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The Risks of Off-Balance Sheet Derivatives in U.S. Commercial Banks
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Abstract: This study employs both contingent and non-contingent claim models to test for the existence of market discipline hypothesis for derivative contracts in U.S. banking industry. In addition to the Capital Asset Pricing Model (CAPM) measure of systematic risk and standard deviation of a bank's equity return, we apply Ronn-Verma option pricing model to assess whether market participants incorporate derivatives positions when they price banks' market risk. The benefit of using the contingent claim model is that the traditional linear models seem to be inadequate in estimating the non-linear relation between derivatives and bank risks. In order to capture the differences in marginal propensity to risk (MPR) across banks, we divide our bank holding company (BHC) sample into three groups: big, medium, and small. The conclusions are as follows. First, among the derivatives contracts, swaps are the major contracts that are incorporated in market risk valuation. They are viewed as risk reducing tools according to the three risk measures (Beta, equity return risk, and implied asset volatilities) for both big and medium BHCs. Second, futures, forwards, and options do not seem to have a major effect in valuation of bank market risk for all the three BHCs groups. However, we find a significant positive relationship between these three types of derivatives and market systematic risk (Beta). Third, generally, market participants view swaps positions as more of potential risk diversification tools. Fourth, small BHCs have the highest MPR while big banks have the lowest MPR. Finally, more capital and regulations on bank derivatives activities are required to minimize the impact of derivatives on banks' market risk.

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I. Introduction

When the banking industry is burdened by multiple regulations and wide range of risks – credit risk, interest rate risk and foreign exchange risk – it is forced to extend its operations to include derivative contracts in addition to its on-balance sheet activities. The use of derivatives contracts in the form of futures, forwards, options, and swaps accelerated during the 1992-2008 period and accounted for much of the growth in the off-balance sheet (OBS) activities. These financial products generate fee income and provide management with tools to hedge interest rate risk and foreign exchange risk. However, they also lead to other different types of risks for banking institutions. The 1997-1998 Asian financial crisis left banks that had large positions in the Asian derivatives securities markets with large losses. Other notable examples of risks in use of derivatives are the collapse of Barings investment bank in the United Kingdom and the bankruptcy of Orange County in California in the 1990s.¹

Theoretical underpinnings suggest that derivative activities may be related to bank risk in three ways. First, derivative contracts are an obligation against a bank and its customers to make a payment in the future under certain circumstances in which the banks and their customers would prefer not to make the payment. Thus derivative contracts will increase a bank's risk. Second, derivative contracts will reduce a bank's customer risk due to professional management and size of the transaction among other factors. Third, Avery and Berger (1991) claim that derivative contracts may reduce risk if they are used to hedge rather than to speculate.

This study answers the questions of how market participants evaluate derivative contracts in their market risk evaluations. Are derivatives contracts risk increasing (reducing) factors? Does bank size matter when the market evaluates the impact of banks' derivative contracts on systematic and unsystematic risk? To answer these

¹ Saunders, A. and Cornett, M. (2004). *Financial Markets and Institutions: A Modern Perspective*, 2nd ed. NY: McGraw Hill.

questions, we perform the following two-stage analysis. In stage one, we estimate the dependent variables, which include three market risk measures (1) systematic market risk (β), (2) standard deviation of banks' equity return (σ_E), and (3) implied asset volatility from the Ronn-Verma (1986) option model (σ_V). In the second stage, we regress the dependent variables on the derivatives risk variables and the on-balance sheet risk variables using a panel econometric technique for bank holding companies (BHCs) sector. The study is organized as follows: section two presents the literature review while section three details the methodology. Section four includes data and empirical analysis. The empirical results are in section five. Conclusions and policy implications are presented in section six.

II. Literature Review

An extensive body of literature documents hypotheses to explain OBS derivative activities. These hypotheses include the regulatory tax hypothesis, the moral hazard hypothesis and the market discipline hypothesis.

In this study we test the market discipline hypothesis, which argues that because OBS activities are uninsured, dependent future claims related to other claims on the banks, banks with safer capital positions will engage in more OBS activities to mitigate banks risk. Bank customers will place more value on these claims when banks are safer. Therefore, banks which have already issued OBS items will have an incentive to reduce their risk position by issuing additional OBS items.

Avery and Berger (1988) suggest that standby letters of credit (SLC) have a positive impact on banks' risk exposure. Benveniste and Berger (1986) maintain that, as banks approach failure, SLC issuance decreases. In addition to the market discipline hypothesis, they also support the regulatory hypothesis by stating that there is a positive relation between SLCs and leverage.

Pavel (1988) finds that there is no relation between loan sales and bank risk. Berger and Udell (1990) and Avery and Berger (1990) conclude that there is a negative relationship between loan commitments and bank risk. Avery and Berger (1991) consider more risk measures and suggest that SLCs have a positive impact on both small and large banks' risk. This result supports the market discipline hypothesis for large banks. Berger

(1991) examines actual bank operating performance instead of stock market prices to counter for the equity effect of disciplining banks' risk-taking. The results reveal that higher capital ratios for both small and large banks are positively related to higher future earnings, lower probability of bankruptcy, and better bank performance.

Hassan (1992) studies the riskiness of commercial letters of credit (CLCs) from the stockholders' and bondholders' points of view. These results suggest that stockholders consider CLCs as a risk-mitigating tool, while debt holders are indifferent about CLC activities. This suggests that more constrained capital requirements are not appropriate for some OBS activities for large commercial banks. Hassan, Karels and Peterson (1994) use a contingent valuation model to test the market discipline hypothesis of OBS activities for bank subordinated debt. Their results support the market discipline hypothesis for most OBS activities and suggest that debt holders and equity holders regard OBS activities risk mitigating tool.

Hassan, Lai, and Yu (2002) study the risk implications of letters of credit (LC) for Canadian banks. They employ single-factor and multi-factor models to measure risk. Their results indicate a negative relationship between various market measures of risk and LCs. Banks with greater portfolio risk (equity and asset risk), high leverage and interest rate risk are less likely to issue LCs.

Khambata and Hirche (2002) describe OBS credit risk of the top 20 European commercial banks. Their results suggest that loan commitments are the largest source of credit risk among traditional OBS instruments. However, the notional amounts of derivative activities make up around 95 percent of the total OBS exposure. An analysis by country of origin points to national differences in the use of derivative leverage. In comparison with U.S. commercial banks, European banks use fewer OBS activities as a multiple of on-balance sheet assets. Khambata and Bagdi (2003) repeat the descriptive study on OBS credit risk across the top 20 Japanese banks. The results suggest that financial derivatives were heavily used by the top four banks and that loan commitments are the largest source of credit risk among traditional OBS instruments. The notional amounts of derivative contracts make up 92 percent of total OBS activities. As compared to the U.S. and European banks, Japanese banks use fewer OBS instruments as a

percentage of their assets. This implies that Japanese banks are in general more conservative and risk averse than their U.S. or European counterparts.

