toxic assets and from bad loans from January 2007 to September 2009 (IMF, 2009).

financial derivatives may be counterproductive and may increase the risks of small BHCs that are exposed to higher interest rate risk sensitivity.

We also analyze the impact of the global financial crisis on the use of financial derivatives. In the global financial crisis, the relationship between interest rate derivatives and exchange rate derivatives and risk exposures is stronger than in normal time, and the positive relationship between credit derivatives and credit risk became less pronounced.

Our paper is closely related to Choi and Elyasiani (1997) and Yong, Faff and Chalmers (2009). Choi and Elyasiani (1997) measure the interrelation of derivative exposure and the interest rate and exchange rate risks of the U.S. BHCs. They find that the use of financial derivatives further exposes BHCs towards risks and this effect is particularly pronounced for exchange rate risk (see also Choi, Elyasiani and Kopecky (1992) and Hirtle (1997)). Chaudhry, et al. (2000) analyze how different types of exchange rate derivatives affect BHCs' exposure towards risks. They find that exchange rate options tend to increase risk whereas swaps are mainly used to mitigate risk exposures. Carter and Sinkey (1998) focus on large community banks that act as end-users of interest rate derivatives. They find that the use of interest rate derivatives is positively associated with interest rate risk. More recently, Yong, et al. (2009) invesigate the relationship between finanical derivative activites and interest rate and exchange rate risks of Asia-Pacific banks, controling for the influence of a large set of on-balance sheet banking activities. Their finding suggests that the level of interest rate derivative activities is positively associated with long-term interest rate risk exposure but negatively associated with short-term interest rate exposure, the derivative activity of banks has no significant influnce on their exchange rate risk exposure. In our paper, we extend their analysis by including credit derivatives that measure the exposure of BHCs to credit risk.

The paper is organized as follows. Section 2 briefly reviews the extant literature on the use of financial derivatives by financial institutions. Section 3 presents the data selection and basic data description. Section 4 describes the empirical methodology. Section 5 contains the empirical findings. It analyzes how the use of financial derivatives affects BHCs' risk exposures. Section 6 concludes the paper.

## 2. Brief Literature Review: Why Do Banks Use Financial Derivatives?

First, we describe the role of financial derivatives in bank hedging activities. Second, we discuss the impact of financial derivatives on risk taking incentives of banks. Third, we review the use of financial derivatives for trading purposes.

According to Diamond's (1984) model, banks would use financial derivatives to hedge against the risk that

they cannot control, such that they can focus on monitoring their borrowers.[4] Brewer, Minton and Moser (2000) find that banks that use interest rate derivatives increase commercial and industrial lending faster than banks that do not use interest-rate derivatives. Hirtle (2009) shows that the use of credit derivatives increases the supply of bank credit but mainly for large firms. Banks could by hedging also focus on the activities where they retain a competitive advantage. Schrand and Unal (1998) confirm this view in the case of savings and loan institutions. Minton, Stulz and Williamson (2009) argue that the use of credit derivatives by banks is limited questioning the size of the benefits of credit derivatives used for hedging purposes.

Banks may use financial derivatives to lower the probability of default and in this way avoid the costs of financial distress.[5] In this view, banks would hedge especially the risks that exacerbate the costs of financial distress (see Smith and Stulz (1985) and Stulz (2003)).[6] Empirically, consistent with this theory, Gorton and Rosen (1995) find that banks, especially large dealer banks, use interest rate derivatives mainly to hedge their interest rate risk; Purnanandam (2007) shows that banks closer to financial distress hedge against interest rate risk more aggressively. Duffee and Zhou (2001) argue that credit derivatives hedge a bank against the financial distress and this additional flexibility allows the bank to avoid lemon problem due to bank information superiority. In recent study, Norden, Buston, and Wagner (2011) also find banks use credit derivatives to improve their management of credit risks. The notion that banks use financial derivatives to hedge and that banks are risk-averse, however, is not universally accepted: Hirtle (1997), Sinkey and Carter (2000), Gunther and Siems (2002) and Yong, et al. (2009) find that increases in the bank's use of interest-rate derivatives correspond to greater interest rate risk exposure.

Morisson (2005) stresses that hedging by financial derivatives has a dark side. He argues that the informational value of bank loan ceases to exist if banks can trade in the credit derivatives market. More specifically, when the bank incorporates credit default protection, it is no longer exposed to the borrower's potential default. Consequently, the bank can no longer commit to monitoring and screening its borrowers. In addition, the adverse selection problem may be present as well. The bank may want to buy credit protection against the borrowers it perceives as the most risky. This is aligned with empirical evidence from Dahiya, Puri and Saunders (2003) that identifies a significant negative stock price reaction for a borrower when a bank announces the borrower's loan to be sold.

[4] Boot and Thakor (1991) argue that banks with large off-balance sheet activities (e.g., loan commitments) lower their risk exposures compared to banks that lend on a spot market. Their result dwells on observation that loan commitments precommit a bank to the given interest rate in the future.

[5] Bauer and Ryser (2004) formally model the use of financial derivatives by banks that want to mitigate the occurrence of bank runs.

[6] Géczy, Minton and Schrand (1997) show that corporations use exchange rate derivatives to mitigate cash flow variations, such that they are able to exploit profitable growth opportunities. For determinants of corporate hedging, see Nance, Smith Jr and Smithson (1993) and Mian (1996).

Besides hedging purposes, banks also use financial derivatives for trading purposes. Revenues generated by trading activities drive banks to provide financial derivative products to the small banks and nonfinancial firms. Smith (1993) argues that banks should recognize the benefit of providing financial derivatives products and the related services and make good use of it. Revenues come from generated fee income and stronger customer relationships. If used for hedging purposes, financial derivatives can prevent financial distress for bank customers (e.g., small banks, nonfinancial firms), increasing the stability of bank revenues.

The bank involvement in dealing and trading in financial derivatives markets requires a substantial investment in capital, skilled employees, and good reputation, which all act as entry barriers for small banks. Tufano (1989) analyzes financial innovations and the first-mover advantage in investment banking in light of substantial costs associated with the development of new product. Hunter and Timme (1986) argue that the size and technical efficiencies allow large banks to take a lead in financial innovations. Consequently, trading activities of financial derivatives are limited to a set of large banks, whereas smaller banks have little chance to provide full-size risk management services and a broad range of financial derivatives products to their clients.

## 3. Data Sources, Sample Selection and Data Description

The data used in this paper are combined from multiple sources. For the information on a bank's use of financial derivatives, we use Call Report data from the BHC database at the Federal Reserve Bank of Chicago, where the firm-level data is collected using the FR Y-9C report,[7] the Call Report contains quarterly balance sheet, off-balance sheet, and income statement information for all U.S. BHCs. In our analysis, we use unbalanced quarterly panel data from 1997-2011. Second, we use historical BHCs' stock prices from the Center of Research of Security Price (CRSP) at the University of Chicago. The macroeconomic data is obtained from the Federal Reserve Board of Governors.[8] Stock price and macroeconomic data are monthly unbalanced data between 1997 and 2011. We split BHCs into large BHCs and small BHCs. Table 1 presents the variables used, their definitions and sources.

<Insert Table 1 here>

Table 2 summarizes the notional principal amounts of financial derivatives held by U.S. BHCs in the fourth quarter of 2011. Panel A of Table 2 provides a breakdown of financial derivatives by contract types for all U.S. BHCs (in the first column), our sample BHCs (in the second column) and the large BHCs in our sample (in the fourth column). In the fourth quarter of 2011, BHCs with total assets of approximately $16.5

[7] These data are available at: https://www.chicagofed.org/applications/bhc_data/bhcdata_index.cfm.
[8] These data are available at: http://www.federalreserve.gov/econresdata/default.htm.

trillion held nearly $284 trillion of financial derivative contracts, indicating that financial derivative contracts were more than 17 times of the BHCs' total asset. Interest rate derivative contracts (including futures, forwards, swaps and options) accounted for more than $243 trillion and nearly 86% of the total amount. Exchange rate derivative contracts accounted for $29.5 trillion. Credit derivative contracts, accounted for $11.5 trillion. For the interest rate derivative contracts, swaps were the largest individual derivative contract type. The interest rate swaps accounted for more than $171 trillion (nearly 70% of interest rate contracts). In the case of exchange rate derivative contracts, the exchange rate forwards were the most important individual contract type. The value of exchange rate forwards was $13.8 trillion, nearly half of all exchange rate derivative contracts. For credit derivatives, 97% of all credit derivatives held by U.S. BHCs were credit default swaps.

<Insert Table 2 here>

In the second column of Panel A we include financial derivatives data about the sample BHCs in our study and compare it to the data from the total U.S. BHCs (in third column). The total assets of the BHCs in our sample were almost $14.3 trillion, which accounted for 87% of the total assets of all U.S. BHCs. The financial derivative contracts used by BHCs from our sample were more than $277 trillion, or 95% of the total amount. This indicates that the BHCs in our sample well reflect the U.S. BHCs and the U.S. financial derivatives market.

In the fourth column of Panel A, the values for the large BHCs in our sample are presented and compared to the total U.S. BHCs (in the fifth column) and with our sample (in the sixth column). large BHCs held $13.2 trillion of total assets. This accounts for 80% of the total assets of all U.S. BHCs and 92% of total assets of all BHCs in our sample. The large BHCs held more than $277 trillion of financial derivative contracts, which accounts for 97% of the total BHCs' financial derivative contracts and 99.9% of financial derivative contracts in our sample. This indicates that the large BHCs are the main participants in the U.S. financial derivatives market.

Panel B of Table 2 presents the breakdown of financial derivatives with respect to their reported purposes (trading vs. hedging). More than $277 trillion (out of $284 trillion held by BHCs in total) of financial derivative contracts were held for trading, which accounts for over 98% of all financial derivative contracts. The financial derivatives held for trading were largely (98%) concentrated in the large BHCs. Interestingly, this is less pronounced for financial derivatives held for hedging purposes. The large BHCs held 85% of the financial derivatives reportedly used for hedging purposes. The implication is that the small BHCs in our sample act as end-users in the financial derivatives market and hold financial derivatives for hedging purposes.

Table 3 compares the on-balance sheet and off-balance sheet variables for the total sample, the large BHCs and small BHCs between 1997 and 2011, *t*-statistics based on unequal group variance are employed. Panel A compares the use of interest rate derivatives. The average large BHC has lower interest margin ratio, more loans and deposit and more interest rate derivatives than the average small BHC. Panel B focuses on exchange rate variables. The large BHCs have more foreign currency assets and deposits and are more active in the exchange rate derivatives market than small BHCs. Panel C depicts credit risk variables. The large BHCs have higher market liquidity and funding liquidity, more loan charge offs, more loan provisions and non-performing loans, hold more credit derivatives than small BHCs. Panel D presents control variables. Large BHCs' assets are 30 times higher than small BHCs, and they have lower capital ratio and hold more financial derivatives.

<Insert Table 3 here>

Table 3 shows that large and small BHCs employ different strategies to engage in financial derivatives markets. Large banks can build on their scale advantage in financial derivatives activities. They act as market markers and provide financial derivatives products to small banks and nonfinancial firm. In these activities, small BHCs can hardly compete with large BHCs due to their scale disadvantage. They use financial derivatives products mainly for hedging purposes as end-users.

## 4. Empirical Methodology

The empirical analysis employs differences in means and the two-stage time-series, cross-section regression model to analyze the relationship between risk exposures and the use of financial derivatives. The regression proceeds in two stages (consistent with Fama and French (1992)). In the first stage, the changes in the market return, interest rate, exchange rate and credit spread are regressed against the stock returns of each BHC. In this way we obtain risk betas that measure the BHC's systematic (i.e., nondiversifiable) exposure towards market risk, interest rate risk, exchange rate risk and credit risk. In the second stage regression, the on-balance sheet variables and financial derivatives variables are regressed against risk betas.

*First-stage Regression***:** The monthly stock returns of publicly traded BHCs are used to measure exposures of each bank towards market risk, interest rate risk, exchange rate risk and credit risk. Such multi-factor model has also been employed by Flannery and James (1984), Choi and Elyasiani (1997) and Hirtle (1997). The first-stage regression is as follows:

$$\text{Stock Return}_{it}=\alpha_i+\beta_{\text{Market},it}\ \text{Market Return}_{it}+\beta_{\text{Interest},it}\ \text{Interest Rate}_{it}+\beta_{\text{Exchange},it}\ \text{Exchange Rate}_{it}+\beta_{\text{Credit},it}\ \text{Credit Risk}_{it}+\varepsilon_{it} \quad (1)$$

where $\beta_{Market,it}$, $\beta_{Interest,it}$, $\beta_{Exchange,it}$, $\beta_{Credit,it}$ are risk exposures of BHC i towards market risk, interest rate risk, exchange rate risk and credit risk exposures at time t, respectively; $\alpha_i$ are constant error terms and $\varepsilon_{it}$ are random error terms.

Dependent variable Stock Return is the access rate of stock return over the risk-free rate (i.e., annualized rate on three month U.S. Treasury bill). Independent variable Market Return denotes the excess rate of return on the Standard and Poor's 500 index over the risk-free rate. Independent variable Interest Rate is defined as the rate of change in the price of three-month U.S. Treasury bill rate, i.e., $(\sqrt[4]{\frac{1+r_{t-1}}{1+r_t}} - 1)$ where r is annualized rate on three-month U.S. Treasury bill. Independent variable Exchange Rate is the rate of change in the nominal broad dollar index, i.e., $(e_t-e_{t-1})/e_t$ where e is the value of the U.S. dollar against a basket of foreign currencies.[9] Independent variable Credit Risk is defined as the change of BBB bond yield, i.e., $(b_t-b_{t-1})/b_t$, where b is the BBB bond yield in the U.S. market. All data are calculated on a monthly basis.

To adjust for possible bias due to cross-equation dependencies, the regression equations for each of the BHCs are estimated as a simultaneous equation system, using a modified Seemingly Unrelated Technique (SUR). The modified SUR technique, developed by Chamberlain (1982), MaCurdy (1982) and Choi and Elyasiani (1997), is a variation of the standard SUR method and produces asymptotically efficient estimates without imposing either conditional homoskedasticity or serial independence restrictions on disturbance terms.[10]

The market model regressions are performed quarterly by using a 4-year rolling window to estimate time-varying beta coefficients for each BHC. That is, market return, interest rate, exchange rate and credit risk are regressed on stock return of the individual-bank data based on forward looking 4-year time interval. This process results in separate risk betas for each BHC of each quarter in the sample. The values of $\beta_{Market,it}$, $\beta_{Interest,it}$, $\beta_{Exchange,it}$, $\beta_{Credit,it}$ are therefore quarter and bank specific and are treated as panel data in the second stage regression.

*Second-stage Regression*: In the second step, interest rate risk $\beta_{Interest,it}$, exchange rate risk $\beta_{Exchange,it}$ and credit risk $\beta_{Credit,it}$ generated in the first stage are regressed in a panel data regression against bank-specific on-balance sheet and off-balance sheet (i.e., financial derivatives) variables.[11] To increase the accuracy of

9 The nominal broad dollar index is a weighted average of the foreign exchange value of the U.S. dollar against the currencies of a broad group of major U.S. trading partners. Weights for the broad index can be found at http://www.federalreserve.gov/releases/H10/Weights. For more information on exchange rate indexes for the U.S. dollar, see "Indexes of the Foreign Exchange Value of the Dollar," Federal Reserve Bulletin, 91:1 (Winter 2005), pp. 1-8 (http://www.federalreserve.gov/pubs/bulletin/2005/winter05_index.pdf).

