AN EMPIRICAL EXAMINATION OF INTEREST RATE RISK DISCLOSURE AND MANAGEMENT IN BANK HOLDING COMPANIES

by

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Abstract

This dissertation examines interest rate risk disclosure and interest rate risk management in bank holding companies (BHCs). Interest rate risk is the risk that a bank's earnings and economic value of equity are adversely affected by changes in interest rates.

In the first essay, I examine the disclosure of interest rate risk in BHCs' 10-K filings. First, I document that interest rate risk disclosures of BHCs from 1997 to 2009 vary cross-sectionally and change over time. While the number of BHCs disclosing maturity gap analysis as an interest rate risk measure declined from 1997 to 2009, there was an increase in interest rate risk simulation disclosures over the same time period. Second, I hypothesize and find that interest rate risk disclosures are related to nontraditional banking activities, time deposit funding, derivative use and institutional investor ownership; the associations are different for large and small BHCs. Third, in examining the information content of interest rate risk disclosures, I find increased short-term abnormal trading volumes for BHCs disclosing simulation for the first time. Furthermore, I find higher two-day cumulative abnormal returns around the 10-K filing dates for a sub-sample of BHCs whose interest rate risk simulation disclosures project improved profitability or enhanced equity value. These results suggest that the disclosures provide incremental information to investors.

In my second essay, I evaluate BHCs' management of interest rate risk as related to earnings. I first build an α-gap model that is based on α – the ratio of changes in rates of rate sensitive liabilities to changes in rates of rate sensitive assets – to explain how interest rate changes affect changes in net interest income. This model decomposes changes in net interest income into rate variances and volume variances, which reflect the outcome of managing interest rate risk and the outcome of changing the size and composition of assets and liabilities, respectively. I posit that greater rate variances indicate more effective interest rate risk management as related to earnings, ceteris paribus. Next, using a sample of bank holding companies from 1998 to 2010, I document that increases in net interest income are primarily driven by positive volume variances, suggesting that BHCs tend to grow net interest income by changing the size and composition of assets and liabilities and not by effectively managing interest rate risk. In investigating whether interest rate risk management affects the valuation of net interest income, I find that the persistence of net interest income varies positively with interest rate risk management. Furthermore, I find that interest rate risk management positively impacts the association of net interest income and market returns, and the impact is stronger during 1996 to 2006 than during the financial crisis period of 2007 to 2010.

My study provides new insights into banks' disclosure practices and their management of interest rate risk. The evidence presented in this dissertation can help guide the efforts of the market regulators and accounting standard setter to enhance interest rate risk disclosures of financial institutions, and can help banking regulators monitor interest rate risk.

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CHAPTER ONE:

INTRODUCTION

This dissertation investigates the disclosure and management of interest rate risk in bank holding companies (BHCs). It consists of two essays. First, I document the variations in interest rate risk disclosures, examine the determinants of interest rate risk disclosures and investigate whether the disclosures provide incremental information to investors. Second, based on a new theoretical model, I develop measures to assess the management of interest rate risk as related to earnings. I use the measures to evaluate to what extent BHCs are able to manage interest rate risk in generating net interest income, and to explore how interest rate risk management as related to earnings affects the valuation of net interest income.

Successfully managing risk is essential to the success, and in some cases, survival, of a financial institution. Key risks include interest rate risk, credit risk, liquidity risk, operational risk and regulatory risk. The acceptance and management of interest rate risk is inherent to a bank's role as a financial intermediary. Interest rate risk has two distinct but complementary perspectives: the earnings perspective and the economic perspective. From the earnings perspective, interest rate risk is defined by the effect of interest rate movement on earnings, or typically, net interest income. Alternatively, from the economic perspective, interest rate risk is defined by the effect of interest rate movement on economic value of equity. Banks' interest rate risk management is different from non-financial firms in that interest rate risk management for banks is used not only to mitigate potential loss, but also to directly profit from interest rate risk exposure.

My research is motivated by several factors. The past 30 years have witnessed the highest and lowest interest rates in United States history. In particular, the recent historically low interest rate environment and weak economic conditions present significant interest rate risk uncertainty to financial institutions. Substantial loan losses during the financial crisis and sharp declines in the value of securities portfolios placed downward pressure on earnings for many banks. The spread between borrowing and lending rates has narrowed for many banks, causing lending profitability to fall. At the same time, some banks fund long-term assets with short-term liabilities to generate earnings, but this practice also poses risks to a bank's earnings and economic value of equity should interest rates increase. Financial regulators jointly issued *Advisory on Interest Rate Risk Management* in 2010 to remind financial institutions of sound practices for measuring and managing interest rate risk, and where necessary, mitigating exposure to potential increases in interest rates (Federal Financial Institutions Examination Council, 2010). Thus, understanding interest rate risk management is essential to understanding banks' risk profiles and earnings sustainability in today's challenging environment.

Furthermore, although there has been voluminous literature addressing interest rate risk, some important and less explored areas remain. First, there is limited research investigating the disclosure of interest rate risk (Hodder, 2001; Ahmed, Beatty and Takeda, 1997) even though interest rate risk management is critical to banks' operations. BHCs currently disclose maturity gap analysis and/or interest rate sensitivity from simulation, as part of the 10-K filing's "Item 7A Market Risk Disclosure" under the requirement of the Financial Reporting Release No. 48 (FRR 48, hereafter) issued by the Securities and Exchange Commission (SEC, hereafter) in 1997. More recently, the Financial Accounting Standard Board (FASB, hereafter) proposed the Accounting Standards Update to Financial Instruments (Topic 825), which would require a financial institution to disclose gap analysis with derivative items and interest rate sensitivity measures in every interim and annual reporting period (FASB, 2012). By documenting the variations in BHCs' existing interest rate risk disclosures and investigating the determinants of the disclosures, my research will help inform accounting standard setters about the disclosure practices of BHCs. Additionally, by developing measures to assess the management of interest rate risk, my study can help guide the accounting standard setters and market regulators' efforts in improving interest rate risk disclosure.

Second, existing research on interest rate risk (e.g., Flannery and James, 1984a, 1984b; Schrand, 1997) typically uses maturity gap to measure banks' interest rate risk management and its resultant interest rate risk exposure. Many BHCs disclose maturity gap as part of their interest rate risk disclosures. Although straightforward and widely used, maturity gap analysis is inadequate to assess interest rate risk due to its limitations (Staikouras, 2006).[1] For example, maturity gap is a static measure which assumes no future growth and cannot handle different degrees of changes in the interest rates of a bank's assets and liabilities. An improved method that can overcome the shortcomings of maturity gap would provide new insights into interest rate risk management.

Third, because the existing literature has not developed a measure for interest rate risk management as related to earnings, another less explored area is how well banks are able to manage interest rate risk in generating net interest income, although researchers have long identified interest rate risk as a determinant of banks' profitability (e.g., Ho and Saunders, 1981; Hanweck and Ryu, 2005). By exploring to what extent bank management generates net interest income by managing interest rate risk and by changing the size and composition of assets and

[1] Under maturity gap analysis, individual assets and liabilities are categorized by the time buckets in which they mature or reprice. The difference between assets and liabilities in each time bucket is calculated and referred to as a maturity gap. By convention, maturity gap is the one-year gap calculated as the dollar value of the differences between assets and liabilities repricing or maturing within 12 months.

liabilities, my study sheds light on banks' net interest income generating activities and interest rate risk management.

My sample in this dissertation consists of public traded commercial BHCs and thrift holding companies (referred to as BHCs, collectively). In my first essay, I document that interest rate risk disclosures under the SEC's FRR 48 vary cross-sectionally and underwent significant changes from 1997 to 2009. While the number of BHCs disclosing maturity gap analysis as an interest rate risk measure declined from 1997 to 2009, there was an increase in the disclosure of net interest income simulation and economic value of equity simulation over the same time period. I hypothesize and find that interest rate risk disclosures are related to nontraditional banking activities, time deposit funding source, derivative usage and institutional investor ownership. In addition, the associations are different for large and small BHCs. For example, for the largest size quartile of BHCs, I find a positive relation between the level of nontraditional banking activities and interest rate risk disclosure. This is consistent with the hypothesis that BHCs disclose more sophisticated measures of interest rate risk to signal their operational sophistication. In addition, I find a positive association between the level of time deposit funding and interest rate risk disclosure, suggesting that large BHCs with a higher level of time deposit funding have more interest rate risk exposure and thus are more likely to disclose interest rate risk. There is a negative association between derivative usage and interest rate risk disclosure, suggesting that large BHCs regard derivatives as a means to reduce interest rate risk exposure, leading to less interest rate risk disclosure. Furthermore, higher institutional ownership is positively associated with interest rate risk disclosures for large BHCs.

In investigating whether interest rate risk disclosures are useful, I examine changes in trading volume and changes in stock prices. I document increased short-term abnormal trading volumes around 10-K filing dates for BHCs disclosing interest rate risk simulation measures for the first time, suggesting that the disclosures alter investors' beliefs about firm values. Additionally, I examine whether the stock market reacts differently to information regarding projected profitability and equity value implied in changes in interest rate risk simulation disclosures from the previous filing period to the current filing period. Using a subsample of the 50 largest BHCs disclosing interest rate risk measures in both 10-Ks and 10-Qs during 2003 and 2005, I find higher two-day cumulative abnormal returns around the filing dates for BHCs whose interest rate risk simulation disclosures project improved profitability or enhanced equity value, indicating that the disclosures provide useful information to investors.

In my second essay, I develop an α-gap model that links interest rate risk management from the earnings perspective to changes in net interest income. This model decomposes changes in net interest income into rate variances and volume variances.[2] Rate variances are changes in net interest income attributable to changes in interest rates and reflect the outcome of interest rate risk management. Rate variances are modeled through α-gap, which is the dollar amount difference between rate sensitive assets and rate sensitive liabilities adjusted for the different interest rate changes of rate sensitive assets and liabilities. I empirically show that the α-gap model performs better in explaining changes in net interest income than the traditional maturity gap model.

From the α-gap model I develop two proxies for interest rate risk management: (1) an indicator variable of positive rate variances and (2) a continuous variable equivalent to standardized rate variances. I evaluate how effectively BHCs manage interest rate risk to generate net interest income for a sample of 2,565 firm-years from 332 unique publicly traded

[2] The rate and volume variances are similar to the price and quantity variances for materials in cost accounting.

BHCs during 1998 to 2010. I document that during 1998 to 2010 only 36.8% of BHCs have rate variances greater than zero, whereas 71.3% have volume variances greater than zero. I find that, on average, BHCs' increases in net interest income consist of positive volume variances and negative rate variances, suggesting that BHCs tend to generate net interest income by changing the size and composition of their balance sheet and not by effectively managing interest rate risk.

Furthermore, I investigate whether interest rate risk management affects the valuation of net interest income. Interest rate risk management is likely to positively affect the persistence of net interest income by enhancing future yields on a bank's assets and by reducing future funding costs, and as a consequence, positively affect the valuation of net interest income. I find that BHCs with more effective interest rate risk management have more persistent net interest income, and have a stronger association between net interest income and market returns than other BHCs. I find the valuation effect is stronger during the pre-financial crisis period of 1996 to 2006 than during the financial crisis period of 2007 to 2010.

This dissertation makes several important contributions. First, my research on interest rate risk disclosure enriches the literature on voluntary disclosure of firms' material market risks. Different from the previous papers (Hodder, 2001) and Ahmed, Beatty and Takeda (1997), I document the variances in interest rate risk disclosure choices and investigate financial institutions' operational characteristics and management incentives underlying observed market risk disclosures. Furthermore, my study covers a long sample period from 1997 through 2009, during which the regulatory and interest rate environments have changed significantly since prior research was conducted (Hodder, 2001; Ahmed, Beatty and Takeda; 1997). In addition, I provide evidence that interest rate risk disclosure provides incremental information to investors, indicating that the FASB proposed Accounting Standards Update to Financial Instruments

(Topic 825) has the potential to increase the information usefulness of interest rate risk disclosure by making the disclosure more consistent and comparable (FASB, 2012).

Second, the theoretical α-gap model and its related measures assessing interest rate risk management from the earnings perspective will be useful to investors, regulators, standard setters and bank management. I empirically demonstrate that, to assess interest rate risk management, the α-gap model is not only superior to the conventional maturity gap model, but also that the measures based on the α-gap model have the ability to capture the process and outcome of interest rate risk management from the earnings perspective. My study suggests that α and α-gap, as well as rate and volume analysis in the 10-K filing, can be considered as part of interest rate risk disclosures. My study can lead investors to an improved understanding of financial institutions whose disclosures are often considered complex and lacking transparency (e.g., Levine, 2004). My study is also useful for banking regulators' examination of banks' interest rate risk. Bank management can also employ the α-gap model to interest rate risk management.

Third, in estimating rate sensitive liabilities using FR Y-9C (i.e., the regulatory Consolidated Financial Statements), there is a lack of consensus as to what proportion of non-maturity deposits to include (e.g., Flannery and James, 1984b; Purnanandam; 2007). Additionally, a few researchers have suggested that a venue for future research is to use maturity gap disclosed in banks' annual reports rather than use banks' regulatory filings (Thorton, 2004; Allen, 2004). My study sheds light on this issue by comparing the dollar amount of rate sensitive assets and liabilities obtained from maturity gap analysis from BHCs' 10-Ks and those estimated from FR Y-9C. On average, I find that rate sensitive liabilities obtained from maturity gap analysis in 10-Ks are equivalent to including 25% of non-maturity deposits plus other rate sensitive liabilities using data from FR Y-9C.

The remainder of the dissertation is organized as follows. Chapter Two presents the institutional background of interest rate risk disclosures and management. Chapter Three provides a review of the literature relevant to my research questions. In Chapter Four, I investigate interest rate risk disclosure in BHCs' 10-K filings. In Chapter Five, I build an α-gap model to assess the management of interest rate risk as related to earnings, empirically assess to what extent BHCs are able to generate earnings by managing interest rate risk, and explore how interest rate risk management as related to earnings affects the valuation of net interest income. Chapter Six summarizes my main findings, highlights contributions and discusses future research.

CHAPTER TWO:

INSTITUTIONAL BACKGROUND

This chapter provides the background of interest rate risk of financial institutions. I first introduce the two perspectives of interest rate risk and methods to measure interest rate risk. This introduction is followed by banking regulators' views on interest rate risk management. Finally, I provide a brief overview of BHCs' interest rate risk disclosures.

1. Measuring Interest Rate Risk

According to the Office of the Comptroller of the Currency's (OCC) 1998 *Interest Rate Risk: Comptroller's Handbook*, there are two different but complementary perspectives of measuring interest rate risk: the earnings perspective and the economic perspective. The earnings perspective focuses on the short term (usually one-year), and measures interest rate risk in terms of earnings. It quantifies interest rate risk as the change in earnings (typically, net interest income) caused by changes in interest rates. In contrast, the economic perspective focuses on the long term, and measures interest rate risk in terms of true capital value. It quantifies interest rate risk as the change in economic value of equity that occurs as asset portfolio value and liability portfolio values rise and fall with changes in interest rates. Interest rate risk from the economic perspective can be referred to as the "duration risk" of a financial institution. The linkage between these two perspectives is that economic value of equity indicates the balance sheet's capacity to produce long-term earnings.

There are various techniques available to measure interest rate risk, focusing on the earnings perspective and/or the economic perspectives. These techniques include maturity gap analysis, duration analysis, earnings simulation and economic value of equity simulation. Maturity gap analysis is capable of measuring earnings and economic value sensitivities, though its link with earnings is more widely used. Maturity gap analysis originated in the 1970s (Kaufman, 1972; Clifford, 1975a,b), and reports the entire book value of each main type of interest-earning asset and interest-bearing liability that reprices in various time buckets. The most commonly used time buckets are within one year, one to five years, and beyond five years. Maturity gap analysis can measure interest rate risk from both the earnings perspective and the economic perspective. For the time buckets within one year, maturity gap analysis suggests how net interest income could be impacted by interest rate changes. "Positive maturity gap" typically means that within one year more assets reprice than liabilities, and "negative maturity gap" typically means within one year more liabilities reprice than assets. The rationale for the relation between maturity gap analysis and net interest income is straightforward: for a bank with a positive maturity gap, net interest income would rise if rates rise and fall if rates fall; the opposite is true for a bank with a negative maturity gap. On the other hand, maturity gap analysis could be a crude measure of economic value sensitivity as it provides an estimate of duration under certain assumptions (e.g., Hodder and McAnally, 2001; Ryan, 2002).

Overall, maturity gap is generally regarded more as a measure of earnings sensitivity to interest rate changes by banks and regulators than as a measure of economic value of equity from the economic perspective. For example, the *Joint Policy Statement of Interest Rate Risk* by the OCC, the Federal Reserve and the FDIC points out that, "Measurement systems used to assess the effect of changes in interest rates on reported earnings range from simple maturity gap reports to more sophisticated income simulation models". Despite its wide usage, several shortcomings are inherent in maturity gap analysis. For example, it is a static measure which assumes no growth and cannot handle different degrees of changes in rates of assets and liabilities; it cannot deal with embedded options such as prepayment and early withdrawal; it cannot reflect the interest rate sensitivity of off-balance-sheet positions such as loan commitments. However, it can reflect derivatives' impact on maturity gap, if derivatives were included in maturity gap analysis.

Duration analysis was introduced into banks' interest rate risk management during the late 1970s and 1980s, although the concept of Macaulay duration dates back to 1938 (Macaulay, 1938)[3]. It was once touted as the key to superior interest rate risk management in the 1980s, as it captures the long-term interest rate risk of equity. Though duration analysis is a cornerstone in interest rate risk management and bond investment, duration analysis cannot handle large changes in interest rates, nor can it handle administered interest rates. A more sophisticated alternative to duration analysis is economic value of equity produced by simulation models (Matz, 2009). [4]

Simulations are potentially valuable tools to capture the size and direction of a bank's interest rate exposure. Simulations use dynamic models with the ability to incorporate a wide variety of possible interest rate scenarios and complicated on-balance-sheet and off-balance-sheet asset and liability positions. Simulations include earnings simulation and economic value of equity simulation. Earnings simulation measures net income or net interest income sensitivity to rate changes over the next one or two years. Economic value of equity simulation measures economic value of equity sensitivity to rate changes. Compared to maturity gap analysis, simulations are much harder to conduct for two primary reasons. First, simulation models require considerable data and assumptions. This could be an advantage or a disadvantage,

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[3] Duration analysis usually uses modified duration, which is the approximate percentage change in price given a 1% (100 basis point) interest rate change. In contrast, Macaulay duration is the weighted average maturity of cash flows and is expressed in time units.

[4] While duration analysis infers the sensitivity of financial instruments to interest rate change, economic value of equity infers the market value or present value (Matz, 2009).

depending on how carefully data are collected and assumptions are developed. The OCC cites the "myriad of assumptions" in its 1998 *Interest Rate Risk: Comptroller's Handbook* as a limitation for the simulation method. Second, although simulation models provide a specific measure of interest rate risk exposure, the outcome could be less revealing, because it can be difficult to isolate the effects of interest rate change. In sum, simulation models are powerful tools if and only if used carefully. If used imprudently, the simulation models can intentionally or inadvertently understate risk exposure (Matz, 2009).

2. Regulators' Views on Interest Rate Risk

Due to the Savings and Loans Crisis in the 1980s which eventually required a $150 billion taxpayer bailout (Curry and Shibut, 2000), banking regulators have taken measures to address interest rate risk in banks and thrifts, with a growing emphasis on simulation techniques and the economic perspectives on interest rate risk.

In 1992, the FDIC, the Federal Reserve and the OCC issued *An Advanced Notice of Proposed Rulemaking on Interest Rate Risk*. It proposed that all banks should use a duration-weighted maturity ladder to estimate the change in a bank's economic value for a 100 basis point parallel shift in interest rates. Although in the final statement, certain banks identified as low risk were exempted from this requirement, it reflected regulators' growing emphasis on the economic perspective of interest rate risk.

In 1996, the FDIC, the Federal Reserve and the OCC issued the *Joint Policy Statement on Interest Rate Risk*. It emphasizes the importance of measuring interest rate risk from not only the earnings perspective, but also from the economic perspective. It encourages banks to use simulation models in measuring interest rate risk. For example, it states that "a well-managed bank will consider both earnings and economic perspectives when assessing the full scope of its interest rate risk exposure." It also points out that banks with significant holdings of instruments with intermediate and long-term maturities or embedded options should assess the potential long-term impact of changes in interest rates. Since only economic approaches to measuring interest rate risk capture the potential long-term impact of interest rate changes, the regulators are essentially telling banks with those types of holdings that they must use a duration or economic value of equity approach to quantify their interest rate risk exposures. Furthermore, the 1996 Joint Policy Statement notes that the scenarios used in measuring interest rate risk "should incorporate a sufficiently wide change in market interest rates (e.g., +/- 200 basis points over a one year horizon) and include immediate or gradual changes in market interest rates as well as changes in the shape of the yield curve in order to capture the material effects of any explicit or embedded options." This explicitly encourages banks to use simulation techniques.

In 1997, banking regulators incorporated interest rate risk into the examiner's ratings system, by transforming the "CAMEL" rating system into "CAMELS." The "S" rating stands for a bank's sensitivity to market risk, which includes risk exposures to interest rates, exchange rates, and commodity prices. For the majority of banks, market risk is equivalent to interest rate risk. The *Commercial Bank Examination Manual* from the Federal Reserve notes that interest rate risk measurement systems should use appropriate financial measurement techniques to measure interest rate risk exposure of both earnings and economic value.

In January 2010, in the environment of historically low interest rates, the FDIC notes in its *Advisory on Interest Rate Management* that "current computer technology allows even some smaller, less sophisticated institutions to perform comprehensive simulations of the potential impact of changes in market rates on their earnings and capital…. Institutions are encouraged to use the full complement of analytical capabilities of their interest rate risk simulation models."

Banking regulatory bodies have also proposed their own economic value of equity simulation models of measuring interest rate risk. The Office of Thrift Supervision (OTS) and the Federal Reserve have both developed their own simulation models intending to monitor banks' interest rate risk. Several papers evaluate these interest rate risk simulation models and their overall conclusion is that the regulatory interest rate risk simulation models are capable of accurately measuring interest rate risk from the economic perspective. Neuberger (1992, 1993) compares the Fed's approach with the OTS regulatory framework. He finds that the OTS approach is more rigorous. He also concludes that the interest rate risk exposure of U.S. banks is not excessive, yet his results are based on the aggregation of bank balance sheets and omits off-balance sheet items. Wright and Houpt (1996) compare the Fed "basic model", which uses maturity data from the call report as well as important assumptions about underlying cash flows and price sensitivities, against the OTS's more sophisticated simulation model. They find that the Fed "basic model" is capable of measuring general magnitude of interest rate risk. Sierra and Yeager (2004) examine the Federal Reserve's economic value model, which is similar to economic value of equity simulation, against the actual performance of community banks whose assets are under $1 billion. Their findings are supportive of the Fed model as rising rates hit liability-sensitive banks (as identified by EVM) more when compared to their financial gains obtained during periods of falling rates. The overall conclusion of these papers is that the regulatory interest rate risk simulation models are capable of accurately measuring interest rate risk from the economic perspective

3. Interest Rate Risk Disclosure by BHCs

3.1 Requirements of SEC's FRR 48

The SEC's market risk disclosure rule FRR 48 was a response to growth in the use of financial instruments and perceived inadequacy of GAAP disclosures in the 1990s. FRR 48 addresses market risks arising from changes in interest rates, foreign currency exchange rates, commodity prices, equity prices, and other market changes that affect market risk sensitive instruments (SEC, 1997). It requires registrants to present estimates of market risk in one of three alternative formats: (1) a tabular format of financial instruments, (2) sensitivity analysis, or (3) value-at-risk.

The tabular disclosure includes the amounts of the market risk sensitive instruments and their contract terms, categorized by expected maturity date. The purpose is to enable readers to determine the amount and timing of future cash flows from the instruments. For example, banks may disclose maturity gap analysis as a tabular presentation format of interest rate risk.

Sensitivity analysis is the measurement of potential loss in future earnings, fair values, or cash flows of market sensitive instruments resulting from one or more selected hypothetical changes in interest rates, foreign currency rates, commodity prices, and other market rates or prices over a selected time. For example, banks may disclose the effects on net income of a 100 or 200 basis point instantaneous, parallel shift in the yield curve.

Value-at-risk describes a general class of probabilistic models that measure the risk of loss in market risk sensitive instruments. These models measure the potential loss that could occur in normal markets, over a defined period, within a certain confidence level. Value-at-risk is typically used to measure trading risk, and is rarely used to measure interest rate risk exposures of commercial banks' non-trading instruments (SEC, 1997; Hodder, 2001).

For commercial BHCs, interest rate risk is the market risk that materially affects its earnings and cash flow. In practice, BHCs disclose maturity gap analysis as a tabular format, and/or disclose simulation results as sensitivity analysis. The next section discusses BHCs' interest rate risk disclosure.

3.2 Interest Rate Risk Disclosure by BHCs under FRR 48

Before 1997, interest rate risk is typically disclosed in Item 7 Management Discussions and Analysis under titles such as "Asset/Liability Management" or "Interest Rate Risk Management". Since 1997, FRR 48 requires public companies to disclose "Quantitative and Qualitative Disclosure about Market Risk" as Item 7A in the 10-K. Hence, BHCs put their interest rate risk disclosures under Item 7A, or specify the pages numbers where interest rate risk is disclosed if they continue to disclose interest rate risk in Item 7. Small BHCs that are exempted from FRR 48 continue to disclose interest rate risk as part of Item 7. In interest rate risk disclosures, a majority of BHCs state that their Asset/Liability Management Committee or a similar committee monitor interest rate risk, and interest rate risk policies and procedures are in place. Almost every BHC specifies at least one of the following interest rate risk measurement techniques: maturity gap analysis (as a tabular format under FRR 48), net interest income simulation and economic value of equity simulation (as sensitivity analysis under FRR 48).

Three examples of BHCs' interest rate risk measurement disclosures are provided in the Appendix: (1) an example of a BHC that discloses net interest income simulation and economic value of equity simulation, (2) an example of a BHC that discloses net interest income simulation and maturity gap analysis, and (3) an example of a BHC that only discloses economic value of equity simulation.

Appendix: Examples of Interest Rate Risk Disclosures

This appendix presents three examples of bank holding companies' interest rate risk disclosure:
1. An example of a bank holding company that discloses net interest income simulation and economic value of equity simulation.
2. An example of a bank holding company that discloses net interest income simulation and gap analysis.
3. An example of a bank holding company that only discloses economic value of equity simulation.

1. An example of a bank holding company that discloses net interest income simulation and economic value of equity simulation
(Note: economic value of equity is also called market value of equity):

U.S. Bankcorp (TIC: USB), 2008 10-K
Interest Rate Risk Management In the banking industry, changes in interest rates are a significant risk that can impact earnings, market valuations and safety and soundness of an entity. To minimize the volatility of net interest income and the market value of assets and liabilities, the Company manages its exposure to changes in interest rates through asset and liability management activities within guidelines established by its Asset Liability Policy Committee ("ALPC") and approved by the Board of Directors. The ALPC has the responsibility for approving and ensuring compliance with the ALPC management policies, including interest rate risk exposure. The Company uses net interest income simulation analysis and market value of equity modeling for measuring and analyzing consolidated interest rate risk.

Net Interest Income Simulation Analysis One of the primary tools used to measure interest rate risk and the effect of interest rate changes on net interest income is simulation analysis. The monthly analysis incorporates substantially all of the Company's assets and liabilities and off-balance sheet instruments, together with forecasted changes in the balance sheet and assumptions that reflect the current interest rate environment. Through this simulation, management estimates the impact on net interest income of a 200 basis point upward or downward gradual change of market interest rates over a one-year period. The simulation also estimates the effect of immediate and sustained parallel shifts in the yield curve of 50 basis points as well as the effect of immediate and sustained flattening or steepening of the yield curve. This simulation includes assumptions about how the balance sheet is likely to be affected by changes in loan and deposit growth. Assumptions are made to project interest rates for new loans and deposits based on historical analysis, management's outlook and repricing strategies. These assumptions are validated on a periodic basis. A sensitivity analysis is provided for key variables of the simulation. The results are reviewed by the ALPC monthly and are used to guide asset/liability management strategies.

The table below summarizes the interest rate risk of net interest income based on forecasts over the succeeding 12 months. At December 31, 2008, the Company's overall interest rate risk position was asset sensitive to changes in interest rates. The Company manages its interest rate risk position by holding assets on the balance sheet with desired interest rate risk characteristics, implementing certain pricing strategies for loans and deposits and through the selection of derivatives and various funding and investment portfolio strategies. The Company manages the overall interest rate risk profile within policy limits. The ALPC policy limits the estimated change in net interest income to 4.0 percent of forecasted net interest income over the succeeding 12 months. At December 31 2008 and 2007, the Company was within policy.

SENSITIVITY OF NET INTEREST INCOME

	December 31, 2008				December 31, 2007			
	Down 50 Immediate	Up 50 Immediate	Down 200 Gradual*	Up 200 Gradual	Down 50 Immediate	Up 50 Immediate	Down 200 Gradual	Up 200 Gradual
Net interest income	*	.37%	*	1.05%	.54%	(1.01)%	1.28%	(2.55)%

* *Given the current level of interest rates, a downward rate scenario can not be computed.*

Market Value of Equity Modeling The Company also utilizes the market value of equity as a measurement tool in managing interest rate sensitivity. The market value of equity measures the degree to which the market values of the Company's assets and liabilities and off-balance sheet instruments will change given a change in interest rates. The ALPC policy limits the change in market value of equity in a 200 basis point parallel rate shock to 15.0 percent of the market value of equity assuming interest rates at December 31, 2008. The up 200 basis point scenario resulted in a 7.6 percent decrease in the market value of equity at December 31, 2008, compared with a 7.6 percent decrease at December 31, 2007. The down 200 basis point scenario resulted in a 2.8 percent decrease in the market value of equity at December 31, 2008, compared with a 3.5 percent decrease at December 31, 2007. At December 31, 2008 and 2007, the Company was within policy.

The valuation analysis is dependent upon certain key assumptions about the nature of assets and liabilities with non-contractual maturities. Management estimates the average life and rate characteristics of asset and liability accounts based upon historical analysis and management's expectation of rate behavior. These assumptions are validated on a periodic basis. A sensitivity analysis of key variables of the valuation analysis is provided to the ALPC monthly and is used to guide asset/liability management strategies. The Company also uses duration of equity as a measure of interest rate risk. The duration of equity is a measure of the net market value sensitivity of the assets, liabilities and derivative positions of the Company. The duration of assets was 1.6 years at December 31, 2008, compared with 1.8 years at December 31, 2007. The duration of liabilities was 1.7 years at December 31, 2008, compared with 1.9 years at December 31, 2007. At December 31, 2008, the duration of equity was 1.2 years, unchanged from December 31, 2007.

2. An example of a bank holding companies that discloses net interest income simulation and gap analysis:

Old Point Financial Corp (TIC: OPOF), 2008 10-K
Item 7A. Quantitative and Qualitative Disclosures About Market Risk

This information is incorporated herein by reference from Item 7, "Management's Discussion and Analysis of Financial Condition and Results of Operations", on pages 14 through 33 of this report on Form 10-K.

Interest Sensitivity

An important element of earnings performance and the maintenance of sufficient liquidity is proper management of the interest sensitivity gap. The interest sensitivity gap is the difference between interest sensitive assets and interest sensitive liabilities in a specific time interval. This gap can be managed by repricing assets or liabilities, which are variable rate instruments, by replacing an asset or liability at maturity or by adjusting the interest rate during the life of the asset or liability. Matching the amounts of assets and liabilities maturing in the same time interval helps to hedge interest rate risk and to minimize the impact of rising or falling interest rates on net interest income.

The Company determines the overall magnitude of interest sensitivity risk and then formulates policies governing asset generating and pricing, funding sources and pricing, and off-balance sheet commitments. These decisions are based on management's expectations regarding future interest rate movements, the state of the national and regional economy, and other financial and business risk factors. The Company uses computer simulations to measure the effect of various interest rate scenarios on net interest income. This modeling reflects interest rate changes and the related impact on net interest income and net income over specified time horizons.

Based on scheduled maturities only, the Company was liability sensitive at the one-year timeframe as of December 31, 2008. It should be noted, however, that non-maturing deposit liabilities, which consist of interest checking, money market and savings accounts, are less interest sensitive than other market driven deposits. On December 31, 2008 non-maturing deposit liabilities totaled $187.1 million, or 29.89%, of total interest-bearing liabilities. In a rising rate environment these deposit rates have historically lagged behind the changes in earning asset rates, thus mitigating the impact from the liability sensitivity position. The asset/liability model allows the Company to reflect the fact that non-maturing deposits are less rate sensitive than other deposits by using a decay rate. The decay rate is a type of artificial maturity that simulates maturities for non-maturing deposits over the number of months that more closely reflects historic data. Using the decay rate, the model reveals that the Company is asset sensitive.

When the Company is liability sensitive, net interest income should decrease if interest rates rise since liabilities will reprice faster than assets. Conversely, if interest rates fall, net interest income should increase, depending on the optionality (prepayment speeds) of the assets. When the Company is asset sensitive, net interest income should rise if rates rise and should fall if rates fall.

The most likely scenario represents the rate environment as management forecasts it to occur. Management uses a "static" test to measure the effects of changes in interest rates on net interest income. This test assumes that management takes no steps to adjust the balance sheet to respond to the shock by repricing assets/liabilities, as discussed in the first paragraph of this section.

Under the rate environment forecasted by management, rate shocks in 50 to 100 basis point increments are applied to see the impact on the Company's earnings. The rate shock model reveals that a 50 basis point decrease in rates would cause an approximate 1.87% annual decrease in net income. The rate shock model reveals that a 100 basis point rise in rates would cause an approximate 3.11% annual increase in net income and that a 200 basis point rise in rates would cause an approximate 5.86% annual increase in net income. (emphasis added)

TABLE III
INTEREST SENSITIVITY ANALYSIS

As of December 31, 2008 (in thousands)	Within 3 Months	4-12 Months	1-5 Years	Over 5 Years	Total
Uses of funds					
Federal funds sold	$ 17,814	$ —	$ —	$ —	$ 17,814
Taxable investments	8,913	20,252	55,308	921	85,394
Tax-exempt investments	500	2,104	8,474	3,583	14,661
Total investments	27,227	22,356	63,782	4,504	117,869
Loans					
Commercial	32,908	3,783	19,845	13,816	70,352
Tax-exempt	—	—	—	2,738	2,738
Consumer	2,468	2,580	26,982	8,760	40,790
Real estate	119,322	28,493	282,820	90,204	520,839
Other	1,373	547	312	501	2,733
Total loans	156,071	35,403	329,959	116,019	637,452
Total earning assets	$ 183,298	$ 57,759	$393,741	$120,523	$755,321
Sources of funds					
Interest-bearing transaction accounts	$ 12,902	$ —	$ —	$ —	$ 12,902
Money market deposit accounts	135,791	—	—	—	135,791
Savings accounts	38,412	—	—	—	38,412
Time deposits $100,000 or more	32,591	69,934	25,237	—	127,762
Other time deposits	37,648	96,730	73,524	—	207,902
Federal funds purchased, repurchase agreements and other borrowings	33,282	—	—	—	33,282
FHLB advances	70,000	—	—	—	70,000
Total interest bearing liabilities	$ 360,626	$ 166,664	$ 98,761	$ —	$626,051
Rate sensitivity GAP	$(177,328)	$(108,905)	$294,980	$120,523	$129,270
Cumulative GAP	$(177,328)	$(286,233)	$ 8,747	$129,270	

3. An example of a bank holding company that only discloses economic value of equity simulation
(Note: economic value of equity is also called market value of portfolio equity):

Royal Bancshares (TIC: RBPAA), 2008 10-K
ITEM 7A. QUANTITATIVE AND QUALITATIVE DISCLOSURE ABOUT MARKET RISK
A simulation model is used to estimate the impact of various changes, both upward and downward, in market interest rates and volumes of assets and liabilities on the net income. This model produces an interest rate exposure report that forecast changes in the market value of portfolio equity under alternative interest rate environment. The market value of portfolio is defined as the present value of existing assets and liabilities. The calculated estimates of changes in the market value of portfolio value are as follows:

	As of December 31, 2009	
(In thousands, except percentages)	Market Value of	Percent of
Changes in Rates	Portfolio Equity	Change
+ 200 basis points	$ 79,554	(21.56%)
+ 100 basis points	92,611	(8.69 %)
Flat rate	101,423	0.00 %
- 100 basis points	103,343	1.89 %
- 200 basis points	103,555	2.10 %

The assumptions used in evaluating the vulnerability of earnings and capital to changes in interest rates are based on management's considerations of past experience, current position and anticipated future economic conditions. The interest rate sensitivity of assets and liabilities as well as the estimated effect of changes in interest rates on the market value of portfolio equity could vary substantially if different assumptions are used or actual experience differs from what the calculations may be based.

CHAPTER THREE:

LITERATURE REVIEW

This chapter reviews literature in accounting and finance, highlighting the findings of prior research relevant to my study on interest rate risk disclosure and interest rate risk management. In the first section, I discuss literature related to interest rate risk disclosures. In the second section, I review the papers that link interest rate risk to financial institutions' profitability.

1. Literature Related to Interest Rate Risk Disclosures

1.1 An Overview of Literature on Voluntary Disclosures

There are numerous studies in the accounting literature on corporate disclosure (see Healy and Palepu, 2001 and Beyer et al., 2012 for a review), which includes mandatory disclosure and voluntary disclosure. Heitzman, Wasley and Zimmerman (2010) construct a disclosure framework incorporating managers' voluntary disclosure incentives and managers' obligations to disclose material information under mandatory disclosure requirements. They develop the concept of a materiality threshold in corporate disclosures and demonstrate that since tests of the voluntary disclosure incentives in the prior literature often capture both voluntary and mandatory disclosures, interpretations of those tests may be problematic.

With respect to interest rate risk disclosure under the SEC's FRR 48, interest rate risk is a material market risk to a BHC due to its role as a financial intermediary. Thus, information on interest rate risk can be considered as above the materiality threshold discussed in Heitzman, Wasley and Zimmerman (2010). Furthermore, within the SEC's mandatory requirement, bank managers have considerable flexibility in choosing disclosure types and content (Hodder, Koonce and McAnally, 2000). Therefore, interest rate risk disclosure may be viewed as a voluntary disclosure of one, two or three interest rate risk measures (i.e., maturity gap, net interest income simulation, economic value of equity simulation) rather than as mandatory disclosure.

Prior researchers discuss a number of factors that affect managers' voluntary disclosure choices: signaling (e.gl, Trueman, 1986), raising external capital (e.g., Lang and Lundholm, 1993), corporate control contests (e.g., Brennan, 1999), stock-based compensation (e.g., Nagar, Nanda and Wysocki, 2003), litigation costs (e.g., Skinner, 1994), and proprietary costs (e.g., Bamber and Cheon, 1998), analyst following (e.g., Lang and Lundholm, 1996), among others. In examining the determinants of variations in interest rate risk disclosures, I relate disclosure choices to management's signaling of operational sophistication. In addition, I investigate banks' operational characteristics that affect banks' interest rate risk exposure.

1.2 Literature on FRR 48 Market Risk Disclosures (Other Than Interest Rate Risk Disclosure)

The SEC's FRR48 addresses market risks arising from changes in interest rates, foreign currency exchange rates and commodity prices that affect market risk sensitive instruments (SEC, 1997). It requires registrants to present estimates of market risk in one of three alternative formats: a tabular format of financial instruments, sensitivity analysis or value at risk.

The first descriptive evidence on companies' practices in disclosing market risk under FRR 48 is provided by Roulstone (1999). He reviews the SEC market risk disclosures made by 25 randomly-selected non-financial firms. He documents that market risk disclosures under FRR 48 have improved greatly from those under SFAS No. 119, but that the disclosures vary in detail and clarity.

Several papers (Linsmeier et al., 2002; Thornton and Welker, 2004; Sribunnak and Wong, 2004) focus on the decision usefulness of market risk disclosure by investigating how the disclosure enables capital market participants to assess market risk. In testing their hypotheses, these papers examine whether there is a difference in trading volume sensitivity or stock price sensitivity to market risk exposure before and after the disclosure. Linsmeier et al. (2002) hypothesize that FRR 48 reduces investors' uncertainty and diversity of opinion regarding changes in interest rates, foreign exchange rates and commodity prices. Consequently, the reduction of uncertainty would dampen trading volume sensitivity to changes in underlying market rates or prices. Using a sample of non-financial firms, the authors examine the relation between absolute changes in underlying market rates/prices and firms' trading volume before and after the disclosure of FRR 48. They find a decline in trading volume sensitivity to underlying market rates/prices changes after disclosure of FRR 48, suggesting that FRR 48 provides useful information which reduces investors' uncertainty and diversity of opinion about the implication of market rates/prices changes on firm value.

In the same vein as Linsmeier et al. (2002), Thornton and Welker (2004) study oil and gas companies' market risk disclosure of changes in commodity prices. They hypothesize that disclosures of sensitivity or value-at-risk, as mandated by FRR 48, increase the precision of investors' information about commodity price exposures, thus altering investors' assessment of commodity betas (i.e., stock price sensitivity to commodity price changes) around 10-K filing dates. As hypothesized, the authors find significant shifts in commodity betas for companies disclosing commodity price sensitivity or value-at-risk. In contrast, they do not find similar shifts in non-disclosers. They conclude that these results are consistent with disclosures under FRR 48 providing useful information to investors.

Sribunnak and Wong (2004) examine foreign exchange sensitivity analysis disclosures for a sample of Fortune 500 non-financial firms for years 1997 to 1999. They document that about two-thirds of these firms reported using foreign exchange derivatives. They focus on the subset of 43% of foreign exchange derivatives users that choose sensitivity analysis. They estimate a probit selection model to distinguish the sensitivity analysis and use the Heckman two-stage procedure to correct for potential sample selectivity bias. They find that entity-level earnings sensitivity disclosure exhibits incremental predictive power for market-based exchange rate exposure and stock return volatility. However, derivatives-level fair value sensitivity disclosure does not have explanatory power for market-based exchange rate exposure or stock return volatility.

One paper explores the value relevance of market risk disclosure. Specifically, Lim and Tan (2007) examine whether FRR 48 value-at-risk estimates disclosed by 81 non-financial firms during the period 1997 to 2002 are value relevant using the earnings-returns association. Their results indicate that high value-at-risk is associated with a weaker earnings-returns relation. They find that value-at-risk estimates are informative for the set of non-financial firms in that investors use the value-at-risk estimates of risk exposures to assess earnings informativeness.