III. Methodology

Our analysis involves two stages. The first stage is to estimate BHCs' market risk using three different risk measures: (i) market systematic risk (Beta), derived from the Capital Asset Pricing Model (CAPM), (ii) standard deviation of banks' daily equity return (σ_{it}^E) which is then annualized to estimate the yearly BHCs' risk, and (iii) contingent option pricing model to estimate the BHCs' implied asset volatility (σ_{it}^V) as a measure of BHCs' risk. The second stage is to regress these three estimated risk measures as the dependent variables on derivatives and on-balance sheet risk measures.

a. Market Risk Measures

1) *Beta or Systematic Risk β_{it}* : Our first risk measure is derived from the CAPM return generating process according to the following equation:

$$R_{it} = \alpha_i + \beta_{it} R_{Mt} + \varepsilon_{it} \dots \dots \dots (1)$$

Where $R_{it} = r_{it} - R_{ft}$ is the holding period return (r_{it}) for the i^{th} over the period t in excess of the risk-free rate of interest (R_{ft}). $R_{Mt} = r_{Mt} - R_{ft}$ is the holding period return (r_{Mt}) for the market portfolio over period t in excess of the risk-free rate of interest (r_{ft}). α_i is the intercept, and ε_{it} is the i^{th} bank-specific factor which is independent of R_{Mt} . Beta represents the systematic risk/security's sensitivity to market-wide events which cannot be diversified away. It reflects differing investor expectations about the relationship between each bank's return and the market return.

2) *Standard Deviation of Equity Return σ_{it}^E* : We are using the standard deviation of banks' equity return as a measure for the market risk which will include both the market risk and bank-specific risk. The standard deviation of banks' equity return will be estimated using the following formula:

$$\sigma_{RE} = \sqrt{\sum_{t=1}^n (\bar{K}_t - \bar{K}_{Avg})^2} \dots \dots \dots (2)$$

\bar{K}_t is the ex-post equity return in period t, and \bar{K}_{Avg} is the average annual return during the year.

3) *Contingent Claim Models*: The standard linear approaches to estimation of banks' market risk might be inadequate because all the risk measures are either linear or monotonic functions of a bank's risk. The contingent claim models correct for this nonlinearity of a bank's risk. Ronn and Verma (1986) introduced a contingent claim model (CCM) nested from Black and Sholes (1973) option pricing model; CCM is essentially a risk-based deposit insurance measure that can be estimated from the market value of a bank's equity and the instantaneous equity's standard deviation. The authors state that the empirical estimation of risk and deposit insurance premium is possible when time series data on the market value of a bank's equity and the book value of its debt are available. The equity of a bank can be presented as follows:

$$E = VN(X) - \rho BN(X - \sigma_v \sqrt{T}) \dots \dots \dots (3)$$

Where:

$$X = \frac{\left(\ln \frac{V}{\rho b} + \frac{\sigma_v^2 T}{2} \right)}{\sigma_v \sqrt{T}} \dots \dots \dots (4)$$

$$\sigma_v = \sigma_E \frac{E}{VN(X)} \dots \dots \dots (5)$$

E is the market value of equity, σ_E is the instantaneous standard deviation of equity return, V is the unobserved post-insurance value of bank assets, B is the book value of debt liabilities, σ_v is the instantaneous standard deviation of asset return, $N(\sim)$ is the univariate cumulative normal distribution function, and T represents the time until the next audit of bank assets. Equations (4 and 5) can be solved simultaneously for two unknowns, V and σ_v , for each observed E and σ_E using an exogenously determined closure rule. Banks are audited each year, and at audit time banks are closed if V_T (terminal value of assets at time T) is less than ρB ($\rho \leq 1$ is a policy parameter). Therefore, the maturity of debt is assumed to be 1.

b. On-Balance Sheet Accounting Risk Factors

1) *Leverage Risk (LEV)*: Beaver, Kettler, and Scholes (1970) indicate that an increase in debt magnifies equity holders' return volatility. Hamada (1972) reports that approximately one quarter of systematic risk is explained by the degree of financial leverage. On the other hand, Mandelker and Rhee (1984) find that both operating and financial leverage (total liabilities/total assets) jointly determine systematic risk.

Therefore, if these leverage ratios increase, it may lead to higher variability of banks' equity returns and ultimately market risk.

2) *Diversification Risk (DIV)*: a concentrated investment in one category of assets will generate a diversification risk. Concentration of loan operations on one type of client reduces diversification and accentuates diversification risk. This will directly and indirectly affect the market risk. The Herfindahl Index (HI) is used to measure the degree of loan portfolio diversification. A high HI implies high level of loan concentration (less loan diversification) and high bank risk. Greater diversification is expected to cause less variability in earnings. The HI measure is positively related to systematic and unsystematic market risk measures. In this study, we will use the inverse of the HI to translate it from a concentration index to a diversification index.

$$HI = \frac{1}{\sum_{i=1}^n L_i^2} \dots\dots\dots(6)$$

Where n = number of loans types.

3) *Credit Risk (LOSS)*: this type of risk indicates the risk associated with the quality of a bank's earning assets (loans). Low quality bank assets (loans) cause high probability of future defaults risk, reduction in earnings and dividends. Since banks are highly leveraged, Brewer and Lee (1986) conclude that large nonperforming loans or large security losses can bring about insolvency. Furthermore, major fluctuations in interest rates can greatly influence the market value of long-term fixed rate assets. Similarly, a decline in asset quality can lead to write-offs and reduced earnings from the loan portfolio. Thus, *LOSS* is positively related to market measures of risk.

LOSS= loan loss provision/total assets

4) *The Interest Rate Risk (GAP)*: This type of risk arises because of differences in maturity composition of assets and liabilities. For example, changing market interest rates may have a differentiated impact on the value of assets and liabilities. French, Ruback, and Schwert (1983) introduce the nominal contracting hypothesis to explain the sensitivity of commercial bank stock returns. Nominal contracts are those assets which have cash flows that are fixed in nominal terms. On the other hand, cash flows generated by real assets fluctuate with the price level. Overall, most of the assets and liabilities of depository financial institutions can be postulated to be nominal contracts. Thus, according to the nominal contracting hypothesis, a firm's holding of nominal assets is a key driver of maximizing stockholders' wealth. Studies by Fama (1975, 1976), and Fama and Gibbons (1982) establish that unexpected changes in interest rates are directly related to inflationary expectations. Hence, the nominal contracting hypothesis supports the notion that unanticipated changes in the interest rate would affect a bank's equity value depending on the duration of nominal assets and liabilities held by the firm. The greater the amount of net nominal assets and the longer the duration of these assets, the higher would be the interest rate sensitivity of a bank's common stock. In other words, the greater the absolute value of GAP, the more the bank is exposed to unexpected changes in interest rates. Therefore, GAP is positively related to market-related risk measures.