10 The SUR regression has been employed in recent studies by Viale, Kolari and Fraser (2009), Yong, et al. (2009), Ammer, Vega and Wongswan (2010), Białkowski, Etebari and Wisniewski (2012) and Lim, Sum and Khun (2012).

11 The betas generated in the first stage are used as dependent variables in the second stage, the most recent literatures that use the

our estimation in the second-stage, we weight each observation by the inverse of the standard errors of $\beta_{Interest,it}$, $\beta_{Exchange,it}$ and $\beta_{Credit,it}$ obtained in the first stage. This procedure is suggested by Doidge, Griffin and Williamson (2006) and Chue and Cook (2008), so that the betas that are estimated more precisely in the first stage receive a heavier weight in the second stage.

The equations can be written as follows:

$$\beta_{Interest,it} = \gamma_i + \sum_j \delta_j X_{jit} + \sum_j \eta_j Y_{jit} \quad (2)$$

where $X_{jit}$ are on-balance-sheet variables (including Interest Margin, C&I Loans, Mortgage Loans, Other Loans, Domestic Deposits) and three control variables (Size, Total Capital Ratio and GDP growth) and $Y_{jit}$ are the notional principal amounts of interest rate derivatives used. In a slightly changed specification, $Y_{jit}$ can be interest rate derivatives and interest rate derivatives for hedging.

$$\beta_{Exchange,it} = \Phi_i + \sum_j \xi_j A_{jit} + \sum_j \varsigma_j B_{jit} \quad (3)$$

where $A_{jit}$ are on balance sheet variables (including Assets in Foreign Currencies, Foreign Exchange Deposits) and two control variables (Size, Total Capital Ratio and GDP growth) and $B_{jit}$ are the notional principal amounts of exchange rate derivatives used. In a slightly changed specification, $B_{jit}$ can be exchange rate derivatives and exchange rate derivatives for hedging.

$$\beta_{Credit,it} = \psi_i + \sum_j \mu_j O_{jit} + \sum_j \nu_j P_{jit} \quad (4)$$

where $O_{jit}$ are on balance sheet variables (including Market Liquidity, Funding Liquidity, Non-Performing Loans, Loan Charge-Offs, Loan Loss Provisions) and two control variables (Size, Total Capital Ratio and GDP growth) and $P_{jit}$ are the notional principal amounts of credit derivatives used. In a slightly changed specification, $P_{jit}$ can be credit derivatives and net credit protection bought.

We also account for the presence of the global financial crisis by adding dummy variable Crisis which is one during the financial crisis 2007-2010 and zero in all other periods. We estimate the following regression equations:

$$\beta_{Interest,it} = \gamma_i + \sum_j \delta_j X_{jit} + \sum_j \eta_j Y_{jit} + \theta_i Crisis_t + \sum_j \kappa_j Crisis_t Y_{jit} \quad (5)$$

risk exposure as dependent variable in the second stage can be found in Chue and Cook (2008), Hutson and Stevenson (2009), Choi and Jiang (2009), and Bredin (2011).

$$\beta_{Exchange,it} = \Phi_i + \sum_j \xi_j A_{jit} + \sum_j \varsigma_j B_{jit} + \upsilon_i Crisis_t + \sum_j \omega_j Crisis_t B_{jit} \quad (6)$$

$$\beta_{Credit,it} = \psi_i + \sum_j \mu_j O_{jit} + \sum_j \nu_j P_{jit} + \pi_i Crisis_t + \sum_j \rho_j Crisis_t P_{jit} \quad (7)$$

# 5. Empirical Results

## 5.1. First-stage Regression Results

In the first stage, we estimates the beta coefficients of market risk, interest rate risk, exchange rate risk and credit risk for each BHC in each quarter in our sample. We also perform regressions for each group of the BHCs in the sample. Correlation between the first-stage variables are shown in Table 4.

<Insert Table 4 here>

From the correlation between variables presented in Table 4, we observe that exchange rate and credit risk are significantly negatively correlated with stock return. On the other hand, interest rate is significantly positively correlated with stock return. Market return is only significantly positively correlated with stock return for the small group.

In Table 5, we report the results of the multifactor index model for total sample, large BHCs and small BHCs for the entire sample period. The results indicate that market risk beta ($\beta_{Market}$) and interest rate beta ($\beta_{Interest}$) are statistically significant (at 1% level on two-tail tests) for the total sample and for two subsamples (large BHCs and small BHCs). The exchange rate beta ($\beta_{Exchange}$) is significant for the total sample and small BHCs but not for the large BHCs. The credit risk beta ($\beta_{Credit}$) is significant in all cases.

<Insert Table 5 here>

In Table 5, risk betas can be compared across large and small BHCs. The market risk beta ($\beta_{Market}$) is higher for the large BHCs, followed by the total sample and small BHCs. This is consistent with the popular notion that large BHCs, acting as market makers and holding large proportion of financial derivatives for trading purposes, have higher risks and are more exposed to the market risk (Standard and Poor's, 2011). The results also show that small BHCs are more sensitivity to the interest rate risk, exchange rate risk and credit risk than large BHCs. Higher sensitivity to the interest rate risk and credit risk is aligned with the notion that lending (and associated credit risk) is the core business of small BHCs.

Figure 5-Figure 8 depict the movement of average interest rate risk, exchange rate risk, credit risk and market risk across time for large and small BHCs. Interestingly, interest rate risk reaches the bottom in

years 2005 and 2006 and then increases with the start of the global financial crisis. This shows that BHCs were substantially exposed to interest rate risk in the global financial crisis. Similarly to the changes of interest rate risk, exchange rate risk, credit risk and market risk increase also substantially in the global financial crisis. At the end of the global financial crisis, we also observe that large BHCs are exposed to higher interest rate risk, exchange rate risk, credit risk and market risk than small BHCs (see Figure 5-Figure 8). This conclusion is consistent with our hypothesis that BHCs are exposed to higher risks during the financial crisis than in normal times and large BHCs are exposed to higher risks than smaller ones.

<Insert Figure 5-Figure 8 here>

## 5.2. Bank-specific Determinants of Risk Betas: Initial Analysis

This section presents the weighted instrumental-variable estimator of the second stage regression using the panel data regression model based on (2), (3) and (4). The dependent variables in the regression are interest rate, exchange rate and credit risk betas generated in the first stage regression. The independent variables are on-balance sheet variables and the variables depicting the use of financial derivatives from Table 3. Three control variables are introduced: the natural log of asset, the total risk-based capital ratio and GDP growth. All standard errors are heteroskedasticity-consistent.

In the estimation, the financial derivatives variables and the interacted terms between Crisis and financial derivatives variables are instrumented with their one quarter lagged counterparties, exposures variables from trading revenue (interest rate exposures, foreign exchange exposures and credit exposures), and income tax rate.[12] Following Baum (2006), the GMM estimator is also employed for the consistent and efficient estimating in the presence of non-i.i.d errors.

Instrument variables are statistically significant (at least at 10%) at large in the first-stage of weighted instrument-variable estimation. For the Anderson and Rubin (1949) test of the validity of the instruments, the hypothesis that the instruments are not valid is rejected at the 5% level for all regression model based on (2), (3) and (4). Besides this, the underidentification test (measured by Kleibergen-Paap rk LM statistic, Kleibergen and Paap (2006)), and weak identification test (measured by Cragg-Donald Wald F statistic and Kleibergen-Paap Wald rk F statistic, Cragg and Donald (1993) and Baum, Schaffer and Stillman (2007)) also confirm the validity of the instruments.

Correlations among the on-and off-balance variables used in the second-stage estimation are presented in Table 6. Correlations among on-and off-balance sheet variables of interest rate risk (in Panel A) are

[12] Ashcraft (2008) uses corporate income tax rates as an instrument for the mix of debt in regulator capital.

generally low, while the correlations among BHCs size and interest rate derivatives are generally higher (which are both above 0.2). This implies there is no multicollinearity problem for the on-balance sheet variables and the use of interest rate derivatives is often and significantly impacted by the BHC size. And the similar results also conclude in the case of exchange rate derivatives (in Panel B), while the correlations are all above 0.2. The high correlation for the credit risk variables are between the loan loss provisions and non-performing loans and loans charge-offs, which might show that the evaluation of BHCs' non-performing loans has significant impact on the loan loss provisions and loan charge-offs (in Panel C). Correlations between financial derivatives contracts for trading purposes and the total sum of financial derivatives are high. This indicates the use of one form financial derivatives appears to be accompanied by the use for trading purposes.

<Insert Table 6 here>

Figure 9 provides the first inspection of the impact of interest rate derivatives on interest rate risk sensitivity. In Figure 9 BHCs are split in quartiles according to their interest rate derivatives (interest rate derivatives/total assets). We can find that during the financial crisis interest rate risk sensitivity (and credit risk sensitivity) is higher for BHCs with interest rate derivatives in the highest quartile compared to the BHCs with lower interest rate derivatives usage (and credit derivatives usage; see Figure 11). The relationship between exchange rate risk sensitivity and exchange rate derivatives is inverse: during the financial crisis, exchange rate risk sensitivity is higher for BHCs with exchange rate derivatives in the lowest quartile compared to the BHCs with higher exchange rate derivatives (see Figure 10).

<Insert Figure 9-Figure 11 here>

Table 7 provides the weighted instrumental-variable regression results. Panel A analyzes the exposure towards interest rate risk. The results show that commercial and industrial loans, and mortgage loans are positively and significantly associated with interest rate risk for the large BHCs. On the other hand, domestic deposits are negatively associated with interest rate risk (and statistically significant for the small BHCs). This may indicate that BHCs with higher lending activities are more exposed to interest rate risk, especially for the smaller BHCs (i.e., small BHCs), they can mitigate higher interest rate risk sensitivity with stronger engagement in deposit-taking activities.

<Insert Table7 here>

Panel A in Table 7 shows that higher GAP ratio and capital ratio are associated with higher interest rate risk for large BHCs. The size of a BHC has significant and positive impact on interest rate risk of total sample and small BHC, indicating that there seems to be a direct relationship between the size of BHCs and their level of interest rate risk sensitivity. This finding is consistent with the results obtained by Elyasiani and

Mansur (1998, 2004), Saporoschenko (2002), Reichert and Shyu (2003), and Faff, Hodgson and Kremmer (2005). GDP growth has a significant and positive impact on interest rate risk of large BHCs, but for the small BHCs, the relation between GDP growth and interest rate risk is negative.

The use of interest rate derivatives is positively associated with interest rate risk and is significant at 10% for the total sample, indicating that the use of interest rate derivatives corresponds to greater interest rate risk. This result is consistent with the previous studies (e.g., Hirtle (1997); Reichert and Shyu (2003); Yong, et al. (2009)), providing empirical support to our conclusion in the table 2 that BHCs are using interest rate derivatives for trading purposes rather than for risk hedging purposes.

Panel B in Table 7 analyzes the exchange rate risk of BHCs. It shows that foreign exchange deposits are positively associated with exchange rate risk for small BHCs whereas assets in foreign currencies are positively associated with exchange rate risk for total sample and large BHCs but negatively for small BHCs. The explanation may be that small BHCs naturally combine foreign exchange deposit-taking with lending in same foreign currencies and better hedge against exchange rate risk than large BHCs.

We also see that total assets are negatively and significantly associated with exchange rate risk (for large BHCs). This may suggest that only large BHCs have powers to expand in assets in foreign currencies and collect foreign exchange deposits.

The use of exchange rate derivatives is negatively (and significantly at 1%) associated with exchange rate risk for total sample, large BHCs and small BHCs. This demonstrates BHCs that use exchange rate derivatives are less exposed to exchange rate risk. The interaction term between large and exchange rate derivatives has a positive and significant coefficient. This indicates that the marginal impact of exchange rate derivatives on exchange rate risk for small BHCs is significantly higher than for large BHCs.

Panel C of Table 7 depicts the credit risk exposures of BHCs. Market liquidity is negatively and significantly at 1% associated with credit risk for total sample and small BHCs but not for large BHCs. The explanation resides in the observation that BHCs with higher market liquidity are less exposed to credit risk. Loan charge offs are positively associated with credit risk but only statistically significantly at 1% for the total sample. Loan loss provisions are negatively associated with credit risk for total sample (significant at 1%). This is aligned with the view that large BHCs that are strongly engaged in lending activity with higher loss provision for the related repayment problems expose to lower credit risk. The size of a BHC is positively (and statistically significantly) related to credit risk.

The use of credit derivatives is positively related to credit risk for the total sample, large BHCs and small

BHCs. The relationship is stronger for large BHCs compared to the total sample and small BHCs. This indicates that the positive relationship between credit derivatives and credit risk is especially pronounced for large BHCs.

In short, the uses of interest rate derivatives and credit derivatives are positively and significantly associated with interest rate and credit risk. For exchange rate derivatives, the use of exchange rate derivatives is negatively and significantly associated with exchange rate risk. Small BHCs use financial derivatives to lower their risk exposures more successfully than large BHCs.

### 5.3. Reported Purposes of Financial Derivatives and Risks

To further depict the relationship between risks and financial derivatives, we analyze how the derivatives for hedging purposes affect interest rate risk, exchange rate risk and credit risk.[13]

<Insert Table 8 here>

Panel A in Table 8 shows that interest derivatives for hedging are negatively and significantly related to interest rate risk for the total sample and large BHCs, while the interest rate derivatives for hedging have no significant effect on interest rate risk of small BHCs. The results suggest that as BHCs increases the amount of interest rate derivatives for hedging, the interest rate risk of BHCs decreases. The negative impact of interest rate derivatives for hedging on risk is stronger for large BHCs than small BHCs.

Panel B in Table 8 report results for exchange rate derivatives and exchange rate derivatives for hedging. The direct effect of increased exchange rate derivatives is negative and significant for total sample, large BHCs and small BHCs. For total BHCs and large BHCs, exchange rate derivatives for hedging have a significant effect on the exchange rate risk: the exchange rate risk appears to decline as the amount of exchange rate derivatives for hedging increases. The exchange rate risk to small BHCs appears to increase as the exchange rate derivatives for hedging rise.

Panel C in Table 8 shows that net credit protection bought is negatively related to credit risk for total BHCs and large BHCs (only significant for large BHCs at 1%), while for small BHCs, the sign is positive and insignificant.

The relationships between on-balance sheet variables, control variables and risk betas are similar as in

[13] In this part, as bank regulatory reports do not break our credit derivatives held for trading and for hedging purpose, we use the net credit protection bought, which is the notional principal of credit derivatives on which the bank is the beneficiary (credit protection bought) minus the notional principal amount of credit derivatives on which the bank is guarantor (credit protection sold), as the variable to evaluate the banks use credit derivatives for hedging. See also Minton, Stulz and Williamson (2009) and Hirtle (2009).

Table 7. These results point to the different impact of financial derivatives for hedging across different types of BHCs. large BHCs are larger BHCs and more likely use the exchange rate derivatives in international financial markets whereas small BHCs are much smaller and they mainly focus on the domestic market. The different impact of financial derivatives for hedging on risks for large BHCs and small BHCs can also be observed from the interaction term of large and financial derivatives for hedging: as the coefficients on the interaction term are negative strongly statistically significant, the negative impact of financial derivatives for hedging is significantly higher for large BHCs.

In brief, Table 8 confirms that financial derivatives for hedging are negatively related to risks of total sample and large BHCs. This is aligned with the view that financial derivatives held for hedging will reduce risks. Our results also indicate that this relation is much stronger for large BHCs.

We now analyze whether the relationship between risks and financial derivatives has changed in the global financial crisis 2007-2010.