Two papers study the ability of value-at-risk measures in predicting the variability of trading revenues for financial institutions. Jorion (2002) examines trading value-at-risk disclosed by eight U.S. banks from 1995 to 1999 and finds that value-at-risk disclosures have predictive ability with respect to the variability of banks' trading revenues. In extending Jorion (2002)'s findings, Liu, Ryan, and Tan (2004) examine trading value-at-risk disclosures of 17 banks under FRR 48 during 1997 to 2002. They find that banks' trading value-at-risk disclosures predict the variability of trading revenues and that the predictive power is positively related to the banks' technical sophistication. They also show that trading value-at-risk has predictive power for return variability, beta, and realized returns.

1.3 Literature on Interest Rate Risk Disclosures

Three studies have examined interest rate risk disclosures in BHCs' annual reports. Ahmed, Beatty and Takeda (1997) are the first to document banks' interest rate risk disclosures using 1994 annual reports. They provide descriptive evidence on banks' interest rate risk disclosures and derivatives use by examining interest rate risk disclosures in 152 BHCs' 1994 annual reports. They find that most banks disclose maturity gap analysis in annual reports and the magnitude of maturity gap is positively related to liquidity and non-performing loans, and negatively related to bank size.

Hodder and McAnally (2001) point out that due to the flexibility provided in FRR 48 in choosing different disclosure formats and in applying firm specific assumptions, market risk disclosures lack comparability. They use three BHCs' interest rate risk disclosures to illustrate how financial analysts may convert the tabular format of markets risk disclosure into the sensitivity format and the value-at-risk format with analysts' own assumptions.

My study is mostly closely related to Hodder (2001), which is the only paper that provides large sample evidence regarding BHCs' interest rate risk disclosure. Specifically, she examines the relevance and reliability of interest rate sensitivity from simulation disclosed in BHCs' annual reports. Her sample contains 375 separate BHCs over the three-year period beginning with 1997 and ending with 1999. To examine the reliability, she assesses the association of interest rate sensitivity disclosures and realized performance. The results show that the SEC income and economic value of equity sensitivity disclosures are not reliable, in the sense that they have little association with future changes in income or fair values, conditional on actual changes in interest rates. To evaluate the relevance, she provides evidence on the extent to which these disclosures are useful in explaining the firm's cost of equity. The tests on relevance provide no evidence that SEC income or fair value sensitivities are relevant to the cost of equity or other observable measures of bank risk. In summary, Hodder (2001) points out that the interest rate risk simulations disclosed by BHCs are poor forecasts of actual performance, and are not related to cost of capital, thus lacking both reliability and relevance.

1.4 Summary

My study on interest rate risk disclosure extends prior literature on market risk disclosures, including interest rate risk disclosures, in several ways. First, I investigate the factors affecting management interest rate risk disclosure choices, which has not been studied by prior researchers.

Second, in examining the information contents of interest rate risk sensitivity disclosures, I examine changes in trading volatility and stock price around the filing dates to explore whether the disclosure provides incremental information to investors. In contrast, the previous research (Hodder, 2001) assesses whether interest rate risk sensitivity disclosure has predictive power over one-year ahead earnings and economic value of equity, and whether the disclosure affects banks' cost of capital.

2. Literature on Interest Rate Risk of Financial Institutions

2.1 Literature on Risk Management and Interest Rate Risk

Risk management has received considerable academic attention for the past several decades and especially during the recent financial crisis. While early literature, notably Modigliani and Miller (1958), proposes that risk management is irrelevant under perfect market conditions because investors can manage risk for themselves, researchers have long argued that the existence of market imperfections necessitates risk management and that risk management can increase firm value. Benefits of risk management can be classified as a reduction in expected costs related to financial distress, underinvestment, tax payment, asymmetric information and an undiversifiable risk of stakeholders (see Stulz, 1984; Smith and Stulz,1985; Nance, Smith and Smithson; 1993; Froot, Scharfstein and Stein, 1993; Leland, 1998 among others).

Banks' interest rate risk management is different from non-financial firms in that interest rate risk management for banks is essential not only to mitigate risk and reduce expected costs, but also to directly profit from interest rate risk exposure.[5] To meet the demands of customers and to execute business strategies, banks make loans, purchase securities, and take deposits with different maturities and interest rates. These activities leave banks exposed to interest rate risk, and banks cannot be profitable without taking interest rate risk (Collins, Lai and McNulty, 1997).

The popularity of measuring and managing interest rate risk came with the advent of money market certificates in 1978, the Federal Open Market Committee policy change in 1979, and the phasing out of Regulation Q in 1980. These financial deregulations changed the norm in which banks used to operate and manage interest rates on assets and liabilities (Gardner and Mills, 1981). Furthermore, as a consequence of the savings and loan crisis in the 1980s, the banking industry and the academic community have paid very close attention to interest rate risk. The vast majority of academic studies on the interest rate risk of financial institutions appear in the 1980s and 1990s (see Staikouras, 2003, 2006 for review). Generally speaking, the literature falls into two distinctive yet closely related streams. One stream of literature focuses on the

[5] In the practice of bank management, in a broad sense interest rate risk management can be referred to as asset-liability management, which is a mechanism to address the risk faced by a bank due to a mismatch between assets and liabilities either due to liquidity or changes in interest rates. Financial institutions create asset-liability management committees to govern asset-liability management.

effect of duration gap (proxied by maturity gap in empirical papers) on financial institutions' stock price sensitivity to interest rates. It is related to interest rate risk from the economic perspective. The other stream of literature studies interest rate risk as a determinant of financial institutions' profitability. It is related to interest rate risk from the earnings perspective. My study on interest rate risk management as related to earnings is related to the second stream of literature that links interest rate risk and financial institutions' profitability. I review this stream of literature below.

2.2 Literature on Interest Rate Risk and Profitability

The seminal study of the determinants of banks' profitability (measured by net interest margins) starts with the analytical model in Ho and Saunders (1981). Ho and Saunders (1981) analyze banks' profitability using the expected utility approach. In their model, a bank is assumed to be a risk-averse dealer in the loan and deposit market where the loan requests and deposit supplies arrive non-synchronously and the bank is assumed to maximize its expected utility of wealth. They show that the optimal pure spread (i.e., banks' profitability) depends on the degree of management risk aversion, the size of bank transactions, the banking market structure, and interest rate volatility.

The analytical model in Ho and Saunders (1981) has been expanded in subsequent papers (e.g., Allen, 1988; Angbazo, 1997; Hanweck and Ryu; 2005). Allen (1988) considers various types of loans with interdependent demand and posits that the optimal pure spread may be reduced as a result of product diversification. In the theoretical modeling part of his paper, Angbazo (1997) incorporates credit risk. Furthermore, in the theoretical modeling part of Hanweck and Ryu (2005), the authors present a dynamic model that overcomes the static limitation of the previous models and that considers production-line specializations.

In addition to the studies that analytically model banks' profit-generating behaviors, the majority of papers empirically examine factors that contribute to banks' net interest income or net interest margin. One of the first empirical studies is Flannery (1981). He develops a method to estimate average asset and liability maturities for a sample of large banks, and tests whether banks' profitability is subject to interest rate fluctuation because of differences in their asset and liability maturities. He finds that large banks effectively hedge themselves against interest rate risk by assembling asset and liability portfolios with similar average maturities. However, his finding that large banks are not interest rate sensitive is different from most later literature.

Saunders and Schumacher (2000) test the analytical model in Ho and Saunders (1981) using data from six European countries and the United States for the period 1988 to 1995. The authors find that market interest rate volatility and regulatory requirements, including interest rate restrictions on deposits, reserve requirements and leverage ratios, have significant effects on net interest margins across these countries.

Angbazo (1997) uses call report data from 1989 to 1993 to investigate determinants of banks' profitability. Regressing net interest margins on proxies for interest rate risk (measured by maturity gap), credit risk, liquidity and leverage, he finds that net interest margins of money-center banks are affected by credit risk, but not by interest rate risk, which is consistent with these banks' greater concentration in short-term assets and derivative hedging instruments. By contrast, regional banking firms' net interest margins are sensitive to interest rate risk but not to credit risk. He concludes that net interest margins of commercial banks reflect both credit risk and interest rate risk premiums.

Using quarterly regulatory data from 1986 to 2003, Hanweck and Ryu (2005) extend the Ho and Saunders (1981) framework by incorporating banks' product-line specializations. They find that banks with different product-line specializations and asset sizes respond in dissimilar ways to interest rate risk changes and credit risk changes. They also find that the maturity gaps of different repricing frequencies moderate the effects of changes and volatility in short-term market interest rates on bank net interest margins.

Lai and Hanssan (1997) and Collins, Lai and McNulty (1997) use a simultaneous-equations model that jointly determines maturity gaps and net interest margins. Using annual data for the majority of the population of insured commercial banks for the years 1984 to 1987 (the only years for which repricing data were collected), Lai and Hanssan (1997) find that net interest margins are significantly associated with various maturity gaps for banks with assets of less than $300 million. Collins, Lai and McNulty (1997) evaluate the relation of maturity gap positions and net interest margins in determining thrift portability. Using data on thrifts spanning the period 1984 through 1988, they argue that the industry could not be reasonably profitable if thrifts did not take on significant interest rate risk. They estimate that over 50% of thrift profits earned during this period were the result of negative maturity gap positions.

Ahmed, Beatty and Bettinghaus (2004) investigate the efficacy of one-year maturity gap in explaining future changes in the net interest income of banks. Rather than directly use one-year maturity gap disclosure in banks' annual reports, as in Ahmed, Beatty and Takeda (1997), the authors use proxies estimated from banks' call reports. The authors find that both the fixed and variable one-year maturity gap are significantly related to changes in net interest income, and interpret it as evidence in support of maturity gap's efficacy as a risk measurement tool. However, the discussants of the paper (Allen, 2004; Thornton, 2004) reach less sanguine conclusions. Thornton (2004) comments that the estimated coefficients on maturity gap measures are economically too small. Allen (2004) comments that the greatest explanatory power of the maturity gap model comes from changes in asset size, while the explanatory power of maturity gap measures is very low. The discussants cast doubt on the efficacy of maturity gap in estimating the impact of changes in market interest rates on banks' net interest income. Both discussants suggest that a venue for future research is to use actual maturity gap disclosed in banks' annual reports, rather than use the proxy estimated from call reports, and examine the efficacy of maturity gap and change in net interest income.

2.3 Summary

This dissertation contributes to the literature on interest rate risk in several ways. Existing papers have used different measures for banks' interest rate risk. Some studies use changes in market interest rates (e.g., Hanweck and Ryu, 2005; Saunders and Schumacher, 2000), but such measures only reflect interest rate risk exposure faced by banks and do not reflect banks' interest rate risk management. Other papers use maturity gap (e.g., Lai and Hanssan, 1997; Collins, Lai and McNulty,1997; Hanweck and Ryu, 2005). Yet maturity gap blurs the difference between interest rate risk management and its resultant interest rate risk exposure, in that maturity gap, on one hand, is a traditional measure of interest rate risk exposure and, on the other hand, is an outcome of interest rate risk management. Furthermore, due to the lack of a clear proxy for interest rate risk management, researchers have not explored *how* banks profit from managing interest rate risk. I extend the literature by developing measures that explicitly capture the process and outcome of interest rate risk management in generating net interest income.

I also contribute to the existing literature by developing the α-gap model that decomposes changes in net interest income into rate variances and volume variances. This provides a framework for future research to develop new testable hypotheses and conduct empirical investigation into banks' net interest income generating activities and interest rate risk management.

Furthermore, in estimating rate sensitive liabilities (as part of the calculation of maturity gap) using the regulatory filings such as call reports or FR Y-9C, there is a lack of consensus as to what proportion of non-maturity deposits to include. Most papers exclude non-maturity deposits from rate sensitive liabilities (e.g., Flannery and James, 1984b; Lai and Hanssan, 1997; Hanweck and Ryu, 2005), while some papers include an ad hoc portion of non-maturity deposits in rate sensitive liabilities (e.g., Purnanandam; 2007). A few researchers have suggested that a venue for future research is to use maturity gap disclosed in banks' annual reports rather than use banks' regulatory filings (Thorton, 2004; Allen, 2004). My study sheds light on this issue by comparing the dollar amount of rate sensitive assets and liabilities obtained from maturity gap analysis from BHCs' 10-Ks and those estimated from FR Y-9C. On average, I find that rate sensitive liabilities obtained from maturity gap analysis in 10-Ks are equivalent to including 25% of non-maturity deposits plus other rate sensitive liabilities using data from FR Y-9C.

CHAPTER FOUR:

BANK HOLDING COMPANIES' INTEREST RATE RISK DISCLOSURES

1. Introduction

This study empirically examines interest rate risk disclosures in bank holding companies' (BHCs, hereafter) 10-K filings. Interest rate risk is the uncertain effect that changes in market interest rates have on a firm's earnings and economic value of equity. Successfully measuring, managing and monitoring interest rate risk is essential to the profitability and, in some cases, survival of a financial institution.

There are significant risks to financial institutions as a result of the recent historically low interest rate environment, and banking regulators have a heightened interest in monitoring interest rate risk in order to prevent systemic risks. Financial regulators issued *Advisory on Interest Rate Risk Management* in 2010 to remind financial institutions of sound practices for measuring interest rate risk, and where necessary, mitigating exposure to potential increases in interest rates (Federal Financial Institutions Examination Council, 2010).

Given the importance of interest rate risk, the past several decades have seen numerous studies on interest rate risk in financial institutions (see Staikouras, 2003, 2006 for reviews). However, only a few papers examine the disclosure of interest rate risk by financial institutions (Hodder, 2001; Ahmed, Beatty and Takeda, 1997). This is not surprising as financial institutions' disclosures are often considered to be complex and lacking transparency (e.g., Levine, 2004).

This paper explores BHCs' interest rate risk disclosures by (1) documenting what interest rate risk measures are disclosed in the annual reports of BHCs, (2) identifying the factors that affect BHCs' choice of interest rate risk disclosures, and (3) examining whether interest rate risk disclosures provide incremental information to investors.

There are various interest rate risk measurement techniques that BHCs can use, ranging from gap analysis to simulations. Banking regulators recommend a well-managed bank measure interest rate risk exposure from the earnings perspective by using gap analysis and net interest income (NII, hereafter) simulation and from the economic perspective by using economic value of equity (EVE, hereafter) simulation (the Office of the Comptroller of the Currency, 1997).

The earnings perspective focuses on the short term and measures interest rate risk in terms of earnings. Gap analysis and NII simulations provide interest rate risk measures from the earnings perspective. Gap analysis reports the entire book value of each main type of interest-earning asset and interest-bearing liability that reprices in various time buckets. NII simulation uses simulation models to measure the degree to which NII will change given a change in market interest rates.

In contrast, the economic perspective focuses on the long term and measures interest rate risk in terms of EVE.[6] EVE simulation uses models to measure the degree to which the present value of assets and liabilities will change given market interest rate changes.

My analysis is based on a sample of 2,261 firm-year observations consisting of 336 unique public commercial BHCs and thrift holding companies from fiscal years 1997 to 2009.[7] My sample starts in fiscal year 1997 because Financial Reporting Release No. 48 (FRR 48, hereafter), issued by the Securities and Exchange Commission (SEC, hereafter), mandates firms

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[6] EVE is calculated as the difference between the present value of asset cash flow and the present value of liability cash flow. Because cash flow has principal and interest components, EVE is comprised of two ingredients: the present value of carrying equity and the present value of NII (Payant, 2007).

[7] My sample does not include the BHCs that are members of the British Banking Association involved in manipulating LIBOR, but including them does not change the inferences in my regression analyses.

disclose market risks beginning in that year. I obtain interest rate risk disclosures from 10-K filings and record the type of interest rate risk measures provided: gap analysis, NII simulation, and/or EVE simulation.

When disclosing interest rate risk, managers in BHCs have considerable flexibility (Hodder, Koonce and McAnally, 2000). Indeed, interest rate risk disclosures have significantly changed from 1997 to 2009. For example, the most frequently chosen disclosure in 1997 was gap analysis only without any simulations, accounting for 59.4% of BHCs. This percentage dropped to 8.1% in 2009. In contrast, the most frequently chosen disclosure in 2009 was to disclose only NII simulation, accounting for 26.6% of all BHCs, increasing sharply from 3.8% in 1997.

I rank interest rate risk disclosures into different orders using three criteria: number of interest rate risk measures disclosed, technique sophistication and the earnings orientation of managers and investors. I consider interest rate risk disclosure as a function of the use of interest rate risk measurement techniques and the incentives to disclose them. Nontraditional banking activities, time deposit funding source and use of derivatives impact BHC's interest rate risk exposure, thus affecting interest rate risk disclosure.[8] In addition, BHCs that use more sophisticated interest rate risk measures may have the incentive to disclose these measures in order to signal technological sophistication. Furthermore, institutional investors and analysts may impact interest rate risk disclosure.

[8] Gorton and Rosen (1995) define the traditional activities of a bank as the financing of loans with deposits to generate net interest income. Nontraditional banking activities include all other activities generating noninterest income. In regulatory filings, noninterest income includes income from fiduciary activities, service charges on deposit accounts, fees and commissions from brokerage and investment banking, trading revenues, as well as insurance income.

I divide my sample into quartiles by total assets to control for the well-known size effect in banks (e.g., Demsetz and Strahan, 1997; Haan and Poghosyan, 2011). I find that the determinants of interest rate risk disclosures differ significantly for large and small BHCs.

Ex ante, nontraditional banking activities could be negatively associated with interest rate risk disclosure, as nontraditional banking activities decrease interest rate risk exposure and thus decrease the use of sophisticated interest rate risk measures, or positively associated with interest rate risk disclosure, if BHCs intend to signal their operational sophistication and technological advances. For large BHCs, I find a positive relation between the level of nontraditional banking activities and interest rate risk disclosure. This positive effect of nontraditional banking activities for large BHCs suggests the dominating effect of the signaling incentive. In addition, I find a positive association between the percentage of time deposit funding and interest rate risk disclosure, suggesting that large BHCs with a higher level of time deposit funding have more interest rate risk exposure and are thus more likely to disclose interest rate risk. There is a negative association between derivative usage and interest rate risk disclosure, suggesting that large BHCs regard derivatives as a means to reduce interest rate risk exposure. Additionally, higher institutional ownership is positively associated with interest rate risk disclosure.

For small BHCs, I find a negative relation between the level of nontraditional banking activities and interest rate risk disclosure, suggesting that for small BHCs, interest rate risk disclosure is driven by the level of interest rate risk exposure from the asset side. I also find a positive relation between the level of time deposit funding and interest rate risk disclosure. I did not find a significant association between derivative usage and interest rate risk disclosure. Turning to institutional investors, for small BHCs there is a negative association between the percentage of institutional ownership and interest rate risk disclosure, suggesting investors' emphasis on the earnings perspective, rather than on the economic perspective.

In supplemental analysis, I investigate changes in interest rate risk disclosures, including adding NII simulation, adding EVE simulation and dropping gap analysis. I find that the determinants of interest rate risk disclosure also impact the likelihood of changing interest rate risk disclosures.

Turning to the information usefulness of interest rate risk disclosure, prior research has provided mixed evidence. I apply two approaches that are different from the prior literature and, overall, I find simulation disclosures provide incremental information to investors.

First, using BCHs that disclose simulation for the first time, I examine the information content of simulation disclosure. I find that, for BHCs disclosing only NII simulation for the first time, the mean and median of abnormal trading volume measures are greater than those of matched firms, but there is no significant difference in abnormal return volatility. Additionally, there is weak evidence that disclosing both NII and EVE simulations for the first time results in greater abnormal trading volume.

Second, I examine whether the market reacts differently to information on projected profitability and equity value implied in changes in NII and EVE sensitivity disclosures from the previous filing period to the current filing period. I collect data for the 50 largest BHCs in my sample from the end of 2003 through 2005 from 10-Ks and10-Qs (when interest rate risk measures were disclosed in 10-Qs). For BHCs disclosing interest rate risk measures in both 10-Ks and 10-Qs, I find higher two-day cumulative abnormal returns around the filing dates for BHCs whose simulation disclosures project improved profitability or enhanced equity value.

This paper makes several contributions. First, since the financial crisis, there is a renewed interest in enhancing disclosures of credit risk, interest rate risk and liquidity risk (FASB 2010, 2012). In June 2012, the FASB proposed the Accounting Standards Update to Financial Instruments (Topic 825), which would require a financial institution to disclose gap analysis with off-balance-sheet items and NII and EVE sensitivities in every interim and annual reporting period (FASB, 2012). This paper shows that NII and EVE simulation disclosures provide incremental information to investors. Thus, the Financial Accounting Standard Board (FASB) proposed Update has the potential to increase the information usefulness of interest rate risk disclosures by making interest rate risk disclosures more consistent and comparable than under FRR 48 (FASB, 2012).

Second, this study enriches the literature on the SEC's FRR 48 disclosures. Prior research on FRR 48 (e.g., Hodder, 2001; Linsmeier et al. 2002; Liu, Ryan and Tan, 2004) focuses on decision usefulness and the economic consequences of market risk disclosures. The sample periods in those papers are a few years before or after 1997 (as 1997 is the year when FRR 48 was adopted), and the sample periods usually end in the early 2000s. Different from prior papers, my study investigates institutions' operational characteristics and management incentives underlying the observed interest rate risk disclosures. Furthermore, I document the trends in interest rate risk disclosure choices and explore the determinants of disclosure over a longer time period from 1997 through 2009, during which the regulatory and interest rate environments have changed significantly since prior research was conducted.

Third, my research should be of interest to banking regulators. Banking regulators have emphasized measuring interest rate risk using simulation techniques, especially EVE simulation from the economic perspective. While this study documents the increased use of simulations over time, this study also finds that the use of EVE simulation remains below 50% among BHCs. Furthermore, my research examines the factors affecting interest rate risk disclosures. Banking regulators' understanding of the link between banks' operational characteristics and the usage and disclosure of recommended interest rate risk measurement techniques will help inform future decisions about the application of effective banking regulation. This understanding will also allow for a more tailored examination of banks' interest rate risk management.

This paper proceeds as follows. Section 2 discusses the background and reviews the literature. Section 3 develops hypotheses of the determinants of interest rate risk disclosures. Section 4 presents the sample, variables and descriptive statistics. Section 5 reports the regression analysis on the determinants of interest rate risk disclosures. Section 6 reports the analysis on changes in interest rate risk disclosures. Section 7 investigates the information usefulness of interest rate risk disclosures. Section 8 concludes.

2. Background and Literature Review

2.1. Background on Interest Rate Risk Measurement and Disclosure

2.1.1 Interest Rate Risk Measurement Techniques

There are two different but complementary perspectives for measuring interest rate risk: the earnings perspective and the economic perspective (OCC, 1998). The earnings perspective focuses on the short term (usually one year) and measures interest rate risk in terms of earnings. It quantifies interest rate risk as the change in earnings caused by a change in interest rates. In contrast, the economic perspective focuses on the long term and measures interest rate risk in terms of economic value. It quantifies interest rate risk as the change in economic value of equity that occurs as asset and liability portfolio values rise and fall with changes in interest rates.[9] The linkage between the earnings and economic perspectives is that EVE is an indicator for the long-term earnings capacity residing in financial positions on the balance sheet.

There are various techniques available to measure interest rate risk that focus on the earnings perspective and/or the economic perspectives. These techniques include gap analysis, duration analysis, earnings simulation and EVE simulation. Maturity gap analysis originated in the 1970s (Kaufman, 1972; Clifford, 1975a,b). It is generally regarded as a measure of earnings sensitivity to interest rate changes by banks and regulators (OCC, 1996). Despite its wide usage, well-known shortcomings are inherent in gap analysis.[10]

Duration analysis was introduced into banks' risk management during the late 1970s and 1980s. Although the duration concept is a cornerstone of interest rate risk management, duration analysis cannot handle large changes in rates, nor can it handle administered interest rates. A more sophisticated alternative to duration analysis is EVE produced by simulation models.[11]

Simulations are potentially valuable tools to capture the size and direction of a bank's interest rate exposure. They use dynamic models with the ability to incorporate a wide variety of possible interest rate scenarios and complicated on-balance-sheet and off-balance-sheet asset and liability positions. Simulations include earnings simulation and EVE simulation. Earnings

[9] EVE is different from regulatory capital. EVE is used to measure interest rate risk exposure, while regulatory capital is to ensure capital adequacy against financial stress or credit risk. Regulatory capital refers to the capital requirement by regulatory agencies that determines how much capital is required to be held for a certain level of risk-weighted assets. The capital requirements are put into place for depository institutions to ensure that these institutions are not participating or holding investments that increase the risk of default.

[10] For example, gap analysis is a static measure which assumes no growth and cannot handle different degrees of change in rates of assets and liabilities; it cannot deal with embedded options such as prepayment and early withdrawal; it cannot reflect the interest rate sensitivity of off-balance-sheet positions such as loan commitments.

[11] While duration analysis infers the sensitivity of financial instruments to interest rate change, EVE infers the market value or present value (Matz, 2009). I do not include duration analysis disclosures in my study because few BHCs state that they use duration analysis or disclose the duration of their assets and liabilities.

simulation measures NII or net income sensitivity to rate changes over the one or two year.[12] EVE simulation measures EVE sensitivity to rate changes. Compared to gap analysis, simulations require a large amount of data and assumptions. The accuracy of simulation outcomes depends on how carefully data are collected and assumptions are developed. In addition, although simulation models provide specific measures of interest rate risk exposure, the measures could be less revealing because the inputs are hard to observe or verify by outsiders, and therefore interest rate risk exposure could be inadvertently or intentionally misstated (Matz, 2009).

2.1.2. Regulators' Views on Interest Rate Risk

In light of the Savings and Loan Crisis in the 1980s, banking regulators have taken measures to address interest rate risk in banks and thrifts with a growing emphasis on simulation techniques and the economic perspective on interest rate risk. Appendix A describes important documents regarding banking regulators' views on interest rate risk.

2.1.3. Interest Rate Risk Disclosures by BHCs

FRR 48 requires public companies to disclose market risk in their 10-K filings, as well as in their 10-Q filings, if there are material changes in reported market risks since the 10-K was filed. Market risk from interest rate movements represents a major market risk inherent in banking. In disclosing interest rate risk, most BHCs start with stating who monitors interest rate risk (usually the Asset and Liability Management Committee or a similar committee), and what interest rate risk policies and procedures are in place. BHCs then disclose at least one type of

[12] Theoretically, earnings simulation can be income simulation or NII simulation. In my sample, only a few BHCs disclose net income simulation. Therefore, I use NII simulation as earnings simulation. Income simulation, if disclosed in rare cases, is counted as NII simulation.

interest rate risk measurement. Appendix B provides an example of a BHC that disclosed net interest income simulation and gap analysis.

2.2 Literature Review

2.2.1 Literature on Disclosures

There are numerous studies in the accounting literature on corporate disclosure (see Beyer et al., 2012 for a review). One strand of literature studies the determinants of corporate disclosure policy. Under mandatory disclosure requirements, firms may still have considerable discretion when faced with disclosure decisions (e.g., Heitzman, Wasley and Zimmerman, 2010). In disclosing interest rate risk under FRR 48, managers have considerable flexibility in choosing disclosure types and content (Hodder, Koonce and McAnally, 2000). Yet no existing papers have studied the determinants of disclosure related to FRR 48.

Another stand of literature studies the decision usefulness and economic consequences of disclosure. In the realm of interest rate risk disclosure and FRR 48, existing research has focused on the decision usefulness and economic consequences of the disclosure, which are discussed below.

2.2.2 Literature on FRR 48

Several studies examine FRR 48 disclosures by non-financial companies. Linsmeier et al. (2002) and Thornton and Welker (2004) investigate changes in trading volume and commodity beta shifts of oil and gas producers, respectively, around 10-K filing dates for first-time FRR 48 disclosures, and find that FRR 48 disclosures change the risk assessment of investors. Sribunnak and Wong (2004) examine foreign exchange sensitivity disclosures and find it difficult to compare the disclosures across firms due to the flexibility allowed by FRR 48.

They find mixed evidence on whether sensitivity disclosures have incremental predictive power for market-based exchange rate exposure and stock return volatility.

Two papers study FRR 48 disclosures by financial institutions. Liu, Ryan, and Tan (2004) examine the trading value-at-risk disclosures of 17 banks under FRR 48. They find that banks' trading value-at-risk predicts the variability of trading revenues and that the predictive power is positively related to the banks' technical sophistication. They also show that trading value-at-risk has predictive power for return variability, beta, and realized returns. In contrast, Hodder (2001) finds no evidence that interest rate risk disclosures for BHCs are relevant or reliable. I discuss Hodder (2001) in detail in the next section.

2.2.3 Literature on Interest Rate Risk Disclosures

There are only a few studies examining interest rate risk disclosures in BHCs' annual reports (Ahmed, Beatty and Takeda, 1997; Hodder, 2001). Ahmed, Beatty and Takeda (1997) provide descriptive evidence on banks' interest rate risk disclosures and derivatives use by examining interest rate risk disclosures in the annual reports of 152 BHCs in 1994. They find that most banks disclose maturity gap analysis in annual reports and the magnitude of maturity gap is positively related to liquidity and non-performing loans, and negatively related to bank size. Hodder (2001) provides evidence on the relevance and reliability of disclosures of interest rate risk sensitivity results from simulation techniques in BHCs' 10-Ks for the years 1997 to 1999. She finds that interest rate risk sensitivity disclosures are poor forecasts of actual performance, and are not related to cost of capital, thus lacking both reliability and relevance.

My study is closest to Hodder (2001). However, my study differs from Hodder (2001) in that (1) I examine the factors affecting the choices of interest rate risk disclosures, which have not been studied in prior literature and (2) I utilize new approaches to investigate the information usefulness of NII and EVE sensitivities (discussed in Section 7).

2.2.4. Literature on Interest Rate Risk Sensitivities from Simulation

Regulatory bodies such as the Office of Thrift Supervision (OTS) and the Federal Reserve have their own simulation models to measure interest rate risk exposure, which are intended to monitor banks' interest rate risk. Several papers evaluate these interest rate risk simulation models and the overall conclusion is that the regulatory interest rate risk simulation models are capable of accurately measuring interest rate risk from the economic perspective (Wright and Houpt ,1996; Sierra and Yeager, 2004). The only existing paper that investigates the simulation models used by BHCs, rather than regulators, is Hodder (2001) as reviewed earlier.

3. Hypotheses Development on Determinants of Interest Rate Risk Disclosure

In this section, I identify the factors that affect BHCs' choice of interest rate risk disclosures. I first rank the combinations of the three types of interest rate risk measures- gap analysis, NII simulation and EVE simulation. Next, I investigate firm characteristics that affect interest rate risk disclosures.

3.1. Ordering Interest Rate Risk Disclosures

Managers' can utilize any combination of the three types of interest rate risk measures (i.e., gap analysis, NII simulation and EVE simulation) which results in seven total combinations of interest rate risk measures.[13]

[13] There are seven combinations because 2x2x2 – 1 = 7.

The seven combinations of disclosures can be rank ordered using three criteria: number of interest rate risk measures disclosed, technique sophistication and the earnings orientation of managers and investors.

For the first criterion, I consider three (two) interest rate risk measures to be a more comprehensive disclosure than two (one) of the three measures.

For the second criterion of technique sophistication, simulation techniques are more sophisticated than gap analysis and can overcome the shortcomings of gap analysis (Matz, 2009). Hence, I regard simulations from the earnings or economic perspectives as having more information usefulness compared to gap analysis.

The third criterion is the earnings orientation of managers and investors, who are likely to be more focused on short-term earnings than on the long-term economic value of a firm. In this regard, NII simulation can be considered a more important disclosure than EVE simulation.

Based on these three criteria, I rank the seven combinations of interest rate risk disclosures into four major order schemes, as shown in Appendix C. Therefore, based upon this ranking, it could be said that certain types or combinations of interest rate risk measures are more *extensive* in their ability to disclose interest rate risk.

How management assesses the order of interest rate risk disclosures should vary across different sizes of BHCs. For example, while both gap analysis and NII simulation are from the earnings perspective, larger BHCs may prefer NII simulation and smaller BHCs may still place emphasis on gap analysis. Ex ante, it is not clear how differently BHCs of various sizes would weigh these multiple factors.

3.2. BHCs' Characteristics Related to Interest Rate Risk Disclosure

As discussed above, the choice of interest rate risk disclosure is a function of both managers' use of interest rate risk measurement techniques and the incentives to disclose them. I consider the influence of nontraditional banking activities, time deposit funding, interest rate derivatives usage and capital market incentives in making disclosure choices.

3.2.1. Nontraditional Banking Activities

BHCs generate NII through traditional banking activities and noninterest income through nontraditional banking activities. Noninterest income has increased dramatically since the 1980s due to technological advances, financial product innovation, and regulatory and legislative changes (DeYoung and Rice, 2004). Nontraditional banking activities tends to reduce interest rate risk exposure because shifting from NII, which is highly sensitive to interest rate movements and business cycles, towards nontraditional fee-based income, which is much less sensitive to interest rate movements, yields the risk-reducing benefits of diversification.[14] Many studies support this argument. For example, Rogers and Sinkey (1999) find that commercial banks with higher levels of nontraditional activities have less exposure to interest rate risk. Thus, I expect a negative association between nontraditional banking activities and interest rate risk disclosure, as BHCs with less interest rate risk exposure are less likely to use sophisticated interest rate risk measures.

Related to using interest rate risk measures, BHCs choose which interest rate risk measures to disclose. BHCs may strategically disclose interest rate risk simulation measures to signal their technological advantages and operational sophistication. As BHCs with higher

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[14] Certain nontraditional banking activities have high interest rate risk. For example, the noninterest income arising from mortgage servicing and asset-securitization can be highly sensitive to changes in interest rates. However, in my sample, mortgage servicing (asset-securitization) income has a mean of 0.4% (0.08%) and a median of 0.04% (0%). Additional analysis does not find evidence that these components of noninterest income affect interest rate risk disclosures.

nontraditional banking activities tend to be larger and more sophisticated, these BHCs have a greater incentive to disclose interest rate risk simulation measures versus BHCs with lower nontraditional banking activities. In this regard, I expect a positive association between nontraditional banking activities and interest rate risk disclosure.

Ex ante, the association between nontraditional banking activities and interest rate risk disclosure can be (1) negative under the interest rate exposure argument or (2) positive if BHCs strategically disclose interest rate risk measures.

3.2.2. Time Deposit Funding

The three main categories of funding sources for a bank are non-maturity deposits, time deposits and nondeposit funding. Non-maturity deposits and time deposits (taken together, deposit funding) are the major funding sources. Non-maturity deposits do not have contractual maturity and have a low interest rate sensitivity (e.g., Flannery and James, 1984). Time deposits (i.e., certificate of deposits, or CDs) have predetermined maturities and are highly rate sensitive. Nondeposit funding is generally rate sensitive, but it only accounts for a small portion of funding sources for most banks (Demirguc-Kunt and Huizinga, 2012). Thus, on the funding side, interest rate risk exposure is likely to be primarily driven by time deposits. BHCs that rely on a higher percentage of time deposit funding are more likely to have greater interest rate risk exposure, and thus are more likely to use advanced interest rate risk measurement techniques. Accordingly, I expect a positive association between the percentage of time deposit funding and interest rate risk disclosure.

On the other hand, BHCs with less reliance on deposit funding tend to be larger and more sophisticated. Large and sophisticated banks are more likely to strategically disclose interest rate risk simulation to signal their operational sophistication. Thus, I expect a negative association between the percentage of time deposit funding and interest rate risk disclosure.

Taken together, the association between time deposit funding and interest rate risk disclosure can be (1) positive under the interest rate risk exposure argument, or (2) negative if BHCs strategically disclose interest rate risk measures to signal operational sophistication.

3.2.3. Derivative Use

BHCs engage in interest rate derivative contracts both as intermediaries and as end users. As an intermediary, the role of interest rate derivatives is for business purposes and not for interest rate risk management. As an end user, interest rate derivatives can be used to speculate or to hedge interest rate risk.[15]

A large body of research investigates whether banks use derivatives to hedge or to speculate and whether derivative use mitigates interest rate risk (e.g., Schrand, 1997; Purnanandam, 2007). Because the use of interest rate derivatives changes interest rate risk profiles, I expect that derivative use influences the use and disclosure of interest rate risk measurement techniques. If derivative use decreases interest rate risk exposure, there would be a negative association between derivative use and interest rate risk disclosure. On the other hand, if derivative use and more advanced interest rate risk measures are used as complements to each other, there would be a positive association between derivative use and interest rate risk disclosure.

[15] In FR Y-9C, BHCs report derivative contracts used in the course of dealing and other trading businesses as "contracts held for trading purposes," and report derivative contracts as end users as "contracts held for non-trading purposes." Interest rate derivatives that are used for non-trading purposes may indicate interest rate risk management by means of derivatives.

Ex ante, I hypothesize that the effect of derivative use on interest rate risk disclosures can be either positive or negative.

3.2.4. Capital Market Incentives

Capital market pressure from institutional investors and financial analysts impacts BHCs' interest rate risk disclosure in several ways. First, prior research has established a positive association between the level of corporate disclosure and institutional investor ownership and financial analyst following (e.g., Lang and Lundholm,1996; Healy, Hutton, and Palepu, 1999). I expect expanded interest rate risk disclosures for BHCs with higher institutional holdings and more analysts following.

Second, investor myopia (Bushee, 1998, 2001) may lead institutional investors to focus more on interest rate risk from the earnings perspective, which is measured by gap analysis and NII simulation, and focus less on interest rate risk from the economic perspective, which is measured by EVE simulation. Because investor myopia decreases the likelihood of disclosing EVE simulation, the level of institutional investor ownership and financial analyst following is negatively associated with interest rate risk disclosures.

Ex ante, I hypothesize that the level of institutional investor ownership and financial analyst following can have an either negative or positive effect on interest rate risk disclosures.

3.2.5. Other Factors

Total assets, profitability and leverage also impact interest rate risk disclosure. They are among the factors in the CAMELS ratings and are used by banking regulators in assessing size and riskiness.[16] Banking regulators have been long advocating banks put in place comprehensive management systems that measure and control interest rate risk exposure effectively, with a growing emphasis on measures of EVE. Furthermore, the regulators place more oversight on financial institutions that are larger, more complex and risky. Both the Federal Reserve and the OCC have developed separate examination programs for large and complex banking organizations and community banks. Thus, I use total assets, profitability and leverage to proxy for regulatory pressure to use interest rate risk measures.

Aside from regulatory pressure, it is necessary to control for total assets because large BHCs generally have more complex financial products, more nontraditional banking activities and more sophisticated risk-management systems (e.g., Hunter and Timme, 1986; Rogers and Sinkey, 1999). In addition, size and profitability are related to expanded disclosures (e.g., Lang and Lundholm, 1993).

4. Sample and Descriptive Statistics

4.1. Sample Construction

Table 1 Panel A reports the sample selection process. I construct my sample of BHCs with SIC 6021, 6022, 6035 and 6036 from the Compustat-CRSP Merged Database from fiscal year end 1997 to fiscal year end 2009. I start from fiscal year 1997 because FRR 48 requires firms to disclose "Market Risk Disclosures" since 1997. I restrict my sample to BHCs that have

[16] CAMELS rating is a bank rating system where banking regulators rate institutions according to six factors. The six factors are represented by the acronym "CAMELS": C - Capital adequacy; A - Asset quality, M - Management quality, E - Earnings, L - Liquidity, S - Sensitivity to market risk.

FR Y-9C data available on the Chicago Federal Reserve website.[17] The intersection of databases yields 5,340 firm-years. Next, I hand-collect Item 7A from 10-Ks in the SEC's EDGAR database. I further eliminate firm-years that do not have 10-Ks in the SEC EDGAR database and firm-years in which interest rate risk disclosures could not be found.[18] I read through each Item 7A disclosure, and record the types of interest rate risk measurement – gap analysis, NII simulation and/or EVE simulation. BHCs disclose gap analysis by tabulating their maturity gap positions in time buckets. The disclosure of NII simulation and EVE simulation is generally accompanied by percentages of NII sensitivities and EVE sensitivities for assumed interest rate changes. Quantitative disclosures are required to be recorded as interest rate risk disclosure. If a BHC only states that it uses gap analysis or NII/EVE simulation but does not provide specific figures, then I do not record the BHC as disclosing the interest rate risk measure. Furthermore, I delete 1101 firm-years that have missing variables for regression analysis and 72 firm-years whose fiscal year end is not in the 4th quarter. To reduce the influence of outliers and to reduce the size effect, I eliminate 65 firm-years out of the 1st and 99th percentile of total assets, net income or prices. My final sample consists of 2,261 firm-year observations and 336 unique BHCs.

Due to the well-known size effect of BHCs, I categorize the firm-year observations on an annual basis into quartiles based on total assets. The descriptive statistics on size are reported in Panel B of Table 1. Quartile 4 is the quartile with the largest total assets. Its mean ($29 billion) is much larger than the median ($11 billion) and 75th percentile ($27 billion), suggesting that the

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[17] FR Y-9C is a regulatory report that collects basic financial data from a domestic BHC and savings and loan holding company on a consolidated basis in the form of a balance sheet, an income statement, and detailed supporting schedules, including a schedule of off balance-sheet items.

[18] In their 10-Ks, the 33 firm-years (6 unique BHCs) state that interest rate risk is discussed in their shareholders' annual reports on the firms' websites. However, I was not able find those annual reports on these firms' websites.

size distribution is highly skewed. In my regressions, I use the log of total assets as a control variable to reduce the skewness.

4.2. Descriptive Statistics on Interest Rate Risk Disclosure

4.2.1. Three Interest Rate Risk Disclosure Types from 1997 to 2009

BHCs must disclose at least one of the three types of interest rate risk measures. The percentages of BHCs disclosing each interest rate risk measure are reported in Table 2 Panel A and graphed in Figure 1. A few trends are worth noticing. First, gap analysis is losing popularity among BHCs of all sizes. For large BHCs, less than 50% of BHCs disclosed gap analysis in 2009. Second, the earnings perspective as measured by NII simulation and by gap analysis dominates the economic perspective as measured by EVE simulation. Third, size is an important factor in determining the disclosure type: the larger the size, the more likely for a BHC to disclose simulations and the less likely to disclose gap analysis.

The trend documented above may be due to two important factors. First, banking regulators have emphasized simulation techniques and the economic perspective on interest rate risk. Second, technological advances are likely to contribute to the trends. Liu, Ryan and Tan (2004) find that technically sophisticated institutions provide more accurate value-at-risk disclosure than other institutions, and value-at-risk disclosures improve over time. In line with their technical sophistication argument, the increased disclosure of simulations probably results from technological advances over the sample periods. Furthermore, technological advances diffuse from large BHCs to small BHCs over time.