5) *Operating Risk (Size Risk, SIZE)*: According to Saunders, Strock, and Travlos (1990), the larger the BHC, the greater is its ability to diversify away its asset risk. Furthermore, the "too big to fail" doctrine enables large banks to maximize the value of implicit failure guarantees associated with deposit insurance and bank closure policy. The larger the bank, the more the analysis is conducted about the bank's equity and debt, and the lower is the risk. Larger banking firms may be more protected by some regulatory rules that the small banking firms are not. All these reasons together suggest a negative relation between bank size and market risk measures for BHCs.

6) *Dividend Payout Variability Risk (POR)*: According to Brewer and Lee (1986), bank equities are affected by the earning power of bank assets. Therefore, a bank's stock price is negatively related to the variability of its rate of return. BHCs will always want to keep a stable dividend policy once it is established, and it will be reluctant to cut down the dividends. A higher dividend payout ratio may signal higher earning power while

stability of dividend payout ratio suggests stability in the bank's earning levels, implying a lower level of market risk. POR is negatively related to market risk measures.

IV. Data and Empirical Model

a. Data Analysis

Our sample consists of 54 BHCs during the period 2000-2008. We are limited to this number of BHCs and the time span because we have restricted our study to those BHCs that are available in Center for Research in Security Prices (CRSP) database. There is a trade-off between including more time-series points but less cross-section points, or less time-series points but more cross-section points. Given this trade-off, we choose to have more cross-section points since our primary interest is in the impact of derivatives measures on BHCs' market risks of the largest number of BHCs. However, a nine year period should be reasonable relative to recent research in this area.

Our data sets are designed in a way to capture the differences in the marginal propensity to risk (MPR). This may be affected by the operational size differences between BHCs. Operation size of each BHC is an important factor in determining the MPR since large BHCs react differently from small BHCs or medium-size BHCs. In order to test this hypothesis and ensure that size classification does not interfere with the SIZE factor included in the regression model, we divide our BHCs sample into three groups, namely big, medium, and small. The independent variable SIZE is included as a control variable in order to measure the impact of derivative contracts on the market overall risk, while the three size classifications are to assess the differences in the MPR among the three size groups. It may also be viewed as a statistical smoothing process in order to eliminate some of the outliers from the sample. A simple investigation of the BHCs sample reveals upper and lower size outliers. The number of BHCs with total assets less than \$100 trillion is in the range of 30-40 BHCs during our study period while only about 10-20 BHCs have assets worth more than \$100 trillion. Within less than \$100 trillion bracket there are about 15-20 BHCs ranging between \$20 million and \$100 million while about 15-30 BHCs have less than \$20 trillion in total assets value. This significant difference in the distribution of the BHCs' total assets may suggest that there is a significant difference in MPR and risk management policies for each group of the

BHCs. Therefore, each group will include 18 BHCs. The 18 largest BHCs account for at least 80% of total assets of all BHCs, 18 medium BHCs account for 12% of total assets and 18 small BHCs account for only 2% of total assets.

First, we collected the following data from CRSP: daily return for each of BHCs, equally weighted return to proxy for market portfolios' return, and daily rate of return for one month Treasury bills to proxy for risk free rate. Then we estimated the yearly value of the systematic risk measure (β), using the ordinary least square (OLS) method for each BHC. Second, using the daily rate of return for each BHC, we calculated the standard deviation of equity return (σ_{RE}), to calculate our second measure of market risk. Yearly average rate of return is computed from the daily rate of return for each BHC. Third, we collected the data required to compute the independent variables, both derivatives and on-balance sheet items from the Federal Depository Insurance Corporation (FDIC), for the 54 BHCs during the same period of study.

Fourth, we have collected data of the market value of equity (E) and book value of debt (B) from COMPUSTAT, used along with the data collected from CRSP to solve equation (4) and (5) simultaneously to get the value of the unobserved implied asset volatility (σ_{it}^V) and the unobserved post-insurance value of bank assets (V). We used a numerical routine to get the simultaneous solution of our two unknowns. Following Ronn and Verma (1986) procedure, the initial estimate that we used for the value of V was the sum of market value of equity and the face value of the debt. The value of σV was σ_E scaled down by the leverage ratio. The values of the cumulative normal probability distribution N were obtained using the polynomial approximation

$$N(z) = 1 - \frac{1}{\sqrt{2\pi}} [\exp(-z^2 / 2)] [a_1 k + a_2 k^2 + a_3 k^3 + a_4 k^4 + a_5 k^5] \dots \dots (7)$$

for $z > 0$ and obtaining $N(z)$ for $z < 0$ by symmetry, $N(0)$ equal exactly to $1/2$. Where

$$k = \frac{1}{1 + pz}; P = 0.2316419; a_1 = 0.31938153; a_2 = -0.356563782;$$

$$a_3 = 1.781477937; a_4 = -1.821255978; \text{ and } a_5 = 1.330274429.$$

b. Description of Empirical Model

After we estimate the dependent variables (three market risk measures β , σ_E , and σ_V), we regress these dependent variables on the derivative and on-balance sheet variables as they appear in the following equations.

$$\beta_{it} = \alpha_0 + \alpha_1 DERV_{it}^K + \alpha_2 LEV_{it} + \alpha_3 DIV_{it} + \alpha_4 LOSS_{it} + \alpha_5 GAP_{it} + \alpha_6 SIZE_{it} + \alpha_7 POR_{it} + v_{it} \dots (8)$$

$$\sigma_{it}^E = \alpha_0 + \alpha_1 DERV_{it}^K + \alpha_2 LEV_{it} + \alpha_3 DIV_{it} + \alpha_4 LOSS_{it} + \alpha_5 GAP_{it} + \alpha_6 SIZE_{it} + \alpha_7 POR_{it} + v_{it} \dots (9)$$

$$\sigma_{it}^V = \alpha_0 + \alpha_1 DERV_{it}^K + \alpha_2 LEV_{it} + \alpha_3 DIV_{it} + \alpha_4 LOSS_{it} + \alpha_5 GAP_{it} + \alpha_6 SIZE_{it} + \alpha_7 POR_{it} + v_{it} \dots (10)$$

Where the dependent variables are:

β_{it} : the systematic risk measure for bank i at time t.

σ_{it}^E : the standard deviation of equity returns for BHCs i at time t.

σ_{it}^V : the implied asset volatility estimated from the Ronn-Verma model for bank i at time t.

The on-balance sheet variables are used as control variables to evaluate the relationship between derivatives contracts and banks' market risk from the equity holder's perspective. Following is brief definition of the independent variables in equations 8-10.

$DERV_{it}^K$: Represents the notional value of derivative contracts for bank i at time t, K represent the type of the derivative contracts (futures, forwards, options, and swaps). Each of these types includes the notional value of the interest rate contracts, exchange rate contracts, commodity exchange contracts, and equity exchange contracts.