### 5.4. The Global Financial Crisis and Financial Derivatives

Table 9 analyzes the role of financial derivatives in the global financial crisis. The global financial crisis denoted by dummy variable Crisis has a significantly positive (at 1%) impact on interest rate risk of total sample and small BHCs. The coefficients of the interaction terms between Crisis and interest rate derivatives are negative and significant (for total sample and large BHCs), which suggests that the positive impact of interest rate derivatives on interest rate risk is stronger during the financial crisis than in normal times (Panel A). While the dummy variable Crisis has no direct significant effect on exchange rate risk and credit risk, the coefficients of the interaction terms between Crisis and exchange rate derivatives (for large BHCs and small BHCs) and between Crisis and credit derivatives (for total sample and large BHCs) are negative and significant, which suggests that the impact of exchange rate derivatives on exchange rate risk is higher during the crisis than in normal time (Panel B), whereas the impact of credit derivatives on credit risk is lower during the crisis than in normal times (Panel C).

<Insert Table 9 here>

Table 9 depicts the impact of the global financial crisis on interest rate, exchange rate and credit risk. Table 9 shows that the positive relationship between interest rate derivatives and interest rate risk becomes more pronounced during the global financial crisis, while the negative relationship between exchange rate derivatives and exchange rate risk also increases during the global financial crisis, but is only significant for large BHCs and small BHCs. The global financial crisis seems to lower the positive impact of credit

derivatives on credit risk for total sample and large BHCs, whereas its impact in the case of small BHCs was not statistically significant.

In Table 10 we further examine financial derivatives based on their reported purposes for hedging. For total sample, interest rate derivatives are positively related to interest rate risk and the global financial crisis further exacerbates this positive relation. In contrast, interest derivatives for hedging are negatively related to interest rate risk for total sample and the global financial crisis has no significant effect on the relation between interest rate derivatives for hedging and interest rate risk. For large BHCs and small BHCs, the global financial crisis has established a significantly positive effect on the relationship between interest rate derivatives for hedging and interest rate risk.

<Insert Table10 here>

The impact of the global financial crisis on exchange rate risk is positive and statistically significant at 1% for large BHCs. For total sample, the interacted terms between Crisis and exchange rate derivatives and exchange rate derivatives for hedging are statistically and negatively significant, which indicates the negative relationship between exchange rate derivatives and exchange rate derivatives for hedging and exchange rate risk is stronger during the global financial crisis than in normal times, and the results of large BHCs and small BHCs are also consistent with the conclusion of total sample.

The global financial crisis negatively and significantly (at 1%) affects credit risk. For total sample and large BHCs, the global financial crisis decreases the positive relationship between credit derivatives and credit risk. The global financial crisis has no significant impact on the relation between net credit protection bought and credit risk.

In summary, Table 10 shows that for total sample and large BHCs, the global financial crisis increases the positive (negative) relationship between financial derivatives and interest rate risks (exchange rate risk), while the global financial crisis decreases the positive relation between credit derivatives and credit risk. For small BHCs, the global financial crisis only increases the negative relationship between exchange rate derivatives and exchange rate risks.

The impact of the global financial crisis can be explained in the following way. During the global financial crisis, the risks associated with financial derivatives increased, which in turn increased the impact of financial derivatives on risks sensitivity of BHCs. In addition, large BHCs may have increased the use financial derivatives for trading (indicating speculative purposes). In contrast, small BHCs may have used financial derivatives even more for hedging purposes which lowered their risk exposures during the global financial crisis.

## 6. Conclusions

In this paper, we examine whether financial derivatives magnify or mitigate interest rate risk, exchange rate risk and credit risk sensitivities of the publicly traded U.S. BHCs in the period from 1997 to 2011. The regression proceeds in two stages. In the first stage, the changes in the excess market returns, interest rates, exchange rates and credit risk are regressed against the stock returns of each bank. In this way we obtain betas that measure market risk, interest rate risk, exchange rate risk and credit risk. The estimation procedure applies a modified seeming unrelated simultaneous method that adjusts for cross-equation dependencies as well as heteroskedasticity and serial correlation. In the second stage regression, we employ the weighted instrumental-variables estimation and the on-balance sheet variables and financial derivatives variables are regressed against risk betas generated in the first stage.

The sample in this paper accounts for more than 86% of the asset of the U.S. banking system and more than 95% of the U.S. financial derivatives market. Hence, the results well reflects the characteristic of banks and financial derivatives market in the U.S. Also, in order to examine the differences between BHCs that act as dealers and the ones that act as end-users, we divide the sample into large BHCs and small BHCs. In addition, we divide derivatives with respect to their reported purposes (i.e., trading vs. hedging).

Our results suggest the use of financial derivatives have significant effects on the risk exposures. For BHCs in our sample, we find that more pronounced use of interest rate derivatives and credit derivatives corresponds to greater interest rate risk exposure and credit risk exposure, whereas more pronounced use of exchange rate derivatives is associated with lower exchange rate risk exposure. By examining the effect of financial derivatives for hedging on risk sensitivities, we find evidence that the use of financial derivatives for hedging purposes is negatively related to risk sensitivities of BHCs (for total sample and large BHCs but not necessarily for small BHCs). During the global financial crisis, the relationship between interest rate and exchange rate derivatives and risk exposures is stronger than in normal time, and the positive relationship between credit derivatives and credit risks became less pronounced.

Policy implications immediately follow. Our analysis predicts that limiting or even banning the use of financial derivatives across all BHCs (through e.g. the Volker rule in the Dodd-Frank Wall Street Reform and Consumer Protection Act) may be counterproductive and may increase risks especially for BHCs that mainly use financial derivatives for hedging purposes. The counterproductive effect may even be more pronounced during a financial crisis.

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**Table 1 Description of Variables**

| Variable | Definition | Data Sources |
|---|---|---|
| **First-Stage Variables** | | |
| Stock Return | Measured by the excess rate of return of stock price over the risk-free rate | Center of Research of Security Price |
| Market Return | Measured by the excess rate of return on market portfolio S&P 500 over the risk- free rate | Center of Research of Security Price |
| Interest Rate | Measured by the percentage changes of the price of three-month U.S. Treasury bill | H.15, Federal Reserve Board of Governors |
| Exchange Rate | Measured by the change in nominal broad dollar index | G.5, Federal Reserve Board of Governors |
| Credit Risk | Measured by the change of BBB bond yield | Center of Research of Security Price |
| **Interest Rate Risk Variables** | | |
| Interest Margin | (Interest margin) /average interest earning assets | FR Y-9C, BHCK4074/(total assets) |
| Commercial& Industrial Loans | Commercial and industrial loans /total assets | FR Y-9C, (BHCK1763+BHCK1764)/ (total assets) |
| Mortgage Loans | Mortgage loans/total assets | FR Y-9C, (BHCK1410+BHCK1590)/ total assets |
| Other Loans | (Loans-commercial &industrial loans-mortgage loans)/total assets | FRY-9C, (BHCK2122-BHCK1766-BHCK1410-BHCK1590)/ total assets |
| Domestic Deposits | Domestic deposits /total assets | FR Y-9C, (BHDM6631+BHDM6636)/ total assets |
| GAP Ratio | Interest sensitive assets that are repriceable within one year or mature within one year/ interest rate-sensitive liabilities that are repriceable within one year or mature within one year | FR Y-9C, BHCK3197/ BHCK3296 |
| Interest Rate Exposures | Interest rate exposures/ total assets | FR Y-9C, BHCK8757/ total assets |
| Interest Rate Derivatives for Trading | Notional principal amounts of interest rate contracts for trading purposes/total assets | FR Y-9C, BHCK A126/ total assets |
| Interest Rate Derivatives for Hedging | Notional principal amounts of interest rate contracts for other-than trading purposes/total assets | FR Y-9C, BHCK 8725/ total assets |
| Interest Rate Derivatives | Notional principal amounts of interest rate contracts/ total assets | FR Y-9C, (BHCK A126+ BHCK 8725)/ total assets |
| **Exchange Rate Risk Variables** | | |
| Assets in Foreign Currencies | Assets in foreign offices/total assets | FR Y-9C, (BHCK0397+BHCK1742+BHCK1746+BHCK2081+BHCK1296)/ total assets |
| Foreign Exchange Deposits | Deposits denominated in foreign currencies and in foreign offices/total assets | FR Y-9C, (BHFN6631+BHFN6636)/ total assets |
| Foreign Exchange Exposures | Foreign exchange exposures/ total assets | FR Y-9C, BHCK8758/ total assets |
| Exchange Rate Derivatives for Trading | Notional principal amounts of exchange rate contracts for trading purposes/total assets | FR Y-9C, BHCK A127/ total assets |
| Exchange Rate Derivatives for Hedging | Notional principal amounts of exchange rate contracts for other-than trading purposes/total assets | FR Y-9C, BHCK 8726/ total assets |
| Exchange Rate Derivatives | Notional principal amounts of exchange rate contracts /total assets | FR Y-9C, (BHCK A127+ BHCK 8726)/ total assets |
| **Credit Risk Variables** | | |
| Market Liquidity | (Cash+ securities + fed funds lent)/total assets | FRY-9C, (BHCK0081+BHCK0395+BHCK0397+BHCK1754+BHCK1773)/ total assets |
| Funding Liquidity | (Federal funds sold + securities purchased under agreements)/total assets | FR Y-9C, (BHDMB987+BHCKB989/ total assets |
| Non-Performing Loans | (Total amount of loans classified as non-performing )/total assets | FR Y-9C, (BHCK5524+BHCK5525+BHCK5526)/ total assets |
| Loan Charge-Offs | Loan charge-offs/total assets | FR Y-9C, BHCK4635/ total assets |
| Loan Loss Provisions | Loan loss provisions/total assets | FR Y-9C, BHCK4230/ total assets |
| Credit Exposures | Credit exposures/ total assets | FR Y-9C, F186/ total assets |
| Credit Protection Sold | Notional principal amounts of credit risk protection sold/total asset | FR Y-9C, (BHCKC968+BHCKC970+BHCKC972+BHCKC974) / total assets |
| Credit Protection Bought | Notional principal amounts of credit risk protection bought/total asset | FR Y-9C, (BHCKC969+BHCKC971+BHCKC973+BHCKC975) / total assets |
| Net Credit Protection Bought | Notional principal amounts of credit risk protection bought/total asset | FR Y-9C, (BHCKC969+BHCKC971+BHCKC973+BHCKC975) / total assets |
| | (Credit risk protection bought - Credit risk protection sold)/total asset | FR Y-9C, ((BHCKC969+BHCKC971+BHCKC973+BHCKC975)-(BHCKC968+BHCKC970+BHCKC972+BHCKC974)) / total assets |
| Credit Derivatives | (Credit risk protection bought + Credit risk protection sold)/total asset | FR Y-9C, ((BHCKC969+BHCKC971+BHCKC973+BHCKC975)+(BHCKC968+BHCKC970+BHCKC972+BHCKC974)) / total assets |
| **Control Variables** | | |
| Natural Log of Total Assets | log (total assets) | FR Y-9C, log (BHCK2170) |
| Total Risk-Based Capital Ratio | Total capital ratio | FR Y-9C, BHCK7205 |
| GDP Growth | The GDP growth in each state | http://www.bea.gov/regional/ |
| Income Tax Rate | Corporate income tax rates in each state, as the data before 2000 is missing, we use the income tax rate in 2000 to measure the corporate income tax rates from 1997-1999 | www.taxfoundation.org |
| Crisis | Equals to 1 if the growth rate of the quarterly net operate income for the whole banking system in the U.S. is negative during the financial crisis 2007-2010, and 0 otherwise. | |
| Large | Equals to 1 if the asset of the BHCs is larger or equal to $50 billion, and 0 otherwise. | |

**Table 2 Financial Derivatives at the U.S. BHCs (Notional principal amounts, in $ billion)**

| | Total U.S. BHCs | BHCs in our sample | | Large BHCs in our sample | | |
|---|---|---|---|---|---|---|
| **Panel A: Types of Financial Derivatives** | | | | | | |
| | Value | Value | % of Total | Value | % of Total | % of sample |
| **Interest Rate Contracts** | **(1)** | **(2)** | **(3)** | **(4)** | **(5)** | **(6)** |
| Futures | 5980 | 5710 | 95.48 | 5700 | 95.32 | 99.82 |
| Forwards | 31000 | 30300 | 97.74 | 30200 | 97.42 | 99.67 |
| Exchange-traded Option | 3760 | 3660 | 97.34 | 3660 | 97.34 | 100.00 |
| OTC | 5230 | 5150 | 98.47 | 5150 | 98.47 | 100.00 |
| Swaps | 171000 | 168000 | 98.25 | 168000 | 98.25 | 100.00 |
| Total Interest Rate Contracts | 243000 | 238000 | 97.94 | 237890 | 97.94 | 99.95 |
| **Exchange Rate Contracts** | | | | | | |
| Futures | 87 | 86 | 98.28 | 86 | 98.28 | 100.00 |
| Forwards | 13800 | 13000 | 96.38 | 13300 | 96.38 | 100.00 |
| Exchange-traded Contracts | 34 | 34 | 100.00 | 34 | 100.00 | 100.00 |
| OTC | 3100 | 3080 | 99.35 | 3080 | 99.35 | 100.00 |
| Swaps | 10300 | 10000 | 98.06 | 10100 | 98.06 | 100.00 |
| Total Exchange Rate Contracts | 29500 | 28300 | 96.95 | 28300 | 96.95 | 100.00 |
| **Credit Derivatives** | | | | | | |
| Credit Default Swaps | 11100 | 10800 | 97.30 | 10800 | 100.00 | 100.00 |
| Total Return Swaps | 179 | 131 | 73.18 | 131 | 100.00 | 100.00 |
| Credit Options | 97 | 97 | 100.00 | 97 | 100.00 | 99.69 |
| Other Credit Derivatives | 103 | 103 | 100.00 | 103 | 100.00 | 99.03 |
| Total Credit Derivatives | 11479 | 11131 | 96.96 | 11131 | 100.00 | 100.00 |
| **Total Assets** | 16500 | 14300 | 86.67 | 13200 | 80.00 | 92.31 |
| **Total Derivatives** | 283979 | 277431 | 95.18 | 277321 | 97.65 | 99.96 |
| **Panel B: Financial Derivatives for Different Purposes** | | | | | | |
| Interest Rate Contracts Held For Trading | 238000 | 234000 | 98.32 | 234000 | 98.32 | 100.00 |
| Foreign Exchange Contracts Held For Trading | 28800 | 28000 | 97.22 | 28000 | 97.22 | 100.00 |
| Credit Protection Sold | 11000 | 10700 | 97.27 | 10700 | 97.27 | 100.00 |
| Interest Rate Contracts Held for Hedging | 4970 | 4240 | 85.31 | 4190 | 84.31 | 98.82 |
| Foreign Exchange Contracts Held for Hedging | 710 | 680 | 95.77 | 679 | 95.63 | 99.85 |
| Credit Protection Bought | 11300 | 10900 | 97.88 | 10900 | 97.88 | 100.00 |

Source: The financial data is for 4th quarter 2011 from Financial Statements data from Call Reports (FR Y-9Cs).