4.2.2. Seven Interest Rate Risk Disclosure Combinations in 1997 versus 2009

Table 2 Panel B and Figure 2 contrast percentages of the seven combinations of the three types of interest rate risk measures in 1997 versus 2009. In the figures and table, the label gap1 (gap0) indicates a BHC discloses (does not disclose) tabulated gap analysis, NII1 (NII0) indicates a BHC discloses (does not disclose) quantitative NII simulation results, and EVE1 (EVE0) indicates a BHC discloses (does not disclose) quantitative EVE simulation results.

For the full sample, in fiscal year 1997 BHCs disclosing only gap analysis accounted for the largest percentage, 59%, and this combination declined to only 8% in 2009. In 2009, BHCs disclosing only NII simulation accounted for the largest percentage, 26%, followed by BHCs disclosing both gap analysis and NII simulation at 24%. In 2009, no BHCs in Quartile 4 (the largest quartile) disclosed only gap analysis, while 18.6% BHCs in Quartile 1 (the smallest quartile) did so. In 2009, 19% (12%) of BHCs in Quartile 4 (1) disclosed all three types of interest rate risk measurement. Large BHCs are more likely to report two or three types of interest rate risk measurements and are more likely to disclose simulations.

4.3. Variable Measurement and Descriptive Statistics

Below I discuss the proxies for the expected contributing factors of interest rate risk disclosure. Table 3 Panel A displays the descriptive statistics of these variables for the full sample, large BHCs (Quartile 4) and small BHCs (Quartile 1).

I use the percentage of noninterest income in total operating income (*non_int_inc_pctg*) to proxy for the level of non-traditional banking activities (Stiroh, 2004).[19] For the full sample, the percentage of noninterest income has a mean (median) of 23.1% (20.8%) with a standard deviation of 11.5%. Large BHCs have higher percentages of noninterest income, indicating that

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[19] In additional analysis, I use adjusted percentage of noninterest income in total operating income (*non_int_inc_pctg2*), where adjusted noninterest income equals total noninterest income less service charges and fees on deposits. This adjustment eliminates the portion of noninterest income corresponding to the more traditional activity of gathering deposits (Rogers and Sinkey, 1999). The results are qualitatively similar.

large BHCs tend to be more diversified and more sophisticated in their operations. In contrast, small BHCs rely more heavily on NII.

I use the ratio of time deposit funding to total funding sources (*time_deposit_pctg*) to measure the percentage of time deposit funding, where total funding sources consist of non-maturity deposits, time deposits and nondeposit funding The time deposit funding percentage in the full sample has a mean (median) of 37.6% (37.8%) with a standard deviation of 12.4%. Examining across quartiles, the average time deposit funding percentages in the largest quartile and the smallest quartile are 32.0% and 40.6%, respectively.[20]

Derivative use (*derivative use*) is one if a BHC reports non-zero notional amount of derivatives held for non-trading purposes in FR Y-9C, zero otherwise. On average, 41% of BHCs in the full sample hold interest rate derivatives for non-trading purposes. For large (small) BHCs, on average 73% (20%) of BHCs are users of interest rate derivatives. This result points to the possibility of economies of scale in derivative use in that small BHCs may not have the necessary resources and skills to use derivatives. In addition, management in small BHCs may be more averse to the risk posed by derivatives and thus rely more on traditional on-balance-sheet interest rate risk management.

For capital market incentives, I use the percentage of shares outstanding held by institutional investors *(Inst_own_pctg)*.[21] The larger the size of a BHC, the higher are institutional investor holdings. Large BHCs have a mean of 44% shares outstanding that are held

[20] Untabulated statistics show that total deposit funding, which is the sum of non-maturity funding and time deposit funding, has a mean (median) of 90.6% (92.2%), suggesting that deposit funding is a primary source of funds, and that nondeposit funding only consists of less than 10% of funding sources on average. Additionally, large BHCs have lower levels of total deposit funding than small BHCs.
[21] In addition, I conduct analysis using analyst following. The proxy I use is the log of the sum of one and the number of analysts following a BHC (*log_anl_folw*). The two variables, institutional investors and analyst following, have a Pearson (Spearman) correlation coefficient of 0.79 (0.78). The results are qualitatively unchanged if analyst following is used in place of institutional investors.

by institutional investors. In contrast, small BHCs only have a mean of 9% shares outstanding that are held by institutional investors, and 50 of the 561 firm-years in this quartile do not have any institutional investors. In my empirical analysis, I use the log of one plus the percentage of institutional holdings.

The control variables – size, profitability and leverage – are measured by log of total assets (*LogTA*), ROA (*ROA*) and the Tier 1 leverage ratio (*Tier1_lev*), respectively. Whereas the previous variables vary greatly across quartiles, *ROA* and *Tier1_lev* are relatively less affected by size. The means of *ROA* for the full sample and for large and small BHCs are approximately 3%. While the regulatory requirement for the Tier 1 leverage ratio for a well-capitalized bank is 5%, BHCs in my full sample have a mean (median) of 8.84% (8.68%). Small BHCs have higher Tier 1 leverage ratios than large BHCs across the size quartiles, suggesting that large BHCs tends to be more leveraged and more risky.

Table 3 Panel B reports the correlation coefficients. Consistent with the discussions above, total assets are positively correlated with other variables, such as the percentage of noninterest income and the percentage of institutional ownership.

5. Regression Results on Interest Rate Risk Disclosure

To test whether the expected factors are associated with interest rate risk disclosure, I estimate ordered logit models.[22] I use the ordered logit model because the combinations of

[22] The ordered logit model fits this purpose better than the binary logit or probit model, or the conditional logit or probit model. The binary logit or probit model in which Y = 1 for disclosure and Y = 0 for no disclosure is not suitable as the interest rate risk disclosure choices have seven combinations. The conditional logit or probit model (including its special case, multinational logit or probit model) is not proper either. Although the conditional logit or probit model allows the dependent variable to have more than two categories, the main problem is its property of the independence of irrelevant alternatives (IIA), where errors are assumed to be independent for each category (Greene,

interest rate risk disclosure are rank ordered into more than two levels. I estimate the ordered logit model within each quartile on all four order schemes of interest rate risk disclosure. I assess whether an order scheme is appropriate through the p-values of the estimated cutoffs for each disclosure combination. In the regressions I control for firm and year fixed effects.[23]

5.1. Regression Results for the Large BHCs (Quartile 4)

Table 4 reports the ordered logit regression results for large BHCs (Quartile 4). Although I run regressions on interest rate risk disclosures that are ordered into four or seven levels, I only report the results where the interest rate risk disclosures are ordered into four levels. When the interest rate risk disclosures are ordered into seven levels, the estimated cutoff values of the seven levels are not significant, rejecting the appropriateness of those order schemes. This is consistent with the previous conjecture that in the largest quartiles, gap analysis is not a criterion in assessing order preferences.

Column (1) in Panel B reports the estimates for large BHCs (Quartile 4). The coefficients on the percentage of noninterest income, time deposit funding, derivative use and percentage of institutional holdings are all highly significant at the 0.01 level, suggesting they are strong determinants of interest rate risk disclosure. To shed light on the economic significance and direction of influences of these determinants, I estimate the mean marginal effects of these statistically significant predictors. I report the results in Panel C of Table 4.

Regarding the percentage of noninterest income, if it increases by 1%, the probability of disclosing both NII and EVE increases 63.1%, the probability of disclosing only NII (EVE)

2003). Circumventing the IIA problem, the ordered logit or probit model allows the dependent variable to assume values which are ordinal and ordered in nature.

[23] To generate consistent estimates for ordered logit model with fixed effects, I apply the hybrid method which uses robust standard errors to adjust for lack of independence in the repeated observations, as discussed in Allison (2005).

decreases 27.5% (5.2%), and the probability of disclosing only gap decreases 30.4%.[24] This suggests that BHCs with higher levels of nontraditional banking activities tend to strategically disclosure interest rate risk measures to signal their operational sophistication and technological advancement.[25]

The mean marginal effect of the percentage of time deposit funding is also economically substantial. If the percentage of time deposit funding increases by 1%, on average, the probability of disclosing both NII and EVE increases 10.5%, the probability of disclosing only NII (EVE) decreases 4.6% (0.09%), and the probability of disclosing only gap increases 5.1%. This suggests BHCs that rely more heavily on time deposit funding have higher interest rate risk exposure; thus, these BHCs disclose more extensive interest rate risk measures.

Regarding derivative use, if a BHC switches from a non-user to a user of interest rate derivatives, on average the probability of disclosing both NII and EVE decreases 17.7% and the probability of choosing other disclosure combinations increases. The negative effect of derivatives use on interest rate risk disclosure indicates that management views derivatives as mitigating interest rate risk and thus uses less rigorous interest rate risk measurement techniques.

For large BHCs, the percentage of institutional holdings is conducive to disclosing both NII and EVE simulations and the effect is economically important. If the percentage of

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[24] Because the ordered logit model relies on the idea of cumulative probability, the sums of the probabilities of the marginal effects of the 4 levels add up to 0. That is, if a firm's choice of a certain interest rate risk disclosure combination increases, then the firm's chance of choosing another interest rate risk disclosure combination must decrease to offset this increase. Thus, if the percentage of noninterest income increases, the increased probability of disclosing both NII and EVE is offset by decreased probabilities of choosing other disclosures.

[25] A competing argument is that some components of noninterest income such as mortgage servicing fees could be highly rate sensitive and require more rigorous interest rate risk measurement techniques. I regress interest rate risk disclosure on the components of noninterest income as well as other variables (untabulated). I find that the percentage of mortgage servicing fees is not significant while other non-rate sensitive components such as trust income are positive and highly significant, supporting the hypothesis that BHCs with higher levels of non-traditional banking activities strategically disclose interest rate risk measures to signal sophistication.

institutional holdings increases by 1%, on average, the probability of disclosing both NII and EVE increases 26.2%.

5.2. Regression Results for Small BHCs (Quartile 1)

Table 4 reports the ordered logit regression results for small BHCs (Quartile 1). Similar to the large BHCs, I only report the results where the interest rate risk disclosures are ordered into four levels because when the interest rate risk disclosures are ordered into seven levels, the estimated cutoff values of the seven levels are not significant, rejecting the appropriateness of seven-level order schemes.

Column (1) in Panel B of Table 4 reports the determinants of interest rate risk disclosures. The coefficient on the percentage of noninterest income is not significant. There is a positive association between time deposit funding and interest rate risk disclosures. As reported in Panel C, the mean marginal effects show that if the percentage of time deposit funding increases by 1%, on average, the probability of disclosing both NII and EVE increases 13.8% and the probability of disclosing NII increases 10.9%. The results indicate that for small BHCs, higher levels of time deposit funding are associated with higher levels of interest rate risk exposure, thus more extensive interest rate risk disclosure may be required.

In addition, the percentage of institutional ownership is negatively associated with interest rate risk disclosure, indicating investor focus on the earnings perspective. The mean marginal effect shows that small BHCs with high institutional ownership are less likely to disclose both NII and EVE simulations, but more likely to disclose only NII simulation.

In Column (2), I report the estimates and p-values from statistical tests of the difference between coefficients in Quartile 4 and Quartile 1. To obtain the test statistics, I run an ordered logit regression (untabulated) with pooled observations from Quartile 4 and Quartile 1. I include a dummy variable that takes the value of one if the firm-year is in Quartile 4. This dummy variable also interacts with all predictive variables. The p-values on the interaction coefficients test the differences between the coefficients in Quartile 4 versus Quartile 1. The estimates and p-values of the interaction coefficients reported in Column (2) reveal that the determinants of interest rate risk disclosure are distinctively different from Quartiles 4 and 1.

5.3. Regression Results for Quartile 3 and Quartile 2

For brevity, I do not elaborate on the results for Quartile 3 and Quartile 2, which are untabulated. However, I will highlight two key findings. First, the order schemes that have seven levels are found significant for Quarter 3 and Quarter 2. This suggests that BHCs in Quartile 2 and 3 make decisions whether to use and/or disclose gap analysis. Second, for Quartile 3, a higher percentage of nontraditional banking activities are positively associated with higher levels of interest rate risk disclosure. In contrast, for Quartile 2, a higher percentage of nontraditional banking activities are negatively associated with higher levels of interest rate risk disclosure.

5.4. Interest Rate Risk Disclosures during the Financial Crisis Period

The financial crisis period during 2007 to 2009 may affect the associations of the factors and interest rate risk disclosure.

I run separate ordered logit regressions for the pre-financial crisis period of 1997 to 2006 and the financial crisis period of 2007 to 2009. I do not tabulate the results, and summarize the results below:

The results during 1997 to 2006 are qualitatively similar to the results of the full sample period of 1997 to 2009. For the financial crisis period of 2007 to 2009, institutional holdings are not significant, suggesting that interest rate risk disclosures are less affected by capital market incentives during 2007 to 2009.

Specifically, for Quartile 4 (largest) during 2007 to 2009 time deposit funding is still significantly positively associated with interest rate risk disclosures, consistent with the results during 1997 to 2006; however, the effects of nontraditional banking activities, institutional holdings and derivative use on interest rate risk disclosures are no longer significant. For BHCs in Quartile 2, during 2007 to 2009, institutional holdings are no longer significant, but all other factors are significant and qualitatively similar to the pre-financial crisis period. For BHCs in Quartile 3 and Quartile 1 (smallest), the results during the financial crisis period are qualitatively similar to the pre-financial crisis period.

6. Duration Analysis on Changes in Interest Rate Risk Disclosure

6.1. Descriptive Statistics

Next, I investigate whether nontraditional banking activities, time deposit funding, derivative use and institutional investor ownership are also associated with changes in interest rate risk disclosure. As I require at least two consecutive years of data, my sample of firm-year observations dropped from 2261 firm-years with 336 unique BHCs to 1925 firm-years with 310 unique BHCs. Among them, 205 firm-years with 180 unique BHCs changed interest rate risk disclosures. The frequency of the changes in interest rate risk disclosures are reported in Panel A of Table 5, and graphed in Figure 3. The changes by disclosure type (frequencies in parentheses) include: add NII simulation (79), drop gap (67), add EVE simulation (51), add gap (31) and drop EVE simulation (15). No BHC dropped NII simulation. For the 79 (51) BHCs that added NII

(EVE) simulation, 23 BHCs added NII and EVE simulations simultaneously, while 56 (28) BHCs only added NII (EVE) simulation.

6.2. Regression Results

Two regression methods could be used. The first method is a binary logit (or probit) regression in which the dependent variable is coded one if a disclosure change occurs and zero otherwise. The second method is duration analysis applying the Cox proportional hazard model, where the dependent variable is the time until the interest rate risk disclosure change occurs.[26] I opt for this second method for the following reason. The descriptive statistics of interest rate risk changes reveal that 205 firm-years with 180 unique BHCs in my sample changed interest rate risk disclosure during 1997, the first year of mandatory disclosure, and 2009, when the data collection ends. As the trend is to adopt and disclose NII and EVE simulations and to stop using or disclosing gap, the event of interest rate risk disclosure change may not have yet occurred within the study period such that my data are right censored and randomly censored. Because the Cox proportional hazard model can readily handle time-dependent explanatory variables (Frees, 2004), I use the Cox proportional hazard model in my estimation and inferences.

The sample used in duration analysis consists of firm-years that have not yet changed interest rate risk disclosure and firm-years that have changed interest rate risk disclosure in the current year. Each firm is considered as one independent observation. Year dummies are included in the model to control for market interest rate shocks and business cycles. Again, I split my samples into size quartiles.[27] I consider three interest rate risk changes – adding NII simulation, adding EVE simulation and dropping gap. I do not consider the changes in interest

[26] Duration analysis has been widely used in economics and finance. Examples include unemployment (Elbers and Ridder, 1981), bankruptcy (Shumway, 2001) and investment (Whited, 2006).
[27] If a firm migrates across different size quartiles, I include the firm in the quartile where it falls most frequently.

rate risk disclosure combinations because these observation numbers are too small to run regressions.

Estimates from the Cox proportional hazard model for Quartile 4 and Quartile 1 are reported in Panel B of Table 5.

For large BHCs (Quartile 4), BHCs with higher nontraditional banking activities are more likely to add NII simulation to their interest rate risk disclosures, consistent with the argument of strategic disclosure. BHCs with higher time deposit funding proportions are more likely to add NII or EVE simulation. These results are consistent with the ordered regression results on interest rate risk disclosure for Quartile 4.

For small BHCs (Quartile 1), the coefficients for nontraditional banking and time deposit funding are not significant. For both quartiles, the percentage of institutional investor holdings is positively associated with the likelihood of adding NII simulation, but negatively associated with adding EVE simulation, indicating the earnings focus of capital market investors.

Untabulated results from the Cox proportional hazard model for Quartile 3 and Quartile 2 also confirm the findings from the ordered logit regressions.

6.3. Interest Rate Risk Disclosure Changes during the Financial Crisis Period

To investigate whether the recent financial crisis affects BHCs changing interest rate risk disclosures, I examine the total number of observations changing disclosure types and the average number of observations per year changing disclosure types for the period prior to the financial crisis (1997-2006) and the period since the financial crisis (2007-2009). Figure 4 contrasts the two periods. Figure 4A is for the full sample, Figure 4B is for Quartile 4 (largest), and Figure 4C is for Quartile 1(smallest). In Figure 4A, 4B and 4C, the graph on the left (right) compares the total number of observations (the average number of observations per year) changing disclosure types for the period 1997-2006 and the period 2007-2009. These figures suggest that less BHCs added NII and/or EVE simulation disclosures during the financial crisis period than during the period prior to the financial crisis. Furthermore, more BHCs stopped disclosing EVE simulation during the financial crisis period than during the pre-financial crisis period.[28]

7. Information Usefulness of Interest Rate Risk Disclosures

Whether market risk disclosures, including interest rate risk disclosures, are useful to investors remains unsettled. Prior research utilizes a short time period around 1997 until the early 2000s, and has provided mixed evidence. Linsmeier et al. (2002) and Liu, Ryan, and Tan (2004) support the decision usefulness of market risk disclosures, whereas Hodder (2001) finds that interest rate risk disclosures lack relevance and reliability. As pointed out by Liu, Ryan, and Tan (2004), market risk disclosures are expected to improve over time as firms become more sophisticated at disclosure. Additionally, the literature use data from the late 1990s to early 2000s, which may be less relevant today.

In this section, I attempt to add clarity to the previous research by examining the information usefulness of interest rate risk simulation disclosures, as simulation disclosures are gaining popularity among regulators and BHCs.

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[28] An interesting question would be whether BHCs which stopped disclosing EVE simulation during the financial crisis period had worse performance compared with other BHCs. Because only 5 BHCs in the full sample stopped disclosing EVE simulation, regression analysis was not feasible. I constructed a control sample for these 5 BHCs (the "change" sample) using the matching approach. A firm in the control sample is matched on the same year with total assets within the range of 80% and 125% of a firm in the change sample, and nontraditional banking activities being closest to the firm in the change sample. I tested whether there are significant differences in the means and medians of capital ratios, ROA and institutional holdings, but I did not find any significant differences.

Two approaches are applied. First, I examine the information content of simulation disclosures using BCHs that disclose simulation for the first time. Second, I examine whether market returns respond to changes in projected NII and EVE sensitivities under simulation disclosures for a subsample of large BHCs.

7.1 Information Content of Simulation Disclosures for First-time Simulation Disclosers

7.1.1 Research Design

In this section, I examine the information content of simulation disclosures using BCHs that disclose simulation for the first time. BHCs that disclose simulation in 10-Ks for the first time provide a clean setting to examine the information content of simulation disclosure.

Prior literature considers abnormal trading volumes and abnormal return volatilities to evaluate information content (e.g., Beaver, 1968; Landsman and Maydew 2002). Trading volume is caused by the disagreement among individual investors as to price, whereas return volatilities reflect changes in the expectations of the market as a whole (Beaver, 1968; Holthausen and Verrecchia, 1990). The analytical work in Kim and Verrecchia (1991) shows that "trading volume preserves differences among individual investors that are cancelled out in the averaging process that determines equilibrium price". Because trading volume and returns capture different aspects of the market's utilization of information, a disclosure generating a large price response may not necessarily induce trading (Bamber and Cheon 1995). In other words, there could be a trading volume response to a disclosure without a corresponding price response, and vice versa.

7.1.2 Measures of Information Content

Next, I construct proxies for abnormal trading volumes and abnormal return volatilities to evaluate the information content of simulation disclosures. Following prior literature, I use two abnormal trading volume measures (e.g., Landsman and Maydew 2002). The first measure is the median-adjusted abnormal trading volume (*AVOL1*). It is the difference between (1) a firm's daily shares traded as a percent of total outstanding shares, cumulated from the event date to one trading day after the event date and (2) the median trading volume over a 252-day period ending 21 days prior to the event date, deflated by the standard deviation of the daily percentage of shares traded over a 252-day period ending 21 days prior to the event date. The second measure is the mean-adjusted abnormal trading volume (*AVOL2*). It is the difference between (1) the two-day cumulative daily percentage of shares traded on the event date and one trading day after the event date and (2) the mean daily percentage of shares traded over a 252-day period ending 21 days prior to the event date, deflated by the standard deviation of the daily percentage of shares traded over a 252-day period ending 21 days prior to the event date. I include both abnormal trading volume measures in my analyses because the prior literature does not have a generally accepted method of measuring abnormal trading volumes, although the mean-adjusted trading volume is more biased by sharp increases in trading activities in the non-event window than median-adjusted trading volume (Bamber, Barron and Stober, 1999).

I measure abnormal return volatility (denoted AVAR) as the two-day abnormal return variance around the event date, deflated by the abnormal return variance over a 252-day period ending 21 days prior to the event date. Abnormal return is the difference between actual return and the expected return estimated through a market model using returns over the 252-day period ending 21 days prior to the event date. I require at least 150 trading days to calculate abnormal trading volume and abnormal return volatility.

7.1.3 Sample Construction

The sample composition is reported in Panel A of Table 6. I require BHCs to have at least 100 days of daily returns from CRSP to calculate the information content measures. My sample of BHCs disclosing simulation measures for the first time consists of two subsamples. The first subsample is 20 BHCs which added both NII and EVE disclosures. The other subsample is 43 BHCs which only added NII simulation disclosures.[29] I denote this sample as the change sample.

I match each BHC in the change sample with a BHC that does not disclose any simulation (the control sample). I select the control sample from the same year as the change sample to control for the year effect. I require total assets of BHCs in the control sample to be between 25% to 200% of the BHCs in the change sample and the percentage of non-traditional banking activities of the control BHCs to be the closest to the BHCs in the change sample.

7.1.4 Analyses of the Information Content of Simulation Disclosures

Panel B in Table 6 compares the means and medians of abnormal trading volume and abnormal return volatility for BHCs in the change sample and those in the control sample.

For BHCs that disclose NII simulations for the first time, the mean and median of abnormal trading volume measures are significantly greater than those of the control sample that discloses no simulation. This indicates that NII simulation disclosures cause divergence in opinions among individual investors, resulting in increased trading volumes. However, abnormal return volatilities are not significantly different, suggesting that investors as a whole lack consensus in interpreting NII simulation disclosures.

[29] In the analyses below, I do not include the 3 BHCs that add EVE simulation disclosures to their gap analysis because the sample size is too small for statistical inferences to be reliable.

For BHCs that disclose both NII and EVE simulation for the first time, there is weak evidence that NII and EVE simulation disclosures have information content. The median value of the median-adjusted abnormal volume of the change sample is greater than that of the control sample (one-sided p-value=0.097). I do not find significant differences in the mean and medians of the mean-adjusted abnormal volume, possibly because the mean-adjusted trading volume is more biased by sharp increases in trading activities in the non-event window than median-adjusted trading volumes (Bamber, Barron and Stober, 1999). There are no significant differences among the change sample and the control sample on other measures of information content.

Overall, the results suggest that simulation disclosure provides incremental information to investors in terms of trading volume responses.

7.2 Market Reactions to Changes in NII/EVE Sensitivities from Simulation Disclosures

7.2.1 Research Design

In NII (EVE) simulation disclosures, BHCs provide projected percentage changes in NII (EVE) in response to different interest rate change scenarios.[30] For brevity, I use “NII (EVE) sensitivities” to refer to projected percentage changes in NII (EVE). To investigate whether simulation disclosures provide new information to investors, I test whether good news or bad news conveyed in NII (EVE) sensitivities cause different market reactions.

I first classify NII (EVE) sensitivities as good news or bad news. I classify NII sensitivities as good news if NII sensitivities in the current period are higher than in the previous period because increasing NII indicates improved profitability. By the same token, I classify NII

[30] For example, a BHC may state their simulation model reveals that a 50 basis point decrease in rates would cause an approximate 1.87% annual decrease in net interest income.

sensitivities as bad news if NII sensitivities in the current period are lower than in the previous period.

Likewise, I classify EVE sensitivities as good news if EVE sensitivities in the current period are higher than in the previous period because increasing EVE indicates higher capital value. Similarly, I classify EVE sensitivities as bad news if EVE sensitivities in the current period are lower than in the previous period.

Next, I evaluate whether the market responds more positively to good news than to bad news implied in NII and EVE sensitivities. I measure market reactions using cumulative abnormal returns in a narrow window consisting of the filing date and one day after the filing date. If simulation disclosure is useful to investors, then I expect cumulative abnormal returns to be higher for BHCs projecting good news than for BHCs projecting bad news.

This research design differs from Hodder (2001). My approach assesses the ability of simulation disclosures to convey new information by examining the association between short-window abnormal returns around filing dates and good news or bad news implied in the sensitivity measures. In contrast, Hodder (2001) assesses the ability of simulation disclosures to predict future performance of earnings and economic value by examining the association between the magnitude of NII (EVE) sensitivities and the magnitude of realized income changes (realized economic value changes). These two approaches represent different aspects of the decision usefulness of simulation disclosures.

7.2.2 Sample Composition

I hand-collect NII (EVE) sensitivities under different interest rate scenarios from simulation disclosures for the largest 50 BHCs in my sample during year end 2003 through year end 2005. The largest 50 BHCs are chosen because they are mostly likely to disclose simulations and they are economically important. The period during the end of 2003 through the end of 2005 is chosen for two reasons. First, market interest rates were gradually rising from the bottom of the interest rate cycle at the end of 2003. It resembles today's market interest rate environment where market interest rates are at the bottom of the interest rate cycle. Second, during 2003 to 2005, BHCs were not as exposed to credit risks as they were during the financial crisis.

Because some BHCs disclose interest rate risk not only in 10-Ks but also in 10-Qs, I collect both 10-Ks and 10-Qs. Table 6 presents the sample compositions. Among the 50 BHCs, 8 did not disclose simulations and are excluded from the sample. Among the remaining 42 BHCs, 21 BHCs disclose simulations in their 10-Qs and 10-Ks and they comprise the quarterly sample; 23 BHCs disclose simulations only in 10-Ks and they comprise the annual sample.

Because classifying NII (EVE) sensitivities into good news or bad news is based on changes in NII (EVE) sensitivities from the last filing period to the current filing period, I calculate changes in NII and EVE sensitivities from the previous quarter (year) to the current quarter (year). The quarterly "change" sample consists of 152 firm-quarters, where 118 observations (15 unique BHCs) disclose only NII simulation, 26 observations (5 unique BHCs) disclose both NII and EVE simulation, and 8 observations (1 unique BHC) disclose only EVE simulation. The annual "change" sample consists of 44 firm-years, where 24 observations (12 unique BHCs) disclose only NII simulation, 16 observations (9 unique BHCs) disclose both NII and EVE simulation, and 4 observations (2 unique BHC) disclose only EVE simulation.[31] To

[31] I do not examine the changes in EVE sensitivities due to the small sample size: there is only 1 unique BHC in the quarterly change sample, and only 2 unique BHCs in the annual change sample.

save space, the descriptive statistics of NII (EVE) sensitivities under the rising and falling interest rate scenarios are not tabulated and are available upon request.

7.2.3 Classifying NII and EVE Sensitivities

Next, I classify NII (EVE) sensitivities as good news and bad news, based on changes in NII (EVE) sensitivities from the last filing period to the current filing period. The coding procedure for this classification is detailed in Appendix D. In the procedure, I denote the variable *Qtr_NII_sensitivity* (*Yr_NII_sensitivity*) as NII sensitivities for the quarterly (annual) sample. *Qtr_NII_sensitivity* (*Yr_NII_sensitivity*) takes the value of *NII bn,bn, NII gn,bn, NII bn,gn, NII gn,gn. NII* indicates the variable is for NII simulation, *gn* or *bn* on the left (right) side denotes good news or bad news for rising (falling) interest rates scenarios. For example, *NII gn,bn* represents good news for rising interest rates scenarios, and bad news for falling interest rates scenarios. The similar coding scheme applies to changes in EVE.

If a BHC discloses both NII and EVE simulations, then I concatenate the coding of NII and EVE sensitivities: *Qtr_NII_EVE_sensitivity* (*Yr_NII_EVE_sensitivity*). For example, *NII gn,bn_EVE gn,bn* represents that in disclosing NII sensitivities, a BHC conveys good news for rising interest rates and bad news for falling interest rates, and at the same time in disclosing EVE sensitivities, a BHC conveys good news for rising interest rates and bad news for falling interest rates.

Table 8 summarizes the values of the coding for classifying NII and EVE sensitivities.

7.2.4 Market Reactions of BHCs Disclosing Only NII Sensitivities

After classifying NII and EVE sensitivities as good news or bad news under rising and falling interest rate scenarios, respectively, I evaluate whether the market responds more positively to good news than to bad news implied in NII and EVE sensitivities. I measure market reactions using *CAR (0,1)*, which is cumulative abnormal returns in a narrow window consisting of the filing date and one day after the filing date. The abnormal return is the difference between the raw return and the value-adjusted CRSP market return.

First, I examine *CAR (0,1)* for BHCs that disclose only NII sensitivities. If simulation disclosure is useful to investors, then I expect *CAR (0,1)* to be higher for BHCs disclosing good news for both rising and falling interest rate scenarios than for BHCs disclosing bad news for both rising and falling interest rate scenarios. For BHCs that disclose good news for rising interest rate scenarios and bad news for falling interest rate scenarios, or vice versa, I expect their *CAR (0,1)* to be higher than BHCs disclosing bad news for both rising and falling interest rate scenarios and to be lower than BHCs disclosing good news for both rising and falling interest rate scenarios.

Table 9 reports the empirical analysis for the quarterly sample of BHCs disclosing only NII sensitivities. Panel A of Table 9 reports the frequency for different categories of good news and bad news in NII sensitivities, and the mean and median *CAR (0,1)* for BHCs disclosing each category. For example, 17.8% of observations disclosed *NII bn,bn*. These observations have a two day cumulative abnormal return mean of -0.002, lower than observations disclosing any other category of NII sensitivities.

To further compare market reactions to NII sensitivities, I regress cumulative abnormal return *CAR (0,1)* on the categorical variable *Qtr_NII_sensitivity*, controlling for the numbers of interest rate scenarios and size.[32] I use the log of total assets or the log of market value as the proxy for size. The category *NII bn,bn* is used as the estimation baseline. The regression results are reported in Panel D of Table 8. The results show that, compared with other types of changes

[32] I do not control for gap analysis because I employ quarterly filings where gap analysis is not disclosed.

in NII sensitivities, BHCs disclosing *NII bn,bn* have significantly lower short-window market abnormal returns compared with BHCs disclosing other categories (i.e., *NII gn,gn, NII bn,gn* and *NII gn,bn*). Additionally, BHCs disclosing *NII gn,gn* have a higher coefficient than BHCs in other categories (*NII bn,gn* and *NII gn,bn*), suggesting BHCs with *NII gn,gn* have higher *CAR (0,1)*. Overall, the results indicate that NII sensitivities provide new information to investors.

7.2.5 Market Reactions of BHCs Disclosing Both NII and EVE Sensitivities

Table 10 reports market return responses to NII and EVE sensitivities for BHCs that disclose both NII and EVE simulations.

Panel A of Table 10 reports the frequency for different categories of NII and EVE sensitivities, and the mean and median *CAR (0,1)* for BHCs disclosing each category. No BHC disclosure falls within the category of *NII gn,gn_EVE gn,gn.* Three BHCs' disclosures fall within the category of *NII bn,bn_EVE bn,bn.* Descriptive statistics in Panel A show that the mean and median of *CAR (0,1)* are lower for BHCs disclosing *NII bn,bn_EVE bn,bn* than BHCs disclosing other categories.

As shown in Panel D of Table 9, I regress the two-day cumulative abnormal returns on the categorical variable *Qtr_NII_EVE_sensitivity*, controlling for the number of interest rate scenarios and size. In Column (1) through (4) in Panel D of Table 9, I use the category of *NII bn,bn_EVE bn,bn* as the baseline. I find that the coefficients of other disclosures are significantly positive, suggesting that BHCs disclosing *NII bn,bn_EVE bn,bn* had lower *CAR (0,1)* than other BHCs after controlling other factors.

In Column (5) through (8) in Panel D of Table 9, I use the disclosure categories that have at least three bad news (*bn*) values and at most one good news (*gn*) value as the baseline: *NII bn,bn_EVE bn,bn, NII gn,bn_EVE bn,bn, NII bn,bn_EVE gn,bn* and *NII bn,bn_EVE bn,gn.* I expect other disclosures would have higher abnormal returns than the baseline disclosures. The regression results find evidence supporting this prediction.[33]

7.3 Further Discussion

In *7.1*, I find that disclosing sensitivities from simulation for the first time increases abnormal trading volume but does not change price. In *7.2*, I find that good news or bad news implied in NII and EVE sensitivities affect market returns. I reconcile this seemingly inconsistent result in the effect of simulation disclosures on stock price as follows: when BHCs disclose simulation for the first time, investors do not have prior information to assess this new piece of information. In contrast, when examining information implied in NII and EVE sensitivities, at least two filing periods of simulation disclosures are available to assess this information. I evaluate how increasing or decreasing NII and EVE sensitivities over two filing periods, rather than the level of sensitivities alone in one period, impacts investors' reactions. Overall, the results suggest that simulation disclosure is most useful when it can be compared with prior period disclosures.

8. Conclusions

This study empirically examines interest rate risk disclosures in the banking industry. First, using a sample of 2,261 firm-year observations consisting of 336 unique BHCs from fiscal years 1997 to 2009, I document that the disclosure of maturity gap analysis declined steadily, and that the disclosure of NII simulation and EVE simulation doubled over the same time period.

[33] Appendix I reports the frequencies and two-day abnormal returns of the BHCs reporting NII/EVE simulation on an annual basis. No statistical analysis was conducted due to the small sample size.

Second, I hypothesize and find that interest rate risk disclosures are related to nontraditional banking activities, time deposit funding source, derivative usage and institutional investor ownership; the associations are different for large and small BHCs.

Third, I investigate the information usefulness of interest rate risk disclosure. I find that for BHCs disclosing NII simulation for the first time, there is an increase in abnormal trading volumes, suggesting that NII simulation provides new information to investors. Using the largest 50 BHCs in my sample from the end of 2003 to the end of 2005, I provide evidence that the market reacts to good news or bad news implied in simulation disclosures. Overall, my findings suggest that interest rate risk simulation disclosures provide incremental information to investors.

This study should be of interest to bank management, investors, banking regulators and policy makers. The evidence of how BHCs disclose interest rate risk measures in their 10-K filings from 1997 to 2009 can be useful to bank management in assessing their interest rate risk measurement policy and practices. It also improves investors' understanding of BHCs' interest rate risk measurement and interest rate risk disclosure practices.

In addition, banking regulators' understanding of the link between banks' operational characteristics and the usage and disclosure of recommended interest rate risk measurement techniques will help inform future decisions about applying effective banking regulation and will allow for a more tailored examination of banks' interest rate risk management.

Furthermore, my study suggests that interest rate risk disclosure provides incremental information to investors. In particular, I find that good news or bad news implied in simulation disclosure in every interim and annual filing is associated with short-term cumulative abnormal returns around the filing date. This is important in light of the FASB's proposed Accounting

Update (Topic 815) to enhance interest rate risk disclosures, which would require a financial institution to disclose NII and EVE sensitivities in every interim and annual reporting period (FASB, 2012). My findings suggest that the proposed disclosure could be useful to investors.

This paper opens several avenues for future research. First, future studies could examine interest rate risk disclosures during the financial crisis and how the interaction of interest rate risk and credit risk jointly affects interest rate risk disclosures. Second, future studies could investigate the details of interest rate risk disclosures over a longer time period and with a larger sample to further evaluate the information usefulness of interest rate risk disclosures.

Appendix A: Important Documents on Interest Rate Risk from Banking Regulators

In 1992, the Federal Deposit Insurance Corporation (FDIC), the Federal Reserve and the Office of the Comptroller of the Currency (OCC) issued *An Advanced Notice of Proposed Rulemaking on Interest Rate Risk*. It proposed that all banks use a duration-weighted maturity ladder to estimate the change in a bank's economic value for each 100 basis point parallel shift in interest rates. Although in the final statement, certain banks identified as low risk are exempted from this requirement, it reflects regulators' growing emphasis on the economic perspective of interest rate risk.

In 1996, the FDIC, the Federal Reserve and the OCC issued the *Joint Agency Policy Statement on Interest Rate Risk*. It emphasizes the importance of measuring interest rate risk from not only the earnings perspective, but also from the economic perspective. It encourages banks to use simulation models in measuring interest rate risk. For example, it states that "a well-managed bank will consider both earnings and economic perspectives when assessing the full scope of its interest rate risk exposure." It also points out that banks with significant holdings of instruments with intermediate and long-term maturities or embedded options should assess the potential long-term impact of changes in interest rates. Since only economic approaches to measuring interest rate risk capture the potential long-term impact of interest rate changes, regulators are essentially telling banks they must use a duration or economic value of equity approach to quantify their interest rate risk exposure. Furthermore, the *Joint Agency Policy Statement on Interest Rate Risk* notes the scenarios used in measuring interest rate risk "should incorporate a sufficiently wide change in market interest rates (e.g., +/- 200 basis points over a one year horizon) and include immediate or gradual changes in market interest rates as well as changes in the shape of the yield curve in order to capture the material effects of any explicit or embedded options." This explicitly encourages banks to use simulation techniques.

In 1997, banking regulators explicitly incorporated interest rate risk into their ratings system, by transforming the "CAMEL" rating system into "CAMELS." The "S" rating stands for a bank's sensitivity to market risk, which includes risk exposure to interest rates, exchange rates, and commodity prices. For the majority of banks, market risk is equivalent to interest rate risk. The *Commercial Bank Examination Manual* notes that interest rate risk measurement systems should use appropriate financial measurement techniques to measure the interest rate risk exposure of both earnings and economic value.

In 2010, the FDIC, the Federal Reserve and the OCC noted in its interagency *Advisory on Interest Rate Management* that "many institutions now use some form of simulation modeling to measure interest rate risk exposure. In fact, current computer technology allows even some smaller, less sophisticated institutions to perform comprehensive simulations of the potential impact of changes in market rates on their earnings and capital…. Institutions are encouraged to use the full complement of analytical capabilities of their interest rate risk simulation models."

Regulatory bodies have also proposed their own economic value of equity simulation models for measuring interest rate risk. The Office of Thrift Supervision (OTS) collects extensive interest risk data from thrift institutions and uses Monte Carlo simulations to generate economic value of equity under different interest rate scenarios (Wright and Houpt, 1996). The Federal Reserve also developed a proprietary economic value of equity model (called EVM). The Fed operationalized the model in the first quarter of 1998 by producing a quarterly report for each bank. The reports are the confidential supervisory reports that provide the detailed output of the Fed's EVM (Sierra and Yeager, 2004).

Appendix B: An Interest Rate Risk Disclosure Example

Old Point Financial Corp (TIC: OPOF), 2008 10-K

Item 7A. Quantitative and Qualitative Disclosures About Market Risk

This information is incorporated herein by reference from Item 7, "Management's Discussion and Analysis of Financial Condition and Results of Operations", on pages 14 through 33 of this report on Form 10-K.

Interest Sensitivity

An important element of earnings performance and the maintenance of sufficient liquidity is proper management of the interest sensitivity gap. The interest sensitivity gap is the difference between interest sensitive assets and interest sensitive liabilities in a specific time interval. This gap can be managed by repricing assets or liabilities, which are variable rate instruments, by replacing an asset or liability at maturity or by adjusting the interest rate during the life of the asset or liability. Matching the amounts of assets and liabilities maturing in the same time interval helps to hedge interest rate risk and to minimize the impact of rising or falling interest rates on net interest income.

The Company determines the overall magnitude of interest sensitivity risk and then formulates policies governing asset generating and pricing, funding sources and pricing, and off-balance sheet commitments. These decisions are based on management's expectations regarding future interest rate movements, the state of the national and regional economy, and other financial and business risk factors. The Company uses computer simulations to measure the effect of various interest rate scenarios on net interest income. This modeling reflects interest rate changes and the related impact on net interest income and net income over specified time horizons.

Based on scheduled maturities only, the Company was liability sensitive at the one-year timeframe as of December 31, 2008. It should be noted, however, that non-maturing deposit liabilities, which consist of interest checking, money market and savings accounts, are less interest sensitive than other market driven deposits. On December 31, 2008 non-maturing deposit liabilities totaled $187.1 million, or 29.89%, of total interest-bearing liabilities. In a rising rate environment these deposit rates have historically lagged behind the changes in earning asset rates, thus mitigating the impact from the liability sensitivity position. The asset/liability model allows the Company to reflect the fact that non-maturing deposits are less rate sensitive than other deposits by using a decay rate. The decay rate is a type of artificial maturity that simulates maturities for non-maturing deposits over the number of months that more closely reflects historic data. Using the decay rate, the model reveals that the Company is asset sensitive.

When the Company is liability sensitive, net interest income should decrease if interest rates rise since liabilities will reprice faster than assets. Conversely, if interest rates fall, net interest income should increase, depending on the optionality (prepayment speeds) of the assets. When the Company is asset sensitive, net interest income should rise if rates rise and should fall if rates fall.

The most likely scenario represents the rate environment as management forecasts it to occur. Management uses a "static" test to measure the effects of changes in interest rates on net interest income. This test assumes that management takes no steps to adjust the balance sheet to respond to the shock by repricing assets/liabilities, as discussed in the first paragraph of this section.