LEV_{it} : The leverage variable is computed as the ratio of total liabilities to total assets.

DIV_{it} : The diversification variable is computed using seven different types of loans, as reported in schedule HC-C of the report of income of BHCs, employing the inverse of the Herfindahl Index (HI) reported in equation (6).

LOSS_{it}: The credit risk variable is calculated as the ratio of loan loss provision to total assets.

GAP_{it}: The interest rate risk variable is calculated as the difference between the total market rate assets and the total market rate liabilities divided by the total assets.

SIZE_{it}: The operational risk variable is calculated by taking the natural logarithm of bank assets to avoid the linearity problem.

POR_{it}: The earning variability risk is calculated by dividing the cash dividend by the total assets.

In further discussion, we add dummy variables to test the strength of any derivative's effect on a bank's market risk, given a bank's size group. To this end, we estimated equations (11-13) using the 54 sample BHCs during the period 2000-2008, where any derivative contracts are inserted in the regression as three variables, namely [(SIZEDUM=1 if big, and 0 otherwise) * DERV], second [(SIZEDUM=1 if medium, and 0 otherwise) * DERV], and third [(SIZEDUM=1 if small, and 0 otherwise) * DERV].

$$\beta_{it} = \alpha_1 SIZEDUM_{(BIG/MID/SMALL)} * DERV_{it}^K + \alpha_2 LEV_{it} + \alpha_3 DIV_{it} + \alpha_4 LOSS_{it} + \alpha_5 GAP_{it} + \alpha_7 POR_{it} + v_{it} \quad (11)$$

$$\sigma_{it}^E = \alpha_1 SIZEDUM_{(BIG/MID/SMALL)} * DERV_{it}^K + \alpha_2 LEV_{it} + \alpha_3 DIV_{it} + \alpha_4 LOSS_{it} + \alpha_5 GAP_{it} + \alpha_7 POR_{it} + v_{it} \quad (12)$$

$$\sigma_{it}^V = \alpha_1 SIZEDUM_{(BIG/MID/SMALL)} * DERV_{it}^K + \alpha_2 LEV_{it} + \alpha_3 DIV_{it} + \alpha_4 LOSS_{it} + \alpha_5 GAP_{it} + \alpha_7 POR_{it} + v_{it} \quad (13)$$

This way we estimate not only the directional impact of derivatives on market risk in a given size group, but also the strength of the impact of these derivative activities for a given size group. Therefore, the size group may enhance the effect of derivative contracts on a bank's risk, or discourage the effect of derivatives contracts on banks' risk.

V. Analysis of Empirical Results

a. Size Separation Analysis

Equations 8-10 have been regressed using the random effect methodology, as it appears to be a better estimate than is the fixed effect methodology based on Hausman test (χ^2 values are reported in the table results).

We employ a panel data model instead of simple time series OLS or cross-section OLS for two reasons. First, neither time-series nor cross-section method alone will yield sufficient degrees of freedom in regression analysis. Second, regression based on cross-section cannot be used to account for shifts in market measures of risk and accounting data through time. Moreover, time series alone cannot be used easily to conduct inter-bank relationships and comparisons. Table 1 reports the correlation matrix and it shows that there is relatively high correlation between the derivatives activities. We estimate a separate regression for each of them in order to avoid any colinearity problem. Generally, the correlation matrix indicates no perfect colinearity between the other independent variables. Following are the results of the econometric analysis for each group and each risk measure.

i. Analysis of Derivative Contracts

Futures and forwards: Results reported in tables 2 and 3 suggest that futures and forward contracts are statistically insignificant for all the risk measures for the big and small size groups. In the medium group, both types of contracts are statistically insignificant on the standard deviation of equity return measure (σ_{it}^E) and the implied asset volatility measure (σ_{it}^V); they report positively significant coefficients on the systematic risk measure (BETA). The insignificant relation between futures and forward contracts and the risk measures imply that investors do not price the risk BHCs may incur by taking futures/forward positions. After all, both types of contracts constitute only a small fraction of total derivatives and thus have insignificant impact on the diversification position of banks' assets portfolios. The significant relation between the Beta measure and futures/forwards in the medium BHC group may suggest that market participants price the risk of these contracts in the overall market systematic risk and thus it will be reflected in the required rate of return. However, this inconsistent relation between futures/forwards and Beta might stem from heteroskedasticity as indicated by the LM multiplier reported at the bottom of each table.

Option: Consistent with futures and forward contracts, results in table 4 suggest that option contracts are also statistically insignificant for the three size groups according to the three risk measures. However, we do have the same significant positive relation between options and Beta risk measure. The similar econometric results between futures, forwards, and options might be because of the relatively small portion of the overall notional value of derivative positions held by the sampled BHCs during the period of study. It seems that market participants value the volume effect of this position more than the risk effect. This might occur because the amount of each type of contract is small relative to the BHC's total assets. However, we believe that although each one of these types is small relative to BHC's assets, they are large when they are considered together, hence they should be priced.

Swaps: The swaps contracts comprise about 61% of total derivative positions. Fortunately, the market participants price this position in their required rate of return, and they consider it as a risk-reducing factor according to the three risk measures (Beta, σ_{it}^E , σ_{it}^V) for both big and medium BHCs, as shown in table 5. This means that swaps positions are a concern for well-diversified investors. This negative relation implies that as swaps' market price increases, the bank's risk will be affected negatively. One can argue about the difference between the price effect and the volume effect of these contracts, but we include the swaps notional value which captures the net effect of these two directions. Although swaps contracts are significantly risk-reducing factors for big and medium sized BHCs, they are statistically insignificant for the small BHCs. This insignificant impact might suggest that market participants believe that small BHCs are not able to deal with these complex risk management tools/contracts because they require highly qualified staff and expertise.

ii. Analysis of On-Balance Sheet Accounting Measures

Generally the on-balance sheet accounting measures have the expected regression sign as suggested by theory. We discuss each of them separately.

Leverage (LEV): There is a significant positive impact on both of two risk measures (σ_{it}^E , and σ_{it}^V) for large size BHC, and it is statistically insignificant for the

Beta risk measure. It is also significantly positive on the three risk measures for the small BHCs. Interestingly, it is insignificant for the equity risk and the implied asset risk (σ_{it}^V) for the medium BHCs and significantly negative for the Beta risk measure. The positive significant relation indicates that as a bank's leverage increases, the market incorporate the associated financial risk in risk valuation. This suggests that derivative contracts will contribute to the total leverage of BHCs and increase the overall risk.

Diversification (DIV): This variable has an unexpected significant negative relation with the equity risk (σ_{it}^E) and the implied asset risk (σ_{it}^V) for the three groups. However, it has a significant positive relation with the systematic risk (Beta) for the three groups. The negative sign suggests that as banks become more diversified, they are able to eliminate that portion of risk which is unsystematic risk. The positive but insignificant sign, in the Beta model, suggests that diversification will not eliminate/reduce systematic risk. Derivative contracts can only diversify unsystematic risk, but not systematic risk. The results indicate that the sample BHCs are not well-diversified and, they are mainly using swaps and other non-traditional derivatives as diversification tools.