**Table 3 Financial Characteristics of the Sample BHCs: Large BHCs versus Small BHCs**

| Variable | Group Means | | | Difference in Means | | |
|---|---|---|---|---|---|---|
| | Total Sample | Large (L) BHCs | Small (S) BHCs | L-S | t-Statistic | *p*-value |
| **Panel A: Interest Rate Variables** | | | | | | |
| Interest Margin Ratio | 0.021 | 0.019 | 0.021 | -0.003 | -8.768*** | 0.0000 |
| Commercial & Industrial Loans | 0.109 | 0.143 | 0.107 | 0.036 | 14.828*** | 0.0000 |
| Mortgage Loans | 0.473 | 0.304 | 0.484 | -0.180 | -46.138*** | 0.0000 |
| Other Loans | 0.075 | 0.146 | 0.070 | 0.076 | 31.598*** | 0.0000 |
| Domestic Deposits | 0.732 | 0.546 | 0.744 | -0.198 | -35.160*** | 0.0000 |
| GAP Ratio | 0.048 | 0.313 | 0.030 | 0.283 | 3.085*** | 0.0021 |
| Interest Rate Options Bought | 0.040 | 0.251 | 0.026 | 0.225 | 12.730*** | 0.0000 |
| Interest Rate Options Written | 0.034 | 0.250 | 0.020 | 0.230 | 12.567*** | 0.0000 |
| Interest Rate Forwards & Futures | 0.055 | 0.431 | 0.030 | 0.402 | 13.569*** | 0.0000 |
| Interest Rate Swaps | 0.210 | 1.939 | 0.093 | 1.846 | 12.622*** | 0.0000 |
| Interest Rate Derivatives for Trading | 0.290 | 2.673 | 0.129 | 2.543 | 12.369*** | 0.0000 |
| Interest Rate Derivatives for Hedging | 0.039 | 0.156 | 0.031 | 0.125 | 19.687*** | 0.0000 |
| interest Rate Derivatives | 0.340 | 2.878 | 0.169 | 2.709 | 13.095*** | 0.0000 |
| **Panel B: Exchange Rate Variables** | | | | | | |
| Assets in Foreign Currencies | 0.004 | 0.033 | 0.002 | 0.031 | 14.959*** | 0.0000 |
| Foreign Currency Deposits | 0.010 | 0.071 | 0.006 | 0.065 | 20.657*** | 0.0000 |
| Exchange Rate Options Bought | 0.005 | 0.036 | 0.003 | 0.032 | 12.522*** | 0.0000 |
| Exchange Rate Options Written | 0.006 | 0.036 | 0.003 | 0.033 | 12.465*** | 0.0000 |
| Exchange Rate Forwards & Futures | 0.042 | 0.405 | 0.018 | 0.387 | 15.743*** | 0.0000 |
| Exchange Rate Swaps | 0.008 | 0.073 | 0.004 | 0.069 | 12.320*** | 0.0000 |
| Spot Exchange Rate | 0.005 | 0.036 | 0.002 | 0.033 | 15.665*** | 0.0000 |
| Exchange Rate Derivatives for Trading | 0.060 | 0.535 | 0.027 | 0.508 | 16.351*** | 0.0000 |
| Exchange Rate Derivatives for Hedging | 0.002 | 0.011 | 0.001 | 0.010 | 15.482*** | 0.0000 |
| Exchange Rate Derivatives | 0.061 | 0.547 | 0.029 | 0.518 | 16.622*** | 0.0000 |
| **Panel C: Credit Risk Variables** | | | | | | |
| Market Liquidity | 0.261 | 0.244 | 0.263 | -0.019 | -5.024*** | 0.0000 |
| Funding Liquidity | 0.015 | 0.028 | 0.014 | 0.014 | 8.9975*** | 0.0000 |
| Non-Performing Loans | 0.018 | 0.017 | 0.018 | -0.001 | 2.582*** | 0.0099 |
| Loan Charge-Offs | 0.003 | 0.004 | 0.003 | 0.001 | 9.388*** | 0.0000 |
| Loan Loss Provisions | 0.003 | 0.004 | 0.003 | 0.001 | 5.274*** | 0.0000 |
| Credit Protection Sold | 0.008 | 0.067 | 0.004 | 0.063 | 8.438*** | 0.0000 |
| Credit Protection Bought | 0.009 | 0.073 | 0.004 | 0.069 | 8.807*** | 0.0000 |
| Credit Derivatives | 0.017 | 0.141 | 0.009 | 0.132 | 8.646*** | 0.0000 |
| **Panel D: Control Variables** | | | | | | |
| Asset ($ billion) | 24.2 | 262 | 8.41 | 253.59 | 19.932*** | 0.0000 |
| Total Capital Ratio (%) | 13.95 | 12.60 | 14.04 | -1.44 | -9.282*** | 0.0000 |
| GDP Growth (%) | 2.02 | 1.85 | 1.82 | 0.03 | 0.333 | 0.7391 |
| Income Tax Rate (%) | 41.96 | 42.15 | 41.90 | 0.26 | 3.877*** | 0.0001 |

*Note*: The *t*-statistics are in parentheses. * $p < 0.10$ ** $p < 0.05$, *** $p < 0.01$.

Source: The financial data is between 1997and 2011 and from Financial Statements data from Call Reports (FR Y-9Cs). The t-statistics are based on unequal group variances. Variables used are described in Table 1.

**Table 4 Correlation Coefficients Between Macroeconomic Factors**

This table indicates the extent of multicollinearity, if any, between the various variables used to determine the interest rate, exchange rate, and CREDIT sensitivities for all bank holding companies(BHCs),the top group BHCs, the median group BHCs, and the bottom BHCs in Panel A,B,C and D, respectively. The variables are the excess stock returns(ESR), the market return (MKT), the changes on the price of three-month US Treasury bills (INT), the change in the nominal broad dollar index (FX), and the change in the BBB bond yield (CREDIT).

**Panel A: Total Sample**

| | ESR | INT | MKT | FX | CREDIT |
|---|---|---|---|---|---|
| ESR | 1 | | | | |
| INT | 0.246*** | 1 | | | |
| MKT | 0.00444 | -0.169*** | 1 | | |
| FX | -0.135*** | -0.491*** | 0.0537*** | 1 | |
| CREDIT | -0.0871*** | -0.265*** | -0.0193*** | 0.417*** | 1 |

**Panel B: Large Group**

| | ESR | INT | MKT | FX | CREDIT |
|---|---|---|---|---|---|
| ESR | 1 | | | | |
| INT | 0.506*** | 1 | | | |
| MKT | -0.0116 | -0.173*** | 1 | | |
| FX | -0.283*** | -0.506*** | 0.0642*** | 1 | |
| CREDIT | -0.132*** | -0.269*** | -0.00869 | 0.432*** | 1 |

**Panel C: Small Group**

| | ESR | INT | MKT | FX | CREDIT |
|---|---|---|---|---|---|
| ESR | 1 | | | | |
| INT | 0.367*** | 1 | | | |
| MKT | 0.0712*** | -0.204*** | 1 | | |
| FX | -0.228*** | -0.582*** | 0.112*** | 1 | |
| CREDIT | -0.0535*** | -0.316*** | 0.0357*** | 0.480*** | 1 |

*Note:* The *t* statistics are in parentheses. $^{*}$ $p < 0.10$, $^{**}$ $p < 0.05$, $^{***}$ $p < 0.01$

Sources: Various risks exposures are computed from the four-factor model using data from Center for Research in Security Prices (CRSP) database and Federal Reserve monthly Statistical Releases.

**Table 5 First-stage Estimation of Risks**

Estimates of beta coefficients for the Sample Period of 1997-2011 for BHCs in our sample are given below. These are the market risk ($\beta_{Market}$), interest rate risk ($\beta_{Interest}$), exchange rate risk ($\beta_{Exchange}$), and credit risk ($\beta_{Credit}$). Estimates for the total sample, the large BHCs, and the small BHCs are obtained using a seemingly unrelated robust estimation and monthly data across the sample period. Estimates for each BHC group are obtained by polling all bank data in time.

**Panel A: Regression Results**

| | Intercept | $\beta_{Market}$ | $\beta_{Interest}$ | $\beta_{Exchange}$ | $\beta_{Credit}$ |
|---|---|---|---|---|---|
| Total Sample | 0.00238** | 1.006*** | 0.757*** | -0.315*** | 0.171*** |
| | (2.46) | (40.91) | (15.17) | (-4.10) | (7.63) |
| Large BHCs | 0.00276* | 1.145*** | 0.505*** | -0.186 | 0.0776** |
| | (1.87) | (31.53) | (6.48) | (-1.60) | (2.20) |
| Small BHCs | 0.00205 | 0.922*** | 0.876*** | -0.428*** | 0.216*** |
| | (1.62) | (28.28) | (13.68) | (-4.26) | (7.51) |

| **Panel B:Regression Statistics** | Total Sample | Large BHCs | Small BHCs |
|---|---|---|---|
| R-Square | 0.193 | 0.268 | 0.164 |
| *N* | 10588 | 3766 | 6822 |

*Note:* The *t* statistics are in parentheses. $^{*}$ $p < 0.10$, $^{**}$ $p < 0.05$, $^{***}$ $p < 0.01$.

Sources: The individual computation is based on the monthly data from Center for Research in Security Prices (CRSP) database and Federal Reserve monthly Statistical Releases.

**Table 6 Correlation Between On-and Off-balance Sheet BHCs' Specific Variables**

The common variables are the natural log of total asset (SIZE) which was scaled by 1,000, total risk-based capital ratio (RiskRatio), GDP growth (GDP) and corporate income tax rate (CPtax) in each state. Panel A variables are the interest rate Sensitivity (INT); Interest Margin Ratio (IM), Commercial &Industrial Loans (CIL); Mortgage Loans (MORT); other Loans (OtherLoan), domestic deposits (DEPOSIT), one-year maturity gap (GAP); Interest Rate Derivatives for Trading (IRT), Interest Rate Derivatives for Hedging (IRH); total Interest Rate Derivatives (IRD) and Interest Rate Exposures (IRE). Panel B variables are the exchange Rate Sensitivity (FX), assets in foreign currencies (FOA), foreign currency deposits (FXDEP), Exchange Rate Derivatives for Trading (ERT), Exchange Rate Derivatives for Hedging (ERH); total Exchange Rate Derivatives (ERD) and Exchange Rate Exposures (IRE). Panel C variables are Credit risk Sensitivity(Credit), market liquidity (FLIQ), funding liquidity (MLIQ), loan charge-offs (LCO), loan loss provisions (LLP), non-performing loans (NPL), Credit Protection Sold (CPS), Credit Protection Bought (CPB), Net Credit Protection Bought (NetPB), Credit Derivatives (CDD) and Credit Exposures (CreditE).

**Panel A: Interest Rate Sensitivity**

| | INT | IM | CIL | MORT | OtherLoan | DEPOSIT | GAP | SIZE | RiskRatio | CPTax | IRT | IRH | IRD | Crisis | IRE | GDPgrowth |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| INT | 1 | | | | | | | | | | | | | | | |
| IM | -0.0175** | 1 | | | | | | | | | | | | | | |
| CIL | -0.0137* | 0.0955*** | 1 | | | | | | | | | | | | | |
| MORT | 0.0793*** | 0.0848*** | -0.289*** | 1 | | | | | | | | | | | | |
| OtherLoan | -0.0052 | 0.0504*** | 0.0688*** | -0.510*** | 1 | | | | | | | | | | | |
| DEPOSIT | -0.00941 | 0.188*** | 0.126*** | 0.417*** | -0.172*** | 1 | | | | | | | | | | |
| GAP | -0.0169** | -0.0124* | -0.0447*** | -0.0848*** | -0.00528 | -0.157*** | 1 | | | | | | | | | |
| SIZE | 0.151*** | -0.100*** | 0.135*** | -0.441*** | 0.348*** | -0.544*** | 0.0742*** | 1 | | | | | | | | |
| RiskRatio | -0.0021 | -0.00702 | -0.0648*** | -0.116*** | 0.0135* | -0.118*** | 0.0455*** | -0.00326 | 1 | | | | | | | |
| CPTax | -0.0373*** | -0.0465*** | -0.0953*** | -0.0871*** | 0.0335*** | -0.122*** | 0.00939 | 0.0350*** | 0.0149* | 1 | | | | | | |
| IRT | 0.011 | -0.0949*** | -0.0350*** | -0.229*** | 0.0722*** | -0.354*** | 0.0200*** | 0.390*** | 0.000689 | 0.0202*** | 1 | | | | | |
| IRH | 0.0290*** | -0.0023 | -0.00205 | -0.0490*** | 0.0580*** | -0.216*** | 0.00364 | 0.263*** | -0.00893 | 0.00762 | 0.0812*** | 1 | | | | |
| IRD | 0.00962 | -0.0943*** | -0.0311*** | -0.235*** | 0.0792*** | -0.369*** | 0.0199*** | 0.410*** | 5.19E-05 | 0.0219*** | 0.997*** | 0.153*** | 1 | | | |
| Crisis | 0.294*** | -0.101*** | -0.0382*** | 0.227*** | -0.167*** | 0.00474 | 6.98E-05 | 0.0363*** | -0.00427 | -0.0067 | 0.0159** | -0.00852 | 0.0127* | 1 | | |
| IRE | 0.0176* | -0.0264*** | 0.0151* | -0.102*** | 0.0296*** | -0.150*** | -0.00435 | 0.139*** | 0.0287** | -0.0103 | 0.148*** | 0.0661*** | 0.153*** | 0.0182** | 1 | |
| GDPgrowth | -0.149*** | 0.102*** | 0.0406*** | -0.141*** | 0.0787*** | 0.0303*** | -0.00193 | -0.0048 | 0.00584 | -0.00248 | 0.00275 | -0.0149** | 0.00491 | -0.425*** | -0.0267*** | 1 |

**Panel B: Exchange Rate Sensitivity**

| | FX | FOA | FXDEP | SIZE | RiskRatio | CPTax | ERT | ERH | ERD | Crisis | ERE | GDPgrowth |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| FX | 1 | | | | | | | | | | | |
| FOA | -0.0441*** | 1 | | | | | | | | | | |
| FXDEP | -0.0151** | 0.621*** | 1 | | | | | | | | | |
| SIZE | 0.0296*** | 0.337*** | 0.405*** | 1 | | | | | | | | |
| RiskRatio | -0.00187 | 0.0541*** | -0.0035 | -0.00326 | 1 | | | | | | | |
| CPTax | 0.0220*** | 0.0662*** | 0.0420*** | 0.0350*** | 0.0149* | 1 | | | | | | |
| ERT | -0.0304*** | 0.519*** | 0.655*** | 0.421*** | 0.00387 | 0.0597*** | 1 | | | | | |
| ERH | -0.00672 | 0.190*** | 0.181*** | 0.211*** | 0.0124 | 0.0462*** | 0.212*** | 1 | | | | |
| ERD | -0.0304*** | 0.526*** | 0.657*** | 0.427*** | 0.00453 | 0.0615*** | 0.999*** | 0.254*** | 1 | | | |
| Crisis | 0.161*** | -0.0241*** | -0.0331*** | 0.0363*** | -0.00427 | -0.0067 | -0.0114* | -0.00212 | -0.0114* | 1 | | |
| ERE | -0.0193** | 0.578*** | 0.654*** | 0.351*** | 0.00195 | 0.0802*** | 0.627*** | 0.248*** | 0.627*** | -0.0224** | 1 | |
| GDPgrowth | -0.0612*** | 0.00757 | 0.0208*** | -0.0048 | 0.00584 | -0.00248 | 0.0174** | 0.000949 | 0.0173** | -0.425*** | 0.0243** | 1 |