Under the rate environment forecasted by management, rate shocks in 50 to 100 basis point increments are applied to see the impact on the Company's earnings. The rate shock model reveals that a 50 basis point decrease in rates would cause an approximate 1.87% annual decrease in net income. The rate shock model reveals that a 100 basis point rise in rates would cause an approximate 3.11% annual

Appendix B *(Continued)*

increase in net income and that a 200 basis point rise in rates would cause an approximate 5.86% annual increase in net income. (emphasis added)

TABLE III
INTEREST SENSITIVITY ANALYSIS

As of December 31, 2008 (in thousands)	**Within 3 Months**	**4-12 Months**	**1-5 Years**	**Over 5 Years**	**Total**
Uses of funds					
Federal funds sold	$ 17,814	$ —	$ —	$ —	$ 17,814
Taxable investments	8,913	20,252	55,308	921	85,394
Tax-exempt investments	500	2,104	8,474	3,583	14,661
Total investments	27,227	22,356	63,782	4,504	117,869
Loans					
Commercial	32,908	3,783	19,845	13,816	70,352
Tax-exempt	—	—	—	2,738	2,738
Consumer	2,468	2,580	26,982	8,760	40,790
Real estate	119,322	28,493	282,820	90,204	520,839
Other	1,373	547	312	501	2,733
Total loans	156,071	35,403	329,959	116,019	637,452
Total earning assets	$ 183,298	$ 57,759	$393,741	$120,523	$755,321
Sources of funds					
Interest-bearing transaction accounts	$ 12,902	$ —	$ —	$ —	$ 12,902
Money market deposit accounts	135,791	—	—	—	135,791
Savings accounts	38,412	—	—	—	38,412
Time deposits $100,000 or more	32,591	69,934	25,237	—	127,762
Other time deposits	37,648	96,730	73,524	—	207,902
Federal funds purchased, repurchase agreements and other borrowings	33,282	—	—	—	33,282
FHLB advances	70,000	—	—	—	70,000
Total interest bearing liabilities	$ 360,626	$ 166,664	$ 98,761	$ —	$626,051
Rate sensitivity GAP	$(177,328)	$(108,905)	$294,980	$120,523	$129,270
Cumulative GAP	$(177,328)	$(286,233)	$ 8,747	$129,270	

Appendix C: Four Order Schemes for Interest Rate Risk Disclosures

This Appendix reports ordering schemes for interest rate risk disclosures. "gap" indicates gap analysis, "NII" indicates net interest income simulation, and "EVE" indicates economic value of equity simulation. "1" indicates disclosure, and "0" indicates non-disclosure. Three criteria are considered in the order schemes: (1) number of interest rate risk measures disclosed, (2) technique sophistication and (3) the earnings orientation of managers and investors.

Panel C1: Order Scheme 1

Disclosures ranked from the highest to the lowest			
Disclosing NII and EVE simulation:	4	gap1_NII1_EVE1 or	gap0_NII1_EVE1
Disclosing only NII simulation:	3	gap1_NII1_EVE0 or	gap0_NII1_EVE0
Disclosing only EVE simulation:	2	gap1_NII0_EVE1 or	gap0_NII0_EVE1
Disclosing no simulation:	1	gap1_NII0_EVE0	

Panel C2: Order Scheme 2

Disclosures ranked from the highest to the lowest		
Disclosing all three types of simulation:	7	gap1_NII1_EVE1
Disclosing simulation from the earnings perspective:	6	gap0_NII1_EVE1
	5	gap1_NII1_EVE0
	4	gap0_NII1_EVE0
Disclosing simulation from the economic perspective:	3	gap1_NII0_EVE1
	2	gap0_NII0_EVE1
Disclosing no simulation	1	gap1_NII0_EVE0

Panel C3: Order Scheme 3

Disclosures ranked from the highest to the lowest		
Disclosing all **three** types of disclosures:	7	gap1_NII1_EVE1
Disclosing **two** of the three types, preferring	6	gap0_NII1_EVE1
simulation and then the earnings perspective:	5 or 4	gap1_NII1_EVE0 or gap1_NII0_EVE1
Disclosing **one** of the three types, preferring		gap0_NII1_EVE0 or gap0_NII0_EVE1
simulation and then the earnings perspective:	3 or 2	
Disclosing no simulation	1	gap1_NII0_EVE0

Panel C4: Order Scheme 4

Disclosures ranked from the highest to the lowest		
Disclosing all **three** types of disclosures:	7	gap1_NII1_EVE1
Disclosing **two** of the three types, preferring	6	gap1_NII1_EVE0
the earnings perspective:	5 or 4	gap0_NII1_EVE1 or gap1_NII0_EVE1
Disclosing **one** of the three types, preferring		gap0_NII1_EVE0 or gap1_NII0_EVE0
the earnings perspective:	3 or 2	
Only disclose economic perspective	1	gap0_NII0_EVE1

In Panel C1, disclosures are ranked into 4 levels. Whether to disclose gap analysis or not is not an ordering criterion here. I expect this order scheme to be proper for the largest size quartile where gap is likely to be regarded as unimportant, and for the smallest size quartile where gap is regarded as important.

In Panel C2 through C4, disclosures are ranked into 7 levels and whether to disclose gap analysis is an ordering criterion.

In Panel C3 and C4, disclosing more types of interest rate risk measurement techniques is always considered better. For Panel C3, the criterion of technique sophistication has more emphasis than the criterion of the earnings perspective. For Panel C4, the criterion of the earnings perspective has more emphasis than the criterion of the earnings perspective.

Appendix D: Classifying Net Interest Income (NII) & Economic Value of Equity (EVE) Sensitivities

Panel A: Coding Procedures for Classifying NII and EVE Sensitivities

Below I discuss the coding procedures for classifying NII and EVE sensitivities as good news or bad news, based on changes in NII and EVE sensitivities from the last period. The coding procedure has four steps.

Step 1:

In Step 1, I calculate quarterly (or annual) changes in NII (EVE) sensitivities for each interest rate change scenario from the previous quarter (or year) to the current quarter (or year). A BHC may disclose NII (EVE) sensitivities under several different rising interest rate scenarios (e.g., interest rates change +300 bps, +200 bps or +100 bps). Typically, under different rising interest rate scenarios, the quarterly or annual changes in NII (EVE) sensitivities in response to each rising interest rate scenario are all increasing or all decreasing. In other words, under different rising interest rate scenarios, changes in NII (EVE) sensitivities are usually consistent. The same applies to falling interest rate scenarios: under different falling interest rate scenarios, changes in NII (EVE) sensitivities are usually consistent. To illustrate, the BHC in the example given in Panel B of this Appendix projects that it will have positive (negative) changes in NII sensitivities under two rising (falling) interest rate scenarios, and have negative (positive) changes in EVE sensitivities under two rising (falling) interest rate scenarios.

In my sample, only two observations out of 232 observations disclose inconsistent changes in NII simulation under rising (falling) interest rate scenarios (for example, positive changes in NII sensitivities under one rising interest rate scenario, and negative changes in NII sensitivities under the other rising interest rate scenario). These two observations are excluded from my "change" sample.

Step 2:

Because changes in NII (EVE) sensitivities under different rising interest rate scenarios are always consistent, the changes can be summarized as either positive or negative for the rising interest rate scenario. Similarly, because changes in NII (EVE) sensitivities under different falling interest rate scenarios are always consistent, the changes can be summarized as either positive or negative for the falling interest rate scenario.

If the changes in NII (EVE) sensitivities are positive (negative), it suggests that the BHC projects to increase (decrease) NII (EVE). As increasing NII indicates profitability and increasing EVE indicates higher capital value, a positive change in NII (EVE) sensitivities implies good news, and a negative change in NII (EVE) sensitivities implies bad news. I classify NII (EVE) sensitivities as good news and bad news for the rising interest rate scenario and the falling interest rate scenario separately. If a BHC does not disclose the sensitivities for a rising or falling interest rate scenario, I code it as bad news.

Step 3:

I denote the variable *Qtr_NII_sensitivity* (*Yr_NII_sensitivity*) as the category of NII sensitivities for the quarterly (annual) sample. *Qtr_NII_sensitivity* (*Yr_NII_sensitivity*) takes the value of *NII bn,bn, NII gn,bn, NII bn,gn, NII gn,gn. NII* represents NII simulation, *gn* or *bn* on the *left* side represents good news or bad news for *rising* interest rates scenarios, and *gn* or *bn* on the *right* side represents good news or bad news for *falling* interest rates scenarios. For example, *NII gn,bn* represents good news (i.e., higher NII sensitivities than the previous period) for rising interest rates scenarios, and bad news (i.e., lower NII sensitivities than the previous period) for falling interest rates scenarios. The similar coding scheme applies to EVE.

Step 4:

Step 4 applies to BHCs that disclose both NII and EVE simulations. I concatenate the coding of NII and EVE sensitivities: *Qtr_NII_EVE_sensitivity* (*Yr_NII_EVE_sensitivity*). For example, *NII gn,bn_EVE gn,bn* represents that, by disclosing NII sensitivities, a BHC conveys good news for rising interest rates and bad news for falling interest rates, and at the same time by disclosing EVE sensitivities, a BHC conveys good news for rising interest rates and bad news for falling interest rates.

Appendix D *(continued)*

Panel B: An Example

Step 1: Calculate quarterly (or annual) changes in NII (or EVE) sensitivities for each interest rate change scenario from the previous quarter (year) to the current quarter (year). For example:

Quarterly (Annual) Changes in NII sensitivities			
Rising Interest Rate Scenarios		Falling Interest Rate Scenarios	
+200 bps	+100 bps	-100 bps	-200 bps
0.41%	**0.14%**	**-1.17%**	**-0.23%**

Quarterly (Annual) Changes in EVE sensitivities			
Rising Interest Rate Scenarios		Falling Interest Rate Scenarios	
+200 bps	+100 bps	-100 bps	-200 bps
-3.91%	**-1.69%**	**1.22%**	**0.10%**

* If NII (or EVE) sensitivities for both a gradual and an immediate interest rate change are disclosed for a given interest rate change, only the gradual interest rate change is used for the given interest rate change.

**In all except two observations, the sign of changes in NII (or EVE) sensitivities under rising or falling interest rate scenarios are the same. These two observations of inconsistent changes are deleted from the sample.

Step 2: If the changes in NII (or EVE) sensitivities are positive (“>0”) under rising or falling interest rate scenarios, then code the NII (or EVE) sensitivities as “***gn***” (i.e., good news); if the changes in NII (or EVE) sensitivities are negative or zero (“<= 0”) under rising or falling interest rate scenarios, then code the NII (or EVE) sensitivities as “***bn***” (i.e., bad news). For example:

Quarterly (Annual) Changes in NII sensitivities	
Rising Interest Rate Scenarios	Falling Interest Rate Scenarios
Positive Changes in NII sensitivities (coded as “***gn***”, Good News)	*Negative Changes* in NII sensitivities (coded as “***bn***”, Bad News)

Quarterly (Annual) Changes in EVE sensitivities	
Rising Interest Rate Scenarios	Falling Interest Rate Scenarios
Positive Changes in EVE sensitivities (coded as “***gn***”, Good News)	*Negative Changes* in EVE sensitivities (coded as “***bn***”, Bad News)

Step 3: Denote variable “*Qtr_NII_sensitivity*” to be the quarterly change in NII sensitivities, and variable “*Yr_NII_ sensitivity”* to be the annual change in NII sensitivities. Code changes in NII sensitivities as “NII gn,bn”, “NIIbn,gn”, “NIIgn,gn” or “NIIbn,bn”, where “NII” denotes changes in NII sensitivities, the left (right) “***gn***” or “***bn***” denotes good news or bad news under rising or falling interest rate scenarios. Similarly coding applies to changes in EVE sensitivities. For example:

Variables:
Qtr_NII_sensitivity
Yr_NII_ sensitivity
Value: ***NII gn,bn***

Variables:
Qtr_EVE_ sensitivity
Yr_NII_sensitivity
Value: ***EVE gn,bn***

Step 4: Concatenate variables for observations disclosing both NII and EVE sensitivities. For example:

Variables:
Qtr_NII_EVE_sensitivity
Yr_NII_EVE_sensitivity
Value: ***NII gn,bn_EVE gn,bn***

Table 1: Sample

Panel A: Sample Construction

	Obs.
Top-tier bank holding companies in CRSP-Comupstat Merged database with FR Y-9C data available on Federal Reserve Bank website from 1997 to 2009	5340
Less: Observations that do not have 10-K on SEC Edgar database, or observations whose interest rate risk disclosures could not be found	-1841
Less: Observations that have missing data to calculate variables	-1101
Less: Observations with fiscal year end not in the 4th quarter	-72
Less: Observations of 1st and 99th percentile of total assets, stock returns and net income	-65
Number of observations (full sample)	2261
Number of unique bank holding companies	336
Number of observations with at least two years of data (supplemental sample)	1925
Number of unique bank holding companies (supplemental sample)	310
Number of bank holding companies changing disclosures in the supplemental sample	205

Panel B: Quartiles by Total Assets

Quartile	N	Mean	Std Dev	Min	Q1	Median	Q3	Max
				Total Assets (in millions)				
4	561	29,186	46,804	4,207	7,475	11,378	27,032	341,839
1	563	616	198	272	476	599	728	1,210
ALL	2261	8468	26,208	272	852	1,791	5,154	341,839

Notes: This table reports the sample selection process and the distribution of total assets of the sample BHCs.

Table 2: Descriptive Statistics of Variables in Regressions

Panel A: Descriptive Statistics

Quartile	N	Mean	Std Dev	Q1	Median	Q3	Mean	Std Dev	Q1	Median	Q3
		non_int_inc_pctg (%)					***Inst_own_pctg (%)***				
4	561	32.02	15.02	22.07	29.77	38.06	43.92	22.46	28.51	44.09	59.55
1	563	18.26	7.70	12.90	17.58	21.80	8.99	9.51	1.95	6.61	12.35
ALL	2261	23.06	11.45	15.91	20.84	27.88	24.70	21.61	6.97	18.46	39.15
		time_deposit_pctg (%)					***ROA (%)***				
4	561	31.98	11.97	24.05	31.62	38.63	3.10	0.97	2.57	3.01	3.49
1	563	40.57	12.09	33.22	41.35	49.10	3.16	0.98	2.59	2.92	3.47
ALL	2261	37.62	12.41	29.54	37.81	45.22	3.02	0.88	2.52	2.89	3.35
		tier1_lev (%)					***Derivative use (dummy)***				
4	561	8.24	1.52	7.19	8.16	9.02	0.73	0.45			
1	563	9.49	1.65	8.40	9.23	10.35	0.20	0.40			
ALL	2261	8.84	1.62	7.82	8.68	9.73	0.41	0.49			

Panel B: Correlation Coefficients for Quartile 4 (Largest)

N=561		***a***	***b***	***c***	***d***	***e***	***f***	***g***
Log(non_int_inc_pctg)	***a***		**0.13**	**0.27**	**-0.16**	**0.66**	**0.19**	**0.40**
Log(time_deposit_pctg)	***b***	-0.04		**-0.26**	-0.01	**-0.10**	-0.02	0.04
Log(inst_own_pctg+1)	***c***	**0.22**	**-0.20**		**0.14**	0.07	**0.18**	**0.18**
tier1_lev	***d***	**-0.19**	**-0.41**	**0.11**		0.07	-0.03	**-0.20**
ROA	***e***	**0.69**	**-0.09**	**0.10**	-0.10		0.05	**0.13**
Derivative use	***f***	**0.20**	0.00	**0.19**	-0.03	0.04		**0.23**
LogTA	***g***	**0.39**	**0.17**	**0.23**	**-0.21**	**0.16**	**0.26**	

Panel C: Correlation Coefficients for Quartile 1 (Smallest)

N=563		***a***	***b***	***c***	***d***	***e***	***f***	***g***
Log(non_int_inc_pctg)	***a***		**0.11**	**-0.09**	-0.02	**0.42**	0.07	0.01
Log(time_deposit_pctg)	***b***	**-0.17**		**-0.09**	-0.02	-0. 04	0.07	0.02
Log(inst_own_pctg+1)	***c***	-0.05	0.03		**0.27**	0.01	0.07	**0.39**
tier1_lev	***d***	0.02	-0.12	**0.12**		0.01	0.03	0.05
ROA	***e***	**0.38**	**-0.19**	0.00	**0.09**		0.08	-0.08
Derivative use	***f***	**0.11**	0.03	**0.16**	0.03	-0.03		**0.28**
LogTA	***g***	**0.11**	**0.17**	**0.38**	0.04	-0.07	**0.29**	

Notes: This table reports the descriptive statistics of variables. In Panel B, the upper diagonal presents Pearson correlations, and the lower diagonal presents Spearman correlations. Significance levels at the 0.05 level or better are bolded. ***non_int_inc_pctg*** is noninterest income divided by the sum of net interest income and noninterest income. ***time_deposit_pctg*** is time deposit funding divided by the sum of non-maturity deposits, time deposits and nondeposit funding. In the regressions, I take the natural log of one plus the percentages of ***non_int_inc_pctg*** and ***time_deposit_pctg***. ***LogTA*** is the log of total assets. ***inst_own_pctg*** is the percentage of shares outstanding held by institutional investors. ***tier1_lev*** is the Tier 1 leverage ratio. ***ROA*** is income before income tax and extraordinary items divided by average assets. ***Derivative use*** is one if a BHC reports a non-zero notional amount of derivatives held for non-trading purposes in FR Y-9C, zero otherwise.

Table 3: Ordered Logit Regression of Disclosures for Large BHCs (Quartile 4)

Panel A: Dependent Variable

Dependent variable:				**Quartile 4 (Largest)**	
Disclosures ranked from the highest to the lowest				**Frequency**	**%**
Disclosing NII and EVE simulation:	gap1_NII1_EVE1	or	gap0_NII1_EVE1	194	34.52
Disclosing only NII simulation:	gap1_NII1_EVE0	or	gap0_NII1_EVE0	317	56.23
Disclosing only EVE simulation:	gap1_NII0_EVE1	or	gap0_NII0_EVE1	7	1.25
Disclosing no simulation:	gap1_NII0_EVE0			45	8.01

Panel B: Ordered Logit Regression

Quartile 4 (Largest)	Predicted	Estimate	p-value
Cutoffs			
Disclosing NII and EVE simulation		-102.70	(0.002)**
Disclosing only NII simulation		-95.35	(0.003)**
Disclosing only EVE simulation		-94.91	(0.003)**
Predictive variables			
Log(non_int_inc_pctg)	- or +	17.73	(0.000)***
Log(time_deposit_pctg)	- or +	1.50	(0.051)*
derivative use	- or +	-1.66	(0.003)***
Log(inst_own_pctg+1)	- or +	6.75	(0.004)***
LogTA	?	-1.80	(0.038)**
tier1_lev	?	-0.36	(0.035)**
ROA	?	-0.26	(0.238)
Year, Firm		yes	
Likelihood ratio χ^2		1065.20	(0.001)***
AIC		1071.21	
Pseudo R^2		0.726	
N		562	

Panel C: Mean Marginal Effects

Quartile 4 (Largest)	***non_int_inc_pctg***	***time_deposit_pctg***	***derivative use***	***inst_own_pctg***
Disclosing NII and EVE simulation:	63.1%	10.5%	-17.7%	26.2%
Disclosing only NII simulation:	-27.5%	-4.6%	7.7%	-11.4%
Disclosing only EVE simulation:	-5.2%	-0.09%	1.5%	-2.2%
Disclosing no simulation:	-30.4%	5.1%	8.5%	-12.6%

Notes: This table reports the ordered logit regression results on interest rate risk disclosures for size quartiles 4. "NII" indicates net interest income, and "EVE" indicates economic value of equity. The interest rate risk disclosures are ordered into four levels. ***, **, * indicate two-sided significance levels at the 0.01, 0.05 and 0.10 level or better, respectively. ***non_int_inc_pctg*** is noninterest income divided by the sum of net interest income and noninterest income. ***time_deposit_pctg*** is time deposit funding divided by the sum of non-maturity deposits, time deposits and nondeposit funding. In the regressions, I take the natural log of one plus the percentages of ***non_int_inc_pctg*** and ***time_deposit_pctg***. ***LogTA*** is the log of total assets. ***inst_own_pctg*** is the percentage of shares outstanding held by institutional investors. ***tier1_lev*** is the Tier 1 leverage ratio. ***ROA*** is income before income tax and extraordinary items divided by average assets. ***Derivative use*** is one if a BHC reports a non-zero notional amount of derivatives held for non-trading purposes in FR Y-9C, zero otherwise.

Table 4: Regression Results of Disclosures for Small BHCs (Quartile 1)

Panel A: Dependent Variable in Ordered Logit Regression

Dependent variable:				**Quartile 1 (Smallest)**	
Disclosures ranked from the highest to the lowest				**Frequency**	**%**
Disclosing NII and EVE simulation:	gap1_NII1_EVE1	or	gap0_NII1_EVE1	122	21.79
Disclosing only NII simulation:	gap1_NII1_EVE0	or	gap0_NII1_EVE0	232	41.25
Disclosing only EVE simulation:	gap1_NII0_EVE1	or	gap0_NII0_EVE1	46	8.21
Disclosing no simulation:	gap1_NII0_EVE0			161	28.75

Panel B: Ordered Logit Regression Results

		Quartile 1 (Smallest)		**Quartile 4 vs. Quartile 1**	
		(1)		**(2) Quartile4*Predictors**	
	Predicted	Estimate	p-value	Estimate	p-value
Cutoffs					
Disclosing NII and EVE simulation		57.95	(0.058)*		
Disclosing only NII simulation		64.49	(0.040)**		
Disclosing only EVE simulation		66.42	(0.036)**		
Predictive variables					
Log(non_int_inc_pctg)	-	-5.66	(0.153)	18.16	(0.000)***
Log(time_deposit_pctg)	-	4.67	(0.001)***	-3.66	(0.015)**
derivative use	- or +	0.16	(0.388)	-1.31	(0.048)**
Log(inst_own_pctg+1)	- or +	-14.45	(0.001)***	21.01	(0.000)***
LogTA	?	3.16	(0.029)**	-3.57	(0.003)***
tier1_lev	?	0.27	(0.062)*	-0.45	(0.066)*
ROA	?	0.83	(0.102)	0.52	(0.541)
Year, Firm		yes			
Likelihood ratio χ^2		1407.364	(0.001)***		
AIC		1413.26			
Pseudo R^2		0.833			
N		560			

Panel C: Mean Marginal Effects of Ordered Logit Regression

Quartile 1 (Smallest)	***time_deposit_pctg***	***inst_own_pctg***
Disclosing NII and EVE simulation:	13.8%	-29.8%
Disclosing only NII simulation:	10.9%	-23.6%
Disclosing only EVE simulation:	-7.2%	15.6%
Disclosing no simulation:	-17.4%	37.7%

Table 4 *(Continued)*

Notes: This table reports the ordered logit regression results on interest rate risk disclosures for size quartiles 1. "NII" indicates net interest income, and "EVE" indicates economic value of equity. The interest rate risk disclosures are ordered into four levels. ***, **, * indicate two-sided significance levels at the 0.01, 0.05 and 0.10 level or better, respectively. ***non_int_inc_pctg*** is noninterest income divided by the sum of net interest income and noninterest income. ***time_deposit_pctg*** is time deposit funding divided by the sum of non-maturity deposits, time deposits and nondeposit funding. In the regressions, I take the natural log of one plus the percentages of ***non_int_inc_pctg*** and ***time_deposit_pctg***. ***LogTA*** is the log of total assets. ***inst_own_pctg*** is the percentage of shares outstanding held by institutional investors. ***tier1_lev*** is the Tier 1 leverage ratio. ***ROA*** is income before income tax and extraordinary items divided by average assets. ***Derivative use*** is one if a BHC reports a non-zero notional amount of derivatives held for non-trading purposes in FR Y-9C, zero otherwise.
For Column (2) in Panel B, I run an ordered logit regression with pooled observations from Quartile 4 and Quartile 1. I include interactive dummy variable that takes the value of one if the firm-year is in Quartile 4 and this dummy variable also interacts with all predictive variables.

Table 5: Changing Disclosure Types

Panel A: Changes in Interest Rate Risk Disclosures during 1997 to 2009 (205 BHCs)

	Full Sample (freq.)	Quartile 4 (Largest) (freq.)
add NII and EVE	23	8
add NII only	56	17
add NII (total)	79	25
add NII and EVE	23	8
add EVE only	28	13
add EVE (total)	51	21
add NII and EVE & drop gap	10	4
add NII only & drop gap	14	2
add EVE only & drop gap	3	0
drop gap without adding	54	18
drop gap (total)	81	24
add gap	31	13
drop EVE	15	6

Panel B: Duration Analysis of Disclosure Changes for Large BHCs

	Quartile 4 (largest)					
	Add NII		Add EVE		Drop GAP	
	Estimate	p-value	Estimate	p-value	Estimate	p-value
Log(non_int_inc_pctg)	3.86	(0.020) **	-1.55	(0.183)	-0.12	(0.568)
Log(time_deposit_pctg)	0.59	(0.076)*	0.31	(0.033) **	-0.36	(0.278)
derivative use	-0.81	(0.261)	0.43	(0.601)	1.72	(0.043) **
Log(inst_own_pctg+1)	7.65	(0.033)**	-0.49	(0. 053) *	1.31	(0.524)
LogTA	0.57	(0.167)	0.13	(0.063) *	0.04	(0.864)
tier1_lev	0.33	(0.094)*	-0.15	(0.522)	-0.01	(0.973)
ROA	-0.36	(0.559)	-0.07	(0.879)	0.02	(0.947)
Year	yes		yes		yes	
Event	25		21		24	
# of firms	28		62		69	
Firm-year	65		340		389	
Ward χ^2	30.51 **		28.06 *		9.87	

Table 5 *(continued)*

Panel C: Duration Analysis of Disclosure Changes for Small BHCs

	Quartile 1 (Smallest)					
	Add NII		Add EVE		Drop GAP	
	Estimate	p-value	Estimate	p-value	Estimate	p-value
Log(non_int_inc_pctg)	-0.49	(0.468)	-0.67	(0.143)	-3.74	(0.221)
Log(time_deposit_pctg)	0.31	(0.337)	-0.99	(0.225)	0.61	(0.207)
derivative use	-0.50	(0.602)	0.04	(0.477)	-1.17	(0.061) *
Log(inst_own_pctg+1)	5.37	(0.049)**	-2.77	(0.067) *	-2.95	(0.187)
LogTA	0.99	(0.421)	2.50	(0.300)	1.39	(0.047) **
tier1_lev	-0.04	(0.830)	0.26	(0.351)	0.01	(0.467)
ROA	0.11	(0.745)	-0.33	(0.596)	0.05	(0.449)
Year	yes		yes		yes	
Event	16		5		19	
# of firms	42		65		80	
Firm-year	148		279		333	
Ward χ^2	12.51		15.42		14.20	

Notes: This table reports the duration regression results on interest rate risk disclosures for total assets quartiles 4 and 1. “NII” indicates net interest income, and “EVE” indicates economic value of equity. The interest rate risk disclosures are ordered into four levels. ***, **, * indicate two-sided significance levels at the 0.01, 0.05 and 0.10 level or better, respectively. ***non_int_inc_pctg*** is noninterest income divided by the sum of net interest income and noninterest income. ***time_deposit_pctg*** is time deposit funding divided by the sum of non-maturity deposits, time deposits and nondeposit funding. In the regressions, I take the natural log of one plus the percentages of ***non_int_inc_pctg*** and ***time_deposit_pctg***. ***LogTA*** is the log of total assets. ***inst_own_pctg*** is the percentage of shares outstanding held by institutional investors. ***tier1_lev*** is the Tier 1 leverage ratio. ***ROA*** is income before income tax and extraordinary items divided by average assets. ***Derivative use*** is one if a BHC reports a non-zero notional amount of derivatives held for non-trading purposes in FR Y-9C, zero otherwise.

Table 6: Analysis of Information Content for Simulation Disclosures

Panel A: Sample Compositions for BHCs Disclosing Simulation for the First Time

Change Sample (BHCs disclosing simulation for the first time):	Type of simulation disclosed in the current year		
	both EVE and NII	NII only	EVE only
	Obs.	Obs.	Obs.
Observations that disclose simulations in the *current* year, but did not disclose any simulation in the *previous* year	23	47	3
Less: Observations missing sufficient data in CRSP to compute abnormal returns and abnormal trading volumes	-3	-4	0
Final sample	20	43	3
Control Sample[1]:			
BHCs in the change sample are matched with BHCs that do not disclose any simulation (the control sample)	20	43	NA [2]

Notes: "NII" indicates net interest income, and "EVE" indicates economic value of equity.
Panel A presents the sample composition of BHCs disclosing NII/EVE simulations for the first time.
Each BHC that discloses simulation for the first time (the change sample) is matched with a control BHC.
[1] The requirements to construct the control sample of BHCs are:
(a) The control sample is in the same year as the change sample to control for the year effect.
(b) Total assets of the BHCs in the control sample are between 25% to 200% of the BHCs in the change sample.
(c) The percentage of non-traditional banking activities of the control BHCs is the closest to the BHCs in the change sample.
[2] The three BHCs that add EVE simulation disclosures are not matched with control firms and are not included in the analysis, because the sample size is too small for statistical inferences to be reliable.

Table 6 *(continued)*

Panel B: Analysis of Information Content

	Sample	**N**	**Mean**	***T-Test*** *(p-value)*	**Median**	***Wilconxon*** *(p-value)*	**P25**	**P75**	**Std Dev**
	AVOL1 (median-adjusted abnormal volume)								
Add NII Only	change	43	0.884		0.628		-0.166	1.351	1.266
	control	43	0.352	(0.015)**	-0.010	(0.019)**	-0.247	0.695	0.933
Add NII&EVE	change	20	1.046		0.517		-0.139	1.569	1.596
	control	20	0.691	(0.514)	-0.017	(0.194)	-0.173	1.267	1.542

	Sample	**N**	**Mean**	***T-Test*** *(p-value)*	**Median**	***Wilconxon*** *(p-value)*	**P25**	**P75**	**Std Dev**
	AVOL2 (mean-adjusted abnormal volume)								
Add NII Only	change	43	0.353		0.090		-0.613	0.870	1.247
	control	43	-0.218	(0.010)**	-0.548	(0.015)**	-0.803	0.299	0.934
Add NII&EVE	change	20	0.500		0.050		-0.611	1.149	1.606
	control	20	0.135	(0.501)	-0.439	(0.223)	-0.901	0.400	1.521

	Sample	**N**	**Mean**	***T-Test*** *(p-value)*	**Median**	***Wilconxon*** *(p-value)*	**P25**	**P75**	**Std Dev**
	AVAR (abnormal return volatility)								
Add NII Only	change	43	1.746		1.845		1.625	1.990	0.302
	control	43	1.715	(0.600)	1.816	(0.519)	1.490	1.983	0.325
Add NII&EVE	change	20	1.801		1.902		1.725	1.948	0.222
	control	20	1.875	(0.629)	1.677	(0.558)	1.368	1.997	0.515

Notes: "NII" indicates net interest income, and "EVE" indicates economic value of equity. Panel B reports the analysis of information content measures for the BHCs disclosing simulation for the first time. Each BHC in the change sample is matched with a control firm. ***Sample***=change denotes BHCs disclosing simulation for the first time; ***Sample***=control denotes BHCs in the control sample. ***Add_NIIonly*** denotes disclosing NII simulation only for the first time. ***Add_NII_EVE*** denotes disclosing NII and EVE simulations for the first time. ***AVOL1*** is the median-adjusted abnormal volume. ***AVOL2*** is the mean-adjusted abnormal volume. ***AVAR*** is the abnormal return volatility. The significance levels of the means are based on the two sample T-statistics. The significance levels for the medians are based on Wilconxon-Mann-Whitney statistics.

Table 7: Sample for Simulation Disclosure Sensitivity Analysis

Panel A: Sample Selection for BHCs Disclosing NII/EVE Simulation

	# of BHCs
The largest 50 BHCs by total assets in the full sample	50
Less: BHCs that did not disclose simulation in 10-Ks	-8
BHCs that disclosed simulation in 10-Ks for 2003, 2004 and 2005	42

Panel B: BHCs Disclosing NII/EVE Simulation in Quarterly or Annual Samples

	# of unique BHCs [(1)]	# of observations in the sample	# of observations in the "*change*" sample
Quarterly:			
BHCs disclosing simulation quarterly (in 10-Qs and 10-Ks)	21	175	152
BHCs disclosing NII only	15	135	118[(2)]
BHCs disclosing both NII and EVE	5	31	26[(3)]
BHCs disclosing EVE only	1	9	8
Annual:			
BHCs disclosing simulation annually (in 10-Ks)	23	57	44
BHCs disclosing NII only	12	26	24
BHCs disclosing both NII and EVE	9	25	16[(4)]
BHCs disclosing EVE only	2	6	4

Notes: "NII" indicates net interest income, and "EVE" indicates economic value of equity.

Panel A presents the sample selection of simulation disclosures for BHCs disclosing NII/EVE simulations. Panel B presents the sample composition of NII/EVE simulation disclosures. BHCs may disclose NII/EVE simulation on a quarterly basis in 10-Qs and 10-Ks, or on an annual basis in 10-Ks. For the BHCs in this supplemental analysis, 10-Ks and 10-Qs during 2003 year end, 2004, and 2005 are collected, consisting of 9 quarters of 10-Qs and 3 years of 10-Ks.

Panel B presents the sample composition of BHCs disclosing NII/EVE simulations.

[(1)] Two BHCs are counted in both the quarterly sample and annual sample, because:

- one BHC discloses both NII and EVE simulations quarterly in the 10-K of 2003 and 10-Q of 2004; it changes to disclosing both NII and EVE simulations annually in the 10-Ks of 2004 and 2005.
- one BHC discloses both NII and EVE simulations annually in the 10-Ks of 2003 and 2004; it changes to disclosing both NII and EVE simulations quarterly in the 10-K of 2004 and 10-Q of 2005.

[(2)] Two observations are deleted in the coding process because they disclose inconsistent changes in NII simulation under rising (falling) interest rate scenarios (e.g.., positive changes in NII under the interest rate rising 100 bps scenario, and negative changes in NII under the interest rate rising 200 bps scenario). Thus, these two observations are excluded from my "change" sample (please see the coding scheme for details).

[(3)] 26 observations in the quarterly "change" sample include the following: two BHCs have 8 observations; one BHC only has 3 observations for the 2004 quarterly disclosure; one BHC only has 3 observations for the 2005 quarterly disclosure; one BHC only has 4 observations as it only has 10-K and 10-Q filings during the end of 2004 through the end of 2005.

[(4)] Two BHCs each only have one observation because one BHC changes from an annual to quarterly disclosure, and the other changes from a quarterly to annual disclosure.

Table 8: Summary of Classification of NII and EVE Sensitivities

Panel A: NII Sensitivities

Rising Interest Rate Scenarios	**Falling** Interest Rate Scenarios	*Qtr_NII_sensitivity / Yr_NII_sensitivity*
+	-	*NII gn,bn*
+	+	*NII gn,gn*
-	+	*NII,bn,gn*
-	-	*NII gn,bn*

Panel B: EVE Sensitivities

Rising Interest Rate Scenarios	**Falling** Interest Rate Scenarios	*Qtr_EVE_sensitivity / Yr_EVE_sensitivity*
+	-	*EVE gn,bn*
+	+	*EVE gn,gn*
-	+	*EVE bn,gn*
-	-	*EVE gn,bn*

Notes: "NII" indicates net interest income, and "EVE" indicates economic value of equity.
Panel A and B show all possible coding combinations of NII sensitivities and EVE sensitivities, respectively. For observations disclosing both NII and EVE simulations, there are 16 possible coding combinations. The coding procedures for classifying NII and EVE sensitivities into good news and bad news are detailed in the four steps in Appendix H.

Qtr_NII_sensitivity (*Yr_NII_sensitivity*) denotes NII sensitivities for the quarter (annual) sample. *Qtr_NII_sensitivity* (*Yr_NII_sensitivity*) takes the value of *NII bn,bn, NII gn,bn, NII bn,gn, NII gn,gn. NII* represents NII simulation, *gn* or *bn* on the *left* side represents good news or bad news for *rising* interest rates scenarios, and *gn* or *bn* on the *right* side represents good news or bad news for *falling* interest rates scenarios. For example, *NII gn,bn* represents good news (i.e., higher NII sensitivities than the previous period) for rising interest rates scenarios, and bad news (i.e., lower NII sensitivities than the previous period) for falling interest rates scenarios. The similar coding scheme applies to EVE.

If a BHC discloses both NII and EVE simulations, then I concatenate the coding of NII and EVE sensitivities and I have *Qtr_NII_EVE_sensitivity* (*Yr_NII_EVE_sensitivity*) for the quarterly (annual) sample. For example, *NII gn,bn_EVE gn,bn* represents that, by disclosing NII sensitivities, a BHC conveys good news for rising interest rates and bad news for falling interest rates, and at the same time by disclosing EVE sensitivities, a BHC conveys good news for rising interest rates and bad news for falling interest rates.

Table 9: Market Return Responses to NII Sensitivities in Quarterly Sample

Panel A: Frequency Table of NII Sensitivities

	Qtr_NII_sensitivity		***CAR (0,1)***	
Qtr_NII_sensitivity	Frequency	Percent	Mean	Median
NII bn,bn	21	17.8	-0.002	0.002
NII bn,gn	40	33.9	-0.001	0.002
NII gn,bn	36	30.5	0.003	0.002
NII gn,gn	21	17.8	0.004	0.003
	118	100%		

Panel B: Distributions

	Mean	**Median**	**P25**	**P75**	**Std Dev**
CAR (0,1)	0.001	0.002	-0.006	0.008	0.017
log_ta	8.286	7.912	7.312	9.459	1.086
log_mv	9.857	9.408	8.958	11.255	1.128
NII_Scenario_Cnt	2.1	2	2	2	0.6

Panel C: Pearson (Spearman) Correlation above (below) the Diagonal

	CAR (0,1)	*log_ta*	*log_mv*	*NII_Scenario_Cnt*
CAR (0,1)		0.006	0.011	0.147
log_ta	0.054		**0.980**	**-0.241**
log_mv	0.046	**0.973**		**-0.262**
NII_Scenario_Cnt	0.186	**-0.308**	**-0.305**	

Panel D: Regression Analysis on Market Return Responses to NII Sensitivities

Dependent variable: *CAR (0,1)*

	Estimate	p-value	Estimate	p-value
Qtr_NII_sensitivity				
NII bn,bn (Base)				
NII gn,bn	0.005	(0.102)	0.005	(0.086) *
NII bn,gn	0.007	(0.040) **	0.008	(0.039) **
NII gn,gn	0.014	(0.023) **	0.014	(0.118)
NII_Scenario_Cnt	0.001	0.483	0.001	0.394
log_ta	0.038	0.052 *		
log_mv			0.014	0.253
Quarter	yes		yes	
firm fixed effects	yes		yes	
Adj R-Sq	0.178		0.171	
n	118		118	

Table 9 *(Continued)*

Notes: "NII" indicates net interest income, and "EVE" indicates economic value of equity.
This table presents analysis for BHCs that disclose only NII simulation quarterly. The sample size is 118 for all panels. Panel A presents distributions, Panel B presents Pearson and Spearman correlations, Panel C presents the frequency of quarterly change in NII sensitivities, and Panel D presents regression results.
The estimation in Panel D is an OLS regression:

$$CAR\ (0,1)_{i,t} = \alpha + \sum \beta\ Qtr\_NII\_sensitivity_{i,t} + \gamma\ NII\_Scenario\_Cnt_{i,t} + Size_{i,t} + \varepsilon_{i,t}$$

CAR (0,1) is the two-day cumulative abnormal return for the SEC filing date and the date after the filing date, where the abnormal return is the difference between the raw return and the value-adjusted CRSP market return. *Qtr_NII_sensitivity* represents NII sensitivities for the quarterly sample. Please see Appendix H for the coding procedure. *Size* is proxied by *log_ta* or *log_mv*. *log_ta* is the log of total assets at the end of fiscal year. *log_mv* is the log of market value of equity at the end of fiscal year. *NII_Scenario_Cnt* is the number of interest rate change scenarios for the NII sensitivities disclosure. Standard errors are clustered by firms, and are corrected for heteroscedasticity. ***, **, * indicates significance at the 0.01, 0.05, and 0.10 level (two-tailed), respectively.

Table 10: Market Return Responses to NII and EVE Sensitivities in Quarterly Sample

Panel A: Frequency Table of NII and EVE sensitivities

	Qtr_NII_EVE_sensitivity		***CAR (0,1)***	
Qtr_NII_EVE_sensitivity	Frequency	Percent	Mean	Median
NII bn,bn_EVE bn,bn	3	11.5	-0.021	-0.030
NII bn,bn_EVE bn,gn	2	7.7	-0.004	-0.004
NII bn,bn_EVE gn,bn	1	3.8	0.008	0.008
NII bn,gn_EVE bn,bn	1	3.8	-0.005	-0.005
NII bn,gn_EVE bn,gn	6	23.1	0.000	-0.003
NII bn,gn_EVE gn,bn	2	7.7	-0.005	-0.005
NII gn,bn_EVE bn,bn	2	7.7	-0.002	-0.002
NII gn,bn_EVE bn,gn	2	7.7	0.007	0.007
NII gn,bn_EVE gn,bn	4	15.4	-0.002	-0.003
NII gn,gn_EVE bn,gn	2	7.7	-0.007	-0.007
NII gn,gn_EVE gn,bn	1	3.8	-0.002	-0.002
	26	100%		

Panel B: Distributions

	Mean	**Median**	**P25**	**P75**	**Std Dev**
CAR (0,1)	-0.003	-0.004	-0.009	0.001	0.012
log_ta	10.007	9.538	9.065	11.758	1.351
log_mv	8.358	7.757	7.402	9.887	1.204
NII_Scenario_Cnt	3.3	3.0	2.0	4.0	1.5
EVE_Scenario_Cnt	3.2	2.0	2.0	4.0	1.5

Panel C: Pearson (Spearman) Correlation above (below) the Diagonal

	CAR (0,1)	*log_ta*	*log_mv*	*NII_Scenario_Cnt*	*EVE_Scenario_Cnt*
CAR (0,1)		-0.170	-0.253	0.399	0.361
log_ta	-0.155		**0.984**	**-0.693**	**-0.636**
log_mv	-0.292	**0.876**		**-0.708**	**-0.671**
NII_Scenario_Cnt	**0.414**	**-0.737**	**-0.727**		**0.967**
EVE_Scenario_Cnt	0.350	**-0.756**	**-0.746**	**0.935**	

Table 10 *(continued)*

Panel D: Regression Analysis on Market Return Responses to NII and EVE Sensitivities
Dependent variable*: CAR (0,1)*

	(1) Est.	(2) p-value	(3) Est.	(4) p-value	(5) Est.	(6) p-value	(7) Est.	(8) p-value
Qtr_NII_EVE_sensitivity:								
NII bn,bn_EVE bn,bn								
NII bn,bn_EVE bn,gn	0.030	(0.008) ***	0.030	(0.008) ***				
NII bn,bn_EVE gn,bn	0.030	(0.004) ***	0.030	(0.004) ***				
NII bn,gn_EVE bn,bn	0.037	(0.008) ***	0.037	(0.008) ***				
NII gn,bn_EVE bn,bn	0.031	(0.006) ***	0.031	(0.007) ***				
NII bn,gn_EVE bn,gn	0.029	(0.006) ***	0.029	(0.006) ***	0.007	(0.146)	0.007	(0.143)
NII bn,gn_EVE gn,bn	0.030	(0.009) ***	0.030	(0.009) ***	0.008	(0.166)	0.008	(0.161)
NII gn,bn_EVE bn,gn	0.037	(0.003) ***	0.037	(0.003) ***	0.016	(0.047)**	0.016	(0.045)**
NII gn,bn_EVE gn,bn	0.034	(0.006) ***	0.034	(0.006) ***	0.007	(0.265)	0.007	(0.264)
NII gn,gn_EVE bn,gn	0.044	(0.004) ***	0.044	(0.004) ***	0.008	(0.191)	0.008	(0.191)
NII gn,gn_EVE gn,bn	0.051	(0.002) ***	0.051	(0.002) ***	0.016	(0.036)**	0.016	(0.036)**
NII_Scenario_Cnt	0.003	0.263	0.003	0.258	0.004	0.071*	0.004	0.071*
log_ta	-0.003	0.039 **			0.000	0.631		
log_mv			-0.003	0.041 **			-0.001	0.621
Qtr fixed effects	yes		yes		yes		yes	
firm fixed effects	yes		yes		yes		yes	
	0.642		0.658		0.462		0.461	
	26		26		26		26	

Notes: "NII" indicates net interest income, and "EVE" indicates economic value of equity.
This table presents short-window market return analysis for the BHCs that disclose both NII and EVE simulation quarterly. Panel A presents distributions, Panel B presents Pearson and Spearman correlations, Panel C presents the frequency of quarterly change in NII and EVE sensitivities, and Panel D presents regression results.
The estimation in Panel D is an OLS regression:

$$CAR\ (0,1)_{i,t} = \alpha + \sum\beta\ Qtr\_NII\_EVE\_sensitivity_{i,t} + \gamma\ NII\_Scenario\_Cnt_{i,t} + Size_{i,t} + \varepsilon_{i,t}$$

CAR (0,1) is the two-day cumulative abnormal return for the SEC filing date and the date after the filing date, where the abnormal return is the difference between the raw return and the value-adjusted CRSP market return.
Qtr_NII_EVE_sensitivity represents NII and EVE sensitivities for the quarterly sample. Please see Appendix H for the coding procedure, and Table 8 for the summary of classification values.
Size is proxied by *log_ta* or *log_mv*. *log_ta* is the log of total assets at the end of fiscal year. *log_mv* is the log of market value of equity at the end of the fiscal year. *NII_Scenario_Cnt* is the number of interest rate change scenarios for the NII sensitivities disclosure. Standard errors are clustered by firms, and are corrected for heteroscedasticity.
***, **, * indicates significance at the 0.01, 0.05, and 0.10 level (two-tailed), respectively.