Credit Risk (LOSS): This factor has a significant positive influence on all market risk measures for the big BHCs, as expected. It is also significantly positive on both the equity return risk (σ_{it}^E) and the implied asset risk (σ_{it}^V) but statistically insignificant on the Beta measure for the medium BHCs. It is insignificant for almost all of the risk measures for the small BHCs. The positive sign supports our theoretical discussion and is consistent with the notion that as banks' default risk increases, market participants take this risk into account. Therefore, when derivative positions held by banks increase, more default risk is perceived by the market.

Interest rate risk (GAP): As expected, this variable holds a positive sign on two market risk measures, equity return risk (σ_{it}^E) and implied asset risk (σ_{it}^V) for all the three BHCs groups. This suggests that the greater the absolute value of the interest rate gap, the greater is the bank's risk. The results, however, show an inverse relationship between systematic risk measure (Beta) and GAP, implying that banks may use high gap values to hedge their asset portfolios to reduce risk.

Operational Risk (SIZE): The results indicate a significant negative relation between size and two of the risk measures, equity return risk (σ_{it}^E) and implied asset risk (σ_{it}^V) for all the three bank groups. For the Beta risk measure, the sign, however, is unexpectedly positive for the medium- and small-size BHCs and insignificant for the big BHCs. The positive relation between size and Beta risk could suggest that when banks' operations increase, the market will translate this expansion as a transitory period which will include more risk since banks may hold more assets than they really can manage. The insignificant relation can be justified that Beta measure of risk includes only systematic risk which can't be diversified by increasing a bank's operations.

Earning Variability Risk (POR): This variable has the expected sign for both the big and medium BHCs on both equity return risk, σ_{it}^E , and implied asset risk (σ_{it}^V). Its coefficients are insignificant for the Beta measures of all types of BHCs

b. Analysis of Size Interaction Variables

Tables 6-9 report the results of regression equations 11-13, where we examine the interaction between a bank's size and derivative contracts. The derivative coefficients indicate positive relation with the bank's market risk. However, the quantitative relation is stronger, implying that BHC's size determines the sensitivity level between the percentage changes in the derivatives and the market risk behavior. For example, swaps contracts are found to be a significant risk-reducing factor for both big and medium BHCs groups. Although swaps hold the same significant risk-reducing impact for the same groups, the sensitivity is different when derivative activities interact with the size dummy variables. Moreover, the market participants' valuation of derivative contracts on a bank's market risk is different from one size group to another. For instance, if we consider three banks, the first one from the big BHCs group, the second one from the medium BHCs group, and the third one from the small BHCs group, and each bank decides to increase its positions in swaps in the market by the same scale, then we should expect that the impact of these swaps on banks' market risk valuation to be different across the groups. We would expect the risk sensitivity to be higher for the small size banks than for medium and big banks. The lowest impact will be in the large banking firms since banks' size is negatively related to banks' risk sensitivity to the swaps

contracts. The interaction analysis also suggests that options and futures contracts are significantly risk-reducing factors for the big BHCs while they are insignificant in the separate-groups analysis. Moreover, the on-balance sheet factors generally hold their expected impact on market risk.

VI. Summary Conclusion and Policy Implication

Our analysis was designed in a way to capture the differences in marginal propensity to risk (MPR) which might be affected by differential operational size across BHCs. We believe that the operational size of each BHC is an important factor in determining MPR factors. For example, large BHCs should react differently from small BHCs or medium size BHCs.

The results suggest that swaps contracts are the most important derivatives in market risk valuation. They are also viewed as risk-reducing according to the three risk measures for big and medium BHCs. Second, futures, forwards, and options do not have much influence on the valuation of banks in the three market risk measures (Beta, σ_E , and σ_v) for the three BHC groups. This result may be due to the small value of these contracts relative to swaps contracts, and thus the market participants do not pay as much attention to these positions as risk factors. However, we find a positive and significant relationship between these three types of derivatives and systematic risk (Beta). Third, market participants generally view derivatives, measured by swaps positions, as more potential risk diversification tools. Fourth, small BHCs have a different MPR from both big and medium BHCs, which is consistent with the economy of scope concept and the “too big to fail” doctrine. Generally speaking, risk sensitivity is highest in small-size banking firms and the lowest in the largest banking firms. Therefore, banks’ size is negatively related to banks’ risk sensitivity to the derivative contracts. Fifth, the on-balance sheet variables have coefficients which are consistent with the existing theoretical reasons. They do have an impact on the pricing process of a bank’s equity. To a certain extent, the relation between these accounting risk variables and different market risk measures varies across BHCs groups.

Therefore, higher capital requirements and more regulations on banks’ derivative activities are required to minimize the impact of increasing derivatives position

on banks' risk. Moreover, market participants do not price futures, forwards, and options in their calculations of market risk although these contracts, when combined, should have significant impact on overall bank risk. They cannot be ignored in market valuation.

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Table 1: Correlation Coefficients[□]

	FUT	FOR	OPT	SWAP	LEV	DIV	LOSS	GAP	SIZE	POR
FUT	1.0000									
FOR	0.93442	1.00000								
OPT	0.95076	0.98245	1.00000							
SWAP	0.86128	0.96210	0.95569	1.00000						
LEV	0.080899	0.070288	0.065181	0.070411	1.00000					
DIV	-0.18842	-0.19772	-0.22030	-0.18769	-0.21456	1.0000				
LOSS	0.22292	0.20211	0.17798	0.14896	-0.04343	-0.0629	1.00000			
GAP	-0.15276	-0.17509	-0.21425	-0.18536	-0.25077	0.26808	0.18528	1.00000		
SIZE	0.14839	0.17873	0.158859	0.34855	0.056220	-0.2380	0.20349	-0.3024	1.00000	
POR	0.063253	0.070970	0.071085	0.064501	0.18242	0.00983	0.14695	0.13250	0.0039579	1.00000

[□] **Note:** The correlation coefficients above show all derivatives (FUT, FOR, OPT, SWAP) are highly correlated. Because of high correlations, we estimate each one in a separate model in order to avoid any multicollinearity problem.