**Panel C: Credit Risk Sensitivity**

| | CREDIT | MLIQ | FLIQ | NPL | LCO | LLP | SIZE | RiskRatio | CPTax | CDS | CDB | NetPB | CDD | Crsis | CreditE | GDPgrowth |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CREDIT | 1 | | | | | | | | | | | | | | | |
| MLIQ | -0.0460*** | 1 | | | | | | | | | | | | | | |
| FLIQ | -0.0610*** | -0.0667*** | 1 | | | | | | | | | | | | | |
| NPL | -0.00775 | -0.179*** | -0.0916*** | 1 | | | | | | | | | | | | |
| LCO | 0.0660*** | -0.130*** | -0.0670*** | 0.600*** | 1 | | | | | | | | | | | |
| LLP | 0.0642*** | -0.166*** | -0.0664*** | 0.621*** | 0.909*** | 1 | | | | | | | | | | |
| SIZE | 0.131*** | -0.0067 | 0.191*** | 0.00259 | 0.112*** | 0.0693*** | 1 | | | | | | | | | |
| RiskRatio | -0.0215*** | 0.115*** | 0.0314*** | -0.0556*** | -0.0382*** | -0.0451*** | -0.00326 | 1 | | | | | | | | |
| CPTax | -0.0375*** | 0.127*** | 0.0414*** | -0.0810*** | -0.0604*** | -0.0684*** | 0.0350*** | 0.0149* | 1 | | | | | | | |
| CDS | -0.0002 | -0.0677*** | 0.496*** | -0.0235*** | 0.00363 | 0.00185 | 0.253*** | 0.00543 | 0.00605 | 1 | | | | | | |
| CDB | 0.000926 | -0.0692*** | 0.499*** | -0.0243*** | 0.00349 | 0.00127 | 0.260*** | 0.00528 | 0.00735 | 0.997*** | 1 | | | | | |
| NetPB | 0.0125* | -0.0462*** | 0.274*** | -0.0200** | 2.25E-05 | -0.00571 | 0.198*** | 0.000779 | 0.0175** | 0.407*** | 0.481*** | 1 | | | | |
| CDD | 0.000374 | -0.0685*** | 0.498*** | -0.0239*** | 0.00356 | 0.00155 | 0.257*** | 0.00536 | 0.00671 | 0.999*** | 0.999*** | 0.445*** | 1 | | | |
| Crsis | 0.141*** | -0.207*** | -0.0771*** | 0.336*** | 0.270*** | 0.341*** | 0.0363*** | -0.00427 | -0.0067 | 0.0519*** | 0.0518*** | 0.0219*** | 0.0519*** | 1 | | |
| CreditE | -0.0208** | -0.0443*** | 0.372*** | -0.0427*** | -0.0169* | -0.0239*** | 0.175*** | -0.0197* | 0.0321*** | 0.393*** | 0.398*** | 0.231*** | 0.396*** | -0.0296*** | 1 | |
| GDPgrowth | -0.0822*** | 0.122*** | 0.0569*** | -0.275*** | -0.211*** | -0.276*** | -0.0048 | 0.00584 | -0.00248 | -0.0224*** | -0.0218*** | -0.00431 | -0.0221*** | -0.425*** | 0.0353*** | 1 |

Sources: Financial Statements data from Call Reports (FR Y9Cs); Various risks exposures are computed from the four-factor model using data from Center for Research in Security Prices (CRSP) database and Federal Reserve monthly Statistical Releases.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

**Table 7 Determinants of Interest Rate, Exchange Rate and Credit Risk Betas**

| | Total Sample | | Large BHCs | Small BHCs |
|---|---|---|---|---|
| Variable | | | | |
| **Panel A: Interest Rate Risk Beta** | | | | |
| Interest Margin | 1.955*** | 1.934*** | 7.135*** | 1.656** |
| | (2.80) | (2.77) | (3.02) | (2.51) |
| Commercial& Industrial Loans | 1.458*** | 1.497*** | 8.755*** | 0.758** |
| | (3.70) | (3.77) | (5.68) | (2.00) |
| Mortgage Loans | 0.469* | 0.458* | 2.013* | 0.566** |
| | (1.76) | (1.72) | (1.94) | (2.11) |
| Other Loans | 0.834 | 0.799 | 0.0620 | 0.829 |
| | (1.43) | (1.37) | (0.07) | (1.28) |
| Domestic Deposits | -0.0921 | -0.0650 | 0.575 | -0.568** |
| | (-0.38) | (-0.27) | (0.84) | (-2.29) |
| GAP Ratio | -0.000935 | -0.000927 | 0.0132*** | -0.0315 |
| | (-0.23) | (-0.22) | (2.65) | (-0.66) |
| Natural Log of Total Assets | 0.313*** | 0.318*** | 0.0910 | 0.208*** |
| | (5.30) | (5.48) | (0.92) | (3.31) |
| Total Risk-Based Capital Ratio | 0.0328 | 0.0332 | 5.296*** | 0.0223 |
| | (1.14) | (1.15) | (2.75) | (1.22) |
| GDP Growth | 0.000420 | 0.000227 | 0.0302** | -0.0108** |
| | (0.09) | (0.05) | (2.34) | (-2.29) |
| Interest Rate Derivatives | 0.0281*** | 0.0952* | 0.00661 | 0.0377 |
| | (2.93) | (1.82) | (0.75) | (1.34) |
| Large *Interest Rate Derivatives | | -0.0743 | | |
| | | (-1.39) | | |
| *N* | 6149 | 6149 | 744 | 5405 |
| R-Squared | 0.524 | 0.523 | 0.747 | 0.469 |
| **Panel B: Exchange Rate Risk Beta** | | | | |
| Assets in Foreign Currencies | 2.040* | 2.344** | 4.876*** | -3.448*** |
| | (1.82) | (2.03) | (4.23) | (-2.86) |
| Foreign Exchange Deposits | 0.148 | -0.187 | -0.475 | 3.469*** |
| | (0.19) | (-0.25) | (-0.49) | (3.56) |
| Natural Log of Total Assets | -0.00531 | -0.0156 | -0.702*** | 0.0340 |
| | (-0.09) | (-0.25) | (-6.65) | (0.48) |
| Total Risk-based Capital Ratio | 0.0136 | 0.0136 | 3.779** | 0.0119 |
| | (0.94) | (0.94) | (1.98) | (0.97) |
| GDP Growth | -0.00559 | -0.00600 | -0.00165 | -0.00928 |
| | (-0.97) | (-1.04) | (-0.09) | (-1.57) |
| Exchange Rate Derivatives | -0.525*** | -1.016*** | -0.470*** | -0.919*** |
| | (-4.97) | (-3.90) | (-4.09) | (-4.09) |
| Large *Exchange Rate Derivatives | | 0.602** | | |
| | | (2.36) | | |
| *N* | 6155 | 6155 | 749 | 5406 |
| R-Squared | 0.203 | 0.203 | 0.406 | 0.196 |
| **Panel C: Credit Risk Beta** | | | | |
| Market Liquidity | -0.167*** | -0.169*** | 0.0507 | -0.209*** |
| | (-2.79) | (-2.83) | (0.26) | (-3.34) |
| Funding Liquidity | -0.137 | -0.145 | 0.111 | -0.250 |
| | (-0.98) | (-1.04) | (0.31) | (-1.62) |
| Non-Performing Loans | -0.123 | -0.114 | 0.939 | -0.154 |
| | (-0.56) | (-0.52) | (1.00) | (-0.68) |
| Loan Charge-Offs | 1.767* | 1.825* | 2.983 | 1.847 |
| | (1.69) | (1.74) | (1.42) | (1.62) |
| Loan Loss Provisions | 0.333 | 0.265 | -4.134** | 0.377 |
| | (0.39) | (0.31) | (-2.29) | (0.40) |
| Natural Log of Total Assets | 0.0941*** | 0.0930*** | 0.152*** | 0.104*** |
| | (4.65) | (4.58) | (4.55) | (4.52) |
| Total Risk-Based Capital Ratio | 0.00426 | 0.00416 | 1.252** | 0.00574 |
| | (1.06) | (1.04) | (2.41) | (1.18) |
| GDP Growth | 0.00395** | 0.00397** | 0.0190*** | 0.00171 |
| | (2.07) | (2.07) | (3.23) | (0.86) |
| Credit Derivatives | 0.0984*** | -0.0104 | 0.119*** | 0.0356** |
| | (6.23) | (-0.28) | (7.68) | (1.98) |
| Large*Credit Derivatives | | 0.120*** | | |
| | | (2.92) | | |
| *N* | 5921 | 5921 | 696 | 5225 |
| R-Squared | 0.266 | 0.266 | 0.573 | 0.227 |

*Note*: This table shows the weighted instrumental-variable estimation. The dependent variable in each Panel is our estimates of risk beta of each BHC i at the start time t of 4-year rolling window regression in the first-stage. We weight each observation by the inverse of the standard error of beta coefficients in the first-stage estimation. The regression included bank-specific fixed effects and yearly dummy variables. Heteroskedasticity-consistent standard errors are used and *t* statistics in parentheses.
$^{*}$ $p < 0.10$, $^{**}$ $p < 0.05$, $^{***}$ $p < 0.01$.
Sources: Financial Statements data from Call Reports (FR Y-9Cs); risk betas are computed from the four-factor model using data from Center for Research in Security Prices (CRSP) database and Federal Reserve monthly Statistical Releases.

**Table 8 The Reported Purposes of Financial Derivatives and Risk Betas**

| Variable | Total Sample | | Large BHCs | Small BHCs |
|---|---|---|---|---|
| **Panel A: Interest Rate Risk Beta** | | | | |
| Interest Margin | 2.798*** | 2.805*** | 6.088*** | 2.229*** |
| | (3.50) | (3.64) | (2.61) | (3.12) |
| Commercial& Industrial Loans | 2.549*** | 2.711*** | 9.740*** | 1.250*** |
| | (5.69) | (6.29) | (6.42) | (3.03) |
| Mortgage Loans | 0.829** | 0.860** | 3.224*** | 0.550 |
| | (2.28) | (2.38) | (2.87) | (1.48) |
| Other Loans | 1.071* | 1.079* | 1.044 | 1.186* |
| | (1.77) | (1.89) | (1.07) | (1.73) |
| Domestic Deposits | -0.652** | -0.453* | 0.412 | -1.077*** |
| | (-2.38) | (-1.68) | (0.61) | (-3.70) |
| GAP Ratio | -0.00112 | -0.00208 | 0.00866* | -0.0696 |
| | (-0.26) | (-0.48) | (1.76) | (-1.55) |
| Natural Log of Total Assets | 0.380*** | 0.407*** | 0.432*** | 0.142 |
| | (5.02) | (5.62) | (3.78) | (1.61) |
| Total Risk-Based Capital Ratio | 0.0195 | 0.0213 | 6.633*** | 0.00950 |
| | (1.26) | (1.32) | (3.50) | (1.17) |
| GDP Growth | 0.00884 | 0.00584 | 0.0297** | -0.00226 |
| | (1.64) | (1.12) | (2.34) | (-0.41) |
| Interest Rate Derivatives | 0.0263*** | 0.0979* | 0.0144 | 0.0324 |
| | (2.85) | (1.84) | (1.57) | (1.23) |
| Interest Rate Derivative for Hedging / Interest Rate Derivatives | -0.305*** | 0.00581 | -1.042*** | -0.0652 |
| | (-4.38) | (0.08) | (-5.87) | (-1.02) |
| Large *Interest Rate Derivatives | | -0.0785 | | |
| | | (-1.45) | | |
| Large * Interest Rate Derivative for Hedging / Interest Rate Derivatives | | -1.307*** | | |
| | | (-9.32) | | |
| *N* | 4106 | 4106 | 744 | 3362 |
| R-Squared | 0.564 | 0.582 | 0.758 | 0.467 |
| **Panel B: Exchange Rate Risk Beta** | | | | |
| Assets in Foreign Currencies | 3.224*** | 3.606*** | 4.862*** | -4.983*** |
| | (3.20) | (3.44) | (4.40) | (-3.74) |
| Foreign Exchange Deposits | 0.0639 | -0.218 | 0.218 | 2.252* |
| | (0.08) | (-0.29) | (0.23) | (1.87) |
| Natural Log of Total Assets | 0.0931 | 0.0891 | -0.562*** | 0.564*** |
| | (0.92) | (0.89) | (-5.38) | (3.29) |
| Total Risk-based Capital Ratio | 4.834*** | 4.761*** | 4.957*** | 4.450*** |
| | (4.55) | (4.24) | (2.91) | (3.51) |
| GDP Growth | 0.0142 | 0.0113 | -0.00983 | 0.0211 |
| | (1.05) | (0.85) | (-0.55) | (1.14) |
| Exchange Rate Derivatives | -0.490*** | -1.032*** | -0.418*** | -0.842*** |
| | (-4.62) | (-3.74) | (-3.80) | (-3.54) |
| Exchange Rate Derivative for Hedging /Exchange Rate Derivatives | -0.899*** | -0.142 | -1.654*** | 0.286** |
| | (-6.88) | (-0.66) | (-10.26) | (1.99) |
| Large *Exchange Rate Derivatives | | 0.665** | | |
| | | (2.50) | | |
| Large *Exchange Rate Derivative for Hedging / Exchange Rate Derivatives | | -1.293*** | | |
| | | (-4.76) | | |
| *N* | 1596 | 1596 | 733 | 863 |
| R-Squared | 0.269 | 0.301 | 0.525 | 0.219 |
| **Panel C: Credit Risk Beta** | | | | |
| Market Liquidity | -0.324 | -0.367* | -0.230 | -1.461*** |
| | (-1.50) | (-1.67) | (-0.89) | (-3.62) |
| Funding Liquidity | -0.599 | -0.575 | -0.961* | 0.240 |
| | (-1.42) | (-1.41) | (-1.92) | (0.34) |
| Non-Performing Loans | 0.804 | 0.897 | 1.974* | -0.483 |
| | (0.85) | (0.96) | (1.85) | (-0.27) |
| Loan Charge-Offs | -0.407 | 0.615 | 14.13*** | -7.841 |
| | (-0.13) | (0.18) | (3.62) | (-1.54) |
| Loan Loss Provisions | 0.719 | -0.227 | -13.04*** | 9.725* |
| | (0.24) | (-0.07) | (-4.23) | (1.87) |
| Natural Log of Total Assets | 0.134*** | 0.126*** | 0.125*** | -0.160 |
| | (3.15) | (2.96) | (3.28) | (-0.77) |
| Total Risk-Based Capital Ratio | -0.364 | -0.221 | 0.388 | -2.680** |
| | (-0.67) | (-0.39) | (0.71) | (-2.04) |
| GDP Growth | 0.0318*** | 0.0300*** | 0.0286*** | 0.0297** |
| | (5.40) | (5.09) | (4.20) | (2.16) |
| Credit Derivatives | 0.0902*** | 0.0383 | 0.115*** | 0.0509*** |
| | (6.31) | (1.37) | (7.03) | (2.60) |
| Net Credit Protection Bought/ Credit Derivatives | -0.0296 | 0.0610 | -0.0960*** | 0.0510 |
| | (-1.25) | (0.95) | (-4.28) | (0.68) |
| Large*Credit Derivatives | | 0.0610* | | |
| | | (1.93) | | |
| Large * Net Credit Protection Bought/ Credit Derivatives | | -0.119* | | |
| | | (-1.82) | | |
| *N* | 706 | 706 | 466 | 240 |
| R-Squared | 0.582 | 0.587 | 0.671 | 0.566 |

*Note*: This table shows the weighted instrumental-variable estimation. The dependent variable in each Panel is our estimates of risk beta of each BHC i at the start time t of 4-year rolling window regression in the first-stage. We weight each observation by the inverse of the standard error of beta coefficients in the first-stage estimation. The regression included bank-specific fixed effects and yearly dummy variables. Heteroskedasticity-consistent standard errors are used and *t* statistics in parentheses. $^{*}$ $p < 0.10$, $^{**}$ $p < 0.05$, $^{***}$ $p < 0.01$.
Sources: Financial Statements data from Call Reports (FR Y-9Cs); risk betas are computed from the four-factor model using data from Center for Research in Security Prices (CRSP) database and Federal Reserve monthly Statistical Releases.