Figure 1: Percentages of BHCs with Different Interest Rate Risk Disclosure Types from 1997 to 2009

Figure 1A: Full Sample

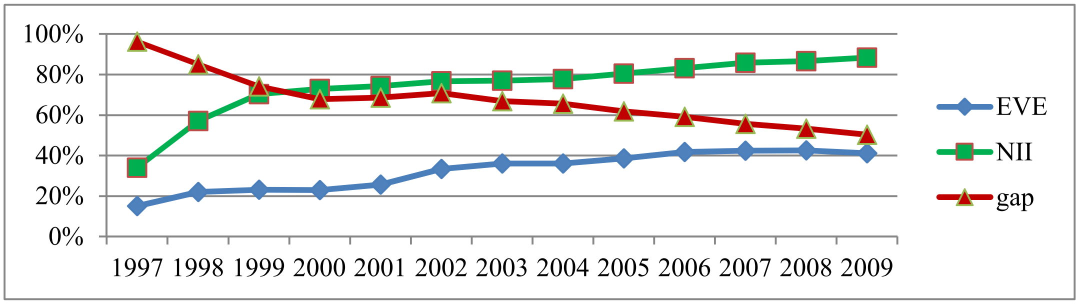


Figure 1B: Quartile 4 (largest)

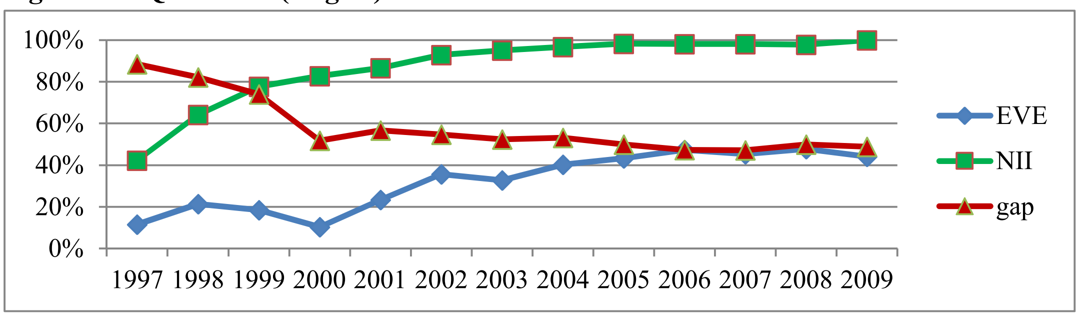
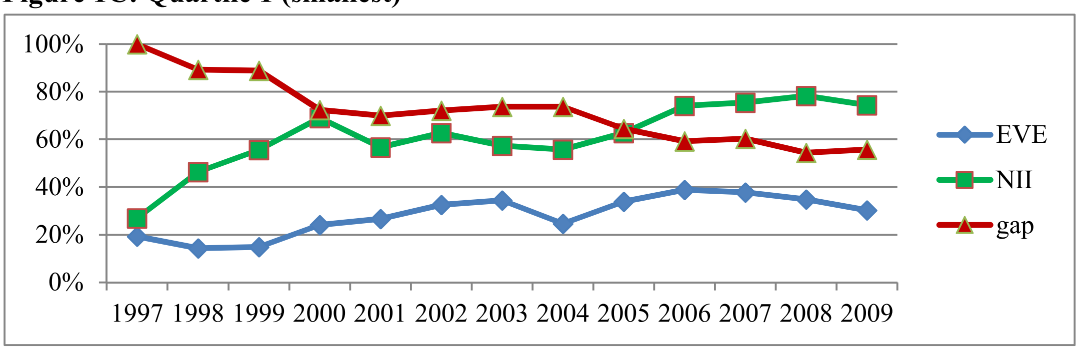


Figure 1C: Quartile 1 (smallest)



Note: The figures show the percentage of BHCs disclosing gap analysis (gap), net interest income simulation (NII) and economic value of equity simulation (EVE) during 1997 to 2009.

Figure 2: Percentages of BHCs with Interest Rate Risk Disclosure Combinations: 1997 vs 2009

Figure 2A: Full Sample (N=2261)

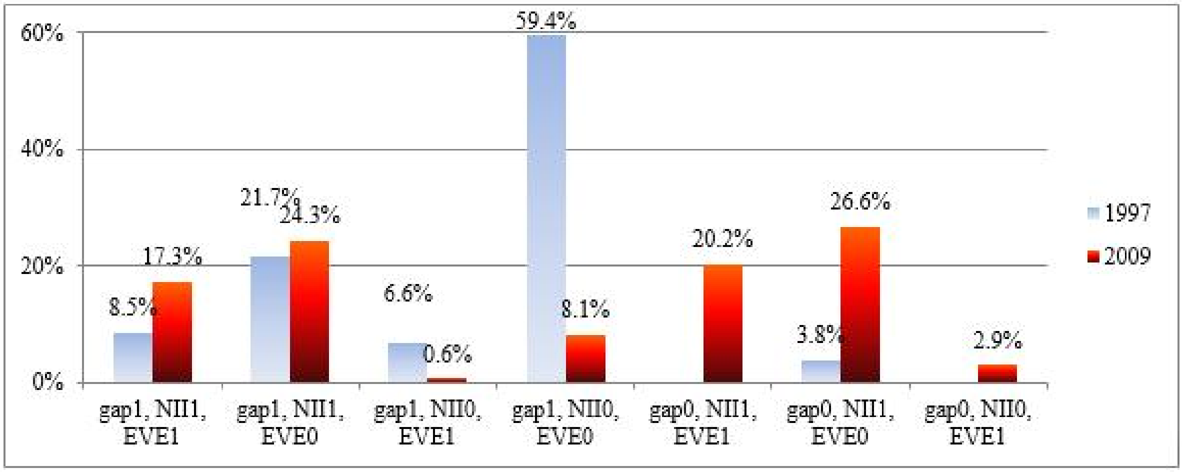


Figure 2B: Quartile 4 (largest)

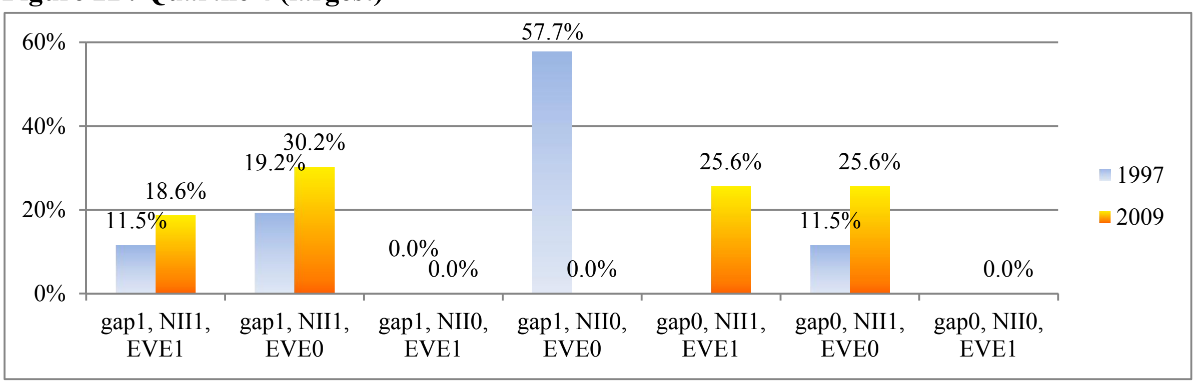
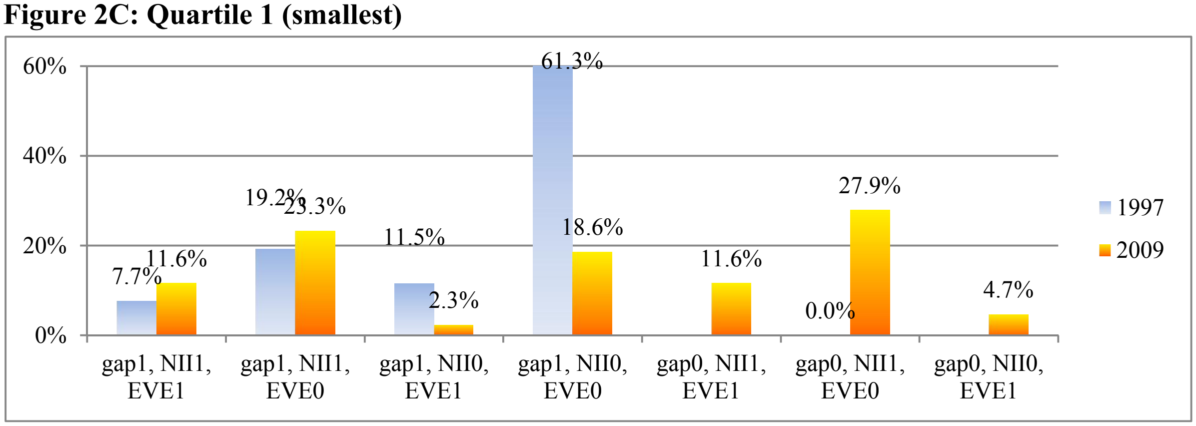


Figure 2C: Quartile 1 (smallest)



Notes: gap1 (gap0): a BHC discloses (does not disclose) gap analysis. NII1 (NII0): a BHC discloses (does not disclose) net interest income simulation measures. EVE1 (EVE0): a BHC discloses (does not disclose) economic value of equity simulation measures.

Figure 3: Changes of Interest Rate Risk Disclosure Types from 1997 to 2009

Figure 3A: Percentage of BHCs Changing Interest Rate Risk Disclosure Type (N=205)

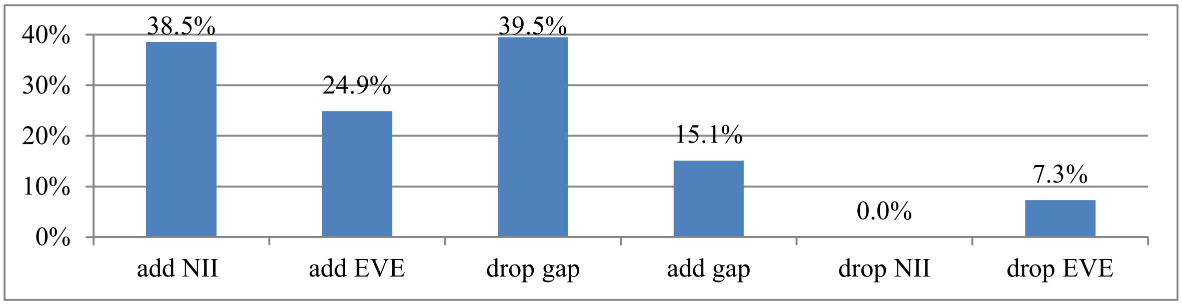
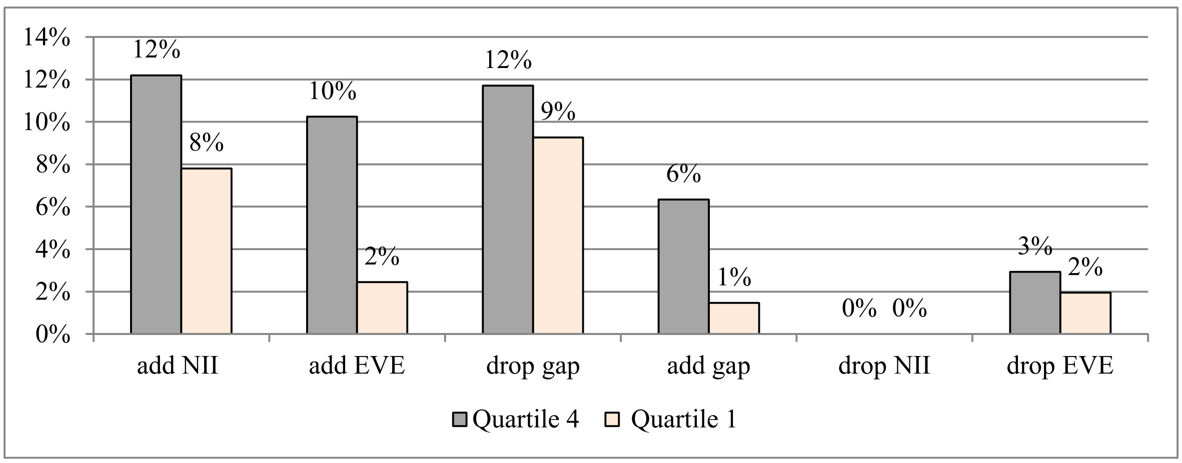


Figure 3B: Percentages BHCs Changing Interest Rate Risk Disclosure Type for Quartile 4 (largest) and Quartile 1 (smallest)



Notes: A total of 205 observations changed interest rate risk disclosures during 1997 and 2009. gap: a BHC discloses gap analysis. NII (EVE): a BHC discloses net interest income (economic value of equity) simulation measures.

Figure 4: Observations Changing Disclosure Types

Figure4A: Full Sample (N=205)

Total Number of Obs. Changing Disclosure Types | Average Number of Obs. per Year Changing Disclosure Types

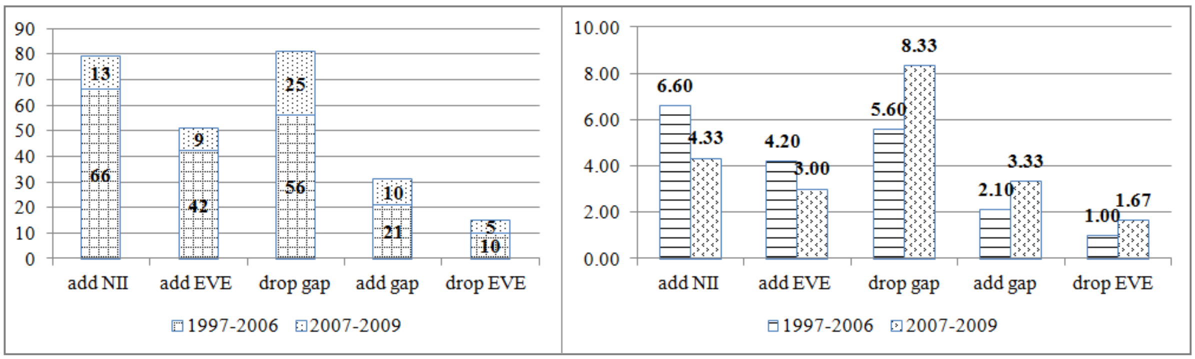


Figure4B: Quartile 4 (largest)

Total Number of Obs. Changing Disclosure Types | Average Number of Obs. per Year Changing Disclosure Types

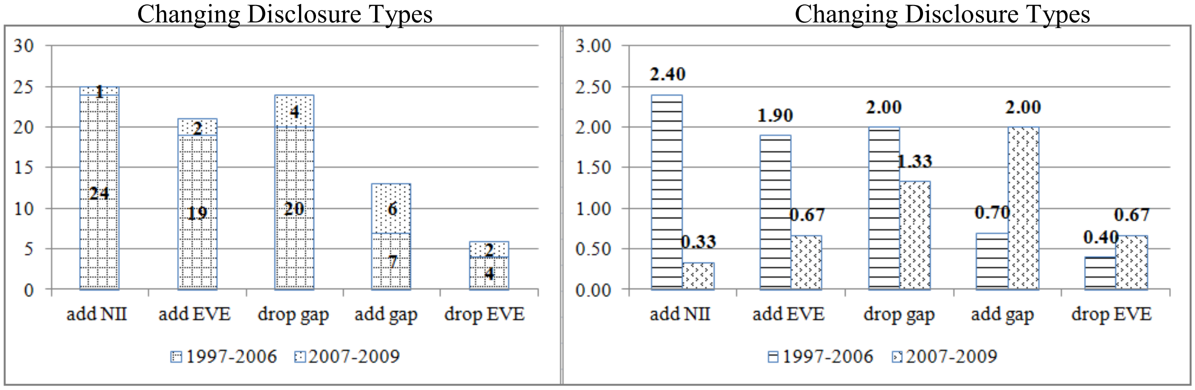
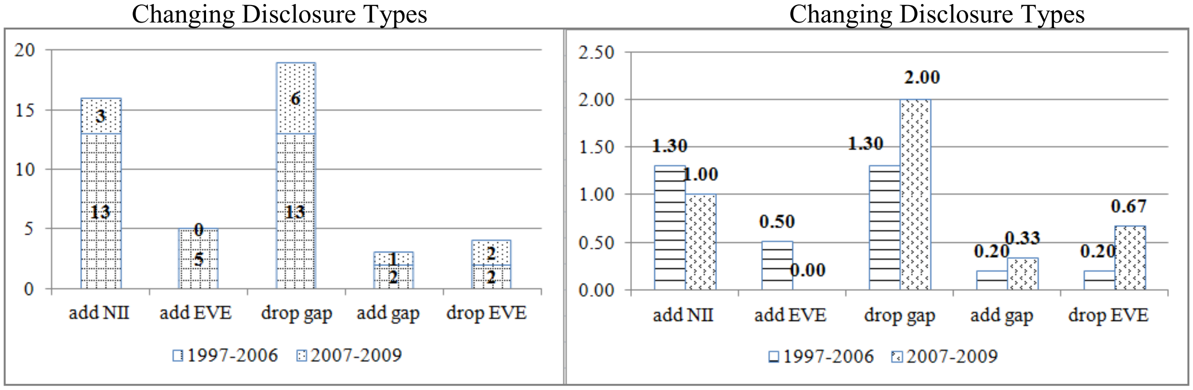


Figure4C: Quartile 1 (smallest)

Total Number of Obs. Changing Disclosure Types | Average Number of Obs. per Year Changing Disclosure Types



Notes: This figure contrasts the total number of observations changing disclosure types and the average number of observations per year changing disclosure types for the period prior to the financial crisis (1997-2006) and the period since the financial crisis (2007-2009). gap: a BHC discloses gap analysis. NII (EVE): a BHC discloses net interest income (economic value of equity) simulation measures.

CHAPTER FIVE:

AN EMPIRICAL EXAMINATION OF INTEREST RATE RISK MANAGEMENT

1. Introduction

Successfully managing risk is essential to the success, and in some cases, survival, of a financial institution. In this paper, I focus on interest rate risk. Interest rate risk is the risk that a bank's earnings and economic value of equity are adversely affected by changes in interest rates. The acceptance and management of interest rate risk is inherent to a bank's role as a financial intermediary. Banks' interest rate risk management is different from non-financial firms in that interest rate risk management for banks is used not only to mitigate potential loss, but also to directly profit from interest rate risk exposure.[34]

My study examines bank holding companies' (BHCs, hereafter) management of interest rate risk as related to earnings, which measures the impact of interest rate risk on net interest income (i.e., interest income minus interest expense).[35] Unless otherwise specified, interest rate risk as related to earnings is referred to as "interest rate risk" in the remainder of this paper. I investigate three questions: (1) what improved method can better measure banks' management of interest rate risk in generating net interest income, (2) to what extent are BHCs able to increase

[34] In the practice of bank management, in a broad sense interest rate risk management can be referred to as asset-liability management, which is a mechanism to address the risk faced by a bank due to a mismatch between assets and liabilities either due to liquidity or changes in interest rates. Financial institutions create asset-liability management committees to govern asset-liability management.

[35] Admittedly, interest rate risk also impacts a bank's earnings through its non-interest income. Consistent with the stream of literature studying a bank's profitability and interest rate risk (see related literature in Section 2.2.1), this paper does not examine the complexity of the impact of interest rate changes on non-interest income.

net interest income through managing interest rate risk, and (3) how does interest rate risk management affect the valuation of net interest income.[36]

The motivation for my study is three-fold. First, the past 30 years have witnessed the highest and lowest interest rates in United States history. In particular, the recent historically low interest rate environment and weak economic conditions present significant interest rate risk uncertainty to financial institutions. The spread between borrowing and lending rates has narrowed for many banks, causing lending profitability to fall. At the same time, some banks fund long-term assets with short-term liabilities to generate earnings, but this practice also poses risks to a bank's earnings and economic value of equity should interest rates increase. Financial regulators jointly issued *Advisory on Interest Rate Risk Management* in 2010 to remind financial institutions of sound practices for measuring interest rate risk, and where necessary, mitigating exposure to potential increases in interest rates (Federal Financial Institutions Examination Council, 2010). Thus, understanding interest rate risk management is essential to understanding banks' risk profile in today's challenging environment.

Second, a less explored area in the literature is to what extent banks are able to manage interest rate risk to generate net interest income, although researchers have studied the relation between banks' interest rate risk and profitability (see Staikouras, 2003, 2006 for review) and have examined banks' interest rate risk disclosures (Hodder, 2001; Ahmed, Beatty and Takeda, 1997). Banks' inability to manage interest rate risk could not only deplete banks' profits and capital, but also contribute to systemic risk in the broader economy as demonstrated by the savings and loan crisis in the 1980s. In addition, net interest income accounts for about 60% of

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[36] I want to thank Professor James Johannes at the University of Wisconsin-Madison for sharing his institutional knowledge. The theory and analysis in this paper are grounded in the course notes and other insights gained in Professor Johannes' bank management course.

all U.S. commercial banks' total operating income (Federal Reserve, 2009), in spite of banks' diversification into non-interest income. Finally, net interest income is gaining more importance due to ongoing federal regulations with respect to certain non-interest income.[37] Therefore, investigating how well banks generate net interest income through interest rate risk management will enable investors and regulators in assessing banks' profitability and earnings sustainability.

Third, existing research on interest rate risk typically uses maturity gap to measure banks' interest rate risk exposure and interest rate risk management (e.g., Schrand, 1997).[38] Additionally, many BHCs disclose maturity gap as part of their interest rate risk disclosures. Although straightforward and widely used, maturity gap analysis is inadequate to assess interest rate risk due to its limitations (Staikouras, 2006). For example, maturity gap is a static measure which assumes no future growth and cannot handle different degrees of changes in the interest rates of a bank's assets and liabilities. An improved method that overcomes the shortcomings of maturity gap is needed in order to adequately assess banks' management of interest rate risk.

The analyses in this paper are based on the α-gap model. This model decomposes changes in net interest income into rate variances and volume variances.[39] Rate variances are changes in net interest income attributable to changes in interest rates and reflect the outcome of interest rate risk management. Rate variances are modeled through α-gap, which is the dollar amount difference between rate sensitive assets and rate sensitive liabilities adjusted for the

[37] For example, under the Dodd Frank Act, the Durbin Amendment limits banks' debit card interchange fees, and the Volcker Rule limits banks' proprietary trading and investment in hedge funds.
[38] Under maturity gap analysis, individual assets and liabilities are categorized by the time buckets in which they mature or reprice. The difference between assets and liabilities in each time bucket is calculated and referred to as a maturity gap. By convention, maturity gap is the one-year gap calculated as the dollar value of the differences between assets and liabilities repricing or maturing within 12 months.
[39] The rate and volume variances are similar to the price and quantity variances for materials in cost accounting.

different interest rate changes of rate sensitive assets and liabilities.[40] α captures the process of how a bank manages interest rates and repricing terms of assets and liabilities to generate net interest income. α-gap further captures the process of adjusting the balances of assets and liabilities. The outcome of managing α and α-gap in response to market interest rate changes is captured by rate variances. Greater rate variances indicate more effective interest rate risk management, *ceteris paribus*.

From the α-gap model I develop two proxies for interest rate risk management: (1) an indicator variable of positive rate variances and (2) a continuous variable equivalent to standardized rate variances. I evaluate how effectively BHCs manage interest rate risk to generate net interest income for a sample of 2,565 firm-years from 332 unique publicly traded BHCs during 1998 to 2010. I document that, during 1998 to 2010, only 36.8% of BHCs have rate variances greater than zero, whereas 71.3% have volume variances greater than zero. I find that, on average, BHCs' increases in net interest income consist of positive volume variances and negative rate variances, suggesting that BHCs tend to generate net interest income by changing the size and composition of their balance sheet, not by effectively managing interest rate risk.

Next, I investigate whether interest rate risk management affects the valuation of net interest income. Interest rate risk management is likely to positively affect the persistence of net interest income by enhancing future yields on a bank's assets and by reducing future funding costs, and as a consequence, positively affect the valuation of net interest income. I find that BHCs with more effective interest rate risk management have more persistent net interest income, and have a stronger association between net interest income and market returns than

[40] Rate sensitive assets are earnings assets maturing or repricing within one year. Rate sensitive liabilities are interest-bearing liabilities maturing or repricing within one year.

other BHCs. Furthermore, I find the valuation effect is stronger during the pre-financial crisis period of 1996 to 2006 than during the financial crisis period of 2007 to 2010.

My study makes several contributions. First, I develop the α-gap model which is superior to the conventional maturity gap model and empirically demonstrate that the measures based on the α-gap model can capture the process and outcome of interest rate risk management. My study can help investors and regulators more accurately assess interest rate risk management. Bank management can also employ the α-gap model to manage interest rate risk.

Second, my study sheds light on banks' strategies in generating net interest income. I find that banks tend to generate net interest income by changing the size and composition of their balance sheet, rather than by managing interest rate risk. Furthermore, I find that the persistence of net interest income varies positively with interest rate risk management, assisting investors to evaluate how an institution's earnings performance is likely to be sustainable into the future.

Third, while the literature on interest rate risk is concentrated in the period of the 1980s and 1990s in the wake of the savings and loan crisis, my study provide new evidence of interest rate risk management from 1998 to 2010, during which the economic, regulatory and interest rate environment changed significantly since most prior research was conducted. By documenting the association of banks' interest rate risk management and the valuation of net interest income, I also add to the literature that relates risk management to valuation.

Fourth, in estimating rate sensitive liabilities using FR Y-9C (i.e., the regulatory Consolidated Financial Statements for BHCs), there is a lack of consensus as to what proportion of non-maturity deposits to include in rate sensitive liabilities (e.g., Purnanandam; 2007). My study sheds light on this issue by comparing the dollar amount of rate sensitive assets and liabilities obtained from maturity gap analysis in 10-K filings and those estimated from FR Y-

9C. On average, I find that rate sensitive liabilities obtained from maturity gap analysis in 10-K filings are equivalent to including 25% of non-maturity deposits plus other rate sensitive liabilities using data from FR Y-9C.

Finally, an important implication of my study is that the measures constructed in my paper, if explicitly disclosed, can provide useful information to financial reporting users. Existing interest rate risk disclosures are inadequate in assessing banks' interest rate risk. Currently, under the Securities and Exchange Commission's Financial Reporting Release No. 48, bank management chooses between two interest rate risk disclosure formats: maturity gap analysis and/or interest rate risk sensitivity from simulation models.[41] Maturity gap analysis has its many limitations. Interest rate sensitivity from simulation incorporates a myriad of assumptions and complex techniques, making it difficult to understand by outsiders and lacking comparability and reliability (Hodder, 2001). In 2012, the Financial Accounting Standard Board (hereafter, FASB) proposed the Accounting Standards Update to Financial Instruments (Topic 825), which requires banks to disclose maturity gap analysis, interest rate risk sensitivity from simulation and duration for financial instruments, thus limiting management's discretion in choosing the different interest rate risk disclosure formats. However, the limitations of disclosing maturity gap and interest rate risk sensitivity from simulation remain in the proposed disclosure. I suggest that the measures in my study, including α and α-gap, as well as rate and volume analysis, could be considered as part of interest rate risk disclosures in order to better understand interest rate risk management.

[41] Interest rate sensitivity from simulation uses dynamic models to estimate changes in net interest income or economic value of equity due to potential changes in market interest rates (e.g., +/- 100 basis points over a one year horizon). For example, a BHC may disclose that "the simulation projects an approximate 1.7% decrease in net interest income if interest rates fall by 100 basis points over the next year" (Premier Financial Bancorp, Inc's 2008 10-K filing).

The structure for the rest of the paper is as follows. In Section 2, I discuss the background of interest rate risk and review the literature. In Section 3, I develop the theoretical α-gap model. Section 4 provides the empirical specification of the α-gap model. Section 5 discusses the effect of interest rate risk management on the valuation of net interest income, and Section 6 presents the empirical evaluation. Section 7 concludes.

2. Background and Literature Review

2.1 Background on Risk Management and Interest Rate Risk Management of Banks

Risk management has received considerable academic attention in the past several decades. Despite the "risk management irrelevancy" theory proposed by Modigliani and Miller (1958), researchers have long argued that the existence of market imperfections necessitates risk management and that risk management can increase firm value. Benefits of risk management can be classified as a reduction in expected costs from the following: financial distress, underinvestment, tax payments, asymmetric information, and the undiversified risk of stakeholders (see Stulz, 1984; Smith and Stulz, 1985; Nance, Smith and Smithson; 1993; Froot, Scharfstein and Stein, 1993; Leland, 1998 among others). Several papers have directly tested the effect of risk management on firm value of non-financial firms (Allayannis and Weston, 2001; Guay and Kothari, 2003; Jin and Jorion, 2006).

Banks' interest rate risk management is different from non-financial firms in that interest rate risk management for banks is essential not only to mitigate risk and reduce expected costs, but also to directly profit from interest rate risk exposure. To meet the demands of customers and to execute business strategies, banks make loans, purchase securities, and take deposits with different maturities and interest rates. These activities leave banks exposed to interest rate risk, and banks cannot be profitable without taking interest rate risk (Collins, Lai and McNulty, 1997).

The link between a bank's interest rate risk management and profitability can be illustrated using its balance sheet positions. A bank's balance sheet consists of investments in interest-earning assets (loans and securities) that are primarily funded by interest-bearing liabilities (deposits and borrowings). Interest-earning assets are categorized into rate sensitive assets and fixed rate assets depending on whether they mature or reprice in one year. Similarly, interest-bearing liabilities are categorized into rate sensitive liabilities and fixed rate liabilities. These financial instruments have varying levels of sensitivity to changes in market interest rates.

Net interest income is subject to interest rate risk because maturity or repricing intervals and interest rate indices of rate sensitive assets and rate sensitive liabilities are different. Banks periodically experience "gaps" in interest rate sensitivities of assets and liabilities - either rate sensitive liabilities will be more sensitive to changes in market interest rates than rate sensitive assets, or vice versa. When rate sensitive liabilities mature or reprice more quickly than rate sensitive assets, an increase in market interest rates could reduce net interest income and profitability, or vice versa. While market interest rates ultimately impact interest rates on a bank's assets and liabilities, a well-managed bank prudently manages its interest rate risk to maximize its net interest income and long-term profitability.[42]

2.2 Literature on Interest Rate Risk of Financial Institutions

The popularity of managing interest rate risk started in the late 1970s with the advent of financial innovations, deregulation and Federal Reserve policy changes (Gardner and Mills,

[42] A bank's interest rate risk management tactics fall into two broad categories: (1) adjusting interest rates on its assets and liabilities and selecting the types and terms of its assets and liabilities, and (2) using derivatives.

1981). Furthermore, due to the Savings and Loan Crisis in the 1980s, close attention was paid to interest rate risk. The vast majority of studies on interest rate risk of financial institutions appeared in the 1980s and 1990s (see Staikouras, 2003, 2006 for review). Among the studies, the stream of literature that is mostly closely related to this paper focuses on the relation of interest rate risk and financial institutions' profitability. The seminal study by Ho and Saunders (1981) models a bank as an intermediary between lenders and borrowers, and shows that the optimal pure spread depends on the degree of management risk aversion, the size of bank transactions, the banking market structure, and interest rate volatility. The analytical model of Ho and Saunders (1981) has been expanded and empirically tested by a number of subsequent papers (e.g., Allen, 1988; Angbazo, 1997; Lai and Hanssan, 1997; Saunders and Schumacher, 2000). Among their findings, a bank's net interest margin (net interest income divided by total assets) is affected by market interest rate volatility, and is associated with various maturity gaps.

A few studies examine BHCs' disclosures of interest rate risk in 10-Ks. Ahmed, Beatty and Takeda (1997) provide the first evidence on banks' interest rate risk disclosures and derivatives usage by examining 152 BHCs' 1994 10-Ks. They find that a majority of banks disclose maturity gap in 10-Ks and the magnitude of maturity gap is positively related to liquidity and non-performing loans, and negatively related to size. Hodder (2001) examines the disclosures of interest rate risk sensitivity from simulation in BHCs' 10-Ks, as required by the SEC's Financial Reporting Release No. 48, for the years 1997 to 1999. She finds that interest rate risk sensitivity disclosures are not associated with actual changes in income or fair values, and are not related to cost of capital, indicating that the disclosures lack reliability and relevance.

Ahmed, Beatty and Bettinghaus (2004) investigate the efficacy of one-year maturity gap in explaining future changes in net interest income for a large sample of bank-level data from call reports during 1990 to 1997. Rather than directly use one-year maturity gap disclosure in banks' annual reports, as in Ahmed, Beatty and Takeda (1997), the authors estimate variable (fixed) maturity gap from banks' call reports by taking the differences between variables (fixed) rate assets and variable (fixed) rate liabilities maturing or repricing in less than one year. By regressing future change in net interest income on fixed maturity gap, variable maturity gap and asset growth, the authors find that both the fixed and variable one-year maturity gap are significantly related to change in net interest income, and they interpret this as evidence in support of maturity gap's efficacy as a risk measurement tool. However, the discussants of the paper cast doubt on the interpretation (Allen, 2004; Thorton, 2004). Thorton (2004) comments that the estimated coefficients on maturity gap measures are economically too small and Allen (2004) comments that the greatest explanatory power of the maturity gap model comes from change in bank sizes, while the explanatory power of maturity gap measures are very low.

In this paper, I extend the previous literature by developing an α-gap model that overcomes the shortcomings of the maturity gap model. I further use measures based on this α-gap model to evaluate banks' interest rate risk management in generating net interest income.

3. Theoretical Relation between Changes in Net Interest Income and α-GAP

3.1 Maturity Gap

Traditionally, banks use maturity gap to measure the interest rate risk exposure of net interest income. Originated in the 1970s, maturity gap reports the entire book value of each main type of interest-earning asset and interest-bearing liability that reprices in various time buckets or gapping periods. The gapping periods could be within one year, one to five years, and beyond five years. The most commonly used gapping period is one year. By convention, maturity gap implies a one-year gapping period, and is defined as the difference between rate sensitive assets (that mature or reprice within one year) and rate sensitive liabilities (that mature or reprice within one year). In other words, maturity gap (*GAP*) is calculated as rate sensitive assets (*RSA*) minus rate sensitive liabilities (*RSL*):

$$GAP = RSA - RSL$$

To relate maturity gap to net interest income, several assumptions are required: (1) interest rates for rate sensitive assets (*RSA*) and rate sensitive liabilities (*RSL*) change by the same amount, Δi, (2) interest rates for fixed rate assets (*FSA*) and fixed rate liabilities (*FSL*) do not change, (3) the size and composition of the balance sheet does not change over time, and (4) all repricing occurs in unison.[43] Under these assumptions, the following equation represents the association between maturity gap (*GAP*) and changes in net interest income (ΔNII):

$$\Delta NII = RSA \times \Delta i - RSL \times \Delta i = (RSA - RSL) \times \Delta i = GAP \times \Delta i$$

When the dollar amount of rate sensitive assets is greater than that of rate sensitive liabilities, maturity gap is positive, which indicates within one year more assets mature or reprice than liabilities. The equation above suggests that for a bank with a positive maturity gap, net interest income would rise if rates rise, and fall if rates fall. The opposite is true for a bank with a negative maturity gap.

3.2 α-GAP

A key assumption in the maturity gap model is that the interest rates of rate sensitive assets and of rate sensitive liabilities change by the same amount. In reality, rate sensitive assets and rate sensitive liabilities may reprice at different rates and change by different amounts.

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[43] Because these assumptions are unrealistic, they are often considered shortcomings of maturity gap analysis. A few studies explore variations of the maturity gap measure to overcome these shortcomings (Johannes, 1992; Morgan and Smith, 1987; McNulty, Morgan and Smith, 1991).

Assume that interest rates for rate sensitive assets (*RSA*) and rate sensitive liabilities (*RSL*) change by different amounts, Δi_{RSA} and Δi_{RSL}, respectively. Define α as the ratio of changes in the average rates of rate sensitive liabilities (Δi_{RSL}) to changes in the average rates of rate sensitive assets (Δi_{RSA}), i.e., $\alpha = \frac{\Delta i_{RSL}}{\Delta i_{RSA}}$. Define *α-GAP* as:

$$\alpha\text{-}GAP = RSA - \alpha \times RSL$$

α-gap (*α-GAP*) is the dollar amount difference between rate sensitive assets and rate sensitive liabilities adjusted for different interest rate changes of rate sensitive assets and liabilities. The association between *α-GAP* and changes in net interest income is represented by the following equation:

$$\Delta NII = RSA \times \Delta i_{RSA} - RSL \times \Delta i_{RSL} = (RSA - \alpha \times RSL) \times \Delta i_{RSA} = \alpha\text{-}GAP \times \Delta i_{RSA}$$

This equation above indicates that, assuming a bank's balance sheet is fixed, positive (negative) *α*-gap implies an increase (a decrease) in net interest income when the average rate for rate sensitive assets increases (decreases).

3.3 The α-GAP Model

Now, I relax the assumption that a bank's balance sheet is fixed by allowing the size and composition of the balance sheet and interest rates on assets and liabilities to change from year *t-1* to year *t*. I use the following notations:

(1) Assume the average interest rate on rate sensitive assets at year *t-1* is $i_{RSA,\, t-1}$, and the average interest rate on rate sensitive liabilities at year *t-1* is $i_{RSL,\, t-1}$ Let the average interest rate on rate sensitive assets at year *t-1* ($i_{RSA,\, t-1}$) change by the amount Δi_{RSA} to the rate of $i_{RSA,\, t}$ at year *t*. Similarly, let average interest rates on rate sensitive liabilities at year *t-1* ($i_{RSL,\, t-1}$) change by Δi_{RSL} to $i_{RSL,\, t}$ at year *t*.

(2) Redefine α-GAP (or equivalently, α-GAP_{t-1}) as rate sensitive assets at the beginning of year t minus the product of α and rate sensitive liabilities at the beginning of year t:

$$\alpha\text{-}GAP_{t-1} = RSA_{t-1} - \alpha \times RSL_{t-1}.$$

Furthermore, from year $t-1$ to year t, assume the amount of rate sensitive assets and the amount of rate sensitive liabilities changes by ΔRSA and ΔRSL, respectively. Define $\Delta\alpha$-GAP as:

$$\Delta\alpha\text{-}GAP = \Delta RSA - \alpha \times \Delta RSL.$$

(3) At year $t-1$, assume that fixed rate assets (FRA_{t-1}) and fixed rate liabilities (FRL_{t-1}) have different average interest rates: $i_{FRA,\ t-1}$ and $i_{FRL,\ t-1}$. From year $t-1$ to year t, assume the amounts of existing FRA_{t-1} and FRL_{t-1} change by ΔFRA_{t-1} and ΔFRL_{t-1}, respectively. Also assume the bank expands by ΔFRA_t and ΔFRL_t with interest rates $i_{FRA,\ t}$ and $i_{FRL,\ t}$, respectively.