Table 2: BHCs Panel Results – Futures

	Panel A: Big BHCs			Panel B: Medium BHCs			Panel C: Small BHCs		
	β	σ_{it}^E	σ_{it}^V	β	σ_{it}^E	σ_{it}^V	β	σ_{it}^E	σ_{it}^V
Constant	2.422 (1.726)^	-.0445 (-.9672)	-.03038 (-.6032)	-1.166 (-.7854)	.0586 (1.3516)	.828 (1.741)^	-7.2568 (-1.9983)**	.0171 (.33144)	.402 (.71088)
Futures	.00189 (.2381)	-.00007 (-.2988)	-.00671 (-.2555)	3.007 (2.465)*	.03875 (1.087)	.4501 (1.154)	112.84 (1.0303)	-1.2704 (-.9076)	-1.3921 (-.9042)
LEV	-1.1084 (-.8793)	.1337 (3.356)*	.18278 (2.938)*	-2.3166 (-2.112)**	.02587 (.8115)	.0835 (.2390)	4.8732 (1.5654)^	.1278 (2.9319)*	.2159 (2.4258)**
DIV	.6412 (1.645)^	-.0487 (-4.023)*	-.5402 (-4.099)*	.5968 (2.2312)**	-.01562 (-2.004)**	-.01706 (-1.996)**	2.3524 (3.7677)*	-.03586 (-3.9402)*	-.3922 (-3.9410)*
LOSS	19.501 (2.396)*	.7440 (3.337)*	.9132 (3.362)*	-9.1277 (-.8853)	.7152 (2.4001)*	.7930 (2.4301)*	-40.627 (-1.5570)^	.03628 (.09996)	.04162 (.10458)
GAP	-25.563 (5.405)*	.3406 (2.330)**	.7889 (2.437)*	-.0230 (-.00575)	.2697 (2.318)**	.30264 (2.373)*	-38.195 (-3.9743)*	.56344 (3.9984)*	.62275 (4.0401)*
SIZE	.00772 (.0991)	-.0080 (-3.051)*	-.0597 (-3.122)*	.5267 (4.965)*	-.0102 (-3.302)*	-.1163 (-3.324)*	.6586 (3.3215)*	-.01827 (-5.9647)*	-.3997 (-5.978)*
POR	-.0086 (1.079)	-.00056 (-2.353)*	-.00061 (-2.313)**	.1142 (.7370)	.006101 (1.348)	.05660 (1.3317)	.01823 (.1056)	-.004925 (-2.2069)**	-.0536 (-2.1845)**
R²	.3711	.2875	.3597	.4310	.2146	.3056	.2458	.3348	.3488
LM	22.21 (.000)*	7.853 (.005)*	7.0477 (.008)*	.000314 (.986)	7.9703 (.005)*	7.9139 (.005)*	2.277 (.131)	7.9599 (.005)*	7.295 (.007)*
DW	1.088 (.000,.000)*	.9418 (.000,.000)*	.7422 (.000,.000)*	.9550 (.000,.000)*	.9332 (.000,.000)*	.9398 (.000,.000)*	.53074 (.000,.000)*	.7427 (.000,.000)	.7572 (.000,.000)*
χ^2	14.277 (.0465)**	31.04 (.0001)*	31.845 (.0000)*	14.879 (.037)**	20.29 (.005)*	20.306 (.0049)*	16.989 (.0175)*	18.495 (.0099)	18.217 (.0110)**

Notes:

- (1) The dependent variables show in the second row; the independent variables show in the first column.
- (2) The numbers between parentheses, below variables' coefficients, are t-statistics,
- (3) The numbers between parentheses, below econometric' tests (LM, DW, χ^2), are P-values.
- (4) Significance level: * = 1%, ** = 5%, ^ = 10%.

Table 3: BHCs Panel Results – Forwards

	Panel A: Big BHCs			Panel B: Medium BHCs			Panel C: Small BHCs		
	β	σ_{it}^E	σ_{it}^V	β	σ_{it}^E	σ_{it}^V	β	σ_{it}^E	σ_{it}^V
Constant	3.197 (2.581)**	-.0333 (-.6960)	-.174 (-.3321)	-1.217 (-1.8237)	.0634 (1.451)	.887 (1.8485)	-6.8817 (-1.8986)**	.0157 (.31495)	.391 (.7138)
Forwards	.0077 (2.260)*	.000036 (.2571)	.00525 (.3218)	.8243 (2.8212)*	.00604 (.6984)	.07665 (.7002)	-.58011 (-.1142)	.05351 (.7940)	.667 (.90352)
LEV	-1.240 (-1.084)	.1284 (3.129)*	.4214 (2.709)*	-2.441 (-2.270)**	.0226 (.7169)	.004501 (.1297)	4.4011 (1.4200)	.1261 (2.9706)*	.21376 (2.448)**
DIV	.6339 (1.783)*	-.0477 (-3.931)*	-.0953 (-4.001)*	.7253 (2.588)*	-.0163 (-1.980)**	-.01811 (-1.994)**	2.3097 (3.6859)*	-.03366 (-3.8381)*	-.366 (-3.8290)*
LOSS	17.985 (2.207)*	.7259 (3.209)*	.9820 (3.227)*	-4.674 (-4.559)	.7606 (2.539)*	.8452 (2.575)*	-32.708 (-1.317)	-.04739 (-.1395)	-.54797 (-1.290)
GAP	-23.64 (-5.314)*	.3467 (2.345)*	.6966 (2.457)*	2.908 (.6715)	.2829 (2.219)**	.3160 (2.2596)**	-40.1150 (-4.0493)*	.5741 (4.1776)*	.6357 (4.233)*
SIZE	-.08201 (-1.264)	-.0088 (-3.379)*	-.0919 (-3.456)*	.5337 (5.0215)*	-.0105 (-3.349)*	-.05165 (-3.3758)*	.6757 (3.3238)*	-.01798 (-6.1003)*	-.1968 (-6.1370)*
POR	-.00677 (-.8997)	-.00052 (-2.136)**	-.00056 (-2.084)**	.0365 (.2312)	.00575 (1.233)	.0622 (1.215)	.021944 (.1273)	-.004758 (-2.135)**	-.05163 (-2.107)**
R²	.4021	.2830	.3747	.4376	.2046	.2932	.2352	.3532	.3904
LM	22.263 (.000)*	6.458 (.011)*	5.5700 (.018)*	.5437 (.461)	7.999 (.005)*	8.1433 (.004)*	1.9564 (.162)	7.9211 (.005)*	7.3488 (.007)*
DW	1.107 (.000,.000)*	.9330 (.000,.000)*	.9321 (.000,.000)*	.9193 (.000,.000)*	.8856 (.000,.000)*	.8857 (.000,.000)	.5002 (.000,.000)*	.8008 (.000,.000)	.8228 (.000,.000)*
χ^2	19.050 (.0265)**	30.69 (.0001)*	31.417 (.0001)*	15.230 (.0332)**	21.78 (.002)*	21.98 (.0026)*	20.951 (.0038)*	23.773 (.0012)*	23.367 (.0015)*

Notes:

- (1) The dependent variables show in the second row; the independent variables show in the first column.
- (2) The numbers between parentheses, below variables' coefficients, are t-statistics,
- (3) The numbers between parentheses, below econometric' tests (LM, DW, χ^2), are P-values.
- (4) Significance level: * = 1%, ** = 5%, ^ = 10%.