**Table 9 Global Financial Crisis, Financial Derivatives and Risk Betas**

| | Total Sample | | Large BHCs | | Small BHCs | |
|---|---|---|---|---|---|---|
| Variable | | | | | | |
| **Panel A: Interest Rate Risk Beta** | | | | | | |
| Interest Margin | 1.955*** | 1.944*** | 7.135*** | 7.089*** | 1.656** | 1.655** |
| | (2.80) | (2.79) | (3.02) | (3.00) | (2.51) | (2.51) |
| Commercial& Industrial Loans | 1.458*** | 1.475*** | 8.755*** | 8.770*** | 0.758** | 0.771** |
| | (3.70) | (3.74) | (5.68) | (5.68) | (2.00) | (2.03) |
| Mortgage Loans | 0.469* | 0.495* | 2.013* | 1.992* | 0.566** | 0.570** |
| | (1.76) | (1.85) | (1.94) | (1.92) | (2.11) | (2.13) |
| Other Loans | 0.834 | 0.881 | 0.0620 | -0.0251 | 0.829 | 0.837 |
| | (1.43) | (1.51) | (0.07) | (-0.03) | (1.28) | (1.29) |
| Domestic Deposits | -0.0921 | -0.116 | 0.575 | 0.554 | -0.568** | -0.566** |
| | (-0.38) | (-0.48) | (0.84) | (0.81) | (-2.29) | (-2.29) |
| GAP Ratio | -0.000935 | -0.00110 | 0.0132*** | 0.0128** | -0.0315 | -0.0301 |
| | (-0.23) | (-0.26) | (2.65) | (2.57) | (-0.66) | (-0.63) |
| Natural Log of Total Assets | 0.313*** | 0.292*** | 0.0910 | 0.0457 | 0.208*** | 0.208*** |
| | (5.30) | (4.98) | (0.92) | (0.46) | (3.31) | (3.32) |
| Total Risk-Based Capital Ratio | 0.0328 | 0.0321 | 5.296*** | 4.964** | 0.0223 | 0.0224 |
| | (1.14) | (1.16) | (2.75) | (2.57) | (1.22) | (1.22) |
| GDP Growth | 0.000420 | 0.000257 | 0.0302** | 0.0320** | -0.0108** | -0.0109** |
| | (0.09) | (0.06) | (2.34) | (2.47) | (-2.29) | (-2.30) |
| Interest Rate Derivatives | 0.0281*** | 0.0171* | 0.00661 | 0.000478 | 0.0377 | 0.0425 |
| | (2.93) | (1.85) | (0.75) | (0.05) | (1.34) | (1.30) |
| Crisis | 0.453*** | 0.442*** | -0.0707 | -0.112 | 0.0436** | 0.0422** |
| | (11.35) | (11.05) | (-0.74) | (-1.11) | (2.09) | (2.01) |
| Crisis *Interest Rate Derivatives | | 0.0151*** | | 0.00763** | | 0.00333 |
| | | (4.96) | | (2.19) | | (0.70) |
| *N* | 6149 | 6149 | 744 | 744 | 5405 | 5405 |
| R-Squared | 0.524 | 0.525 | 0.747 | 0.747 | 0.469 | 0.469 |
| **Panel B: Exchange Rate Risk Beta** | | | | | | |
| Assets in Foreign Currencies | 2.040* | 1.955* | 4.876*** | 4.418*** | -3.448*** | -3.389*** |
| | (1.82) | (1.71) | (4.23) | (3.71) | (-2.86) | (-2.80) |
| Foreign Exchange Deposits | 0.148 | 0.109 | -0.475 | -0.822 | 3.469*** | 3.808*** |
| | (0.19) | (0.14) | (-0.49) | (-0.85) | (3.56) | (3.78) |
| Natural Log of Total Assets | -0.00531 | -0.00203 | -0.702*** | -0.642*** | 0.0340 | 0.0293 |
| | (-0.09) | (-0.03) | (-6.65) | (-6.20) | (0.48) | (0.41) |
| Total Risk-based Capital Ratio | 0.0136 | 0.0139 | 3.779** | 4.497** | 0.0119 | 0.0119 |
| | (0.94) | (0.94) | (1.98) | (2.35) | (0.97) | (0.95) |
| GDP Growth | -0.00559 | -0.00543 | -0.00165 | 0.000674 | -0.00928 | -0.00888 |
| | (-0.97) | (-0.94) | (-0.09) | (0.04) | (-1.57) | (-1.51) |
| Exchange Rate Derivatives | -0.525*** | -0.511*** | -0.470*** | -0.336*** | -0.919*** | -0.991*** |
| | (-4.97) | (-4.81) | (-4.09) | (-2.72) | (-4.09) | (-4.52) |
| Crisis | 0.0113 | 0.0146 | -0.0825 | 0.0514 | 0.0313 | 0.0364 |
| | (0.49) | (0.63) | (-0.93) | (0.54) | (1.40) | (1.63) |
| Crisis *Exchange Rate Derivatives | | -0.0217 | | -0.124*** | | -0.136*** |
| | | (-0.75) | | (-3.53) | | (-2.75) |
| *N* | 6155 | 6152 | 749 | 747 | 5406 | 5405 |
| R-Squared | 0.203 | 0.203 | 0.406 | 0.414 | 0.196 | 0.196 |
| **Panel C: Credit Risk Beta** | | | | | | |
| Market Liquidity | -0.167*** | -0.169*** | 0.0507 | 0.0428 | -0.209*** | -0.209*** |
| | (-2.79) | (-2.82) | (0.26) | (0.22) | (-3.34) | (-3.34) |
| Funding Liquidity | -0.137 | -0.148 | 0.111 | -0.105 | -0.250 | -0.249 |
| | (-0.98) | (-1.06) | (0.31) | (-0.27) | (-1.62) | (-1.61) |
| Non-Performing Loans | -0.123 | -0.119 | 0.939 | 0.968 | -0.154 | -0.154 |
| | (-0.56) | (-0.54) | (1.00) | (1.03) | (-0.68) | (-0.68) |
| Loan Charge-Offs | 1.767* | 1.812* | 2.983 | 2.588 | 1.847 | 1.849 |
| | (1.69) | (1.73) | (1.42) | (1.23) | (1.62) | (1.63) |
| Loan Loss Provisions | 0.333 | 0.278 | -4.134** | -3.777** | 0.377 | 0.373 |
| | (0.39) | (0.32) | (-2.29) | (-2.10) | (0.40) | (0.40) |
| Natural Log of Total Assets | 0.0941*** | 0.0931*** | 0.152*** | 0.145*** | 0.104*** | 0.104*** |
| | (4.65) | (4.60) | (4.55) | (4.34) | (4.52) | (4.52) |
| Total Risk-Based Capital Ratio | 0.00426 | 0.00418 | 1.252** | 1.149** | 0.00574 | 0.00573 |
| | (1.06) | (1.04) | (2.41) | (2.17) | (1.18) | (1.18) |
| GDP Growth | 0.00395** | 0.00382** | 0.0190*** | 0.0154*** | 0.00171 | 0.00172 |
| | (2.07) | (2.00) | (3.23) | (2.66) | (0.86) | (0.86) |
| Credit Derivatives | 0.0984*** | 0.155*** | 0.119*** | 0.203*** | 0.0356** | 0.0453** |
| | (6.23) | (7.16) | (7.68) | (6.94) | (1.98) | (2.12) |
| Crisis | -0.00484 | -0.0000908 | -0.0267 | 0.00456 | 0.0123 | 0.0124 |
| | (-0.67) | (-0.01) | (-1.42) | (0.23) | (0.77) | (0.78) |
| Crisis *Credit Derivatives | | -0.0464*** | | -0.0760*** | | -0.00309 |
| | | (-3.53) | | (-3.63) | | (-0.92) |
| *N* | 5921 | 5921 | 696 | 696 | 5225 | 5225 |
| R-Squared | 0.266 | 0.268 | 0.573 | 0.579 | 0.227 | 0.227 |

*Note*: This table shows the weighted instrumental-variable estimation. The dependent variable in each Panel is our estimates of risk beta of each BHC i at the start time t of 4-year rolling window regression in the first-stage. We weight each observation by the inverse of the standard error of beta coefficients in the first-stage estimation. The regression included bank-specific fixed effects and yearly dummy variables. Heteroskedasticity-consistent standard errors are used and *t* statistics in parentheses.
$^{*}$ $p < 0.10$, $^{**}$ $p < 0.05$, $^{***}$ $p < 0.01$.
Sources: Financial Statements data from Call Reports (FR Y-9Cs); risk betas are computed from the four-factor model using data from Center for Research in Security Prices (CRSP) database and Federal Reserve monthly Statistical Releases.

**Table 10 The Global Financial Crisis, the Reported Purposes of Financial Derivatives and Risk Betas**

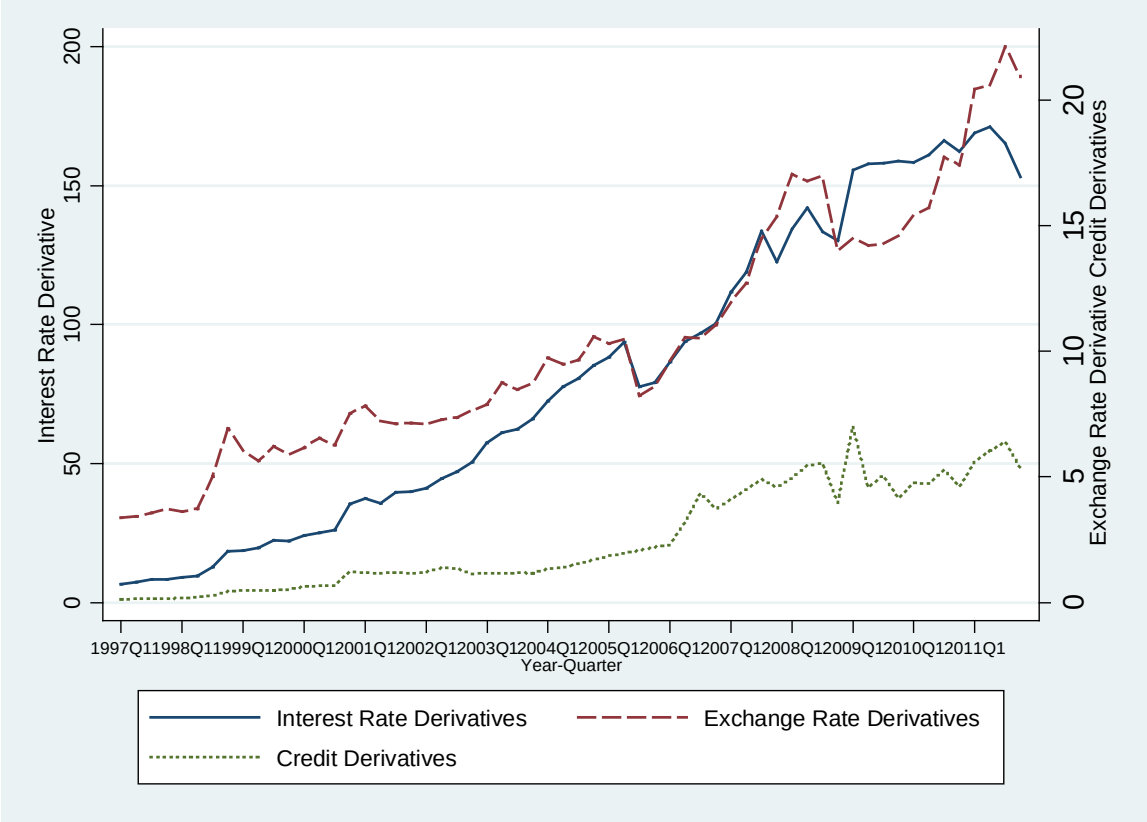
| | Total Sample | | Large BHCs | | Small BHCs | |
|---|---|---|---|---|---|---|
| Variable | | | | | | |
| **Panel A: Interest Rate Risk Beta** | | | | | | |
| Interest Margin | 2.798*** | 2.769*** | 6.088*** | 5.762** | 2.229*** | 2.242*** |
| | (3.50) | (3.47) | (2.61) | (2.45) | (3.12) | (3.13) |
| Commercial& Industrial Loans | 2.549*** | 2.516*** | 9.740*** | 8.785*** | 1.250*** | 1.223*** |
| | (5.69) | (5.60) | (6.42) | (5.80) | (3.03) | (2.94) |
| Mortgage Loans | 0.829** | 0.861** | 3.224*** | 3.254*** | 0.550 | 0.556 |
| | (2.28) | (2.36) | (2.87) | (2.88) | (1.48) | (1.51) |
| Other Loans | 1.071* | 1.091* | 1.044 | 1.395 | 1.186* | 1.130* |
| | (1.77) | (1.79) | (1.07) | (1.40) | (1.73) | (1.65) |
| Domestic Deposits | -0.652** | -0.684** | 0.412 | 0.353 | -1.077*** | -1.091*** |
| | (-2.38) | (-2.51) | (0.61) | (0.54) | (-3.70) | (-3.77) |
| GAP Ratio | -0.00112 | -0.00118 | 0.00866* | 0.0129** | -0.0696 | -0.0714 |
| | (-0.26) | (-0.27) | (1.76) | (2.48) | (-1.55) | (-1.56) |
| Natural Log of Total Assets | 0.380*** | 0.352*** | 0.432*** | 0.412*** | 0.142 | 0.139 |
| | (5.02) | (4.66) | (3.78) | (3.68) | (1.61) | (1.59) |
| Total Risk-Based Capital Ratio | 0.0195 | 0.0181 | 6.633*** | 7.096*** | 0.00950 | 0.00825 |
| | (1.26) | (1.22) | (3.50) | (3.78) | (1.17) | (1.04) |
| GDP Growth | 0.00884 | 0.00975* | 0.0297** | 0.0336*** | -0.00226 | -0.00145 |
| | (1.64) | (1.78) | (2.34) | (2.62) | (-0.41) | (-0.26) |
| Interest Rate Derivatives | 0.0263*** | 0.0169* | 0.0144 | 0.00562 | 0.0324 | 0.0372 |
| | (2.85) | (1.90) | (1.57) | (0.60) | (1.23) | (1.20) |
| Interest Rate Derivative for Hedging / Interest Rate Derivatives | -0.305*** | -0.363*** | -1.042*** | -1.233*** | -0.0652 | -0.127 |
| | (-4.38) | (-4.42) | (-5.87) | (-6.55) | (-1.02) | (-1.61) |
| Crisis | -0.00422 | -0.100* | -0.0519 | -0.467*** | 0.00557 | -0.0840 |
| | (-0.18) | (-1.72) | (-0.54) | (-2.85) | (0.26) | (-1.51) |
| Crisis * Interest Rate Derivatives | | 0.0156*** | | 0.0219*** | | 0.00493 |
| | | (4.61) | | (3.73) | | (1.07) |
| Crisis * Interest Rate Derivative for Hedging / Interest Rate Derivatives | | 0.0997 | | 0.831*** | | 0.113* |
| | | (1.47) | | (3.38) | | (1.73) |
| *N* | 4106 | 4106 | 744 | 744 | 3362 | 3362 |
| R-Squared | 0.564 | 0.566 | 0.758 | 0.761 | 0.467 | 0.468 |
| **Panel B: Exchange Rate Risk Beta** | | | | | | |
| Assets in Foreign Currencies | 3.224*** | 3.053*** | 4.862*** | 4.419*** | -4.983*** | -4.490*** |
| | (3.20) | (2.98) | (4.40) | (3.88) | (-3.74) | (-3.35) |
| Foreign Exchange Deposits | 0.0639 | -0.161 | 0.218 | -0.546 | 2.252* | 2.552** |
| | (0.08) | (-0.20) | (0.23) | (-0.59) | (1.87) | (2.05) |
| Natural Log of Total Assets | 0.0931 | 0.0883 | -0.562*** | -0.555*** | 0.564*** | 0.532*** |
| | (0.92) | (0.87) | (-5.38) | (-5.48) | (3.29) | (3.07) |
| Total Risk-based Capital Ratio | 4.834*** | 4.385*** | 4.957*** | 4.750*** | 4.450*** | 4.066*** |
| | (4.55) | (4.17) | (2.91) | (2.81) | (3.51) | (3.16) |
| GDP Growth | 0.0142 | 0.0118 | -0.00983 | -0.00910 | 0.0211 | 0.0178 |
| | (1.05) | (0.89) | (-0.55) | (-0.53) | (1.14) | (0.97) |
| Exchange Rate Derivatives | -0.490*** | -0.436*** | -0.418*** | -0.266** | -0.842*** | -0.912*** |
| | (-4.62) | (-4.10) | (-3.80) | (-2.25) | (-3.54) | (-3.83) |
| Exchange Rate Derivative for Hedging /Exchange Rate Derivatives | -0.899*** | -0.808*** | -1.654*** | -1.562*** | 0.286** | 0.399** |
| | (-6.88) | (-5.94) | (-10.26) | (-9.82) | (1.99) | (2.46) |
| Crisis | -0.0622 | 0.0994 | -0.0313 | 0.280*** | -0.0797 | 0.0687 |
| | (-1.13) | (1.46) | (-0.42) | (2.98) | (-1.38) | (0.97) |
| Crisis *Exchange Rate Derivatives | | -0.0879*** | | -0.155*** | | -0.160*** |
| | | (-2.88) | | (-4.48) | | (-2.64) |
| Crisis *Exchange Rate Derivative for Hedging / Exchange Rate Derivatives | | -0.435*** | | -0.734*** | | -0.363*** |
| | | (-3.65) | | (-3.71) | | (-2.76) |
| *N* | 1596 | 1593 | 733 | 731 | 863 | 862 |
| R-Squared | 0.269 | 0.280 | 0.525 | 0.548 | 0.219 | 0.227 |
| **Panel C: Credit Risk Beta** | | | | | | |
| Market Liquidity | -0.324 | -0.319 | -0.230 | -0.208 | -1.461*** | -1.250*** |
| | (-1.50) | (-1.52) | (-0.89) | (-0.82) | (-3.62) | (-3.47) |
| Funding Liquidity | -0.599 | -0.611 | -0.961* | -1.294** | 0.240 | 0.00835 |
| | (-1.42) | (-1.46) | (-1.92) | (-2.44) | (0.34) | (0.01) |
| Non-Performing Loans | 0.804 | 0.828 | 1.974* | 2.212** | -0.483 | -1.241 |
| | (0.85) | (0.89) | (1.85) | (2.16) | (-0.27) | (-0.67) |
| Loan Charge-Offs | -0.407 | -0.275 | 14.13*** | 13.59*** | -7.841 | -7.197 |
| | (-0.13) | (-0.08) | (3.62) | (3.45) | (-1.54) | (-1.50) |
| Loan Loss Provisions | 0.719 | 0.295 | -13.04*** | -12.44*** | 9.725* | 8.674* |
| | (0.24) | (0.10) | (-4.23) | (-4.01) | (1.87) | (1.78) |
| Natural Log of Total Assets | 0.134*** | 0.132*** | 0.125*** | 0.116*** | -0.160 | -0.177 |
| | (3.15) | (3.03) | (3.28) | (3.04) | (-0.77) | (-0.86) |
| Total Risk-Based Capital Ratio | -0.364 | -0.314 | 0.388 | 0.168 | -2.680** | -2.979** |
| | (-0.67) | (-0.58) | (0.71) | (0.30) | (-2.04) | (-2.27) |
| GDP Growth | 0.0318*** | 0.0313*** | 0.0286*** | 0.0237*** | 0.0297** | 0.0309** |
| | (5.40) | (5.36) | (4.20) | (3.47) | (2.16) | (2.26) |
| Credit Derivatives | 0.0902*** | 0.127*** | 0.115*** | 0.191*** | 0.0509*** | 0.0223 |
| | (6.31) | (6.85) | (7.03) | (5.37) | (2.60) | (0.84) |
| Net Credit Protection Bought/ Credit Derivatives | -0.0296 | -0.0310 | -0.0960*** | -0.0980*** | 0.0510 | 0.0962 |
| | (-1.25) | (-1.10) | (-4.28) | (-3.62) | (0.68) | (1.09) |
| Crisis | -0.0736*** | -0.0474*** | -0.0622*** | -0.279*** | -0.0957*** | -0.239** |
| | (-4.12) | (-2.60) | (-3.12) | (-6.68) | (-2.67) | (-2.42) |
| Crisis *Credit Derivatives | | -0.0297*** | | -0.0654** | | 0.0267 |
| | | (-3.17) | | (-2.56) | | (1.43) |
| Crisis * Net Credit Protection Bought/ Credit Derivatives | | 0.00915 | | 0.0119 | | -0.175 |
| | | (0.39) | | (0.41) | | (-1.53) |
| *N* | 706 | 706 | 466 | 466 | 240 | 240 |
| R-Squared | 0.582 | 0.585 | 0.671 | 0.677 | 0.566 | 0.575 |