With these notations, through calculation detailed in Appendix A, I obtain the α-gap model below:

$$\begin{aligned}\Delta NII = {} & \underbrace{\alpha\text{-}GAP_{t-1} \times \Delta i_{RSA}}_{\text{(Rate variances)}} \\ & + \underbrace{(\Delta RSA \times i_{RSA,t-1} - \Delta RSL \times i_{RSL,t-1}) + (\Delta FRA_{t-1} \times i_{FRA,t-1} - \Delta FRL_{t-1} \times i_{FRL,t-1})}_{\text{(Volume variances)}} \\ & + \underbrace{\Delta\alpha\text{-}GAP \times \Delta i_{RSA} + (\Delta FRA_t \times i_{FRA,t} - \Delta FRL_t \times i_{FRL,t})}_{\text{(Rate /Volume variances)}}\end{aligned}$$

The α-gap model shows that changes in net interest income (ΔNII) have two major components – rate variances and volume variances. Rate variances are modeled through α-gap. Volume variances have two components: the rate sensitive component ($\Delta RSA \times i_{RSA,t-1} - \Delta RSL \times i_{RSL,t-1}$), and the fixed rate component ($\Delta FRA_{t-1} \times i_{FRA,t-1} - \Delta FRL_{t-1} \times i_{FRL,t-1}$). A minor element of changes in net interest income is rate/volume variances, which also has two components: the rate sensitive component ($\Delta\alpha$-$GAP \times \Delta i_{RSA}$) and the fixed rate component ($\Delta FRA_t \times i_{FRA,t}$ –

$\Delta FRL_t \times i_{FRL,t}$). Rate/volume variances are usually very small compared with rate variances and volume variances, and thus not important in explaining changes in net interest income.[44]

3.4 Implications of the α-GAP Model on Interest Rate Risk Management

Maximizing net interest income while limiting exposure to the potential negative effects of interest rate risk is an important goal of a bank's interest rate risk management (Wilkinson, 2004). Based on the α-gap model, a bank's interest rate risk management process is captured by α, the ratio of Δi_{RSL} to Δi_{RSA}, because α summarizes how a bank manages rates on assets and liabilities and how it selects the types and terms of assets and liabilities. The outcome of a bank's interest rate risk management is captured by rate variances, i.e., the term "$Rate\ Variances = \alpha\text{-}GAP_{t-1} \times \Delta i_{RSA}$" in the α-gap model. A bank grows net interest income primarily by (1) increasing rate variances and (2) increasing volume variances. Rate variances reflect the performance of interest rate risk management, and volume variances reflect the performance of banking officers as well as asset growth (e.g., mergers and acquisitions). Greater rate variances indicate more effective interest rate risk management, *ceteris paribus*.

Combining the perspectives of α and rate variances, I measure the difference of a bank's α from the α that immunizes net interest income from interest rate changes (i.e., *immunization* α). When a bank's α equals its *immunization* α, net interest income is immunized from interest rate changes, and thus rate variances are zero. Let rate variances equal zero in the following equation:

$$Rate\ Variances = \alpha\text{-}GAP_{t-1} \times \Delta i_{RSA} = (RSA_{t-1} - \alpha \times RSL_{t-1}) \times \Delta i_{RSA} = 0.$$

[44] Two complexities are omitted in the α-gap model. First, it assumes maturing or repricing occurs at the beginning of a year, but actual maturing or repricing may happen within different months of a year. Second, if a bank uses derivatives to hedge financial instruments' positions and applies hedge accounting, then the impact of derivatives is incorporated into net interest income.

Thus, I have *immunization* $\alpha = \frac{RSA_{t-1}}{RSL_{t-1}}$ and

Rate Variances = $\alpha\text{-}GAP_{t-1} \times \Delta i_{RSA}$ = (*immunization* α - α) $\times \Delta i_{RSA} \times RSL_{t-1}$.

I denote the difference of a bank's α from its *immunization* α as "*difference from immunization* α" (*Dif from immun* α), and define it as follows:

When $\Delta i_{RSA} > 0$, *Dif from immun* α = *immunization* $\alpha - \alpha$.

When $\Delta i_{RSA} < 0$, *Dif from immun* $\alpha = \alpha -$ *immunization* α.

Difference from immunization α can be viewed as a standardized measure of rate variances due to the positive linear association between the two variables.[45] The more positive (negative) *difference from immunization* α, the more positive (negative) rate variances.[46]

4. Empirical Specification of Variables in *α*-GAP Model

4.1 Empirical Specification of α-GAP Model

From the theoretical model of α-gap, its empirical model can be approximated using the following equation with each term measured using data from BHCs' disclosures:

$$\Delta NII \approx \underbrace{(\alpha\text{-}GAP_{t-1} \times \Delta i_{RSA})}_{\text{(Rate variances)}} + \underbrace{(\text{volume variances})}_{\text{(Volume variances)}} + (\Delta \underbrace{\alpha\text{-}GAP \times \Delta i_{RSA}}_{\text{(Part of Rate/Volume variances)}})$$

The only difference between the theoretical model and its empirical counterpart is the latter only considers the rate sensitive part ($\Delta\alpha\text{-}GAP \times \Delta i_{RSA}$) of rate/volume variances, whereas

[45] Rate variances and *difference from immunization* α are positively associated because:
When $\Delta i_{RSA} > 0$, *Rate Variances* $= \alpha\text{-}GAP_{t-1} \times \Delta i_{RSA}$ = (*Dif from immun* α) $\times \Delta i_{RSA} \times RSL_{t-1}$
When $\Delta i_{RSA} < 0$, *Rate Variances* $= \alpha\text{-}GAP_{t-1} \times \Delta i_{RSA}$ = (*Dif from immun* α)$\times(-\Delta i_{RSA})\times RSL_{t-1}$

[46] The proxies of interest rate risk management capture the effect of the on-balance-sheet approach, as well as the effect of interest rate derivative usage to the extent that hedge accounting is applied and the hedge is effective.

the fixed rate part ($\Delta FRA \times i_{FRA,t} - \Delta FRL \times i_{FRL,t}$) of rate/volume variances is omitted because the data needed to estimate the fixed rate part of rate/volume variances are not available.[47]

4.2 Estimating α Using Data from 10-K and FR Y-9C

In estimating α, its two components Δi_{RSL} and Δi_{RSA} can be estimated as follows:

$$\Delta i_{RSL} = \frac{\text{rate variances of changes in interest expenses}}{RSL_{t-1}}, \text{ and}$$

$$\Delta i_{RSA} = \frac{\text{rate variances of changes in interest income}}{RSA_{t-1}}.$$

where *t-1* indicates the beginning of the year, and Δ indicates the annual change. Thus, to estimate α requires knowledge of (1) rate variances of changes in interest income, (2) rate variances of changes in interest expenses, (3) rate sensitive assets (RSA_{t-1}) and (4) rate sensitive liabilities (RSL_{t-1}). Rate variances of changes in interest expenses and rate variances of changes in interest income are obtained from rate and volume analysis in 10-Ks (SEC, 1990).

Rate sensitive assets (RSA_{t-1}) and rate sensitive liabilities (RSL_{t-1}) can be obtained from maturity gap analysis when it is voluntarily disclosed in 10-Ks. The advantage of using RSA_{t-1} and RSL_{t-1} directly from maturity gap analysis is that they usually incorporate assumptions such as loan prepayment rates and decay rates of non-maturity deposits based on industrial trends and customer behaviors.[48] Appendix B provides an example of maturity gap analysis and an

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[47] In Appendix D, I empirically validate the empirical specification of the α-gap model. The results show that the omitted terms do not affect the efficacy of the model.
[48] Non-maturity deposits include savings accounts, checking accounts and money market deposit accounts. Decay rate is the percentage of runoff of non-maturity deposits during a period.

example of rate and volume analysis disclosed in the 10-K, and illustrates the calculation of the α-gap model measures using these disclosures.[49]

However, RSA_{t-1} and RSL_{t-1} obtained in this way are only available for a subsample of BHCs that disclose maturity gap analysis. To estimate rate sensitive assets and liabilities for the full sample, researchers resort to data from FR Y-9C (e.g., Flannery and James, 1984a, 1984b; Kwan, 1991). Rate sensitive assets and liabilities reported in maturity gap analysis in 10-Ks and those estimated from FR Y-9C are different, because the former usually incorporates important management assumptions, while the latter is solely based on contractual terms and ignores these assumptions. For example, rate sensitive assets calculated from FR Y-9C (denoted as RSA_{t-1}_FR, where "*FR*" refers to variables estimated from FR Y-9C) tend to be smaller than those from maturity gap analysis (RSA_{t-1}), because RSA_{t-1} may incorporate loan prepayment assumptions.

The biggest challenge in using FR Y-9C to estimate rate sensitive liabilities is to determine the appropriate amount of non-maturity deposits. Non-maturity deposits do not have contractual maturities and are subject to administrated rates. In maturity gap analysis in 10-K, BHCs usually divide non-maturity deposits into different time-buckets based on management experience and historical data. When constructing rate sensitive liabilities from FR Y-9C, there is no consensus in prior literature regarding how much of non-maturity deposits should be included in rate sensitive liabilities. A common approach is to treat non-maturity deposits as long-term, fixed-rate liabilities, thus excluding them from rate sensitive liabilities (e.g., Flannery and James, 1984a, 1984b). Based on this approach, I consider rate sensitive liabilities to include

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[49] The adoption of FAS 159 Fair Value Option in 2007 may affect the estimated amount of RSA and RSL, and affect the estimation of α. In my sensitivity analysis, I apply different proxies for α and obtain qualitatively similar results. Thus the results of my paper are not affected by the adoption of FAS 159.

0% of non-maturity deposits, denoted as RSL_{t-1}*_FR0* (where "*FR*" refers to variables estimated from FR Y-9C, and "*0*" refers to 0% of non-maturity deposits). The alternative view is that non-maturity deposits are governed by administrated rates and are subject to withdrawal at any time, and therefore part of those deposits must be included as rate sensitive liabilities (Purnanandam, 2007). Based on this alternative view, I consider rate sensitive liabilities to include 50% of non-maturity deposits (RSL_{t-1}*_FR50*) and 25% of non-maturity deposits (RSL_{t-1}*_FR25*).

To determine which proportion of non-maturity deposits leads to the most accurate estimates of rate sensitive liabilities, I use the subsample of BHCs disclosing maturity gap analysis and reporting FR Y-9C. For this subsample, I am able to obtain rate sensitive assets and rate sensitive liabilities from these two different disclosure sources. In using estimates from gap maturity analysis as the benchmark, I infer which proportion (0%, 50% or 25%) of non-maturity deposits to be included in rate sensitive liabilities when using data from FR Y-9C.

Because BHCs voluntarily disclose maturity gap, it is necessary to investigate whether BHCs' interest rate risk management varies depending on whether they disclose maturity gap analysis. Thus, I investigate whether there are significant differences in rate variances for BHCs disclosing maturity gap and for BHCs that do not. If there are no significant differences in rate variances, I can apply the proportion of non-maturity deposits to the full sample of BHCs in estimating rate sensitive liabilities. In this way, I obtain reasonable measures for rate sensitive assets, rate sensitive liabilities and α for all BHCs.

4.3 Assessing Interest Rate Risk Management

I assess interest rate risk management through α and rate variances. As α assesses how responsive BHCs are to market interest rate changes, I compare a BHC's α with the α estimated from market interest rates (market α). I consider two proxies for market α. The first one is the ratio of changes in six-month Treasury bill rates to changes in three-month LIBOR (i.e., London Interbank Offered Rate), because loans are usually tied to three-month LIBOR, and six-month Treasury bill rates represent the opportunity costs of deposits. The second proxy for market α is one, or the ratio of changes in three-month LIBOR to itself, as BHCs may not only price loans based on three-month LIBOR but also use swaps to link deposit rates to three-month LIBOR. The closer a BHC's α is to market α, the more responsive it is to market interest rate changes.[50]

Rate variances represent the outcome of interest rate risk management. Rate variances greater than zero indicate that BHCs effectively manage interest rate risk, *ceteris paribus*. I assess (a) among all BHCs how many are able to achieve positive rate variances each year, and (b) for an individual BHC what is its history of achieving positive rate variances.

Combining α and rate variances, I then estimate *difference from immunization α* (*Dif from immun α*), which is a standardized measure of rate variances.

5. Interest Rate Risk Management and the Valuation of Net Interest Income

5.1 How Interest Rate Risk Management Affects the Valuation of Net Interest Income

In this section, I explore the impact of interest rate risk management on the valuation of net internet income. On one hand, the ability to managing interest rate risk is likely to lead to more persistent cash flow streams of net interest income by enhancing future yields on a bank's assets and by reducing future funding costs. For example, a bank's interest rate risk management ability can achieve favorable core deposit financing, which results in more persistent abnormal earnings (Kohlbeck and Warfield, 2007). Furthermore, as prior research provides evidence that

[50] Admittedly, it is very difficult to predict changes in market interest rates which are affected by many factors including inflation, recession, unemployment, money supply, domestic and international events and changes in the United States and other financial markets. However, BHCs can actively respond to changes in market interest rates.

more persistent earnings have a stronger valuation effect (Collins and Kothari, 1989; Easton and Zmijewski, 1989), more persistent net interest income would lead to a higher equity market valuation of net interest income. As a consequence, interest rate risk management is likely to be positively associated with the valuation of net interest income through its effect on the persistence of net interest income.

On the other hand, it is possible that a bank may assume excessive risks in managing interest rate risk. For example, a bank may take excessive duration risk which could diminish future net interest income if interest rates change unfavorably. Or a bank may take excessive credit risk, and future interest income would be impaired when loans become delinquent. If BHCs take excessive risk to manage interest rate risk as related to "current" earnings at the cost of "future" earnings, then I will not find evidence that interest rate risk management positively affects the persistence of net interest income, or the valuation of net interest income.

Taken together, whether there is a positive effect of interest rate risk management on the valuation of net internet income is an empirical question. I conduct two analyses to investigate this effect. First, I examine whether interest rate risk management affects the persistence of net interest income. Second, I investigate how interest rate risk management affects the net interest income-returns association (Easton and Harris, 1991).[51]

5.2 Persistence of Net Interest Income

[51] An alternative specification to test the valuation of net interest income is to test the association between changes in net interest income (ΔNII) and stock returns. In untabulated sensitivity analysis, I examine how interest rate risk management impacts the ΔNII-returns association. I find the tests using the ΔNII-returns association yield qualitatively similar results as the tests using the net interest income-returns association.

In examining the persistence of net interest income, I use the following regression of one-year-ahead net interest income on current net interest income to estimate the persistence of net interest income (the firm subscripts are omitted here and in subsequent equations):

$$NII/TA_{t+1} = \beta_0 + \beta_1\, IRR\ mgmt_t + \beta_2\, NII/TA_t + \beta_3\, NII/TA_t * IRR\ mgmt_t + \beta_4\, Size_t + \varepsilon$$

In this equation, *NII/TA* represents net interest income scaled by total assets, *Size* represents the log of total assets. Two proxies for interest rate risk management (*IRR mgmt*) are used: an indicator variable of positive rate variances (*Pos Rate Var*), and *difference from immunization α* (*Dif from immun α*). The coefficient of the interaction term, $NII/TA_t * IRR\ mgmt_t$, represents the difference in net interest income persistence for BHCs that more effectively manage interest rate risk compared to other BHCs. If interest rate risk management positively affects net interest income persistence, I expect this coefficient to be significantly positive. I control for size as it captures many aspects of a bank's operational strategies (e.g., Demsetz and Strahan, 1997) that may affect net interest income persistence.[52]

5.3 Net Interest Income-Returns Association

To investigate how interest rate risk management affects the net interest income-returns association in the second analysis, I run the following regression, controlling for firm and year fixed effects (the firm and year subscripts are omitted here and in subsequent equations):

$$Ret = \beta_0 + \beta_1\, NII + \beta_2\, IRR\ mgmt + \beta_3\, NII*IRR\ mgmt + \beta_4\, Non\text{-}int\ inc + \beta_5\, Non\text{-}int\ exp + \beta_6\, Loan\ loss\ prov + \beta_7\, Tier1\ ratio + \beta_8\, ROA + \beta_9\, Growth + \beta_{10}\, Size + \varepsilon$$

[52] In untabulated analysis, I control for the effect of expanding the assets and liabilities of a bank in generating net interest income, which is proxied by volume variances of changes in net interest income scaled by total assets ($Vol\ Var/TA_t$) or scaled by net interest income ($Vol\ Var/NII_t$). These terms are not significant in the regressions, and do not qualitatively change my results on interest rate risk management.

Two proxies for interest rate risk management (*IRR mgmt*) are used: *Pos Rate Var* and *difference from immunization α*. *Ret* is a firm's one-year buy-and-hold return starting three (two) months after the fiscal year end for the years before (since) 2007. *NII* is net interest income scaled by market value at the beginning of the year. I predict β_3 to be positive if interest rate risk management positively affects the pricing of net interest income into stock returns.

I control for other components of earnings: noninterest income (*Non-int inc)*, noninterest expenses (*Non-int exp)* and loan loss provisions (*loan loss prov)*. Non-interest income (*Non-int inc*) and non-interest expenses (*Non-int exp*) are scaled by market value at the beginning of the year. The distribution of loan loss provisions is highly skewed, so I take the log of the sum of loan loss provisions scaled by market value plus one to obtain *loan loss prov*. Additionally, I control for the log of total asset (*Size*), the Tier 1 leverage ratio (*Tier1 lev*) and asset growth (*Growth*) as literature suggests they affect returns.[53]

I divide the full sample into two periods – before the financial crisis period (1998 to 2006) and the financial crisis and subsequent recession period (2007 to 2010). I expect the association to be more pronounced during the first period because other factors such as credit risk may weaken the effect of interest rate risk management on the net interest income-returns association during the later period.

5.4 Additional Analysis

The level of impact interest rate risk management has on the net interest income-returns association hinges on the importance of interest rate risk management to a BHC's cash flow

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[53] In untabulated analysis, I control for the riskiness of a BHC, proxied by the volatility of monthly stock returns, and my regression results are not qualitatively changed.

generating activities. I consider two factors that moderate the importance of interest rate risk management: term spread and fee income.[54]

5.4.1 Moderating effect of Term Spread

The first factor is the term spread, or the difference between long-term market interest rates and short-term market interest rates. A wide term spread leads to a wide net interest spread, and hence greater net interest income.[55] Thus, the ability to manage interest rate risk is less essential for a period with a larger term spread than for a period with a smaller, even negative, term spread. I expect the effect of interest rate risk management on the net interest income-returns association to be weaker during periods that have a large term spread.

To test the moderating effect of the term spread, I use the following model:

$$Ret = \beta_0 + \beta_1 NII + \beta_2 IRR\ mgmt + \beta_3 NII*IRR\ mgmt + \beta_4 IRR\ mgmt*Term\ Spread + \beta_5 NII*Term\ Spread + \beta_6 NII*IRR\ mgmt*Term\ Spread + \beta_7 Non\text{-}int\ inc + \beta_8 Non\text{-}int\ exp + \beta_9 Loan\ loss\ prov + \beta_{10} Tier1\ ratio + \beta_{11} ROA + \beta_{12} Growth + \beta_{13} Size + \varepsilon$$

where *Term Spread* is proxied by the difference between the annualized federal funds rate and the annualized rate on the three-year Treasury bond. *Term Spread* itself is not included in the regression model as the inclusion of year fixed effects incorporates the effect of term spreads. I predict β_6, the coefficient of the interaction term (*NII*IRR mgmt*Term Spread*) to be negative, as I expect the impact of interest rate risk management on the net interest income-returns association to be weaker in the years of a large term spread.

5.4.2 Moderating effect of Fee Income

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[54] I also considered whether duration mismatch of assets and liabilities would impact the net interest income-returns association, but I do not find evidence of this.

[55] Net interest spread is the difference in borrowing and lending rates of financial institutions.

The second factor is fee income. Fee income includes mortgage servicing fees, fees related to deposit accounts and credit cards, as well as fees from trust operations (Kohlbeck and Warfield, 2007).[56] Prior research suggests that banks with a higher level of fee income have less exposure to interest rate risk (Rogers and Sinkey, 1999). Hence, interest rate risk management is less essential to the profitability for such BHCs. I expect the effect of interest rate risk management on the net interest income-returns association to be weaker for BHCs with a higher level of fee income. I estimate the following model to test the moderating effect of fee income:

$$Ret = \beta_0 + \beta_1 NII + \beta_2 IRR\ mgmt + \beta_3 NII{*}IRR\ mgmt + \beta_4 IRR\ mgmt{*}High\ fee\ income + \beta_5 NII{*}\ High\ fee\ income + \beta_6 NII{*}IRR\ mgmt{*}\ High\ fee\ income + \beta_7 Non\text{-}int\ inc + \beta_8 Non\text{-}int\ exp + \beta_9 Loan\ loss\ prov + \beta_{10} Tier1\ ratio + \beta_{11} ROA + \beta_{12} Growth + \beta_{13} Size + \varepsilon$$

where *High fee income* is one if the percentage of non-interest income in total operating income is greater than its median value by year, and zero otherwise. I predict β_6 to be negative, as I expect that the higher the level of fee income, the weaker the impact of interest rate risk management on the net interest income-returns association.

6. Empirical Analysis

6.1 Sample Selection

I obtain my initial sample of commercial BHCs with SIC 6020, 6021, 6035 and 6036 classifications from the CRSP-Compustat Merged Database in the period from 1997 to 2010.[57] I require each BHC have FR Y-9C from the 4th quarter on the Federal Research Bank of Chicago

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[56] Mortgage servicing fees are also subject to interest rate risk, because mortgage servicing fees tend to be lower when interest rates fall and borrowers refinance or prepay their mortgage loans. Because it is not a significant part of interest rate risk, I do not address this complexity.

[57] SIC 6020, 6021, 6035, 6036 are national commercial banks, state commercial banks, federally chartered savings institutions and state chartered savings institutions, respectively. Firms that are primarily engaged in investment banking (e.g., Goldman Sachs) are not in my sample.

database. Next, I hand-collect rate and variance analysis and Item 7A Market Risk Disclosure from BHCs' 10-Ks from the SEC Edgar database. I require each firm to have two consecutive years of available data because my model uses changes in net interest income from the previous year to the current year. I further restrict my sample to firms with a fiscal year ending in the 4th quarter in order to match the FR Y-9C 4th quarter data and the 10-K data. Firms with missing variables are deleted. I remove observations falling in the top or bottom 1% of total assets.[58] The final sample has 2565 firm-years from 332 unique BHCs. As maturity gap analysis is voluntarily disclosed in Item 7A, 1445 firm-years from 215 unique BHCs disclose maturity gap analysis. Panel A of Table 1 presents the sample selection process.

Panel B of Table 1 reports total assets of all firm-years by quartiles. Total assets vary greatly, with the means of each quartile being $33.1 billion, $2.8 billion, $1.2 billion and $0.6 billion. For empirical analyses below, I only tabulate results for the full sample. In untabulated analyses, I conduct analyses by asset quartiles, and find my inferences hold in each quartile.

6.2 Estimating α-GAP Variables

6.2.1 Comparing BHCs Disclosing Maturity Gap to BHCs Not Disclosing Maturity Gap

I first explore whether BHCs that disclose maturity gap analysis differ from other BHCs in managing interest rate risk. Panel A of Table 2 contrasts the distributions of variables for the 1445 observations disclosing maturity gap in 10-Ks and for the 1120 observations not disclosing maturity gap in 10-Ks. The mean of total assets for BHCs that do not disclose maturity gap is $15.5 billion with a standard deviation of $54.2 billion, and the mean of total assets for BHCs

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[58] My sample does not include the five largest BHCs by assets (Bank of America, JP Morgan Chase, Citigroup, Wells Fargo and Goldman Sachs). According to the Federal Reserve, the five largest banks in the U.S. account for 52% of the total banking industry assets as of the end of 2010, and they are not representative of a typical bank in my sample (Federal Reserve Bank of Dallas, 2011). Nor does my sample include BHCs that are members of the British Banking Association; therefore, all BHCs in my sample are interest rate takers.

that disclose maturity gap is $5.1 billion with a standard deviation of $13.3 billion. On average, BHCs that disclose maturity gap have significantly larger net interest income scaled by total assets (mean=0.0354), a larger annual change in net interest income scaled by total assets (mean=0.0027) and larger volume variances scaled by total assets (mean=0.0033) than BHCs that do not disclose maturity gap (with means of 0.0339, 0.0022 and 0.0028, respectively).

Rate variances scaled by total assets have a mean (median) of -0.0004 (-0.0017) for BHCs disclosing maturity gap and -0.0006 (-0.0018) for BHCs not disclosing maturity gap. The means and medians of rate variances are not significantly different for these two groups of BHCs, suggesting these two groups of BHCs do not differ significantly in how they manage interest rate risk to generate net interest income. In untabulated analysis, I test whether disclosing maturity gap is significantly correlated with the proxies of interest rate risk management, and I do not find significant correlations.

In addition, the positive means and medians of volume variances and the negative means and medians of rate variances indicate that increases in net interest income for both groups of BHCs are attributable to volume variances. It suggests that, on average, BHCs tend to generate net interest income by expanding their balance sheet size, not by managing interest rate risk.

6.2.2 α-GAP Variables for BHCs Disclosing Maturity Gap

Table 2 Panel B presents the distributions of α related variables estimated from maturity gap analysis in the 10-K for the 1445 observations. The means (medians) of Δi_{RSA} and Δi_{RSL} are -0.005 (-0.005) and -0.003 (-0.004), respectively, suggesting that rates on rate sensitive liabilities tend to change more slowly than rates on rate sensitive assets. Accordingly, the mean and median of α are less than one (mean=0.802, median=0.743).

Turning to the α-gap (*α-GAP*) and maturity gap (*GAP*) measure, *α-GAP* scaled by total assets has a mean of 0.044 and a median of 0.052, significantly different from *GAP* scaled by total assets which has a mean of -0.068 and a median of -0.055.

In Appendix D, I validate the empirical specification of the *α-GAP* model. The validation is necessary as empirical complexities and the omitted terms from the theoretical model might weaken the relation between changes in net interest income and *α-GAP*. I regress changes in net interest income on *α-GAP*, volume variances and the variable part of the rate/volume variances. The left columns of Panel B of Appendix D report the regression results using the *α-GAP* measure estimated from maturity gap disclosures. The coefficient on *α-GAP* is 0.92 and positively significant. Furthermore, I contrast the regression results of the *α-GAP* model with those of the maturity gap (*GAP*) model. The regression results of the *GAP* model are reported in the right columns of Panel B. The coefficient on *GAP* is not significant. These results show that α-gap better explains changes in net interest income than maturity gap.

6.2.3 Estimating α from FR Y-9C

In this section, I first use the subsample of BHCs that disclose maturity gap and report FR Y-9C to infer what proportion of non-maturity deposits to be included into rate sensitive liabilities when using data from FR Y-9C to estimate *α*. Next, as there is no significant difference in the outcome of interest rate risk management for BHCs disclosing maturity gap and BHCs not disclosing it, I estimate *α* for all BHCs using data from FR Y-9C.

To begin, I estimate rate sensitive assets (RSA_{t-1}*_FR*) and rate sensitive liabilities from FR Y-9C for the 1445 observations disclosing gap maturity analysis. Variable construction is detailed in Appendix C. I use three sets of measures for rate sensitive liabilities: (a) RSL_{t-1}*_FR0*, which includes 0% of non-maturity deposits, (b) RSL_{t-1}*_FR25*, which includes 25% of non-maturity deposits, and (c) *RSL_{t-1}_FR50*, which includes 50% of non-maturity deposits. Thus, deriving from these measures, I have three sets of *α's*: (a) *α_FR0*, (b) *α_FR25* and (c) *α_FR50*.

To assess which measures for rate sensitive liabilities and *α* are most accurate, I compare these measures estimated from FR Y-9C with those estimated from 10-Ks. I calculate the ratio of *RSA_{t-1}_FR* to *RSA_{t-1}*, the ratio of *RSL_{t-1}_FR0* (*RSL_{t-1}_FR50, RSL_{t-1}_FR25*) to *RSL_{t-1}*. I also calculate the ratio of *α_FR0* (*α_FR*50*, α_FR*25) to the *α* estimated from 10-K.

Panel A of Table 3 presents distributions of these ratios. The mean and median of *RSA_{t-1}_FR/RSA_{t-1}* are less than one (mean=0.839, median=0.883), suggesting that *RSA_{t-1}_FR* estimated from FR Y-9C does not account for mortgage prepayment assumptions.[59] Comparing the ratios of rate sensitive liabilities, the distribution of *RSL_{t-1}_FR25/RSL_{t-1}* is closest to one (mean=0.953, median=0.914). Comparing the ratios of *α*, the distribution of *α_FR25/α* is closest to one (mean =0.968, median=0.900).[60] Overall, the distributions indicate that in terms of the mean and median, *α_FR25* is closest to the *α* estimated from maturity gap disclosure.[61]

In my subsequent analysis, I estimate *α_ FR25* for all BHCs and use it to assess the process of interest rate risk management for all BHCs. I report the distributions of *α_ FR25* for the full sample in Panel B of Table 3. The mean and median of *α_ FR*25 are less than one (mean=0.764, median=0.710).

6.3 Assessing Interest Rate Risk Management

6.3.1 Comparing α and Market α

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[59] I do not adjust *RSA_FR* for mortgage prepayments because: (1) the magnitude of adjustment would be small, (2) the prepayment behavior varies significantly year by year, making it difficult to make adjustments, and (3) adjusting *α* estimated from FR Y-9C partly corrects the measurement error in its *RSA_FR* component.

[60] Untabulated results show that the mode of *α_FR0/α* is the closest to one. As a robustness check, I use *α_FR0* as a proxy in my regressions and find qualitatively similar results.

[61] Additionally, I examine the distributions of α*_FR0* (α*_FR25*, α*_FR50*) by asset quartiles. Untabulated analysis shows that the means and medians of the ratios of each quartile are not statistically different from each other.

To assess how a BHC manages interest rate risk in response to changes in market interest rates, I compare the median values of *α_FR25* for the full sample versus the quarterly market *α* from 1998 to 2010. I consider two proxies for market *α*: (1) the ratio of quarterly changes in six-month Treasury bill rates to quarterly changes in three-month LIBOR, and (2) one. As *α_FR25* is estimated from annual data, *α_FR25* has the same value for the four quarters per year.

Figure 1A plots the median values of the average quarterly changes in rates of rate sensitive assets and liabilities (i.e., Δi_{RSA}_*FR* and Δi_{RSL}_*FR25* divided by four) along the left axis. Figure 1B depicts the median values of *α_FR25* and the market *α'*s along the left axis. In both figures, the quarterly changes in three-month LIBOR and quarterly changes in six-month Treasury bill rates are plotted along the right axis. Two patterns are noteworthy.

First, when LIBOR and Treasury bill rates initially drop or initially rise, the median values of *α_FR25* tends to be far less than one. This is because rates of rate sensitive liabilities are more sluggish than rates of rate sensitive assets. For example, during 2008 to 2009, when market interest rates started to fall, BHCs dropped rates for both rate sensitive assets and liabilities. The decrease in rates of rate sensitive assets was greater than the decrease in rates of rate sensitive liabilities. As a result, the median values of *α_FR25* during 2008 to 2009 are less than one. Likewise, in 2004 when market interest rates started to rise, BHCs increased rates for both rate sensitive assets and liabilities, but rates of assets increased faster than rates of liabilities, resulting in the median values of *α_FR25* far less than one in 2004.

Second, when LIBOR and Treasury bill rates have already increased or decreased, the median values of *α_FR25* tend to be closer to one. For example, in 2010, the decrease in rates of rate sensitive assets was less than the decrease in rates of rate sensitive liabilities, possibly because the rates for assets hit the interest rate floors in loan contracts. Thus, the median value of *α_FR25* in 2010 was closer to one than it was in 2008 or 2009. Likewise, in 2005 and 2006, while rates of both rate sensitive assets and liabilities still rose, the increase in rates of rate sensitive assets slowed down, possibly because they reached rate ceilings. As a result, the median values of *α_FR25* are close to one.[62]

6.3.2 Rate Variances

To assess the outcome of interest rate risk management, I examine whether a BHC achieves positive rate variances. First, I assess the percentage of BHCs that are able to achieve positive rate variances each year, as reported in Figure 2A. During the 13 years from 1998 to 2010, only in 2002, 2005 and 2010 did more than 50% of BHCs in the full sample achieve positive rate variances.[63] Second, for each unique BHC, I assess how many years during 1998 to 2010 a BHC was able to achieve positive rate variances. Figure 2B plots the percentage of years a BHC achieves positive rate variances for the 225 BHCs with at least six years of data. The mean of the percentage of years a BHC achieves positive rate variances is 0.38, implying that, on average, a BHC only achieves positive rate variances 38% of the time.[64]

6.3.3 Dif from immun α25

Dif from immun α25 is the difference of a bank's *α_ FR*25 from its *immunization α.* Figure 2C plots the median values of *Dif from immun α25* from 1998 to 2010. It shows that only in 2002, 2005 and 2010 are the median values of *Dif from immun α25* greater than zero.[65]

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[62] Additionally, I examine the distributions of α_*FR0* (α_*FR25*, α_*FR50*) by asset quartiles. Untabulated analysis shows that the means and medians of the ratios of each quartile are not statistically different from each other.

[63] When BHCs are divided into asset quartiles, in three out of the 13 years more than 50% of BHCs in quartile 4 (the largest), quartile 3 and quartile 2 have positive rate variances. In four out of the 13 years more than 50% of BHCs in quarter 1 (smallest) have positive rate variances.

[64] In contrast, untabulated analysis shows that every year during 1998 to 2010 more than 50% of BHCs have positive volume variances. Furthermore, on average, a BHC achieves positive volume variances 71% of the time.

[65] Untabulated statistic tests show the means and medians of *Dif from immu α25* for different asset quartiles are not significantly different from each other.

A drawback of *Dif from immun α25* is that it suffers from extreme values. Its maximum (minimum) value is 1554 (-202). To reduce the influence of extreme values, I winsorize *Dif from immun α25* at the 95^{th} percentile (value=0.98) and 5^{th} percentile (value= -1.14).

6.4 Impact of Interest Rate Risk Management on the Valuation of Net Interest Income

In this section, I first examine whether BHCs that effectively manage interest rate risk have more persistent net interest income, and then examine whether BHCs that effectively manage interest rate risk have a higher net interest income-returns association.

6.4.1 Persistence of Net Interest Income

Panel A of Table 4 presents the variable distributions. The proxies for interest rate risk management are *Pos Rate Var* and *Dif from immun α25*. The indicator variable *Pos Rate Var* has a mean of 0.368, and the continuous variable *Dif from immun α25* has a mean (median) of -0.112 (-1.104), suggesting that, on average, a BHC has negative rate variances.[66]

Panel B of Table 4 presents the correlation coefficients. The Pearson (Spearman) coefficient of *Pos Rate Var* and *NII/TA *Pos Rate Var* is 0.97 (0.97), and the Pearson (Spearman) coefficient of *Dif from immun α25* and *NII/TA * Dif from immun α25* is 0.97 (0.99), suggesting the problem of a high degree of multicollinearity. To remedy the problem of multicollinearity, I test the joint significance of the two regressors, and in separate regressions I exclude the main effect of interest rate risk management and only include the interaction term.

Panel C and Panel D of Table 4 presents the regression results of net internet income persistence. I divide the sample period into 1998 to 2006 and 2007 to 2010. Panel C (Panel D) uses *Pos Rate Var* (*Dif from immun α25*) as the proxy for interest rate risk management. In both

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[66] *Dif from immun α0* has a mean (median) of -0.167 (-1.141). When *Dif from immun α0* is used in the regressions in place of *Dif from immun α25,* the results are similar to the regression using *Dif from immun α25*.

panels across different periods, the coefficients *of* NII/TA_t are significantly positive, indicating current net interest income has predictive value for future net interest income. The coefficients of NII/TA_t *$IRR\ mgmt_t$ are significantly positive when the main effects of $IRR\ mgmt_t$ is excluded. When the main effect of $IRR\ mgmt_t$ is included, the main effect and the interaction term are jointly significant in all cases except for the period of 2007 to 2010 when *Pos Rate Var* proxies for interest rate risk management. Overall, the results suggest that net interest income persistence varies positively with the degree of effective interest rate risk management.

6.4.2 Net Interest Income-Returns Association

Table 5 presents analysis of the effect of interest rate risk management on the association of net interest income and returns. Panel A reports the variable distributions and Panel B presents the correlation coefficients. The proxies for interest rate risk management and the interaction terms of these proxies and net interest income are highly and significantly correlated. For example, the Pearson (Spearman) coefficient *Pos Rate Var* and *NII*Pos Rate Var* is 0.88 (0.96). To remedy the problem of multicollinearity, I test the joint significance of the two regressors, and in separate regressions I exclude the main effect of interest rate risk management and only include the interaction term of interest rate risk management and net interest income.

Panel C and Panel D of Table 5 present the regression results on whether there exists a positive relation between the net interest income-returns association and interest rate risk management. I estimate the model for the full sample period (1998 to 2010), the period before the financial crisis (1998-2006) and the period of the financial crisis and subsequent recession (2007-2010). Panel C uses the indicator *Pos Rate Var* as the proxy for interest rate risk management. For the full sample period of 1998 to 2010, the coefficients on *Pos Rate Var* and *NII*Pos Rate Var* are jointly significant. In the model that only includes *NII*Pos Rate Var*, the coefficient on the interaction term *NII*Pos Rate Var* is significantly positive. This indicates the net interest income-returns association is significantly higher for BHCs with positive rate variances than for BHCs with negative rate variances. Separating the sample periods into 1998 to 2006 and 2007 to 2010, the coefficients on *NII*Pos Rate Var* are significantly positive in both periods, but higher for the period during 1998 to 2006 than for the period during 2007 to 2010. The less pronounced effect during 2007 to 2010 is probably because other factors such as credit risk during the later period weakened the impact of interest rate risk management on the net interest income-returns association. Additionally, BHCs might have taken excessive risk during 2007 to 2010 which weakened the impact.

Panel D of Table 5 uses *Dif from immun α25* as the proxy for interest rate risk management. The results are similar to Panel A for the full sample period and for the period of 1998 to 2006. For the period of 2007 to 2010, the coefficients on *Dif from immun α25* and *NII*Dif from immun α25* are not jointly significant, and when the main effect *Dif from immun α25* is excluded, the coefficient on the interaction term *NII*Dif from immun α25* is only weakly significant at the one-tailed 10% level. Overall, the results in Table 5 suggest that interest rate risk management affects the valuation of net interest income, especially during 1998 to 2006.[67]

6.4.3 Additional Analysis of Moderating Factors

In additional analysis, I evaluate the moderating effects of term spread (*Term spread*) and fee income (*High fee income*) on the impact of interest rate risk management on the net interest income-returns association. For brevity, I only present the results of the regression models that include both the main effect (*IRR mgmt*) and the interaction term (*NII*IRR mgmt*). The results

[67] Untabulated analyses find the results hold for all asset quartiles.

are similar if the main effect (*IRR mgmt*) is excluded.[68] Panel A (Panel B) of Table 6 reports the regression results regarding the moderating effect of term spread (fee income). In both panels, Column (1) to (3) use *Pos Rate Var* as the proxy for interest rate risk management, and Column (4) to (6) use *Dif from immun α25*.

The coefficients on *NII*IRR mgmt*Term Spread* in Panel A are significantly negative at one-tailed 5% level during 1998 to 2006 (one-tailed p-value = 0.029 when *Pos Rate Var* is used as *IRR mgmt*; one-tailed p-value = 0.033 when *Dif from immun α25*is used as *IRR mgmt*), but not significant during other periods. The results suggest that during 1998 to 2006, the impact of interest rate risk management on the net interest income-returns association is weaker when the term spread is wider. The coefficients on *NII*IRR mgmt*High fee income* in Panel B are weakly significantly negative at one-tailed 10% level during 1998 to 2006 (one-tailed p-value = 0.089 when *Pos Rate Var* is used as *IRR mgmt*; one-tailed p-value = 0.059 when *Dif from immun α25*is used as *IRR mgmt*), suggesting that during 1998 to 2006, the higher the level of fee income, the weaker the impact of interest rate risk management on the net interest income-returns association. The moderating effects of term spread and fee income for the financial crisis period during 2007 to 2010 are not significant, possible because other factors such as credit risk during this period dominates the net interest income-returns association.

7. Conclusions

This paper studies the management of interest rate risk as related to earnings (referred to as interest rate risk in this paper) in BHCs. I explore three questions: (1) given current

[68] In untabulated results, I use the difference between the rates of ten-year Treasury bonds and the rates of three-month Treasury bills as term spread and find similar results.

inadequacies, what improved method can better measure interest rate risk management, (2) to what extent are BHCs able to increase net interest income through managing interest rate risk, and (3) how does interest rate risk management affect the valuation of net interest income.

I first establish an α-gap model, which is based on α – the ratio of changes in the rates of rate sensitive liabilities to changes in the rates of rate sensitive assets. The α-gap model decomposes changes in net interest income into rate variances and volume variances. I posit that greater rate variances indicate more effective interest rate risk management, *ceteris paribus*. I demonstrate that the α- gap model is superior to traditional maturity gap analysis in explaining changes in net interest income.

Based on the α-gap model, I empirically assess BHCs' interest rate risk management. I find that, on average, BHCs tend to generate earnings by changing the size and composition of their balance sheet, not by managing interest rate risk. In only three out of the 13 years during 1998 to 2010 did more than 50% of BHCs achieve positive rate variances of changes in net interest income. In addition, interest rate risk management positively impacts the valuation of net interest income, and the effect is stronger during 1996 to 2006 than during the financial crisis period of 2007 to 2010.

My study is relevant in the current historically low interest rate environment which poses significant interest rate risk management challenges to financial institutions. This paper can help guide the market regulator and accounting standard setter's ongoing efforts to develop enhanced disclosure requirements for interest rate risk. My results show that α and α-gap, as well as rate and volume analysis, can be considered as part of interest rate risk disclosures in order to shed light on the process and outcome of interest rate risk management. Additionally, using the measures developed in this paper, investors can better evaluate interest rate risk management in making investment decisions. Banking regulators can apply these measures to monitor banks' interest rate risk profile, earnings sustainability and management quality. Furthermore, this paper expands the existing literature by developing new proxies for measuring interest rate risk management and empirically assessing BHCs' interest rate risk management practices.

This study suggests several venues for future research. First, using finer data sources future research can address the effect of derivatives. This paper does not separate the effects of the on-balance-sheet approach and derivative usage because BHCs do not break down net interest income achieved through the on-balance-sheet approach or through derivative usage in their maturity gap disclosures nor in their rate and volume analysis. Second, future research can incorporate the interrelationship between interest rate risk as related to earnings and other risks such as duration risk and credit risk.