Table 4: BHCs Panel Results – Options

	Panel A: Big BHCs			Panel B: Medium BHCs			Panel C: Small BHCs		
	β	σ_{it}^E	σ_{it}^V	β	σ_{it}^E	σ_{it}^V	β	σ_{it}^E	σ_{it}^V
Constant	2.546 (1.859)**	-.0436 (-.9909)	-.5296 (-.6151)	-.7503 (-.4981)	.0662 (1.556)	.917 (1.963)**	-5.772 (-1.6118)^	.00490 (.0953)	.265 (.4725)
Options	.00078 (.4161)	-.000022 (-.3659)	-.004021 (-.3184)	1.324 (2.250)*	.0143 (.8579)	.21686 (.9188)	29.1714 (1.4167)	-.2891 (-1.069)	-.3240 (-1.0912)
LEV	-1.217 (-.9611)	.1323 (3.358)*	.4264 (2.938)*	-2.574 (-2.328)**	.0219 (.6967)	.00385 (.1117)	3.6823 (1.2004)	-.28914 (-1.069)	.1249 (2.6308)*
DIV	.6486 (1.649)^	-.0486 (-4.028)*	-.1541 (-4.104)*	.5174 (1.937)**	-.01705 (-2.254)**	-.03087 (-2.255)**	2.2993 (3.7436)*	.13584 (3.1328)*	-.303828 (-3.8990)*
LOSS	18.87 (2.356)*	.7437 (3.331)*	.8729 (3.355)*	-10.963 (-1.036)	.6863 (2.264)**	.8593 (2.286)**	-24.8075 (-1.0017)	.12857 (-.36629)	-.4403 (-.3648)
GAP	-25.08 (-5.169)*	.3322 (2.250)**	.6807 (2.3626)*	-.0095 (-.00229)	.2666 (2.260)**	.6996 (2.3166)**	-41.9564 (-4.3574)*	.5964 (4.240)*	.65902 (4.2844)*
SIZE	.00285 (.0382)	-.0079 (-3.178)*	-.0880 (-3.246)*	.5034 (4.542)*	-.01075 (-3.4272)*	-.11921 (-3.460)*	.6140 (3.1314)*	-.01768 (-5.8260)*	-.1932 (-5.8416)*
POR	-.0080 (-1.014)	-.00057 (-2.393)*	-.00681 (-2.354)**	.1202 (.7487)	.006475 (1.425)	.0704 (1.413)	.01254 (.0728)	-.00483 (-2.163)**	-.0526 (-2.142)**
R²	.3742	.2890	.3611	.4079	.2073	.2977	.2557	.2970	.3277
LM	23.165 (.000)*	7.949 (.0005)*	7.1216 (.008)*	.0557 (.813)	7.206 (.007)*	7.1316 (.008)*	1.7203 (.159)	9.3908 (.002)*	8.659 (.003)*
DW	1.088 (.000,.000)	.945634 (.000,.000)*	.94577 (.000,.000)*	.8515 (.000,.000)*	.8845 (.000,.000)*	.8872 (.000,.000)*	.5069 (.000,.000)*	.7802 (.000,.000)*	.7955 (.000,.000)*
χ^2	19.501 (.0068)*	30.545 (.0001)*	31.325 (.0001)*	16.25 (.0223)**	20.982 (.0038)*	21.056 (.0037)*	15.95 (.0256)**	16.857 (.0183)*	16.542 (.0206)**

Notes:

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- (2) The numbers between parentheses, below variables' coefficients, are t-statistics,
- (3) The numbers between parentheses, below econometric' tests (LM, DW, χ^2), are P-values.
- (4) Significance level: * = 1%, ** = 5%, ^ = 10%.

Table 5: BHCs Panel Results – Swaps

	Panel A: Big BHCs			Panel B: Medium BHCs			Panel C: Small BHCs		
	β	σ_{it}^E	σ_{it}^V	β	σ_{it}^E	σ_{it}^V	β	σ_{it}^E	σ_{it}^V
Constant	2.4960 (1.829)**	-.0519 (-1.195)	-.387 (-.8142)	.2863 (.1819)	.0443 (.9708)	.670 (1.3386)	-6.8064 (-1.8822)^	.0115 (.2256)	.340 (.6077)
Swaps	-.00018 (-3.3269)*	-.000019 (-2.0785)*	-.0003 (2.0303)**	-1.1734 (1.662)^	-.0393 (-1.866)^	-.4539 (-1.902)*	-1.4828 (-1.497)	.0706 (.5102)	.8376 (.5523)
LEV	-1.1960 (-.9454)	.1330 (3.408)*	.5272 (2.9832)*	-3.125 (-2.840)*	.0365 (1.1803)	.10202 (.5967)	4.3225 (1.3906)	.1344 (3.084)*	.1234 (2.5864)*
DIV	.6436 (1.639)^	-.0490 (-4.104)*	-.0646 (-4.184)*	.4897 (1.8105)**	-.0242 (-3.124)*	-.58267 (-3.1409)*	2.3009 (3.3675)*	-.03465 (-3.837)*	-.4378 (-3.8370)*
LOSS	19.004 (2.366)*	.7563 (3.393)*	.8265 (3.416)*	-5.442 (-5.159)	.7621 (2.696)*	.8453 (2.737)*	-32.088 (-1.288)	-.0765 (-2.205)	-.0833 (-2.191)
GAP	-25.207 (-5.196)*	.3099 (-2.115)**	.3570 (2.2317)**	-1.033 (-2.499)	.2249 (1.968)**	.4531 (2.025)**	-40.419 (-3.8306)*	.6043 (4.0116)*	.96997 (4.064)*
SIZE	.0073 (.0998)	-.0068 (-2.8314)*	-.077 (-2.898)*	.4326 (3.415)*	-.00894 (-2.489)*	-.09861 (-2.5068)*	.6773 (3.1968)*	-.01858 (-5.7987)*	-.2036 (-5.827)*
POR	-.0082 (-1.033)	-.00062 (-2.625)*	-.00567 (-2.587)*	.1065 (.6571)	.00573 (1.233)	.0606 (1.1909)	.02163 (.12556)	-.00483 (-2.163)*	-.0526 (-2.142)**
R²	.3730	.3006	.3496	.3946	.1478	.2314	.2359	.3370	.3717
LM	22.8193 (.000)*	9.945 (.002)*	9.0184 (.003)*	.0947 (.758)	3.379 (.066)^	3.358 (.067)**	1.9238 (.165)	7.9894 (.005)*	7.3664 (.007)*
DW	1.08755 (.000,.000)*	.9659 (.000,.000)*	.9657 (.000,.000)*	.8659 (.000,.000)*	.6953 (.000,.000)*	.6888 (.000,.000)	.4994 (.000,.000)	.7577 (.000,.000)*	.7730 (.000,.000)*
χ^2	18.793 (.0089)*	30.435 (.0001)*	31.236 (.0001)*	12.935 (.0737)^	39.64 (.0000)*	40.329 (.0000)*	18.846 (.0087)	18.502 (.0099)*	18.169 (.0112)**

Notes:

- (1) The dependent variables show in the second row; the independent variables show in the first column.
- (2) The numbers between parentheses, below variables' coefficients, are t-statistics,
- (3) The numbers between parentheses, below econometric' tests (LM, DW, χ^2), are P-values.
- (4) Significance level: * = 1%, ** = 5%, ^ = 10%.