*Note*: This table shows the weighted instrumental-variable estimation. The dependent variable in each Panel is our estimates of risk beta of each BHC i at the start time t of 4-year rolling window regression in the first-stage. We weight each observation by the inverse of the standard error of beta coefficients in the first-stage estimation. The regression included bank-specific fixed effects and yearly dummy variables. Heteroskedasticity-consistent standard errors are used and *t* statistics in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Sources: Financial Statements data from Call Reports (FR Y-9Cs). Risk betas are computed from the four-factor model using data from Center for Research in Security Prices (CRSP) database and Federal Reserve monthly Statistical Releases.

Figure 1: Usage of Financial Derivatives by Large BHCs ($Trillion)

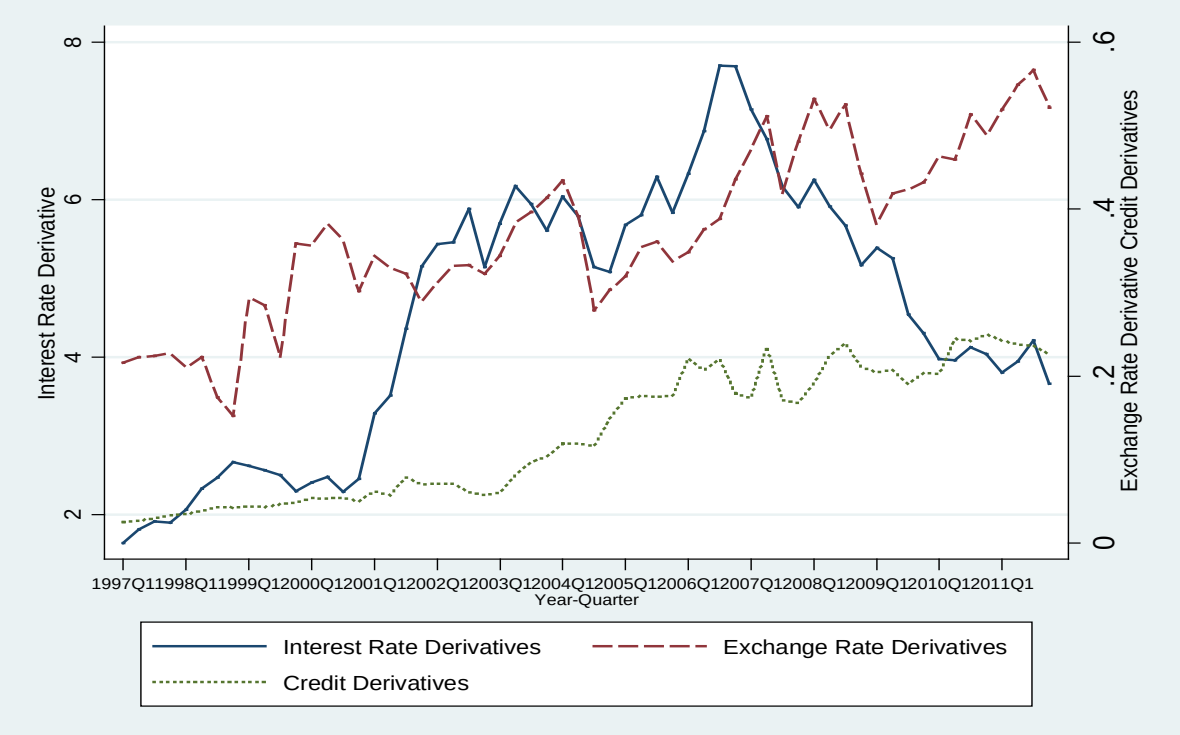
Quarterly Data




Source: Call Report, sample period: 1997:Q1–2011:Q4.

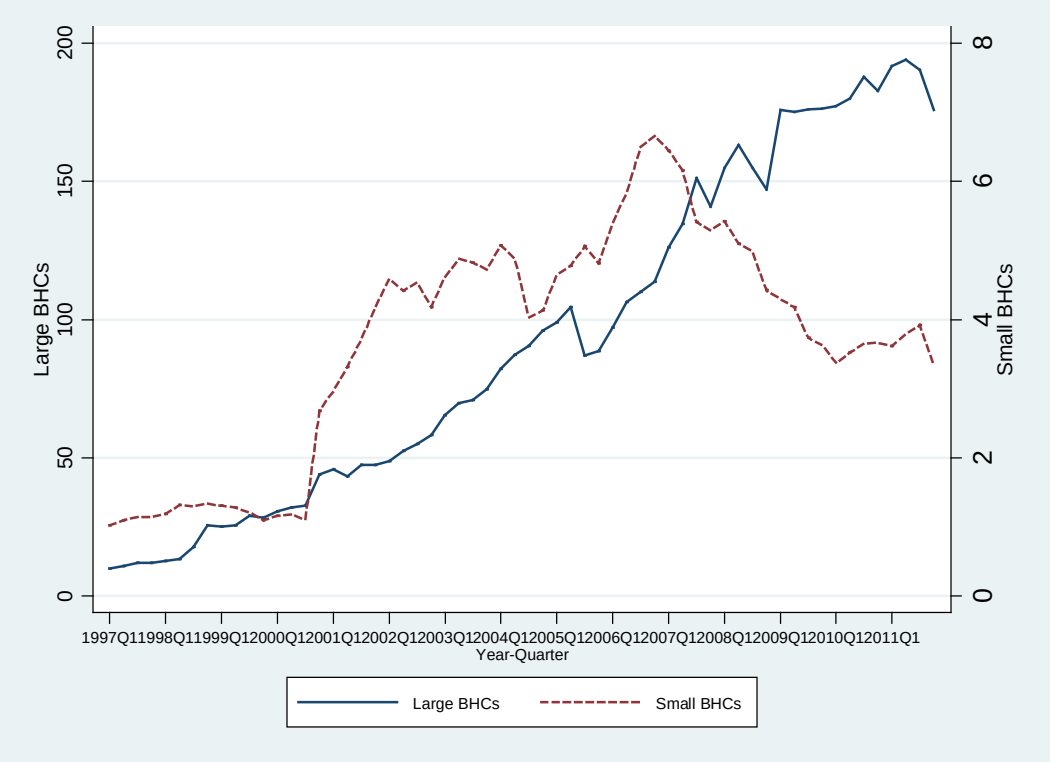
Figure 2: Usage of Financial Derivatives by Small BHCs ($Trillion)

Quarterly Data




Source: Call Report, sample period: 1997:Q1–2011:Q4.

Figure 3: Financial Derivatives Used for Trading Purposes ($Trillion)
Quarterly Data



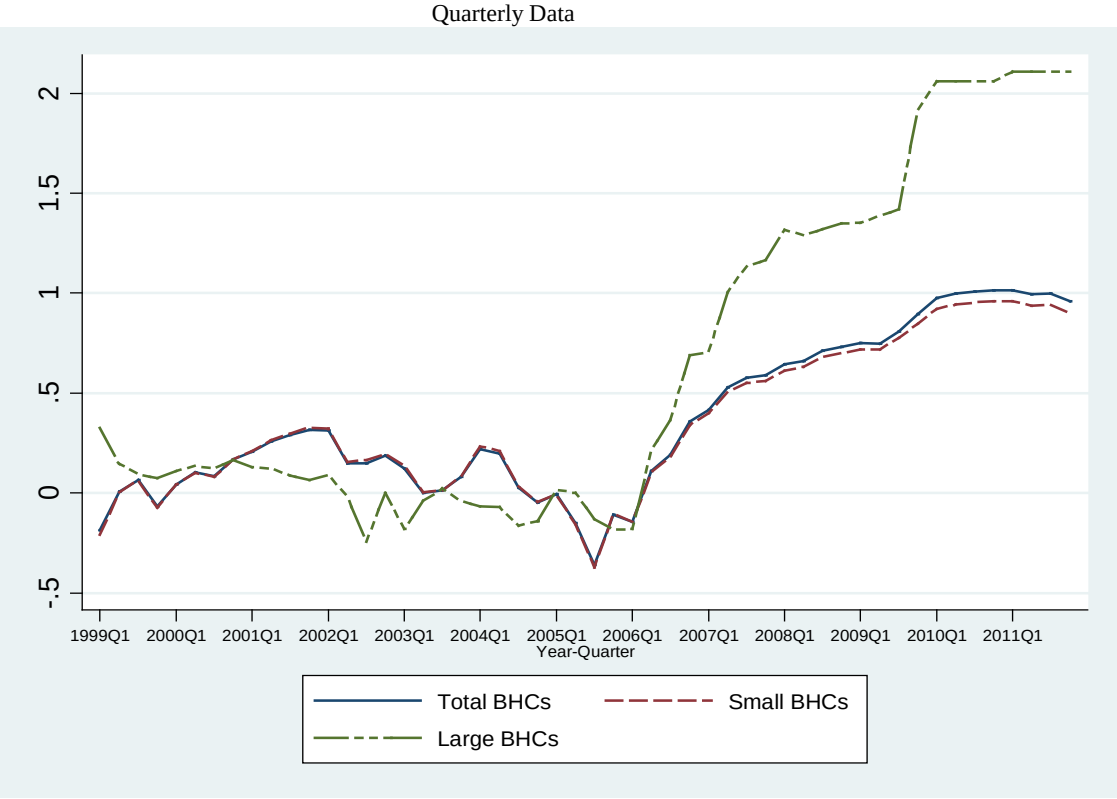

Source: Call Report, sample period: 1997:Q1–2011:Q4.

Figure 4: Financial Derivatives Used for Hedging Purposes ($Trillion)
Quarterly Data


Source: Call Report, sample period: 1997:Q1–2011:Q4.