Appendix A: Theoretical Development of the *α*-GAP Model

Assuming (1) interest rates for *RSA* and *RSL* change by different amounts, Δi_{RSA} and Δi_{RSL}, respectively, and interest rates for fixed rate assets (*FSA*) and fixed rate liabilities (*FSL*) do not change, (2) the size and composition of the balance sheet does not change over time, and (3) all repricing occurs in unison, the following equation represents the association between maturity gap and changes in net interest income (ΔNII). Define α as the ratio of changes in the average rates of rate sensitive liabilities to changes in the average rates of rate sensitive assets, i.e., $\alpha = \frac{\Delta i_{RSL}}{\Delta i_{RSA}}$. Define *α-GAP* as $\alpha\text{-}GAP = RSA - \alpha \times RSL$. The association between *α-GAP* and ΔNII is represented by the following equation:

$$\Delta NII = RSA \times \Delta i_{RSA} - RSL \times \Delta i_{RSL}$$

$$= RSA \times \Delta i_{RSA} - \frac{\Delta i_{RSL}}{\Delta i_{RSA}} \times RSL \times \Delta i_{RSA}$$

$$= (RSA - \alpha \times RSL) \times \Delta i_{RSA}$$

I now turn to a more testable model by allowing the size and composition of the balance sheet and interest rates on assets and liabilities to change from year *t-1* to year *t*. Consider a bank that holds interest-earning assets and interest-bearing liabilities. Let the gapping period be one year. Interest-earning assets are categorized into rate sensitive assets (*RSA*) and fixed rate assets (*FRA*), depending on whether they reprice or mature within one year. Similarly, interest-bearing liabilities are categorized into rate sensitive liabilities (*RSL*) and fixed rate liabilities (*FRL*). Rate sensitive assets (*RSA*) and rate sensitive liabilities (*RSL*) have different average interest rates: i_{RSA} and i_{RSL}, respectively. From year *t-1* to year *t*, $i_{RSA,t-1}$ and $i_{RSL,t-1}$ change by $\Delta i_{RSA,}$ and $\Delta i_{RSL,}$ to $i_{RSA,t-1}$ and $i_{RSL,t-1}$, respectively. Define $\alpha = \frac{\Delta i_{RSL}}{\Delta i_{RSA}}$, or equivalently, $\Delta i_{RSL} = \alpha \times \Delta i_{RSA}$. Define *α-GAP* as $\alpha\text{-}GAP_{t-1} = RSA_{t-1} - \alpha \times RSL_{t-1}$ and $\Delta\alpha\text{-}GAP = \Delta RSA - \alpha \times \Delta RSL$.

At year *t-1*, fixed rate assets (FRA_{t-1}) and fixed rate liabilities (FRL_{t-1}) have different average interest rates: $i_{FRA,\,t-1}$ and $i_{FRL,\,t-1}$. From year *t-1* to year *t*, assume the amount of existing FRA_{t-1} and FRL_{t-1} changes by ΔFRA_{t-1} and ΔFRL_{t-1}. Also assume the bank expands by ΔFRA_t and ΔFRL_t with interest rates $i_{FRA,\,t}$ and $i_{FRL,\,t}$.

With the above assumptions, *NII* for year *t-1* and year *t* can be written as follows:

Appendix A *(continued)*

$$NII_{t-1} = RSA_{t-1} \times i_{RSA,t-1} - RSL_{t-1} \times i_{RSL,t-1} \\ + FRA_{t-1} \times i_{FRA,t-1} - FRL_{t-1} \times i_{FRL,t-1}$$

$$NII_{t} = RSA_{t} \times i_{RSA,t} - RSL_{t} \times i_{RSL,t} \\ + FRA_{t-1} \times i_{FRA,t-1} + \Delta FRA_{t-1} \times i_{FRA,t-1} + \Delta FRA_{t} \times i_{FRA,t} \\ - FRL_{t-1} \times i_{FRL,t-1} - \Delta FRL_{t-1} \times i_{FRL,t-1} - \Delta FRL_{t} \times i_{FRL,t}$$

The change in net interest income (ΔNII) from year *t-1* to year *t* is:

$$\begin{aligned} \Delta NII &= NII_t - NII_{t-1} \\ &= (RSA_t \times i_{RSA,t} - RSA_{t-1} \times i_{RSA,t-1}) - (RSL_t \times i_{RSL,t} - RSL_{t-1} \times i_{RSL,t-1}) \\ &\quad + \Delta FRA_{t-1} \times i_{FRA,t-1} + \Delta FRA_t \times i_{FRA,t} - \Delta FRL_{t-1} \times i_{FRL,t-1} - \Delta FRL_t \times i_{FRL,t} \\ &= (\Delta RSA \times i_{RSA,t-1} + RSA_{t-1} \times \Delta i_{RSA} + \Delta RSA \times \Delta i_{RSA}) - (\Delta RSL \times i_{RSL,t-1} + RSL_{t-1} \times \Delta i_{RSL} + \Delta RSL \times \Delta i_{RSL}) \\ &\quad + (\Delta FRA_{t-1} \times i_{FRA,t-1} - \Delta FRL_{t-1} \times i_{FRL,t-1}) - (\Delta FRA_t \times i_{FRA,t} - \Delta FRL_t \times i_{FRL,t}) \end{aligned}$$

Given $\alpha = \dfrac{\Delta i_{RSL}}{\Delta i_{RSA}}$, the model can be rewritten as:

$$\begin{aligned} \Delta NII &= (RSA_{t-1} - \alpha \times RSL_{t-1})\Delta i_{RSA} + (\Delta RSA \times i_{RSA,t-1} - \Delta RSL \times i_{RSL,t-1}) + (\Delta RSA - \alpha \times \Delta RSL)\Delta i_{RSA} \\ &\quad + (\Delta FRA_{t-1} \times i_{FRA,t-1} - \Delta FRL_{t-1} \times i_{FRL,t-1}) - (\Delta FRA_t \times i_{FRA,t} - \Delta FRL_t \times i_{FRL,t}) \end{aligned}$$

With $\alpha\text{-}GAP_{t-1} = RSA_{t-1} - \alpha \times RSL_{t-1}$ and $\Delta\alpha\text{-}GAP = \Delta RSA - \alpha \times \Delta RSL$, I obtain the *α*-gap model:

$$\begin{aligned} \Delta NII &= \underbrace{\alpha\text{-}GAP_{t-1} \times \Delta i_{RSA}}_{\text{(Rate variances)}} \\ &\quad + \underbrace{(\Delta RSA \times i_{RSA,t-1} - \Delta RSL \times i_{RSL,t-1}) + (\Delta FRA_{t-1} \times i_{FRA,t-1} - \Delta FRL_{t-1} \times i_{FRL,t-1})}_{\text{(Volume variances)}} \\ &\quad + \underbrace{\Delta\alpha\text{-}GAP \times \Delta i_{RSA} + (\Delta FRA_t \times i_{FRA,t} - \Delta FRL_t \times i_{FRL,t})}_{\text{(Rate /Volume variances)}} \end{aligned}$$

Appendix B: Rate and Volume Analysis and Maturity Gap Analysis

Panel A: Rate and Volume Analysis from the 2010 10-K of New York Community Bancorp, Inc.

The following table presents the extent to which changes in interest rates and changes in the volume of interest-earning assets and interest-bearing liabilities have affected our interest income and interest expense during the periods indicated. Information is provided in each category with respect to (i) the changes attributable to changes in volume (changes in volume multiplied by prior rate); (ii) the changes attributable to changes in rate (changes in rate multiplied by prior volume); and (iii) the net change. The changes attributable to the combined impact of volume and rate have been allocated proportionately to the changes due to volume and the changes due to rate.

	Year Ended December 31, 2010 Compared to Year Ended December 31, 2009 Increase/(Decrease)			Year Ended December 31, 2009 Compared to Year Ended December 31, 2008 Increase/(Decrease)		
	Due to			Due to		
(in thousands)	Volume	Rate	Net	Volume	Rate	Net
INTEREST-EARNING ASSETS:						
Mortgage and other loans, net	$ 333,388	$ 10,882	$ 344,270	$ 119,105	$ (53,795)	$ 65,310
Securities and money market investments	(29,379)	(35,709)	(65,088)	(16,314)	(19,513)	(35,827)
Total	304,009	(24,827)	279,182	102,791	(73,308)	29,483
INTEREST-BEARING LIABILITIES:						
NOW and money market accounts	$ 25,648	$ (2,445)	$ 23,203	$ 65,800	$ (86,611)	$ (20,811)
Savings accounts	5,622	(648)	4,974	1,947	(8,267)	(6,320)
Certificates of deposit	639,171	(663,623)	(24,452)	(19,249)	(89,198)	(108,447)
Borrowed funds	(9,525)	10,344	819	54,615	(119,384)	(64,769)
Total	660,916	(656,372)	4,544	103,113	(303,460)	(200,347)
Change in net interest income	$ (356,907)	$ 631,545	$ 274,638	$ (322)	$ 230,152	$ 229,830

From the Rate and Volume Analysis above, I obtain the following data for year 2010:

Rate variances of changes in interest income = -24,827, volume variances of changes interest income = 304,009

Rate variances of changes in interest expense = -656,372, volume variances of changes interest income = 660,916

Rate variances of changes in net interest income (*Rate Var*) = 631,545, volume variances of changes in net interest income (*Volume Var*) = -356,907

Changes in net interest income on tax-equivalent basis (ΔNII) = 274,638

Appendix B *(continued)*

Panel B: Maturity Gap Analysis from the 2009 10-K of New York Community Bancorp, Inc.

	At December 31, 2009						
(dollars in thousands)	Three Months or Less	Four to Twelve Months	More Than One Year to Three Years	More Than Three Years to Five Years	More Than Five Years to 10 Years	More Than 10 Years	Total
INTEREST-EARNING ASSETS:							
Mortgage and other loans[1]	$2,819,255	$ 4,859,321	$10,199,568	$ 6,799,883	$ 1,635,972	$1,444,467	$27,758,466
Mortgage-related securities[2][3]	202,035	608,854	1,069,905	682,370	556,474	120,523	3,240,161
Other securities and money market investments[2]	3,409,619	276,980	115,500	238,012	1,359,067	51,674	5,450,852
Total interest-earning assets	6,430,909	5,745,155	11,384,973	7,720,265	3,551,513	1,616,664	36,449,479
INTEREST-BEARING LIABILITIES:							
NOW and Super NOW accounts	22,283	66,850	165,118	149,019	767,344	612,040	1,782,654
Money market accounts	2,681,562	511,906	982,860	629,030	1,083,330	34,946	5,923,634
Savings accounts	537,330	123,454	304,932	275,201	1,417,092	1,130,285	3,788,294
Certificates of deposit	2,128,959	5,081,799	1,694,703	141,305	7,125	—	9,053,891
Borrowed funds	584,458	1,125,602	1,220,188	988,244	9,889,474	356,720	14,164,686
Total interest-bearing liabilities	5,954,592	6,909,611	4,367,801	2,182,799	13,164,365	2,133,991	34,713,159
Interest rate sensitivity gap per period[4]	$ 476,317	$(1,164,456)	$ 7,017,172	$ 5,537,466	$ (9,612,852)	$ (517,327)	$ 1,736,320
Cumulative interest sensitivity gap	$ 476,317	$ (688,139)	$ 6,329,033	$11,866,499	$ 2,253,647	$1,736,320	
Cumulative interest sensitivity gap as a percentage of total assets	1.13%	(1.63)%	15.01%	28.15%	5.35%	4.12%	
Cumulative net interest-earning assets as a percentage of net interest-bearing liabilities	108.00%	94.65 %	136.73%	161.12%	106.92%	105.00%	

(1) *For the purpose of the gap analysis, non-performing non-covered loans and the allowance for loan losses have been excluded.*

(2) *Mortgage-related and other securities, including FHLB stock, are shown at their respective carrying amounts.*

(3) *Expected amount based, in part, on historical experience.*

From the maturity gap analysis above, I obtain RSA and RSL at the end of 2009, and calculate α and α-gap for year 2010:

RSA_{2009} = 6,430,909 + 5,745,155= 12,176,064, Δi_{RSA} = -24,827/12,176,064 = - 0.002,

RSL_{2009} = 5,954,592 + 6,909,611= 12,864,203, Δi_{RSL} = - 656,372/ 12,864,203 = - 0.051,

$\alpha = \Delta i_{RSL} / \Delta i_{RSA}$ = 25.02,

$\alpha\text{-}GAP_{2010} = RSA_{2009} - \alpha * RSL_{2009}$ = 12,176,064 - 25.02*12,864,203 = - 309,686,295

Appendix C: Variables

Panel A: Construction of Variables from FR Y-9C

Total assets: BHCK2170

Rate sensitive assets: I construct rate sensitive assets by adding interest-earning assets repricing within one year (BHCK3197) and trading assets (BHCK3545). BHCK3197 is interest-earning assets that are repriceable within one year or mature within one year. It reports all assets that the consolidated bank holding company considers interest-earning assets that have a remaining maturity of less than one year or where the repricing frequency is less than one year. Interest-earning assets exclude trading account assets and equity securities. BHCK3545 is trading assets.

Rate sensitive liabilities: I construct rate sensitive liabilities as follows: BHCK3296 (interest-bearing deposit liabilities that reprice within one year or mature within one year) + BHCK3298 (long-term debt with a remaining maturity of more than one year but reprices within one year) + BHCK3409 (long-term debt that is scheduled to mature within one year) + BHCK2332 (other borrowed money with remaining maturity of less than one year) + BHCK2309 (commercial paper) + BHCK3548 (trading liability) + BHCK2920 (liability on acceptance executed and outstanding) + BHDMB993 (fed fund purchased, reported since 2002) + BHCKB995 (securities sold under repo agreement, reported since 2002) + BHCK2800 (fed fund purchased and securities sold under repo agreement, reported before 2002) + a proportion of non-maturity deposits. Non-maturity deposits are constructed as: BHCB2210 (demand deposit) + BHCB3187 (NOW, ATS and other transaction accounts) + BHCB2389 (money market deposit accounts). The proportions include 0%, 50% and 25%.

Net interest income (NII): BHCK4074

Non-interest income: BHCKB497

Non-interest expense: BHCK4093

Loan loss provisions: BHCK4230

Tier 1 leverage ratio: From year 2001 forward, the tier 1 leverage ratio comes from BHCK7204. Before year 2001, the tier 1 leverage ratio is calculated by dividing BHCK7204 (tier 1 capital) by total assets excluding intangible assets (BHCK2170 -BHCK3163- BHCKB026- BHCK5507-BHCK3164).

Income (loss) before income taxes and extraordinary items, and other adjustments: BHCK4301

Appendix C (Continued)
Panel B: Variables and Data Sources

Variable	Construction	Source
α	$\Delta i_{RSL}/\Delta i_{RSA}$	10-K
α_ *FR0*	Δi_{RSL}_*FR0*/Δi_{RSA}_*FR*	FR Y-9C, 10-K
α_ *FR25*	Δi_{RSL}_*FR25*/Δi_{RSA}_*FR*	FR Y-9C, 10-K
α_ *FR50*	Δi_{RSL}_*FR50*/Δi_{RSA}_*FR*	FR Y-9C, 10-K
α-*GAP*	*RSA* - α×*RSL*	10-K
Δi_{RSA}	The change in the rates of rate sensitive assets, where rate sensitive assets are estimated from 10-K. It is constructed as the rate variances of interest income divided by *RSA* at the beginning of the year.	10-K
Δi_{RSA}_*FR*	The change in the rates of rate sensitive assets, where rate sensitive assets are estimated from FR Y-9C. It is constructed as the rate variances of interest income divided by *RSA_FR* at the beginning of the year.	FR Y-9C, 10-K
Δi_{RSL}	The change in the rates of rate sensitive liabilities, where rate sensitive liabilities are estimated from 10-K. It is constructed as the rate variances of interest expenses divided by *RSL* at the beginning of the year.	10-K
Δi_{RSL}_*FR0*	The change in the rates of rate sensitive liabilities, where rate sensitive liabilities are estimated from FR Y-9C. It is constructed as the rate variances of interest expenses divided by *RSL_FR0* at the beginning of the year.	10-K
Δi_{RSL}_*FR25*	The change in the rates of rate sensitive liabilities, where rate sensitive liabilities are estimated from FR Y-9C. It is constructed as the rate variances of interest expenses divided by *RSL_FR25* at the beginning of the year.	FR Y-9C, 10-K
Δi_{RSL}_*FR50*	The change in the rates of rate sensitive liabilities, where rate sensitive liabilities are estimated from FR Y-9C. It is constructed as the rate variances of interest expenses divided by *RSL_FR50* at the beginning of the year.	FR Y-9C, 10-K
Dif from immun α0	Difference between *α_FR0* and *immunization α*, where *α_FR0* and *immunization α* are estimated using *RSL_FR0*. When Δi_{RSA}_*FR0 >0, "Dif from immun α0"=immunization α_FR0 –α_FR0.* When Δi_{RSA}_*FR0 <0, "Dif from immun α0"=α_FR0 - immunization α_FR0.*	FR Y-9C
Dif from immun α25	Difference between *α_FR25* and *immunization α*, where *α_FR25* and *immunization α* are estimated using *RSL_FR25*. When Δi_{RSA}_*FR25 >0, "Dif from immun α25" = immunization α_FR25 – α_FR25.* When Δi_{RSA}_*FR0 <0, "Dif from immun α" = α_FR25-immunization α_FR25.*	FR Y-9C
Ret	One-year buy and hold returns, starting from three (two) months after the fiscal year end for years before 2007 (since 2007).	CRSP
GAP	Maturity gap, constructed as *RSA* minus *RSL*	10-K
Growth	Asset growth, constructed as the change in total assets divided by total assets of the last year	FR Y-9C

Appendix C (Continued)

Variable	Construction	Source
High fee income	An indicator variable equals one if non-interest income divided by the total of net interest income and non-interest income is greater than its median value by year, and zero otherwise	FR Y-9C
Immun α	*immunization α*, i.e., *RSA_FR* at the beginning of the year divided by *RSL_FR0* or *RSL_FR25* at the beginning of the year	FR Y-9C
IRR mgmt	Interest rate risk management as related to earnings, which is referred to as interest rate risk management throughout this paper. It has two measures: (1) positive rate variances (*Pos Rate Var*) and (2) differences from *immunization α* (*dif from immun α25*). Additionally, *dif from immun 0* is used in sensitivity tests.	FR Y-9C, 10-K
Loan-loss prov	Loan loss provisions, constructed as *log (*loan loss provisions*/MV* + 1*)*	FR Y-9C
MV	Market value, constructed as the number of common stock outstanding times the closing price per share	CRSP
NII	Net interest income	
Non-int exp	Non-interest expenses	FR Y-9C
Non-int inc	Non-interest income	FR Y-9C
Pos Rate Var	Positive rate variances. It is an indicator variable equal to one if rate variances (*Rate Var*) are positive, zero otherwise	10-K
Pos Volume Var	Positive volume variances. It is an indicator variable equal to one if volume variances (*Volume Var*) are positive, zero otherwise	10-K
Rate Var	Rate variances of changes in net interest income	10-K
ROA	Return on assets, constructed as income (loss) before income taxes and extraordinary items and other adjustments divided by total assets	FR Y-9C
RSA	Rate sensitive assets, i.e., earnings assets repricing within one year, obtained from maturity gap analysis disclosed in 10-K	FR Y-9C
RSA_FR	Rate sensitive assets, i.e., earnings assets repricing within one year, estimated from FR Y-9C	FR Y-9C
RSL	Rate sensitive liabilities, i.e., interest-bearing liabilities repricing within one year, obtained from maturity gap analysis disclosed in 10-K	FR Y-9C
RSL_FR0	Rate sensitive liabilities, i.e., interest-bearing liabilities repricing within one year estimated from FR Y-9C; includes 0% of non-maturity deposits.	FR Y-9C
RSL_FR25	Rate sensitive liabilities, i.e., interest-bearing liabilities repricing within one year estimated from FR Y-9C; includes 25% of non-maturity deposits.	FR Y-9C
RSL_FR50	Rate sensitive liabilities, i.e., interest-bearing liabilities repricing within one year estimated from FR Y-9C; includes 50% of non-maturity deposits.	FR Y-9C
Size	Log of total assets	FR Y-9C
TA	Total assets	FR Y-9C
Term spread	Difference between the annualized three-year Treasury bond rate and the annualized federal funds rate	Federal Reserve Bank
Tier1 lev	Tier 1 leverage ratio	FR Y-9C
Volume Var	Volume variances of changes in net interest income	10-K

Appendix D: Regression Analysis of *α-GAP* Model

Panel A: Correlation Coefficients

		(a)	*(b)*	*(c)*	*(d)*	*(e)*	*(f)*
ΔNII	***(a)***		**0.864**	**-0.311**	**0.062**	-0.036	**0.389**
α-GAP $_{t-1}$****Δi*** $_{RSA}$	***(b)***	**0.474**		**-0.318**	**0.061**	**-0.056**	**-0.124**
Δα-GAP $_{t-1}$****Δi*** $_{RSA}$	***(c)***	-0.023	**0.072**		**-0.304**	**0.659**	-0.033
ΔGAP $_{t-1}$****Δi*** $_{RSA}$	***(d)***	**0.059**	0.048	**-0.240**		**-0.336**	0.007
ΔGAP $_{t-1}$****Δi*** $_{RSA}$	***(e)***	-0.029	**-0.104**	**0.798**	-0.119		0.028
Volume Var	***(f)***	**0.685**	**-0.204**	**-0.080**	0.034	0.034	

This panel presents the correlation coefficients of the variables in the *α-GAP* model for the 1,445 observations that disclose maturity gap. The upper diagonal presents Pearson correlations, and the lower diagonal presents Spearman correlations. Bolded values are statistically significant at the 0.05 level or better.

Panel B: Regression Analysis of *α-GAP* and *GAP* Models

This panel presents regression models of *α-GAP* and *GAP* models.

The left column of this panel report the regression results for the *α-GAP* model:

$\Delta NII = \beta_0 + \beta_1\ \alpha\text{-}GAP_{t-1} * \Delta i_{RSA} + \beta_2\ \Delta\alpha\text{-}GAP * \Delta i_{RSA} + \beta_3\ Volume\ Var + \varepsilon$

The right column of this panel report the regression results for the *GAP* models:

$\Delta NII = \beta_0 + \beta_1\ GAP_{t-1} * \Delta i_{RSA} + \beta_2\ \Delta GAP * \Delta i_{RSA} + \beta_3\ Volume\ Var + \varepsilon$

DV = Δ***NII***		DV = Δ***NII***	
	Coefficient ***(p-value)***		***Coefficient*** ***(p-value)***
α-GAP $_{t-1}$****Δi*** $_{RSA}$	0.920 ***	***GAP*** $_{t-1}$****Δi*** $_{RSA}$	0.027
	(0.000)		(0.541)
Δα-GAP $_{t-1}$****Δi*** $_{RSA}$	-0.044	***ΔGAP*** $_{t-1}$****Δi*** $_{RSA}$	-0.057
	(0.210)		(0.135)
Volume Var	0.589 ***	***Volume Var***	0.494 ***
	(0.000)		(0.000)
firm, year fixed effects	yes	firm, year fixed effects	yes
N	1445	N	1445
Adj R^2	0.99	*Adj* R^2	0.60

***, ** and * indicate statistical significance at the 0.01, 0.05 and 0.10 level or better, respectively (two-tailed).

Variable Definition: Δ*NII* is changes in net interest income scaled by total assets. Δi_{RSL} is changes in rates of rate sensitive liabilities (*RSL*). Δi_{RSA} is changes in rates of rate sensitive assets (*RSA*). *α* is the ratio of Δi_{RSL} to Δi_{RSA} . $\alpha\text{-}GAP_{t-1} = RSA_{t-1} - \alpha \times RSL_{t-1}.$ $GAP_{t-1} = RSA_{t-1} - RSL_{t-1}.$ *Volume Var* is volume variances scaled by total assets. *t-1* stands for the beginning of the year. Δ indicates changes from the previous year to the current year. All variables are winsorized at the 98% and 2% levels. Please see Appendix C for variable construction.

Table 1: Sample

Panel A: Sample Selection

	Observations
Bank holding companies (SIC 6020 to 6036) in CRSP-Compustat Merged database with FR-Y9C data available on Federal Reserve Bank website from 1997 to 2010	5,542
Less: Firms that do not have 10-Ks on SEC Edgar database, or firms whose rate and volume analysis or Item 7A Market Risk Disclosure are not available in 10-Ks	-1483
Less: Observations that have missing data to calculate variables or do not have two consecutive years of data to calculate change variables	-1348
Less: Firms with fiscal year end not in the 4th quarter	-79
Less: Firms out of 1 and 99 percentile of total assets	-67
Total number of firm-year observations (Full sample, 1998-2010)	2,565
Total number of unique bank holding companies (Full sample, 1998-2010)	332

This panel presents the sample selection process.

Panel B: Total Assets and Quartiles by Total Assets

	TA (Total Assets, $ in millions)					
	n	**Mean**	**Std dev**	**P25**	**Median**	**P75**
ALL	2,565	9,379	35,963	831	1,740	4,937
Quartile 4	635	33,074	66,647	7,156	11,623	28,288
Quartile 3	644	2,858	1,065	2,070	2,622	3,488
Quartile 2	646	1,222	392	919	1,143	1,446
Quartile 1	640	594	207	429	575	741

This panel presents the total assets (dollar in millions) for the 2,565 observations in the full sample. BHCs are divided into quartiles by *TA* (total assets) each year, with Quartile 4 being the largest and Quartile 1 being the smallest.

Table 2: Analysis for BHCs Disclosing Maturity Gap

Panel A: Distributions of Variables for BHCs Disclosing Maturity Gap and BHCs Not Disclosing Maturity Gap

Variable	Disclosing Maturity Gap (1=yes, 0=no)	Mean		Std Dev	P25	Median		P75
TA(in millions)	0	15,525	***	54,161	967	2,503	***	7,895
	1	5,062		13,288	750	1,416		3,414
NII/TA	0	0.0339	***	0.0068	0.0296	0.0335	***	0.0375
	1	0.0354		0.0071	0.0308	0.0350		0.0396
ΔNII/TA	0	0.0022	***	0.0029	0.0001	0.0020	***	0.0040
	1	0.0027		0.0030	0.0006	0.0025		0.0046
Rate Var/TA	0	-0.0004		0.0019	-0.0017	-0.0005		0.0007
	1	-0.0006		0.0020	-0.0018	-0.0006		0.0006
Volume Var/TA	0	0.0028	***	0.0026	0.0010	0.0026	***	0.0042
	1	0.0033		0.0027	0.0014	0.0029		0.0050

This panel contrasts the variable distributions for the 1,445 observations that disclose maturity gap versus the 1,120 observations that do not disclose maturity gap. The significance levels for the means are based on the two-sample *t*-statistics computed under the assumption of independence. The significance levels for the medians are based on the Wilcoxson-Mann-Whitney statistics.

Variable Definition: *TA* is total assets. *NII* is net interest income. *Rate Var* is rate variances. *Volume Var* is volume variances. Δ indicates changes from the previous year to the current year. Please see Appendix C for variable construction.

Panel B: Distributions of *α-GAP* Variables for BHCs Disclosing Maturity Gap

(N=1,445)	Mean	Std dev	P25	Median	P75
Δi_{RSA}	-0.005	0.012	-0.015	-0.005	0.005
Δi_{RSL}	-0.003	0.010	-0.011	-0.004	0.005
α	0.802	0.690	0.430	0.743	1.109
$\alpha\text{-}GAP_{t-1}/TA$	0.044	0.310	-0.089	0.052	0.183
GAP_{t-1}/TA	-0.068	0.135	-0.149	-0.055	0.023

This panel presents the variable distributions for the 1,445 observations that disclose maturity gap.

Variable Definition: The variables are estimated using rate and volume analysis and maturity gap disclosures from 10-K filings. Δi_{RSL} is the change in rates of rate sensitive liabilities (*RSL*). Δi_{RSA} is the change in rates of rate sensitive assets (*RSA*). α is the ratio of Δi_{RSL} to Δi_{RSA}. $\alpha\text{-}GAP_{t-1} = RSA_{t-1} - \alpha \times RSL_{t-1}$, $GAP_{t-1} = RSA_{t-1} - RSL_{t-1}$. *TA* is total assets. *t-1* represents the beginning of the year. Please see Appendix C for variable construction.

Table 3: Distributions of α-related Variables

Panel A: Distributions of α-Related Variables Estimated from Maturity Gap

1,445 obs. disclosing Maturity Gap	**Mean**	**Std dev**	**P25**	**Median**	**P75**
RSA_{t-1}_FR / RSA_{t-1}	0.839	0.269	0.692	0.883	1.000
$RSL_{t-1}\_FR0 / RSL_{t-1}$	0.731	0.303	0.537	0.702	0.942
$RSL_{t-1}\_FR25 / RSL_{t-1}$	0.953	0.319	0.732	0.914	1.140
$RSL_{t-1}\_FR50 / RSL_{t-1}$	1.175	0.362	0.909	1.128	1.360
α_FR0/α	1.418	1.401	0.925	1.141	1.579
α_FR25/α	0.968	0.436	0.726	0.900	1.179
α_FR50/α	0.775	0.327	0.592	0.746	0.958

This panel presents the distributions of α-related variables estimated from maturity gap for the 1,445 observations that disclose maturity gap analysis.

Variable Definition: The following variables are estimated using rate and volume analysis and maturity gap disclosures from 10-K filings: RSA_{t-1} is rate sensitive assets disclosed in maturity gap analysis. RSL_{t-1} is rate sensitive liabilities disclosed in maturity gap analysis. α is the ratio of Δi_{RSL} to Δi_{RSA}, where Δi_{RSA} is changes in rates of rate sensitive assets (*RSA*), and Δi_{RSL} is changes in rates of rate sensitive liabilities (*RSL*).

The following variables are estimated using rate and volume analysis from 10-K filings and data from FR Y-9C: RSA_{t-1}_FR is rate sensitive assets estimated from FR Y-9C. RSL_{t-1}_FR0 is rate sensitive liabilities estimated from FR Y-9C and excludes non-maturity deposits. RSL_{t-1}_FR25 is rate sensitive liabilities estimated from FR Y-9C and includes 25% of non-maturity deposits. RSL_{t-1}_FR50 is rate sensitive liabilities estimated from FR Y-9C and includes 50% of non-maturity deposits. $\alpha\_FR0 = \Delta i_{RSL}\_FR0 / \Delta i_{RSA}\_FR$. $\alpha\_FR25 = \Delta i_{RSL}\_FR25 / \Delta i_{RSA}\_FR$. $\alpha\_FR50 = \Delta i_{RSL}\_FR50 / \Delta i_{RSA}\_FR$. *t-1* stands for the beginning of the year. Δ indicates changes from the previous year to the current year. Please see Appendix C for variable construction.

Panel B: Distributions of α-Related Variables Estimated from FR Y-9C for the Full Sample

(N=2,565)	**Mean**	**Std dev**	**P25**	**Median**	**P75**
Δi_{RSA}_FR	-0.007	1.101	-0.018	-0.007	0.006
Δi_{RSL}_FR25	-0.003	0.177	-0.011	-0.004	0.006
α_FR25	0.764	0.815	0.422	0.710	1.026

This panel presents the distributions of α-related variables estimated from FR Y-9C for the 2,565 observations in the full sample.

Variable Definition: Δi_{RSL}_FR25 is changes in rates of rate sensitive liabilities, where rate sensitive liabilities are estimated from FR Y-9C and include 25% of non-maturity deposits. Δi_{RSA}_FR is changes in rates of rate sensitive assets, where rate sensitive assets are obtained from FR Y-9C. $\alpha\_FR25 = \Delta i_{RSL}\_FR25 / \Delta i_{RSA}\_FR$. Δ indicates changes from the previous year to the current year. All variables are winsorized at the 98% and 2% levels. Please see Appendix C for variable construction.

Table 4: Interest Rate Risk Management and Net Interest Income Persistence

Panel A: Distributions

	Mean	Std Dev	P25	Median	P75
NII/TA	0.035	0.007	0.030	0.034	0.039
Pos Rate Var	0.368	0.482	0.000	0.000	1.000
Dif from immun α25	-0.112	0.794	-0.278	-0.104	0.095
Size	14.699	1.331	13.687	14.441	15.487

This panel presents the distributions of variables for the 2,565 observations during 1998 to 2010.

Panel B: Correlation Coefficients

	(a)	*(b)*	*(c)*	*(d)*	*(e)*	*(f)*	*(g)*
NII/TA $_{t+1}$ (a)		**0.86**	**0.10**	**0.06**	**0.21**	0.01	**-0.24**
NII/TA $_t$ (b)	**0.84**		**0.08**	0.01	**0.22**	-0.04	**-0.26**
Pos Rate Var $_t$ (c)	**0.10**	**0.08**		**0.56**	**<u>0.97</u>**	**0.53**	-0.01
Dif from immun α25 $_t$ (d)	**0.06**	0.03	**0.82**		**0.55**	**<u>0.97</u>**	**-0.05**
NII/TA $_t$ * Pos Rate Var $_t$ (e)	**0.21**	**0.22**	**<u>0.97</u>**	**0.81**		**0.54**	**-0.05**
NII/TA $_t$ * Dif from immun α25$_t$ (f)	0.01	-0.03	**0.83**	**<u>0.99</u>**	**0.81**		-0.04
Size $_t$ (g)	**-0.20**	**-0.22**	-0.02	-0.02	**-0.05**	-0.01	

This panel presents the correlation coefficients. The upper diagonal presents Pearson correlations, and the lower diagonal presents Spearman correlations. Bolded values are statistically significant at the 0.05 level or better.

Panel C: *Pos Rate Var* as the Proxy for Interest Rate Risk Management

$$NII/TA_{t+1} = \beta_0 + \beta_1 NII/TA_t + \beta_2 Pos\ Rate\ Var_t + \beta_3 NII/TA_t * Pos\ Rate\ Var_t + \beta_4 Size_t + \varepsilon$$

		IRR mgmt*: *Pos Rate Var					
		<u>1998 to 2010</u>		**<u>1998 to 2006</u>**		**<u>2007 to 2010</u>**	
		Coeff (p-value)	**Coeff (p-value)**	**Coeff (p-value)**	**Coeff (p-value)**	**Coeff (p-value)**	**Coeff (p-value)**
NII/TA $_t$	+	0.350 ***	0.378 ***	0.345 ***	0.365 ***	0.247 ***	0.325 ***
		(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
IRR mgmt$_t$	+	0.001 ***		0.001 ***		0.001 ***	
		(0.000)		(0.001)		(0.000)	
NII/TA$_t$ *IRR mgmt$_t$	+	0.007 *	0.015 ***	0.003	0.009 ***	0.007	0.017 ***
		(0.057)	(0.000)	(0.404)	(0.004)	(0.308)	(0.004)
Size $_t$	?	0.002 ***	0.002 ***	0.002 ***	0.002 ***	0.008 ***	0.008 ***
		(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Firm, year		yes	yes	yes	yes	yes	yes
F-test of joint sig.		5.03 **		3.14 *		1.54	
N		2352	2352	1737	1737	615	615
Adj R^2		81.89%	80.48%	88.68%	88.02%	80.73%	77.44%

***, ** and * indicate statistical significance at the 0.01, 0.05 and 0.10 level or better, respectively (two-tailed).

Variable Definition: *IRR mgmt* is interest rate risk management. *Pos Rate Var* equals one if rate variances are positive, zero otherwise. *Dif from immun α25* is the differences between α and *immunization α*. *NII* is net interest income. *TA* is total assets. *Size* is the log of total assets. *Dif from immun α25* is winsorized at the 95% and 5% levels. All other variables are winsorized at the 98% and 2% levels. *t-1* stands for the beginning of the year. Standard errors are two-way clustered by firm and year. Please see Appendix C for variable construction.

Table 4 *(Continued)*

Panel D: *Dif from immun α25* as the Proxy for Interest Rate Risk Management

$NII/TA_{t+1} = \beta_0 + \beta_1 NII/TA_t + \beta_2 Dif\ from\ immun\ \alpha25_t + \beta_3 NII/TA_t * Dif\ from\ immun\ \alpha25_t + \beta_4 Size_t + \varepsilon$

		IRR mgmt*: *Dif from immun α25					
		1998 to 2010		**1998 to 2006**		**2007 to 2010**	
		Coeff (p-value)	**Coeff (p-value)**	**Coeff (p-value)**	**Coeff (p-value)**	**Coeff (p-value)**	**Coeff (p-value)**
NII/TA_t	+	0.345 ***	0.340 ***	0.340 ***	0.339 ***	0.235 ***	0.231 ***
		(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
$IRR\ mgmt_t$	+	0.0004 ***		0.000		0.000	
		(0.003)		(0.146)		(0.130)	
NII/TA_t	+	0.020 ***	0.029 ***	0.017 **	0.022 ***	0.034 ***	0.040 ***
$*IRR\ mgmt_t$		(0.000)	(0.000)	(0.011)	(0.000)	(0.001)	(0.000)
$Size_t$	?	0.002 ***	0.002 ***	0.002 ***	0.002 ***	0.008 ***	0.008 ***
		(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Firm, year		yes	yes	yes	yes	yes	yes
F-test of joint sig.		13.78 ***		6.83 ***		11.60 ***	
N		2352	2352	1737	1737	615	615
Adj R^2		82.88%	80.67%	89.05%	88.18%	80.73%	78.32%

***, ** and * indicate statistical significance at the 0.01, 0.05 and 0.10 level or better, respectively (two-tailed).
Variable Definition: *IRR mgmt* is interest rate risk management. *Pos Rate Var* equals one if rate variances are positive, zero otherwise. *Dif from immun α25* is the differences between α and *immunization α*. *NII* is net interest income. *TA* is total assets. *Size* is the log of total assets. *Dif from immun α25* is winsorized at the 95% and 5% levels. All other variables are winsorized at the 98% and 2% levels. *t-1* stands for the beginning of the year. Standard errors are two-way clustered by firm and year. Please see Appendix C for variable construction.

Table 5: Interest Rate Risk Management and Net Interest Income-Returns Association

Panel A: Distributions

	Mean	**Std Dev**	**P25**	**Median**	**P75**
Ret	0.075	0.341	-0.115	0.051	0.247
Pos Rate Var	0.368	0.482	0.000	0.000	1.000
Dif from immun α25	-0.112	0.794	-0.278	-0.104	0.095
NII	0.289	0.180	0.185	0.237	0.317
Non-int inc	0.098	0.074	0.051	0.078	0.117
Non-int exp	0.261	0.199	0.150	0.202	0.283
Loan loss prov	-4.019	1.431	-4.901	-4.137	-3.195
High fee income	0.501	0.500	0.000	1.000	1.000
Term spread	0.563	0.657	-0.020	0.710	1.270
Tier1 ratio	8.915	1.649	7.870	8.730	9.770
ROA	0.012	0.013	0.009	0.014	0.019
Growth	0.084	0.100	0.023	0.074	0.132
Size	14.699	1.331	13.687	14.441	15.487

This panel presents the distributions of variables for the 2,565 observations during 1998 to 2010.

Variable Definition: *Excess Ret* is excess return. *Pos Rate Var* equals one if rate variances are positive, zero otherwise. *Dif from immun α25* is the differences between *α* and *immunization α*. *NII* is net interest income. *Non-int inc* is non-interest income. *Non-int exp* is non-interest expenses. *NII, Non-int inc* and *Non-int exp* are scaled by market value (*MV*) at the beginning of the year. *Loan loss prov* is the log of the sum of loan loss provisions scaled by market value plus one. *Tier1 ratio* is the Tier 1 leverage ratio. *ROA* is return on assets. *Growth* is total assets growth. *Size* is the log of total assets. *Term spread* is the difference between annualized three-year Treasury notes rate and Fed funds rate. *High fee income* is an indicator variable that equals one if non-interest income divided by the total of net interest income and non-interest income is greater than its median value by year, and zero otherwise. Please see Appendix C for variable construction. *Dif from immun α25* is winsorized at the 95% and 5% levels. All other variables are winsorized at the 98% and 2% levels.

Table 5 *(Continued)*

Panel B: Correlation Coefficients

	(a)	*(b)*	*(c)*	*(d)*	*(e)*	*(f)*	*(g)*	*(h)*	*(i)*	*(j)*	*(k)*	*(l)*	*(m)*	*(n)*	*(o)*
Ret (a)		**0.09**	**0.14**	**0.15**	**0.10**	**0.20**	**0.24**	**-0.13**	**-0.10**	0.02	0.31	**-0.01**	0.26	**0.11**	-0.01
Pos Rate Var (b)	**0.10**		**0.57**	**0.88**	**0.43**	**0.18**	**0.11**	**0.13**	**0.13**	-0.03	**0.10**	**0.05**	0.01	**-0.04**	-0.01
Dif from immun α25(c)	**0.15**	**0.84**		**0.55**	**0.84**	**0.28**	**0.18**	**0.24**	**0.19**	-0.03	**0.22**	**0.05**	**-0.07**	**-0.07**	-0.02
Pos Rate Var*NII (d)	**0.13**	**0.96**	**0.82**		**0.65**	**0.61**	**0.35**	**0.53**	**0.38**	**-0.07**	**0.15**	**0.02**	**-0.23**	**-0.11**	**-0.07**
Dif from immun α25*NII(e)	**0.16**	**0.84**	**0.98**	**0.84**		**0.42**	**0.24**	**0.37**	**0.25**	-0.03	**0.15**	**0.05**	**-0.18**	**-0.11**	-0.01
NII (f)	**0.20**	**0.17**	**0.24**	**0.32**	**0.14**		**0.53**	**0.91**	**0.64**	**-0.14**	**0.20**	-0.02	**-0.51**	**-0.17**	**-0.17**
Non-int inc (g)	**0.20**	**0.07**	**0.11**	**0.14**	**0.08**	**0.40**		**0.69**	**0.44**	**0.46**	**0.16**	**-0.08**	**-0.21**	**-0.09**	**0.20**
Non-int exp (h)	**-0.14**	**0.11**	**0.17**	**0.25**	**0.09**	**0.84**	**0.70**		**0.61**	0.04	**0.19**	**-0.05**	**-0.62**	**-0.22**	**-0.10**
Loan loss prov (i)	**-0.01**	**0.13**	**0.17**	**0.24**	**0.12**	**0.64**	**0.42**	**0.61**		0.01	**0.20**	**-0.01**	**-0.60**	**-0.18**	**0.07**
High fee income (j)	0.02	-0.03	**-0.05**	**-0.06**	-0.03	**-0.17**	**0.61**	**0.13**	0.02		0.00	**-0.14**	**0.10**	**-0.05**	**0.40**
Term spread (k)	0.34	**0.08**	**0.15**	**0.10**	**0.11**	**0.17**	**0.15**	**0.15**	**0.17**	0.00		0.03	**-0.11**	-0.03	-0.04
Tier1 ratio (l)	-0.01	**0.06**	**0.06**	**0.05**	**0.05**	0.00	**-0.16**	**-0.08**	-0.02	**-0.15**	0.02		**0.05**	**-0.25**	**-0.26**
ROA (m)	0.01	-0.01	**-0.06**	**-0.10**	-0.03	**-0.47**	**-0.23**	**-0.59**	**-0.57**	**0.07**	**-0.05**	0.05		**0.18**	**0.11**
Growth (n)	**0.06**	**-0.06**	**-0.07**	**-0.07**	**-0.07**	**-0.05**	**-0.11**	**-0.12**	**-0.17**	**-0.08**	**0.00**	**-0.18**	**0.18**		-0.01
Size (o)	-0.04	-0.01	-0.01	**-0.06**	0.02	**-0.30**	**0.23**	**-0.14**	**0.07**	**0.39**	-0.04	**0.09**	**-0.01**	-0.04	

This panel presents the correlation coefficients for the 2,565 observations in the full sample. The upper diagonal presents Pearson correlations, and the lower diagonal presents Spearman correlations. Bolded values are statistically significant at the 0.05 level or better.