Table 6: The interactions of size dummies with FUTURES

	β	σ_{it}^E	σ_{it}^V
FUD1	-0.027560 [.175]	-0.000761225 [.042]	-0.00827935 [.043]
FUD2	1.81148 [.586]	-0.047116 [.442]	-.58263 [.471]
FUD3	25.6720 [.779]	-1.77835 [.291]	-1.94656 [.290]
LEV	-3.86980 [.016]	.160210 [.000]	.551302 [.000]
DIV	1.04033 [.030]	-.038099 [.000]	-.41963 [.000]
LOSS	.646463 [.949]	.832038 [.000]	.909791 [.000]
GAP	-22.2705 [.000]	.653231 [.000]	.728022 [.000]
POR	.00254330 [.844]	-0.000834434 [.001]	-0.00905950 [.001]
R²	.363392	.473774	.495500
LM	2.10027 [.147]	8.35674 [.004]	7.11905 [.008]
DW	.834711 [.000,.000]	1.38775 [.000,.000]	1.39779 [.000,.000]

Table 7: The interactions of size dummies with FORWARDS

	β	σ_{it}^E	σ_{it}^V
FOD1	.010399 [.645]	-0.000441865 [.288]	-0.00469971 [.302]
FOD2	-.180082 [.809]	-.00161730 [.906]	-.0193036 [.898]
FOD3	-.401387 [.935]	-.145399 [.108]	-.551447 [.126]
LEV	-3.95177 [.013]	.170327 [.000]	.166011 [.000]
DIV	.999312 [.038]	-.039125 [.000]	-.053068 [.000]
LOSS	1.86495 [.852]	.829041 [.000]	.9686623 [.000]
GAP	-22.9076 [.000]	.628091 [.000]	.789967 [.000]
POR	.000681945 [.958]	-0.000860591 [.000]	-0.00934502 [.000]
R²	.358624	.469596	.480860
LM	2.94510 [.086]	6.83855 [.009]	5.92601 [.015]
DW	827327 [.000,.000]	1.38447 [.000,.000]	1.39261 [.000,.000]

Notes:

- (1) The dependent variables show in the first row; the independent variables show in the first column.
- (2) The numbers between parentheses are P-values.

Table 8: The interactions of size dummies with OPTIONS

	β	σ_{it}^E	σ_{it}^V
OPD1	-.010145 [.064]	-.000220152 [.031]	-.00439784 [.031]
OPD2	.629390 [.621]	-.00135437 [.954]	.0732958 [.998]
OPD3	31.5867 [.081]	-.115409 [.732]	-.531934 [.720]
LEV	-4.15583 [.009]	.159380 [.000]	.354399 [.000]
DIV	1.00431 [.034]	-.037630 [.000]	-.41432 [.000]
LOSS	1.05074 [.917]	.791121 [.000]	.863722 [.000]
GAP	-22.2915 [.000]	.653424 [.000]	.830042 [.000]
POR	.00197094 [.878]	-.000828958 [.001]	-.00689198 [.001]
R²	.374356	.471721	.493585
LM	2.32772 [.127]	8.58287 [.003]	7.33306 [.007]
DW	.830294 [.000,.000]	1.38609 [.000,.000]	1.39546 [.000,.000]

Table 9: The interactions of size dummies with SWAPS

	β	σ_{it}^E	σ_{it}^V
SWD1	-.00258876 [.075]	-.0000737711 [.004]	-.00801538 [.005]
SWD2	1.93706 [.322]	-.158649 [.000]	-.574533 [.000]
SWD3	12.4923 [.169]	-.333004 [.039]	-.655418 [.044]
LEV	-3.91819 [.013]	.142115 [.000]	.335327 [.000]
DIV	1.02242 [.032]	-.036227 [.000]	-.39856 [.000]
LOSS	1.47222 [.885]	.655458 [.000]	.715573 [.000]
GAP	-19.9902 [.001]	.532876 [.000]	.697712 [.000]
POR	.00149173 [.907]	-.000831776 [.000]	-.00901938 [.000]
R²	.372706	.520263	.532933
LM	2.88194 [.090]	7.42291 [.006]	6.51211 [.011]
DW	.834158 [.000,.000]	1.41037 [.000,.000]	1.42107 [.000,.000]

Notes:

- (1) The dependent variables show in the first row; the independent variables show in the first column.
- (2) The numbers between parentheses are P-values.

Table 10: List of sample BHCs.

Big BHCS	Small BHCS
A B N AMRO HOLDING N V AMSOUTH BANCORPORATION B B & T CORP BANK NEW YORK INC BANK OF AMERICA CORP CITY NATIONAL CORP COMMERCE BANCORP INC NJ FIRST BANCORP NC FIRSTMERIT CORP INVESTORS FINANCIAL SERVS CORP M & T BANK CORP NATIONAL PENN BANCSHARES INC OLD NATIONAL BANCORP POPULAR INC SUNTRUST BANKS INC U S BANCORP DEL WACHOVIA CORP NEW WELLS FARGO & CO NEW A B N AMRO HOLDING N V	AMCORE FINANCIAL INC BANCORPSOUTH INC FIFTH THIRD BANCORP FIRST CITIZENS BANCSHARES INC NC FIRST TENNESSEE NATIONAL CORP FIRSTMERIT CORP FULTON FINANCIAL CORP PA H S B C HOLDINGS PLC KEYCORP NEW NATIONAL CITY CORP NEW YORK COMMUNITY BANCORP INC P N C BANK CORP REGIONS FINANCIAL CORP SKY FINANCIAL GROUP INC SOUTH FINL GROUP INC U M B FINANCIAL CORP VALLEY NATIONAL BANCORP WASHINGTON TRUST BANCORP INC AMCORE FINANCIAL INC
Medium BHCS	
ASSOCIATED BANC CORP B O K FINANCIAL CORP COMERICA INC COMMERCE BANCSHARES INC COMPASS BANCSHARES INC CULLEN FROST BANKERS INC FIRST MEDIUMWEST BANCORP DE MARSHALL & ILSLEY CORP MELLON FINANCIAL CORP MERCANTILE BANKSHARES CORP NORTH FORK BANCORPORATION NY INC NORTHERN TRUST CORP PROVIDENT BANKSHARES CORP REGIONS FINANCIAL CORP SYNOVUS FINANCIAL CORP T C F FINANCIAL CORP UNIONBANCAL CORP ZIONS BANCORP	