Figure 5: Interest Rate Risk Sensitivity

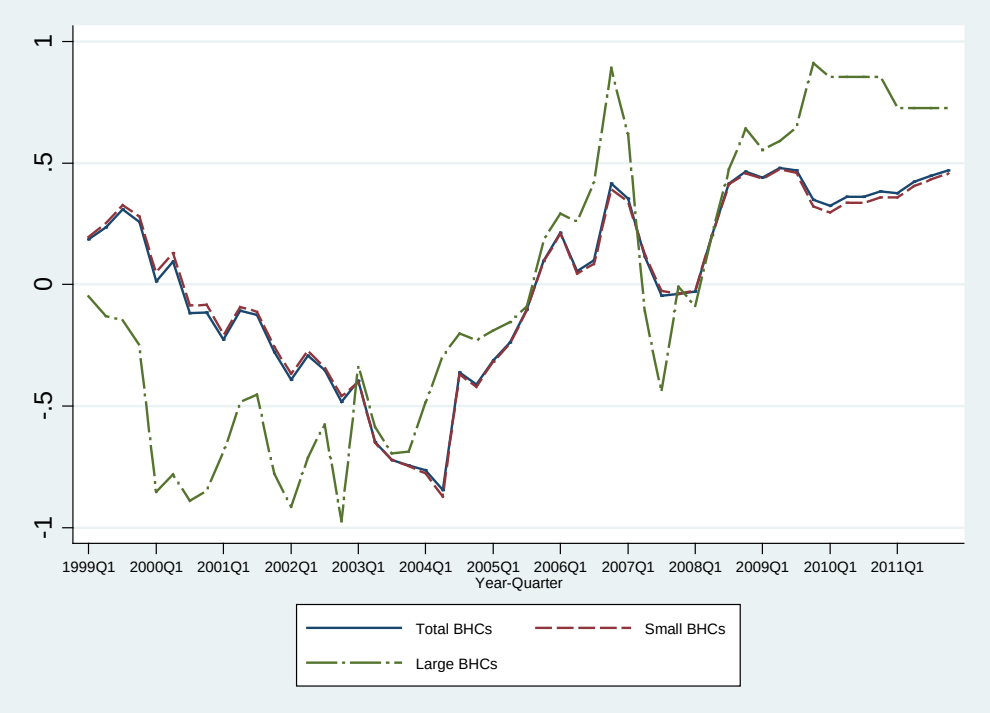
Quarterly Data




Source: Self-calculation, 4-year rolling window, interest rate risk sensitivity is calculated at the mid point of the interval, sample period: 1999:Q1–2011:Q4.

Figure 6: Exchange Rate Risk Sensitivity

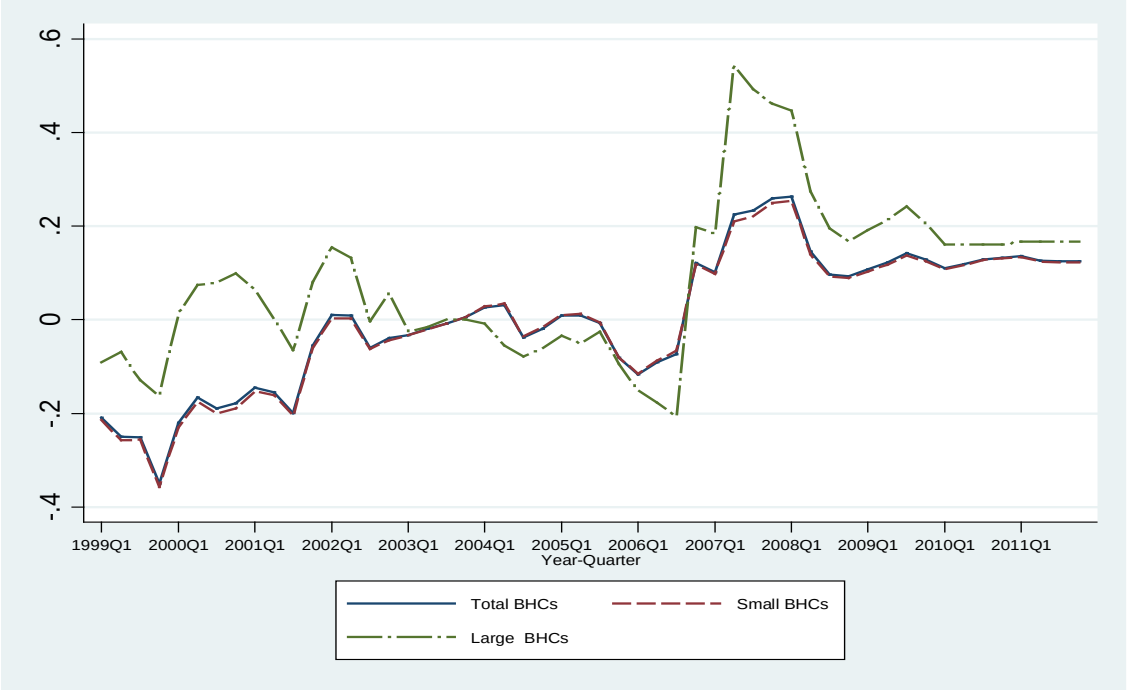
Quarterly Data




Source: Self-calculation, 4-year rolling window, exchange rate risk sensitivity is calculated at the mid point of the interval, sample period: 1999:Q1–2011:Q4.

Figure 7: Credit Risk Sensitivity

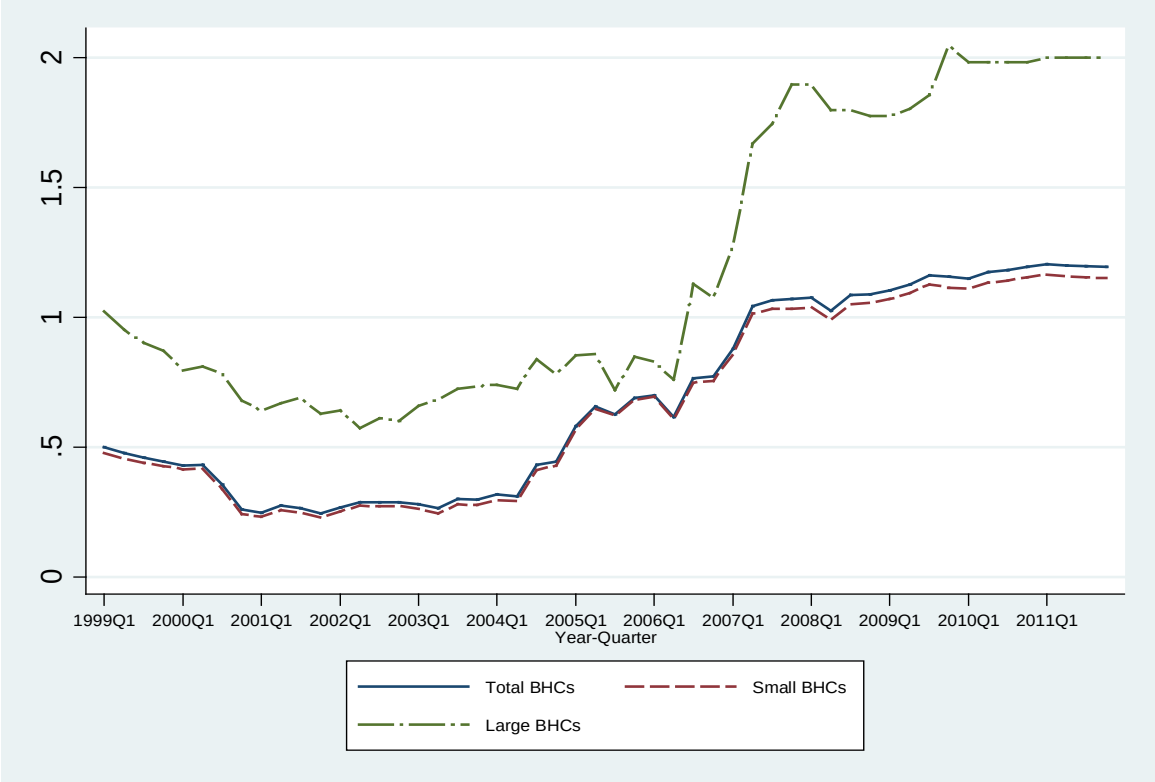
Quarterly Data




Source: Self-calculation, 4-year rolling window, credit risk sensitivity is calculated at the mid point of the interval, sample period: 1999:Q1–2011:Q4.

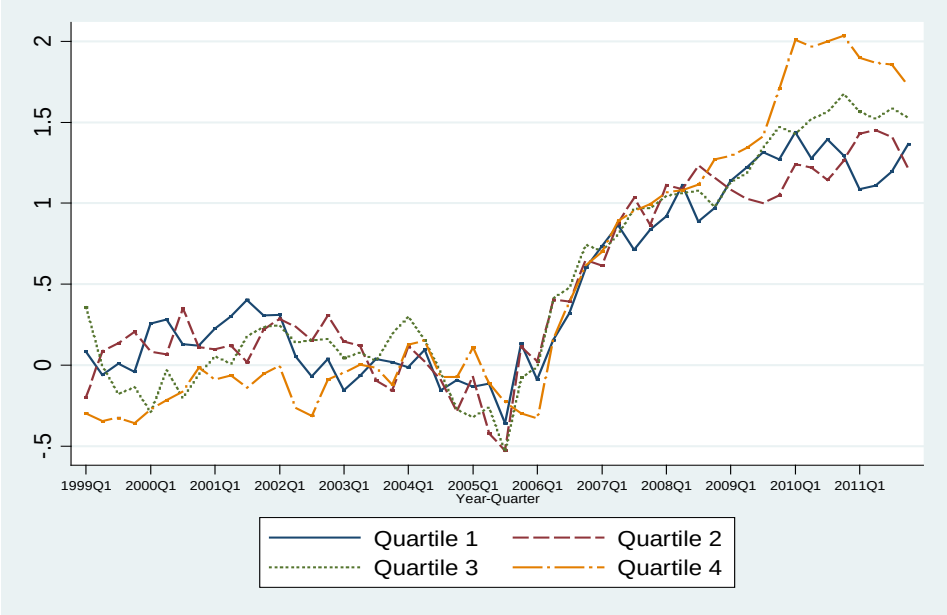
Figure 8: Market Risk Sensitivity

Quarterly Data



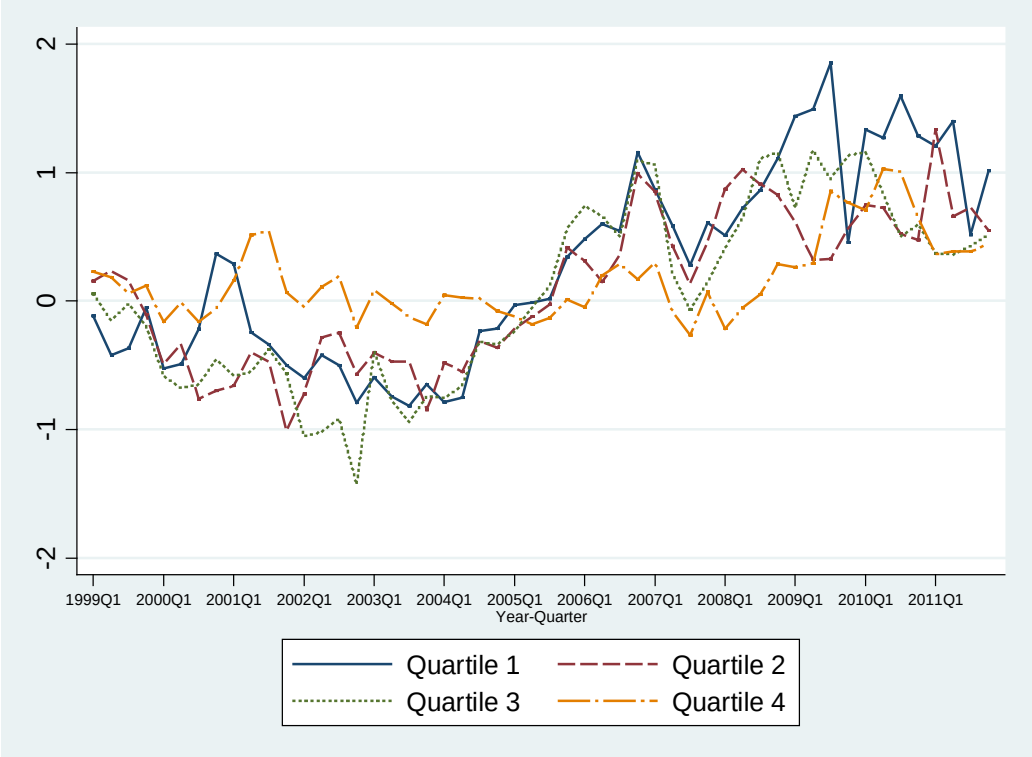

Source: Self-calculation, 4-year rolling window, market risk sensitivity is calculated at the mid point of the interval, sample period: 1999:Q1–2011:Q4.

Figure 9: Interest Rate Risk Sensitivity by Different Size of BHCs (by Interest Rate Derivatives/Total Assets)
Quarterly Data



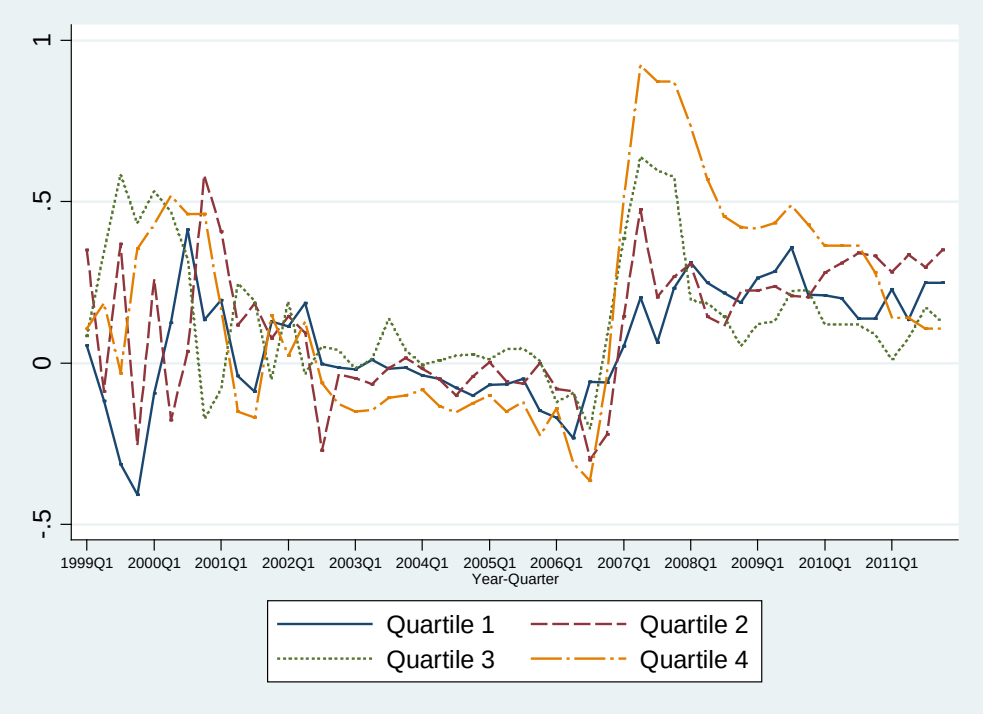

Source: Self-calculation, 4-year rolling window, interest rate risk sensitivity is calculated at the mid point of the interval, sample period: 1999:Q1–2011:Q4.

Figure 10: Exchange Rate Risk Sensitivity by Different Size of BHCs (by Exchange Rate Derivatives/Total Assets)
Quarterly Data




Source: Self-calculation, 4-year rolling window, exchange rate risk sensitivity is calculated at the mid point of the interval, sample period: 1999:Q1–2011:Q4.

Figure 11: Credit Risk Sensitivity by Different Size of BHCs (by Credit Derivatives/Total Assets)
Quarterly Data




Source: Self-calculation, 4-year rolling window, credit risk sensitivity is calculated at the mid point of the interval, sample period: 1999:Q1–2011:Q4.