Variable Definition: *Ret* is one-year buy and hold returns starting from three (two) months after the fiscal year end for years before 2007 (since 2007). *Pos Rate Var* equals one if rate variances are positive, zero otherwise. *Dif from immun α25* is the differences between *α* and *immunization α. NII* is net interest income. *Non-int inc* is non-interest income. *Non-int exp* is non-interest expenses. *NII, Non-int inc* and *Non-int exp* are scaled by market value (*MV*) at the beginning of the year. *Loan loss prov* is the log of the sum of loan loss provisions scaled by market value plus one. *Tier1 ratio* is the Tier 1 leverage ratio. *ROA* is return on assets. *Growth* is total asset growth. *Size* is the log of total assets. *Term spread* is the difference between annualized three-year Treasury notes rate and Fed funds rate. *High fee income* is an indicator variable that equals one if non-interest income divided by the total of net interest income and non-interest income is greater than its median value by year, and zero otherwise. *Dif from immun α25* is winsorized at the 95% and 5% levels. All other variables are winsorized at the 98% and 2% levels.

Table 5 *(Continued)*

Panel C: *Pos Rate Var* as the Proxy for Interest Rate Risk Management

Ret = $\beta_0 + \beta_1 NII + \beta_2 Pos\ Rate\ Var + \beta_3 NII{*}Pos\ Rate\ Var + \beta_4 Non\text{-}int\ inc + \beta_5 Non\text{-}int\ exp + \beta_6 Loan\ loss\ prov + \beta_7 Tier1\ ratio + \beta_8 ROA + \beta_9 Growth + \beta_{10} Size + \varepsilon$

		IRR mgmt*: *Pos Rate Var					
	-	**1998 to 2010**		**1998 to 2006**		**2007 to 2010**	
		Coeff (p-value)	**Coeff (p-value)**	**Coeff (p-value)**	**Coeff (p-value)**	**Coeff (p-value)**	**Coeff (p-value)**
NII	+	1.165 ***	1.066 ***	1.023 ***	1.000 ***	1.050 *	1.011 *
		(0.000)	(0.000)	(0.000)	(0.000)	(0.059)	(0.067)
IRR mgmt	+	**0.032 ***		**0.026 *****		**0.047 ****	
		(0.077)		**(0.000)**		**(0.028)**	
NII* IRR mgmt	+	**0.043**	**0.111 *****	**0.040**	**0.126 *****	**0.026**	**0.038 ****
		(0.188)	**(0.000)**	**(0.202)**	**(0.000)**	**(0.316)**	**(0.025)**
Non-int inc	+	2.592 ***	2.584 ***	2.032 ***	2.051 ***	3.959 ***	3.928 ***
		(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Non-int exp	-	-0.786 ***	-0.772 ***	-1.050 ***	-1.045 ***	-0.624	-0.619
		(0.000)	(0.000)	(0.001)	(0.001)	(0.223)	(0.226)
Loan loss prov	-	-0.033 ***	-0.032 ***	-0.019 **	-0.019 **	-0.037 *	-0.035 *
		(0.000)	(0.000)	(0.028)	(0.030)	(0.090)	(0.081)
Tier1 ratio	?	0.020 ***	0.019 ***	0.010	0.010	0.039 **	0.039 **
		(0.001)	(0.002)	(0.161)	(0.170)	(0.027)	(0.028)
ROA	+	3.523 *	3.642 *	2.899 *	2.803 *	1.563	1.412
		(0.092)	(0.082)	(0.058)	(0.062)	(0.814)	(0.831)
Growth	+	0.090	0.092	-0.006	-0.006	0.199	0.213
		(0.247)	(0.239)	(0.940)	(0.942)	(0.499)	(0.467)
Size	?	-0.096 **	-0.095 **	-0.053	-0.052	-0.253	-0.266
		(0.010)	(0.011)	(0.209)	(0.221)	(0.326)	(0.300)
Firm, year		yes	yes	yes	yes	yes	yes
F-test of joint sig.		13.49 ***		6.74 ***		3.07 **	
N		2565	2565	1737	1737	828	828
Adj R^2		57.9%	58.4%	50.2%	49.5%	65.1%	65.0%

***, ** and * indicate statistical significance at the 0.01, 0.05 and 0.10 level or better, respectively (two-tailed).
Variable Definition: *Ret* is one-year buy and hold returns starting from three (two) months after the fiscal year end for years before 2007 (since 2007). *Pos Rate Var* equals one if rate variances are positive, zero otherwise. *NII* is net interest income. *Non-int inc* is non-interest income. *Non-int exp* is non-interest expenses. *NII, Non-int inc* and *Non-int exp* are scaled by market value (*MV*) at the beginning of the year. *Loan loss prov* is the log of the sum of loan loss provisions scaled by market value plus one. *Tier1 ratio* is the Tier 1 leverage ratio. *ROA* is return on assets. *Growth* is total asset growth. *Size* is the log of total assets. *Dif from immun α25* is winsorized at the 95% and 5% levels. All other variables are winsorized at the 98% and 2% levels. Please see Appendix C for variable construction.

Table 5 *(Continued)*

Panel D: *Dif from immun α25* as the Proxy for Interest Rate Risk Management

$Ret = \beta_0 + \beta_1 NII + \beta_2 Dif\ from\ immun\ \alpha25 + \beta_3 NII^{*} Dif\ from\ immun\ \alpha25 + \beta_4 Non\text{-}int\ inc + \beta_5 Non\text{-}int\ exp + \beta_6 Loan\ loss\ prov + \beta_7 Tier1\ ratio + \beta_8 ROA + \beta_9 Growth + \beta_{10} Size + \varepsilon$

		IRR mgmt*: *Dif from immun α25					
		1998 to 2010		**1998 to 2006**		**2007 to 2010**	
	-	**Coeff (p-value)**	**Coeff (p-value)**	**Coeff (p-value)**	**Coeff (p-value)**	**Coeff (p-value)**	**Coeff (p-value)**
NII	+	1.152 ***	1.143 ***	1.242 ***	1.235 ***	0.843 *	0.845 *
		(0.000)	(0.000)	(0.000)	(0.000)	(0.062)	(0.060)
IRR mgmt	+	**0.067 *****		**0.047**		**0.015 ***	
		(0.000)		**(0.429)**		**(0.094)**	
NII* IRR mgmt	+	**0.152**	**0.355 *****	**0.236 ****	**0.405 *****	**0.233**	**0.271**
		(0.236)	**(0.001)**	**(0.045)**	**(0.000)**	**(0.363)**	**(0.115)**
Non-int inc	+	2.340 ***	2.323 ***	1.770 ***	1.713 ***	4.097 ***	4.094 ***
		(0.000)	(0.000)	(0.001)	(0.001)	(0.000)	(0.000)
Non-int exp	-	-0.716 ***	-0.707 ***	-1.331 ***	-1.166 **	-0.396	-0.398
		(0.000)	(0.000)	(0.008)	(0.018)	(0.333)	(0.329)
Loan loss prov	-	-0.020 *	-0.019 *	-0.010 *	-0.008 *	-0.051 **	-0.051 **
		(0.078)	(0.091)	(0.078)	(0.084)	(0.031)	(0.046)
Tier1 ratio	?	0.019 ***	0.018 **	0.006	0.004	0.034	0.034
		(0.009)	(0.010)	(0.460)	(0.598)	(0.137)	(0.134)
ROA	+	3.491 **	3.566 **	0.801	2.026	0.222	0.205
		(0.030)	(0.027)	(0.805)	(0.523)	(0.956)	(0.959)
Growth	+	0.059	0.063	-0.047	-0.041	0.056	0.059
		(0.498)	(0.471)	(0.598)	(0.642)	(0.880)	(0.873)
Size	?	-0.051	-0.051	-0.005	-0.001	-0.250	-0.252
		(0.206)	(0.209)	(0.918)	(0.980)	(0.459)	(0.454)
Firm, year		yes	yes	yes	yes	yes	yes
F-test of joint sig.		8.24 ***		5.87 ***		0.47	
N		2565	2565	1737	1737	828	828
Adj R^2		61.1%	61.3%	52.5%	52.2%	68.0%	68.0%

***, ** and * indicate statistical significance at the 0.01, 0.05 and 0.10 level or better, respectively (two-tailed).
Variable Definition: *Ret* is one-year buy and hold returns starting from three (two) months after the fiscal year end for years before 2007 (since 2007). *Dif from immun α25* is the differences between *α* and *immunization α*. *NII* is net interest income. *Non-int inc* is non-interest income. *Non-int exp* is non-interest expenses. *NII, Non-int inc* and *Non-int exp* are scaled by market value (*MV*) at the beginning of the year. *Loan loss prov* is the log of the sum of loan loss provisions scaled by market value plus one. *Tier1 ratio* is the Tier 1 leverage ratio. *ROA* is return on assets. *Growth* is total asset growth. *Size* is the log of total assets. *Dif from immun α25* is winsorized at the 95% and 5% levels. All other variables are winsorized at the 98% and 2% levels. Please see Appendix C for variable construction.

Table 6: Moderating Factors and Net Interest Income-Returns Association

Panel A: Moderating Effect of Term Spread

$$Ret = \beta_0 + \beta_1\,NII + \beta_2\,IRR\ mgmt + \beta_3\,NII{*}IRR\ mgmt + \beta_4\,IRR\ mgmt{*}Term\ Spread + \beta_5\,NII{*}Term\ Spread + \beta_6\,NII{*}IRR\ mgmt{*}Term\ Spread + \beta_7\,Non\text{-}int\ inc + \beta_8\,Non\text{-}int\ exp + \beta_9\,Loan\ loss\ prov + \beta_{10}\,Tier1\ ratio + \beta_{11}\,ROA + \beta_{12}\,Growth + \beta_{13}\,Size + \varepsilon$$

		***IRR mgmt*: Pos Rate Var**			***IRR mgmt*: Dif from immun α25**		
		(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
		1998- 2010	**1998-2006**	**2007-2010**	**1998- 2010**	**1998-2006**	**2007-2010**
		Coeff (p-value)	**Coeff (p-value)**	**Coeff (p-value)**	**Coeff (p-value)**	**Coeff (p-value)**	**Coeff (p-value)**
NII	+	0.972 ***	1.428 ***	1.731 **	0.952 ***	1.583 ***	1.528 **
		(0.000)	(0.000)	(0.021)	(0.000)	(0.000)	(0.013)
IRR mgmt	+	0.036	0.008	0.056	0.067	0.037	0.126
		(0.423)	(0.161)	(0.706)	(0.414)	(0.258)	(0.233)
NII*IRR mgmt	+	0.075	0.121 **	-0.238	0.048 *	0.178 **	-0.549
		(0.165)	(0.048)	(0.702)	(0.079)	(0.050)	(0.157)
IRR mgmt	?	0.049	0.060	0.033	0.235	0.431	-0.436
****Term Spread***		(0.294)	(0.283)	(0.808)	(0.028)	(0.000)	(0.206)
NII* Term Spread	?	0.264 **	0.487 **	-0.528	0.053	0.083 **	-0.013
		(0.030)	(0.010)	(0.212)	(0.552)	(0.070)	(0.907)
NII*IRR mgmt	**-**	**-0.129**	**-0.161 ***	**0.072**	**0.052**	**-0.371 ***	**0.128**
****Term Spread***		**(0.432)**	**(0.058)**	**(0.588)**	**(0.374)**	**(0.066)**	**(0.595)**
Non-int inc	+	2.600 ***	1.985 ***	3.903 ***	2.350 ***	1.651 ***	3.904 ***
		(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Non-int exp	-	-0.857 ***	-1.068 ***	-0.495	-0.763 ***	-1.070 ***	-0.406
		(0.000)	(0.001)	(0.343)	(0.000)	(0.006)	(0.234)
Loan loss prov	-	-0.031 ***	-0.020 ***	-0.040 *	-0.019 *	-0.015 **	-0.045 *
		(0.000)	(0.026)	(0.056)	(0.094)	(0.025)	(0.070)
Tier1 ratio	?	0.020 ***	0.011	0.037 **	0.019 ***	0.008	0.039 **
		(0.001)	(0.107)	(0.043)	(0.007)	(0.239)	(0.028)
ROA	+	2.703	2.396 *	0.381	3.012 *	3.893	0.925
		(0.201)	(0.088)	(0.955)	(0.064)	(0.150)	(0.775)
Growth	+	0.117	0.005	0.198	0.077	0.055	0.118
		(0.138)	(0.946)	(0.506)	(0.376)	(0.482)	(0.674)
Size	?	-0.102 ***	-0.057	-0.300	-0.062	-0.039	-0.188
		(0.006)	(0.178)	(0.257)	(0.127)	(0.338)	(0.476)
Firm, year		yes	yes	yes	yes	yes	yes
F-test of joint sig.		0.01	4.12 **	0.01	1.01	8.16 ***	0.08
N		2565	1737	828	2565	1737	828
Adj R^2		59.5%	51.9%	66.1%	63.6%	55.8%	69.4%

***, ** and * indicate statistical significance at the 0.01, 0.05 and 0.10 level or better, respectively (two-tailed).

Table 6 *(Continued)*

Panel B: Moderating Effect of Fee Income

$Ret = \beta_0 + \beta_1 NII + \beta_2 IRR\ mgmt + \beta_3 High\ fee\ income + \beta_4 NII{*}\ IRR\ mgmt + \beta_5 IRR\ mgmt{*}\ High\ fee\ income + \beta_6 NII{*}\ High\ fee\ income + \beta_7 NII * High\ fee\ income * IRR\ mgmt + \beta_8 Non\text{-}int\ inc + \beta_9 Non\text{-}int\ exp + \beta_{10} Loan\ loss\ prov + \beta_{11} Tier1\ ratio + \beta_{12} ROA + \beta_{13} Growth + \beta_{14} Size + \varepsilon$

		IRR mgmt = Pos Rate Var			***IRR mgmt = Dif from immun α25***		
		(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
		1998- 2010	**1998-2006**	**2007-2010**	**1998- 2010**	**1998-2006**	**2007-2010**
		Coeff (p-value)	**Coeff (p-value)**	**Coeff (p-value)**	**Coeff (p-value)**	**Coeff (p-value)**	**Coeff (p-value)**
NII	+	1.228 ***	1.713 ***	0.980 **	1.142 ***	1.824 ***	0.944 **
		(0.000)	(0.000)	(0.011)	(0.000)	(0.000)	(0.013)
IRR mgmt	+	0.074 *	0.033	0.075	0.033	0.009	0.136 *
		(0.075)	(0.104)	(0.551)	(0.303)	(0.137)	(0.087)
High fee income	**?**	-0.024	-0.031	0.133	-0.029	-0.036	0.054
		(0.549)	(0.467)	(0.323)	(0.494)	(0.373)	(0.657)
NII*IRR mgmt	+	0.029	0.017 *	-0.116	0.317	0.023 *	-0.495
		(0.223)	(0.059)	(0.712)	(0.263)	(0.090)	(0.435)
IRR mgmt*High	**?**	-0.006	-0.026	-0.057	0.068	0.016	-0.097
fee income		(0.916)	(0.680)	(0.716)	(0.546)	(0.796)	(0.378)
NII* High	**?**	0.176	0.045	-0.119	0.097	0.031	0.063
fee income		(0.225)	(0.785)	(0.781)	(0.499)	(0.842)	(0.858)
NII* High fee inc	-	**-0.068**	**-0.058**	**-0.058**	**-0.357**	**-0.111**	**-0.178**
****IRR mgmt***		**(0.385)**	**(0.179)**	**(0.494)**	**(0.235)**	**(0.118)**	**(0.682)**
Non-int inc	+	2.242 ***	1.905 ***	3.757 ***	2.302 ***	1.925 ***	3.794 ***
		(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Non-int exp	-	-0.788 ***	-1.138 ***	-0.484	-0.723 ***	-1.210 ***	-0.467
		(0.000)	(0.004)	(0.160)	(0.000)	(0.002)	(0.171)
Loan loss prov	-	-0.026 ***	-0.017 *	-0.037 *	-0.020 **	-0.016	-0.046 *
		(0.007)	(0.073)	(0.070)	(0.074)	(0.102)	(0.060)
Tier1 ratio	?	0.019 ***	0.008	0.039 **	0.019 ***	0.009	0.042 **
		(0.002)	(0.291)	(0.031)	(0.008)	(0.241)	(0.018)
ROA	+	2.909 **	1.992	0.521	3.493	2.481	0.932
		(0.040)	(0.468)	(0.873)	(0.031)	(0.362)	(0.771)
Growth	+	0.145 *	0.052	0.190	0.067	0.048	0.136
		(0.059)	(0.522)	(0.499)	(0.453)	(0.551)	(0.627)
Size	?	-0.080 **	-0.043	-0.270	-0.050	-0.041	-0.189
		(0.028)	(0.307)	(0.308)	(0.222)	(0.333)	(0.480)
Firm, year		yes	yes	yes	yes	yes	yes
F-test of joint sig		0.06	4.06 **	0.01	0.08	3.88 **	0.23
N		2565	1737	828	2565	1737	828
Adj R^2		58.6%	51.4%	65.8%	64.3%	56.6%	69.1%

***, ** and * indicate statistical significance at the 0.01, 0.05 and 0.10 level or better, respectively (two-tailed).

Table 6 *(Continued)*

Variable Definition: *Ret* is one-year buy and hold returns starting from three (two) months after the fiscal year end for years before 2007 (since 2007). *Pos Rate Var* equals one if rate variances are positive, zero otherwise. *Dif from immun α25* is the differences between *α* and *immunization α. NII* is net interest income. *Non-int inc* is non-interest income. *Non-int exp* is non-interest expenses. *NII, Non-int inc* and *Non-int exp* are scaled by market value (*MV*) at the beginning of the year. *Loan loss prov* is the log of the sum of loan loss provisions scaled by market value plus one. *Tier1 ratio* is the Tier 1 leverage ratio. *ROA* is return on assets. *Growth* is total asset growth. *Size* is the log of total assets. *Term spread* is the difference between annualized three-year Treasury notes rate and Fed funds rate. *High fee income* is an indicator variable that equals one if non-interest income divided by the total of net interest income and non-interest income is greater than its median value by year, and zero otherwise. *Dif from immun α25* is winsorized at the 95% and 5% levels. All other variables are winsorized at the 98% and 2% levels. Please see Appendix C for variable construction.

Figure 1: Bank Holding Companies' *α* (from FR Y-9C) versus Market *α*

Figure 1A: Median values of Δi_{RSL} and Δi_{RSA} (from FR Y-9C) for all BHCs

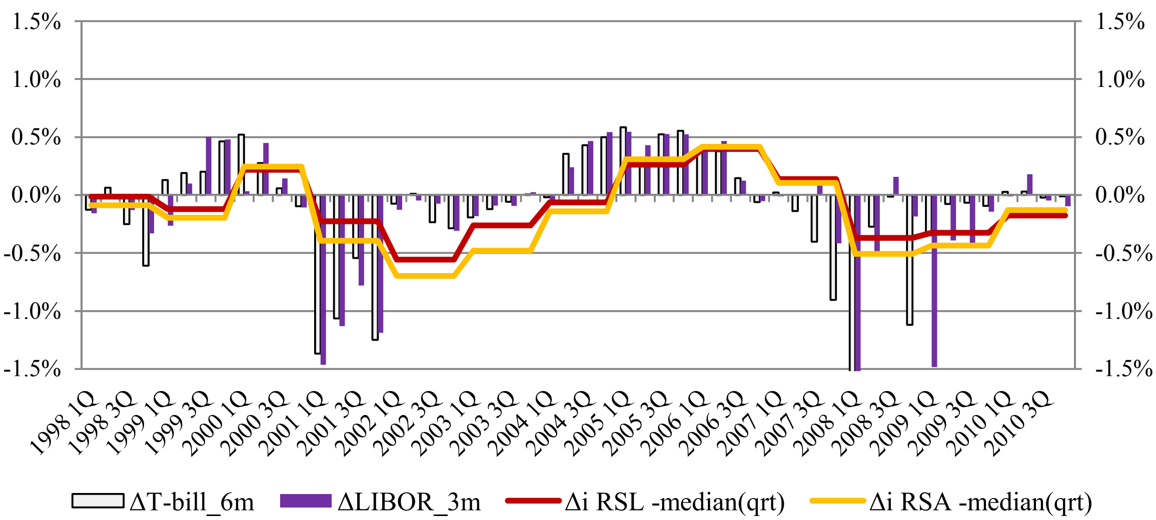

Figure 1A plots median values of the average quarterly changes in rates of rate sensitive assets and rate sensitive liabilities (i.e., Δi_{RSA}*_FR* and Δi_{RSL}*_FR25* divided by four).

Figure 1B: Median values of *α_FR25* (from FR Y-9C) versus Market *α* for all BHCs

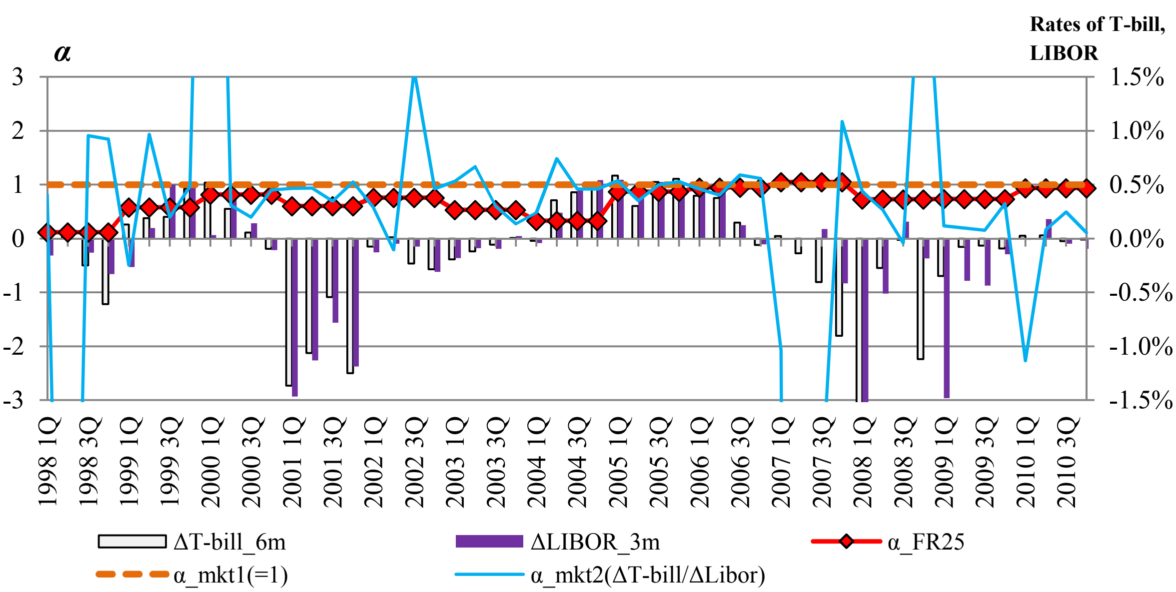

Figure 1B presents the median values of *α_FR25* and market *α*. *α_FR25* is the ratio of Δi_{RSL}*_FR25* to Δi_{RSA}*_FR*. *α_mkt1* equals to one, *α_mkt2* is the ratio of quarterly changes in 6-month T-bill rates (ΔT-bill_6m) to 3-month LIBOR rates (ΔLIBOR_3m).

Figure 2: Assessing Bank Holding Companies' Interest Rate Risk Management

Figure 2A: Percentages of BHCs with Rate Variances >0

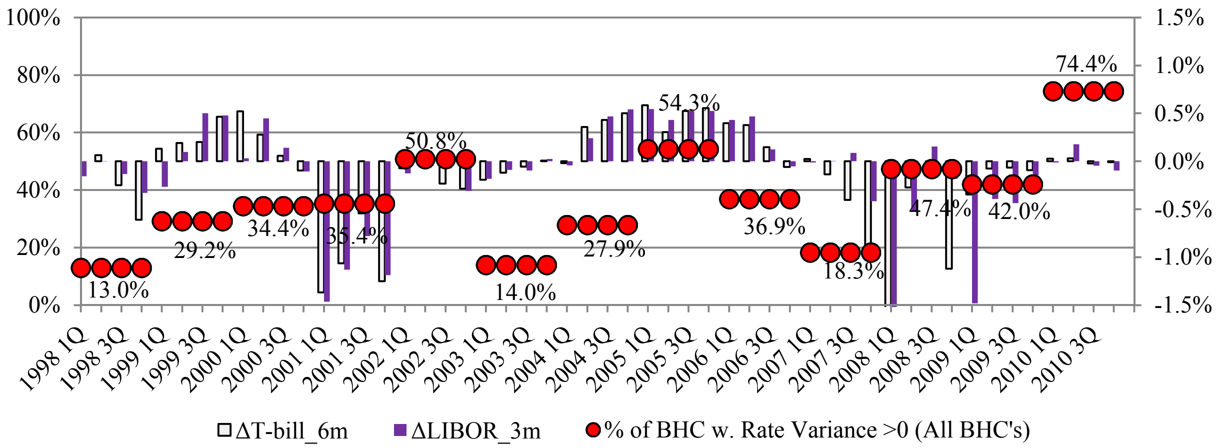

Figure 2A presents the percentages of BHCs achieving positive rate variances by year. The left axis measures the percentage of BHCs with positive rate variances, and the right axis measures the interest rates.

Figure 2B: Percentages of Years in which BHCs have Rate Variances >0

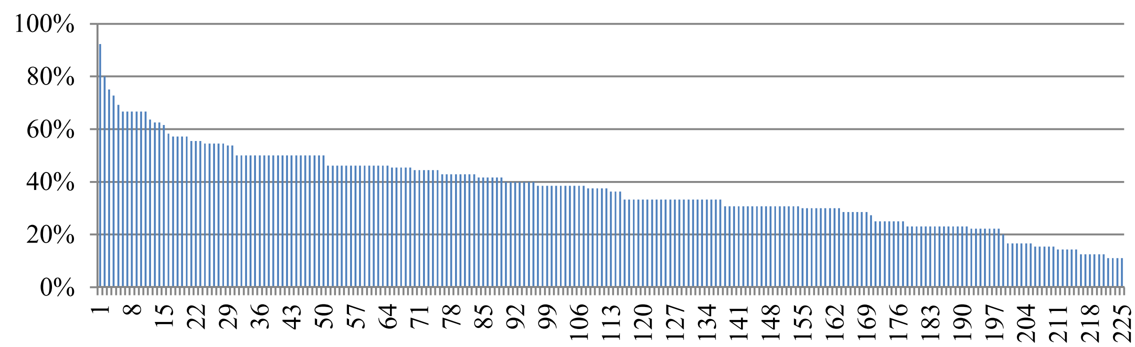

Figure 2B presents the percentages of years in which BHCs have positive rate variances. I require BHCs to have at least 6 years of data (n=225)

Figure 2C: Median Values of *Differences from immunization α_FR25* by Year

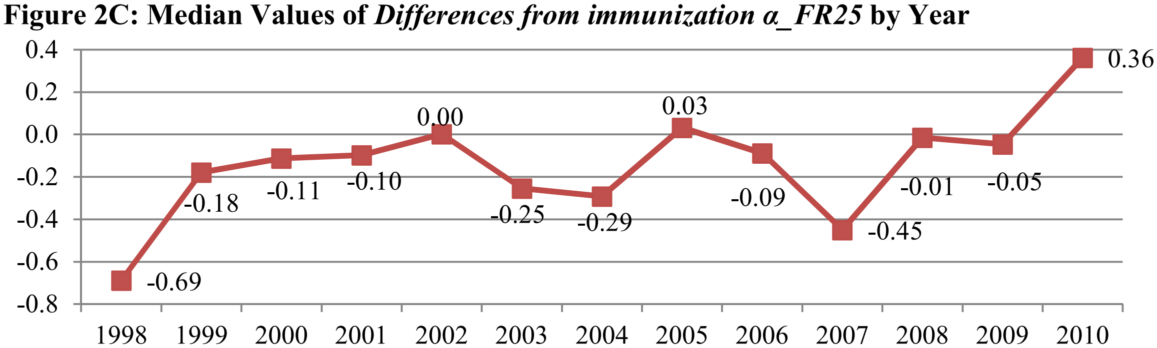

Figure 2C presents the median values of *Differences from immunization α_FR25* for the full sample.

CHAPTER SIX:

CONCLUSION

In concluding this dissertation, I summarize findings and highlight contributions in my three main chapters, and point out venues for future research.

1. Findings and Contributions

1.1 Bank Holding Companies' Interest Rate Risk Disclosure

1.1.1 Findings

The current interest rate risk disclosure is mandated under the SEC's FRR 48, which provides considerable discretion to managers in choosing what interest rate risk information to disclose. I document that disclosures presented in BHCs' annual reports vary cross-sectionally and change over time during 1997 to 2009. For example, the most frequently chosen disclosure in 1997 was gap analysis only without any simulations, accounting for 59.4% of BHCs. This percentage dropped to 8.1% in 2009. In contrast, the most frequently chosen disclosure in 2009 was to disclose only net interest income simulation, accounting for 26.6% of all BHCs, increasing sharply from 3.8% in 1997.

I rank interest rate risk disclosures into different orders using three criteria: number of interest rate risk measures disclosed, technique sophistication and the earnings orientation of managers and investors. I consider interest rate risk disclosure as a function of the use of interest rate risk measurement techniques and the incentives to disclose them. I hypothesize and find that interest rate risk disclosures are related to nontraditional banking activities, time deposit funding source, derivative usage and institutional investor ownership; the associations are different for large and small BHCs. For example, for the largest size quartile of BHCs, I find a positive relation between the level of nontraditional banking activities and interest rate risk disclosure, suggesting large BHCs' incentives to signal their operational sophistication. I find a positive association between the level of time deposit funding and interest rate risk disclosure, suggesting that large BHCs with a higher level of time deposit funding have more interest rate risk exposure and are thus more likely to disclose interest rate risk. There is a negative association between derivative usage and interest rate risk disclosure, suggesting that large BHCs regard derivatives as a means to reduce interest rate risk exposure. Additionally, higher institutional ownership is positively associated with interest rate risk disclosures.

In investigating whether interest rate risk disclosures are useful to investors, I apply two approaches that are different from the prior literature. I document the information content of interest rate risk simulation disclosure, indicated by increased short-term abnormal trading volumes for BHCs disclosing interest rate simulation measures for the first time. Additionally, using detailed disclosure data for the 50 largest BHCs in my sample during 2003 through 2005, I find higher two-day cumulative abnormal returns around the filing dates for BHCs whose interest rate risk simulation disclosures project improved profitability or enhanced equity value. Overall, the analyses suggest that the disclosures of interest rate risk provide incremental information to investors.

1.1.2 Contributions

This study makes several contributions. First, since the financial crisis, there is a renewed interest in enhancing disclosures of credit risk, interest rate risk and liquidity risk (FASB 2010, 2012). In June 2012, the FASB proposed the Accounting Standards Update to Financial Instruments (Topic 825), which would require a financial institution to disclose gap analysis with off-balance-sheet items and NII and EVE sensitivities in every interim and annual reporting period (FASB, 2012). This paper shows that NII and EVE simulation disclosures provide incremental information to investors. Thus, the Financial Accounting Standard Board (FASB) proposed Update has the potential to increase the information usefulness of interest rate risk disclosures by making interest rate risk disclosures more consistent and comparable than under FRR 48 (FASB, 2012).

Second, this study enriches the literature on the SEC's FRR 48 disclosures. Prior research on FRR 48 (e.g., Hodder, 2001; Linsmeier et al. 2002; Liu, Ryan and Tan, 2004) focuses on decision usefulness and the economic consequences of market risk disclosures. The sample periods in those papers are a few years before or after 1997 (as 1997 is the year when FRR 48 was adopted), and the sample periods usually end in the early 2000s. Different from prior papers, my study investigates institutions' operational characteristics and management incentives underlying the observed interest rate risk disclosures. Furthermore, I document the trends in interest rate risk disclosure choices and explore the determinants of disclosure over a longer time period from 1997 through 2009, during which the regulatory and interest rate environments have changed significantly since prior research was conducted.

Third, my research should be of interest to banking regulators. Banking regulators have emphasized measuring interest rate risk using simulation techniques, especially EVE simulation from the economic perspective. While this study documents the increased use of simulations over time, this study also finds that the use of EVE simulation remains below 50% among BHCs. Furthermore, my research examines the factors affecting interest rate risk disclosures. Banking regulators' understanding of the link between banks' operational characteristics and the usage and disclosure of recommended interest rate risk measurement techniques will help inform future decisions about the application of effective banking regulation. This understanding will also allow for a more tailored examination of banks' interest rate risk management.

1.2 An Empirical Examination of Interest Rate Risk Management

1.2.1 Findings

In this study, I investigate to what extent BHCs are able to increase net interest income through managing interest rate risk, and how interest rate risk management affects the valuation of net interest income. I first establish an α-gap model, which is based on α – the ratio of changes in rates of rate sensitive liabilities to changes in rates of rate sensitive assets. The α-gap model decomposes changes in net interest income into rate variances and volume variances. I posit that greater rate variances indicate more effective interest rate risk management from the earnings perspective, *ceteris paribus*. I demonstrate that the α-gap model is superior to traditional maturity gap analysis in explaining changes in earnings. Using a sample of BHCs from 1998 to 2010, I find that, on average, BHCs are not able to effectively manage interest rate risk. BHCs tend to increase net interest income by changing the size and composition of the balance sheet, rather than by managing interest rate risk. In addition, I find that interest rate risk management positively affects the valuation of net interest income, and the impact is stronger during 1996 to 2006 than during 2007 to 2010.

1.2.2 Contributions

Although a large body of literature studies interest rate risk exposure and interest rate risk management, my study differs from the existing literature in several ways and makes several contributions. First, the α-gap model and its related measures in assessing interest rate risk management are more useful than existing models to investors, regulators and bank management. I empirically demonstrate that the α-gap model is not only superior to the conventional maturity gap model, but also that the measures based on the α-gap model have the ability to capture the process and outcome of interest rate risk management. My study can lead investors to an improved understanding of financial institutions whose disclosures are often considered complex and lacking transparency (e.g., Levine, 2004). My study will allow banking regulators' to more accurately examine banks' interest rate risk, as well as earnings and management quality. Bank management can also employ the α-gap model to measure and manage interest rate risk.

Second, this paper can help guide the Financial Accounting Standard Board's (FASB, hereafter) efforts to enhance interest rate risk disclosures. Since the financial crisis, there is a renewed interest in enhancing disclosures of credit risk, interest rate risk and liquidity risk (FASB 2010, 2012). In June 2012, the FASB proposed the Accounting Standards Update to Financial Instruments (Topic 825), which would require a financial institution to disclose the maturity gap, contractual yield and duration for each class of financial instrument (FASB, 2012). My study shows that α and α-gap, as well as rate and volume analysis, should be considered as part of interest rate risk disclosures in order to shed light on the process and outcome of interest rate risk management.[69]

Third, in estimating rate sensitive liabilities using FR Y-9C (i.e., the regulatory Consolidated Financial Statements for BHCs), there is a lack of consensus as to what proportion of non-maturity deposits to include in rate sensitive liabilities. My study sheds light on this issue by comparing the dollar amount of rate sensitive assets and liabilities obtained from maturity gap analysis in 10-K filings and those estimated from FR Y-9C. On average, I find that rate sensitive liabilities obtained from maturity gap analysis in 10-K filings are equivalent to including 25% of non-maturity deposits plus other rate sensitive liabilities using data from FR Y-9C.

Fourth, this study enriches the literature examining risk management and interest rate risk. Banks' interest rate risk management differs from non-financial firms' risk management in

[69] Additionally, I suggest disclosing how interest rate derivatives usage affects rate variances and volume variances.

that banks manage interest rate risk not only to hedge risk but also to profit from interest rate risk exposure. By documenting the association of banks' interest rate risk management and the valuation of net interest income, I contribute to the literature that relates risk management to firm value. Furthermore, while the literature on interest rate risk is concentrated in the period of the 1980s and 1990s in the wake of the savings and loan crisis, my study provides new evidence of interest rate risk management during 1998 to 2010, during which the economic, regulatory and interest rate environment changed significantly since most prior research was conducted.

1.2.3 Suggested Interest Rate Risk Disclosures

In Table 1, I provide a combined table of rate and volume analysis and α-GAP analysis to illustrate how to improve interest rate risk disclosures. First, based on the α-GAP model developed in this dissertation, the suggested disclosure is in a tabular format which combines rate and volume analysis in Column (2) through (8), and α-GAP analysis in Column (9) through (13).

Second, to overcome the shortcoming that the effect of derivatives on interest rate risk is disclosed separately in the notes under hedge accounting rules, the suggested disclosure in Table 1 consists of three sections: interest rate risk disclosures before considering derivatives, the effect of derivatives on interest rate risk, and interest rate risk disclosures after considering derivatives. Admittedly, the measurement of the effect of derivatives on interest rate risk hinges on the hedge accounting rules that are currently under the FASB's consideration.

The intended purpose of this suggested tabular disclosure is to provide useful information to users with respect to interest rate risk and management's ability to manage interest rate risk in generating net interest income. I believe that disclosing a condensed table of rate and volume analysis over the past five years will enable users to understand the manner in which bank management generates net interest income – through changing the size and composition of the balance sheet, or through managing interest rates. Furthermore, disclosing α and α-GAP in conjunction with rate and volume analysis provides additional insights into interest rate risk management. Equally important, the suggested tabular disclosure could help users to assess the amount, timing and uncertainty of cash flows from net internet income, as the findings in this dissertation suggest that interest rate risk management is positively associated with the persistence of net interest income.

2. Future Research

This dissertation points to several directions for future research. First, this dissertation explores interest rate risk disclosure and interest rate risk management separately. Future studies could examine the relation between interest rate risk disclosure and interest rate risk management. It is possible that a bank that provides higher quality interest rate risk disclosure may have a superior risk management system and accounting information system that enables banks to more effectively manage interest rate risk. Understanding the association between interest rate risk disclosure and interest rate risk management would help investors to more efficiently allocate their resources and better monitor bank managers.

Second, on average, during 2007 and 2010 BHCs were not able to manage interest rate risk as related to earnings and took excess duration risk to generate earnings. This finding opens up the question regarding the characteristics of those BHCs that are able to effectively manage interest rate risk as related to earnings within the constraints of duration risk. Identifying these characteristics would provide insights to investors, banking regulators and bank managers in understanding and enhancing interest rate risk management.

Third, in this dissertation, due to data limitation, I am not able to distinguish the effect of interest rate risk management from natural hedging and derivative usage. Future research could explore new ways to separate these two strategies and examine how each strategy affects interest rate risk management from the earnings perspective and the economic perspective

Table 1:

Illustrative Combined Table of Rate and Volume Analysis and α-GAP Analysis (as of December 31, 2012)

Before Considering Derivatives

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
year	Change in NII	Total volume variance	Volume variance of Δinterest income	Volume variance of Δinterest expenses	Total rate variance	Rate variance of Δinterest income	Rate variance of Δinterest expenses	Rate sensitive assets (RSA)	Δr_{RSA}	Rate sensitive liabilities (RSL)	Δr_{RSL}	$\alpha = \Delta r_{RSL} / \Delta r_{RSA}$
2008	$X,XXX	$X,XXX	$X,XXX	$X,XXX	$X,XXX	$X,XXX	$X,XXX	$X,XXX	X.XX%	$X,XXX	X.XX%	X.XX
2009	X,XXX	X,XXX	X,XXX	X,XXX	X,XXX	X,XXX	X,XXX	X,XXX	X.XX%	X,XXX	X.XX%	X.XX
2010	X,XXX	X,XXX	X,XXX	X,XXX	X,XXX	X,XXX	X,XXX	X,XXX	X.XX%	X,XXX	X.XX%	X.XX
2011	X,XXX	X,XXX	X,XXX	X,XXX	X,XXX	X,XXX	X,XXX	X,XXX	X.XX%	X,XXX	X.XX%	X.XX
2012	X,XXX	X,XXX	X,XXX	X,XXX	X,XXX	X,XXX	X,XXX	X,XXX	X.XX%	X,XXX	X.XX%	X.XX

Effects of Derivatives

	Effects of Derivatives								
year	Change in NII	Total volume variance	Volume variance of Δinterest income	Volume variance of Δinterest expenses	Total rate variance	Rate variance of Δinterest income	Rate variance of Δinterest expenses	Rate sensitive assets (RSA)	Rate sensitive liabilities (RSL)
2008	X,XXX	X,XXX	X,XXX	X,XXX	X,XXX	X,XXX	X,XXX	X,XXX	X,XXX
2009	X,XXX	X,XXX	X,XXX	X,XXX	X,XXX	X,XXX	X,XXX	X,XXX	X,XXX
2010	X,XXX	X,XXX	X,XXX	X,XXX	X,XXX	X,XXX	X,XXX	X,XXX	X,XXX
2011	X,XXX	X,XXX	X,XXX	X,XXX	X,XXX	X,XXX	X,XXX	X,XXX	X,XXX
2012	X,XXX	X,XXX	X,XXX	X,XXX	X,XXX	X,XXX	X,XXX	X,XXX	X,XXX

Table 1 *(Continued):*

After Considering Derivatives

year	Change in NII	Total volume variance	Volume variance of Δinterest income	Volume variance of Δinterest expenses	Total rate variance	Rate variance of Δinterest income	Rate variance of Δinterest expenses	Rate sensitive assets (RSA)	Δr_{RSA}	Rate sensitive liabilities (RSL)	Δr_{RSL}	$\alpha = \Delta r_{RSL} / \Delta r_{RSA}$
2008	X,XXX	X,XXX	X,XXX	X,XXX	X,XXX	X,XXX	X,XXX	X,XXX	X.XX%	X,XXX	X.XX%	X.XX
2009	X,XXX	X,XXX	X,XXX	X,XXX	X,XXX	X,XXX	X,XXX	X,XXX	X.XX%	X,XXX	X.XX%	X.XX
2010	X,XXX	X,XXX	X,XXX	X,XXX	X,XXX	X,XXX	X,XXX	X,XXX	X.XX%	X,XXX	X.XX%	X.XX
2011	X,XXX	X,XXX	X,XXX	X,XXX	X,XXX	X,XXX	X,XXX	X,XXX	X.XX%	X,XXX	X.XX%	X.XX
2012	X,XXX	X,XXX	X,XXX	X,XXX	X,XXX	X,XXX	X,XXX	X,XXX	X.XX%	X,XXX	X.XX%	X.XX

Note:
Change in NII = Total volume variances – Total rate variances
Total volume variances = Volume variances of changes in interest income – Volume variances of changes in interest expenses
Total rate variances = Rate variances of changes in interest income – Rate variances of changes in interest expenses
Δr_{RSA}= Rate variances of changes in interest income / RSA
Δr_{RSL}= Rate variances of changes in interest expenses / RSL
$\alpha = \Delta r_{RSL} / \Delta r_{RSA}$

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